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NATIONAL DAM SAFETY PROGRAM. MARTINDALE DAM (NDI NUMBER PA-0044--ETC(U)
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TROUT RUN, CAMBRIA COUNTY
PENNSYLVANIA

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MARTINDALE DAM

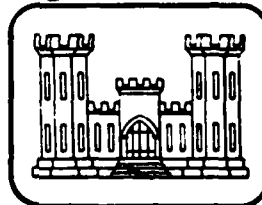
NDI No. PA 00444
PennDER No. 11-17

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PHASE I INSPECTION REPORT NATIONAL DAM INSPECTION PROGRAM

DACW31-80-C-0025✓



prepared for

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

prepared by

MICHAEL BAKER, JR., INC.

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OHIO RIVER BASIN

MARTINDALE DAM
CAMBRIA COUNTY, COMMONWEALTH OF PENNSYLVANIA
NDI No. PA 00444
PennDER No. 11-17

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(6) ~~PHASE I INSPECTION REPORT~~
~~NATIONAL DAM SAFETY PROGRAM~~ *Martindale*
Dam (NDI Number PA-00444, PennDER Number
11-17) in Ohio River Basin, Cambria
County, Pennsylvania. Phase I Inspection
Report.

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

(1)

(15) DACW 32-20-2-001.5

Prepared by: MICHAEL BAKER, JR., INC.
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4301 Dutch Ridge Road
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440775-004

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.

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Martindale Dam, Cambria County, Pennsylvania
NDI No. PA 00444, PennDER No. 11-17
Trout Run
Inspected 24 June 1980

ASSESSMENT OF
GENERAL CONDITIONS

✓
Martindale Dam, owned and operated by the Borough of Portage Water Authority, is classified as a "Small" size - "High" hazard dam. The dam was found to be in fair overall condition at the time of inspection.

Hydraulic/hydrologic evaluations, performed in accordance with procedures established by the Baltimore District, Corps of Engineers, for Phase I Inspection Reports, revealed that the dam, reservoir, and spillway will pass 16 percent of the Probable Maximum Flood (PMF) before overtopping of the dam occurs. A spillway design flood (SDF) in the range of the 1/2 Probable Maximum Flood (1/2 PMF) to the PMF is required for Martindale Dam. The 1/2 PMF was chosen as the SDF because the dam is on the low end of the "Small" size category in terms of its storage and height.

During the 1/2 PMF, the maximum depth and total duration of overtopping are 0.83 feet and 8.5 hours, respectively. Due to the relatively narrow crest width of the dam and the long duration of overtopping, it was judged that failure of the dam is likely during the 1/2 PMF. To assess the increase in damages downstream from the non-failure to failure cases, the 1/2 PMF was routed through the dam and downstream for both conditions. It was determined that there would be a significant increase in economic damages and possible loss of life if the dam failed. The spillway is therefore categorized as being "seriously inadequate."

The owner of the dam should immediately initiate an engineering study to further evaluate the spillway capacity and to develop recommendations for remedial measures to reduce the overtopping potential of the dam.

In summary, Martindale Dam is classified as being in an "Unsafe" - "Non-Emergency" condition on the basis of the results of the hydrologic/hydraulic evaluation.

The inspection and review of information revealed certain items of work which should be performed immediately by the owner. Items 1 and 2 below should be designed and completed

MARTINDALE DAM

under the guidance of a qualified professional engineer experienced in the design of earth dams and appurtenant structures. These items include:

- 1) The owner should immediately initiate an engineering study to further evaluate the spillway capacity in order to develop recommendations for remedial measures to reduce the overtopping potential of the dam.
- 2) Provide upstream closure for the intakes of the water supply line and blow-off pipe.
- 3) Repair the separated joint in the concrete extension to the blow-off pipe.
- 4) Repair the cracks in the spillway training walls.
- 5) Clean and seal the joints between the weir and the spillway training walls.
- 6) Remove the trees and brush growing in the downstream end of the spillway discharge channel.
- 7) Repair the cracks in the bottom slabs of the spillway discharge channel.
- 8) Repair the eroded areas along the upstream face of the embankment.
- 9) Fill the low areas along the crest of the dam.
- 10) Repair the animal burrows in the embankment.

In addition, the following operational measures are recommended to be undertaken by the owner:

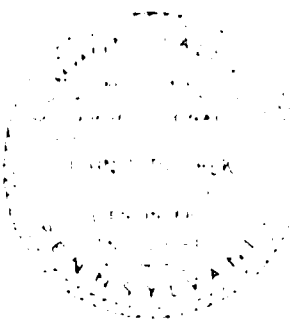
- 1) Develop a detailed emergency operation and warning system.
- 2) During periods of unusually heavy rainfall, provide around-the-clock surveillance of the dam.
- 3) When warning of a storm of major proportion is given by the National Weather Service, the owner should activate the emergency operation and warning systems.

It is further recommended that formal inspection, maintenance, and operational procedures and records be developed and implemented. The wet areas noted in this inspection report should be examined in all future inspections and the condition recorded.

MARTINDALE DAM

Submitted by:

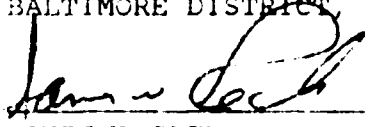
MICHAEL BAKER, JR., INC.


John A. Dziubek, P.E.
Engineering Manager-Geotechnical

Date: 26 August, 1980

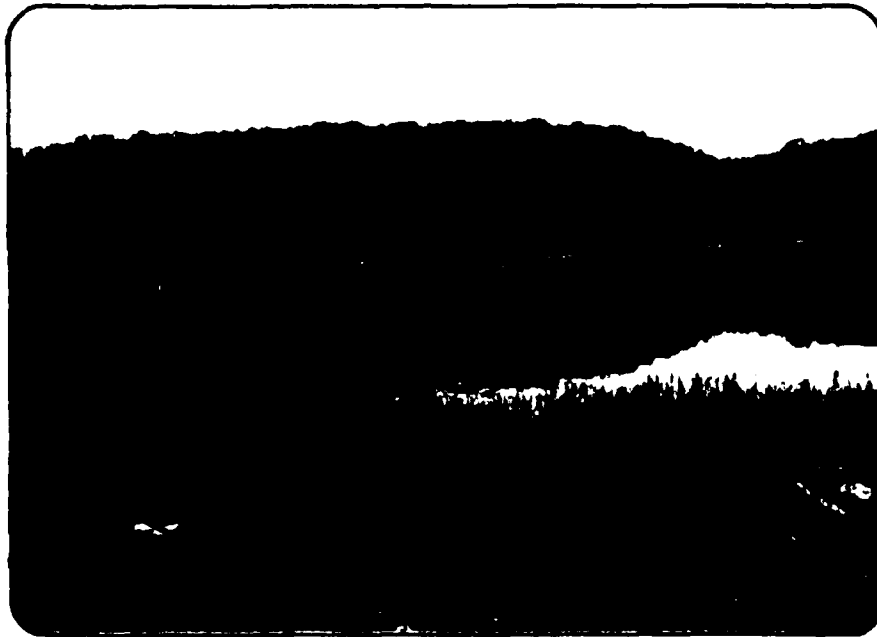
Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS


JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 12 Sep 80

MARTINDALE DAM



Overall View of Upstream Face of Dam from Left Abutment



Overall View of Upstream Face of Dam from Right Abutment

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
MARTINDALE DAM
NDI No. PA 00444, PennDER No. 11-17

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 of Inspection - 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. Description of Dam and Appurtenances - Martindale Dam is a diaphragm, earthfill dam with a height of 17 feet and a total length of 860 feet. The embankment has a crest width of 5 feet. The side slopes of the upstream and downstream faces of the embankment are 1.5H:1V (Horizontal to Vertical) and slightly flatter than 1.5H:1V, respectively. The entire upstream face of the embankment is protected by 15 inch thick, hand-placed riprap. A concrete cut-off wall extends the full length of the embankment and is socketed a maximum of 9 feet in the foundation materials. This core wall extends up to Elevation 2302.5 feet Mean Sea Level (M.S.L.). The reservoir is used as a water supply source for Portage Township.

The spillway, located 180 feet from the right abutment, consists of a concrete, broad-crested weir and a masonry and concrete discharge channel. The crest of the weir is 37 feet long (perpendicular to the direction of flow). The breadth of the weir (parallel to the direction of flow) is 1.0 feet. The weir is currently 2 feet high.

The discharge chute extends approximately 75 feet downstream from the crest of the weir. The bottom of the chute channel consists of 9 inch thick concrete slabs. The sides of the channel are 3 foot high, 12 inch thick masonry walls finished with concrete. The chute is 37 feet wide at the

crest of the weir and begins to gradually taper to a 20 foot width 13 feet downstream from the crest of the weir. There are eleven concrete impact blocks at the downstream end of the chute which act as energy dissipators.

The outlet works for the dam consist of a 10 inch cast-iron water supply line and a 20 inch cast-iron blow-off pipe. The intakes of these pipes are located in the reservoir at the upstream toe of the dam. Both pipes lead into a valve house at the downstream toe of the embankment. There is a 20 inch gate valve on the blow-off pipe and a 10 inch gate valve on the water supply line. Immediately upstream of the gate valve on the water supply line is a 10 inch cast-iron bypass line leading from the water supply line to the blow-off pipe. There is a 10 inch gate valve on this line. Flow in the water supply line can be directed into the blow-off pipe by closing the 10 inch gate valve on the line and opening the 10 inch gate valve located on the bypass.

A 20 inch (inside diameter) concrete pipe extension was added to the downstream end of the blow-off pipe approximately 15 years ago. This extension is 125 feet long. This addition was reportedly made to allow flow from the blow-off line to run directly into the existing stream channel downstream from the dam.

- b. Location - Martindale Dam is located in Portage Township, Cambria County, Pennsylvania. The coordinates of the dam are N 40° 21.2' and W 78° 37.5'. The dam and reservoir can be found on the Beaverdale and Blueknob, Pennsylvania, USGS 7.5 minute topographic quadrangles.
- c. Size Classification - The height of the dam is 17 feet and the reservoir volume at the top of dam (Elevation 2303.9 feet M.S.L.¹) is 47 acre-feet. Therefore, the dam is in the "Small" size category.
- d. Hazard Classification - There are three homes located 550 feet downstream from the dam and two

¹All elevations are referenced to the spillway crest, Elevation 2302.0 feet M.S.L., as determined on the design plans for the dam. The reservoir level is shown as being at Elevation 2323.0 feet on the USGS topographic quadrangle for the area.

homes 1700 feet downstream from the dam. Loss of life and economic damage to these two groups of homes is likely if the dam were to fail. Additional economic damage is likely in Martindale which lies approximately 3500 feet downstream from the dam. This possible loss of life and economic damage places the dam in the "High" hazard category.

- e. Ownership - The dam and reservoir are owned and operated by the Borough of Portage Municipal Authority, 606 Cambria Street, Portage, Pennsylvania.
- f. Purpose of the Dam - The dam and reservoir are used for water supply.
- g. Design and Construction History - The dam was designed by Andrew B. Crichton, Civil and Mining Engineer, Johnstown, Pennsylvania. The dam was constructed in 1909 and 1910 using local labor under the daily supervision of Mr. Frank Weaver, Superintendent of the Portage Municipal Authority, with periodic inspection by Mr. Crichton. In 1915, the embankment was raised 3 feet and the spillway crest was raised 2 feet.
- h. Normal Operating Procedures - The pool is usually at the spillway crest elevation except during late summer when the pool level drops due to low inflow rates and high rates of water usage. The 10 inch water supply valve is kept open except at times of repair to one of the water supply mains. The 20 inch blow-off pipe is operated approximately once a month. The embankment is typically examined once a month.

1.3 PERTINENT DATA

- a. Drainage Area (square miles) - 1.15
- b. Discharge at Dam Site (c.f.s.) -
 - Maximum Known Flood (July 1977) - 230
 - Spillway Capacity (at Pool El. 2303.9 ft. M.S.L.) - 320
- c. Elevation (feet above M.S.L.) -
 - Design Top of Dam - 2305.0
 - Minimum Top of Dam - 2303.9
 - Average Top of Dam - 2304.4
 - Normal Pool (Spillway Crest) - 2302.0
 - Streambed at Toe of Dam - 2287+
 - Maximum Tailwater - Unknown

d. Reservoir (feet) -

Length of Maximum Pool -	800
Length of Normal Pool -	700

e. Storage (acre-feet) -

Top of Dam (El. 2303.9 ft. M.S.L.) -	47
Normal Pool (El. 2302.0 ft. M.S.L.) -	29

f. Reservoir Surface (acres) -

Top of Dam (El. 2303.9 ft. M.S.L.) -	11.5
Normal Pool (El. 2302.0 ft. M.S.L.) -	8.9

g. Dam -

Type -	Diaphragm earthfill
Length (feet) -	860
Height (feet) -	17
Top Width (feet) - Design -	8
Field -	5
Side Slopes - Upstream - Design -	1.5H:1V
Field -	1.5H:1V
Downstream - Design -	1.5H:1V
Field -	Slightly flatter than 1.5H:1V

Zoning - The design plans show that two classes of material were used to construct the embankment. The upstream half of the embankment is reported to be "select material" free of vegetation and stones greater than 4 inches in diameter. The downstream half of the embankment consists of rolled waste material. These two zones of fill are divided by the concrete core wall running along the dam slightly upstream from the centerline of the crest. When the embankment was raised, a 3 foot wide clay puddle core wall was placed above the concrete core wall. No other information concerning the material used to raise the embankment is available.

Cut-off - A concrete cut-off wall was installed along the length of the dam slightly upstream from the centerline of the crest. Design plans show that the wall has a top width of 2 feet and a bottom width of 6 feet. The wall extends up to 6 inches below the original top of dam, Elevation 2302.5 ft. M.S.L., and down 4 to 9 feet below the

original ground surface. When the embankment was raised, a clay puddle core wall 3 feet wide was placed above the concrete core wall. This clay core wall extends to within 6 inches of the current dam crest.

Grout Curtain - Several old grout pipes were observed along the upstream crest of the embankment between field Stations 5+50 and 6+20.² No information concerning the extent of grouting or the dates during which it was performed is available.

Drains - Drains are provided for the spillway discharge channel. None are included for the embankment.

h. Diversion and Regulatory Tunnel - None

i. Spillway -

Type - Broad-crested, concrete weir
Length of Crest Perpendicular to the

Direction of Flow (feet) - 37

Width of Crest Parallel to the

Direction of Flow (feet) - 1.0

Crest Elevation (feet M.S.L.) - 2302.0

Gates - None

Upstream Channel - There is a concrete slab approach channel sloping up to the base of the weir from the reservoir.

Downstream Channel - The spillway discharge channel extends approximately 75 feet downstream from the crest of the weir. The bottom of the chute channel consists of concrete slabs and the channel sides are masonry walls finished with concrete. (Note: these walls were later repaired with gunite). The chute is 37 feet wide at the weir and

²Stationing shown on the field sketch and top of dam profile included in Appendix A of this report was established during the inspection of the dam on 24 June 1980. This stationing differs from that shown on the design drawings for the dam (Plate 3). Unless stated otherwise, stationing mentioned in this report refers to that shown on the field sketch and top of dam profile in Appendix A.

begins to gradually taper to a 20 foot width 13 feet downstream from the crest of the weir. Eleven concrete impact blocks are located at the downstream end of the chute to serve as energy dissipators.

- j. Regulatory Outlets - The outlet works for the dam consist of a 10 inch cast-iron water supply line and a 20 inch cast-iron blow-off pipe. The intakes of these pipes are located in the reservoir at the upstream toe of the dam. Both pipes lead into a valve house at the downstream toe of the embankment. There is a 20 inch gate valve on the blow-off pipe and a 10 inch gate valve on the water supply line. Immediately upstream of the gate valve on the water supply line is a 10 inch cast-iron bypass line leading from the water supply line to the blow-off pipe. There is a 10 inch gate valve on this line. Flow in the water supply line can be directed into the blow-off pipe by closing the 10 inch gate valve on the line and opening the 10 inch gate valve located on the bypass.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Martindale Dam was designed by Andrew B. Crichton, Civil and Mining Engineer, Johnstown, Pennsylvania in 1909. The information available consisted of the Pennsylvania Department of Environmental Resources' (PennDER) File No. 11-17, plans and photographs in the possession of the owner, and an interview with the owner's representative. Information contained in the PennDER file included:

- 1) The original design drawing entitled, "Portage Water Company, Portage, Pennsylvania, Plan of Storage Reservoir on Trout Run," designed by A.B. Crichton, dated 20 April 1909.
- 2) Revisions to the original design drawing for the proposed raising of the embankment and spillway crest, dated 1915.
- 3) The preliminary and final "Report upon the Martindale Storage Reservoir Dam of the Portage Water Company," by an engineer of the Water Supply Commission of Pennsylvania, dated 13 August 1914 and 11 August 1915, respectively.
- 4) Application to drawdown the reservoir in 1959 in order to clear sediment from the reservoir.
- 5) Application to drawdown the reservoir in 1979 in order to clear sediment from the reservoir (this work was never undertaken).
- 6) Various photographs and post-construction inspection reports.

2.2 CONSTRUCTION

The dam was constructed in 1909 and 1910 using local labor under the daily direction of Mr. Frank Weaver and periodic supervision by Mr. Crichton, designer of the dam. In 1915, the embankment was raised 3 feet. At the same time the spillway crest was raised 2 feet to increase the storage capacity of the reservoir. The spillway crest was raised by constructing the 2 foot high, broad-crested weir currently in place in the spillway.

At the same time (estimated 1915) a berm was placed abutting the downstream slope on the right side of the spillway.

In 1957, the concrete surfaces in the spillway discharge channel were gunited. These repairs were required because the concrete had badly deteriorated.

Currently, the Portage Municipal Authority has plans to increase the width of the embankment and to raise the height of the embankment an additional 2 feet. It is not certain at this time if these plans will be carried out.

2.3 OPERATION

The lake level is maintained at normal pool level except for late summer when the reservoir storage is almost completely depleted due to high rates of water consumption and low inflow rates. The chlorinator house, located immediately downstream from the dam, is visited daily except Sunday. Once a month a representative of the owner walks the embankment and examines it for seepage and other problems. The 20 inch blow-off pipe is typically operated once a month. The 10 inch water supply valve is typically open all the time except when repairs are being made to the water mains in the supply system.

2.4 EVALUATION

- a. Availability - PennDER's File No. 11-17 is readily available. Additional information can be obtained at the Authority's office in Portage, Pennsylvania.
- b. Adequacy - The information available is adequate for a Phase I Inspection.
- c. Validity - There is no reason at the present time to doubt the authenticity of the available engineering data. However, several revisions to the dam should be noted. These are:
 - 1) The embankment was raised 3 feet in 1915.
 - 2) The original design plans for the dam show that the spillway crest was intended to be 50 feet long. Prior to building the spillway, the design crest length was reduced to its current size of 37 feet to reduce the cost of the spillway structure.

- 3) The crest of the spillway was raised 2 feet in 1915.
- 4) The vertical distance between the spillway crest and top of dam was increased from 2 feet to 3 feet in 1915 when the top of the dam and spillway crest were raised.
- 5) A new water intake was installed for the 10 inch water supply pipe (date unknown).

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

- a. General - The inspection was performed on 24 June 1980. No unusual weather conditions were experienced and the pool level was approximately 0.1 feet above the crest of the spillway. The dam and appurtenant structures were found to be in fair overall condition at the time of the inspection. Noteworthy deficiencies observed during the visual inspection are described in the following paragraphs. The complete visual inspection check list, field sketch, top of dam profile, and typical cross-section are presented in Appendix A.
- b. Dam - The following is a list of deficiencies observed during the visual inspection of the embankment.
 - 1) Minor erosion of scattered areas along the upstream face of the embankment between the normal pool level and the crest of the dam was observed. Part of this problem is caused by animal burrows in the upstream face of the embankment which have collapsed to form low areas where run-off from the crest of the dam can concentrate. There are also several small areas where the riprap on the upper portion of the embankment has failed. There are no areas where this erosion currently represents a serious problem; however, remedial action is necessary to prevent this problem from progressing.
 - 2) There are several low areas along the crest of the dam, the lowest of which is at Station 4+60 (the approximate location of the outlet pipes) on the top of dam profile (Appendix A). The elevation of the crest of the dam at this station is 2303.9 ft. M.S.L. which is only 1.9 feet above the crest of the spillway weir.
 - 3) Numerous animal burrows were observed in the embankment. Many of these holes have collapsed, causing low areas on the upstream face of the dam, along the crest of the dam, and at scattered locations on the downstream face of the dam.

- 4) There were two wet areas at the left downstream toe of the embankment between field Stations 5+50 and 7+00. It did not appear that these wet areas are the result of seepage through the embankment. The owner's representatives reported that these areas dry up in the summer months. This saturation is probably the result of poor surface drainage in this area.
- c. Appurtenant Structures - The following is a list of deficiencies observed during the visual inspection of the spillway and outlet works.
- 1) A joint in the concrete pipe extension added to the blow-off pipe has separated, leaving a gap of approximately 1 to 2 inches. The location of this separated joint is approximately 15 feet downstream from where the concrete pipe is connected to the cast-iron pipe.
 - 2) Some cracking of both spillway training walls has taken place. A minor amount of seepage is coming through the cracks in the left spillway training wall. This cracking is not serious enough to threaten the stability of the training walls at the present time.
 - 3) The joints between the weir and the spillway training walls are leaking (flow less than 1 g.p.m.).
 - 4) There are trees and brush growing in the downstream end of the spillway discharge channel which could eventually restrict flow in the channel.
 - 5) There are several minor cracks in the bottom slabs in the spillway discharge channel. One of the drains at the downstream end of the channel was flowing approximately 2 to 3 g.p.m.; water is probably flowing through the cracks and into this drain.
- d. Reservoir Area - The slopes of the reservoir are moderate. The watershed is primarily forested with some residential development. Sedimentation has been a problem in the reservoir. The reservoir was dredged in 1959 to remove accumulated sediment. At the present time, sedimentation has reduced the reservoir storage volume to only 55 percent of its

design capacity. Plans were made to dredge the reservoir again in 1979 but this work was never undertaken.

- e. Downstream Channel - Slopes in the channel are moderate with woods and a few open fields along the channel banks. Approximately 120 feet downstream from the dam, an access road for the dam crosses the channel. Flow is carried under this road by a 48 inch corrugated metal pipe. This pipe should not represent a serious obstruction to flow in the channel.

There are three homes located approximately 550 feet downstream from the dam. Two more homes are 1700 feet downstream from the dam. The city of Martindale is located 3500 feet downstream from the dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no formal written instructions for operating the reservoir or evacuating the downstream area in case of an impending dam failure.

It is recommended that formal emergency procedures be adopted, prominently displayed, and furnished to all operating personnel.

4.2 MAINTENANCE OF THE DAM

Maintenance of the dam is considered to be fair. The superintendent typically walks the embankment once a month to determine the necessity of maintenance. It is recommended that formal records of the examinations and necessary maintenance be recorded for future reference. In addition, it is recommended that a rodent control plan be implemented.

4.3 MAINTENANCE OF OPERATING FACILITIES

The 20 inch blow-off pipe is operated once a month. The 10 inch water supply valve is left open except when repairs to the water supply lines are necessary. Maintenance of these facilities is considered to be adequate. It is recommended that upstream control valves (or closures) be installed on the outlet pipes to protect the embankment in the event of a pipe rupture.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

At the present time, there is no formal warning system or evacuation plan in effect. Emergency warning procedures should be developed to notify residents downstream.

4.5 EVALUATION OF OPERATING ADEQUACY

Maintenance and operating procedures for Martindale Dam are considered to be adequate with the exceptions previously noted.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

- a. Design Data - There is no detailed hydrologic or hydraulic design information available for Martindale Dam. The original design plans for the spillway show that the spillway was intended to have a crest length of 50 feet. Prior to construction of the spillway, the design crest length was reduced to its current length of 37 feet. This was reportedly done to decrease the cost of the spillway structure.
- b. Experience Data - No records of the performance of the dam and spillway during significant flood events are maintained. According to the owners representative, a flood which occurred during July 1977 resulted in a flow approximately 18 inches above the crest of the spillway. This corresponds to a discharge of approximately 230 c.f.s.
- c. Visual Observation - The entire crest of the dam, with the exception of a small section at the right abutment, is lower than the design elevation of 2305.0 feet M.S.L. The minimum top of dam elevation is 2303.9 feet M.S.L. which is only 1.9 feet above the crest of the spillway weir. However, as will be discussed in the following section, raising the top of dam to the design elevation will not be sufficient to allow the dam and spillway to safely pass the required spillway design flood (SDF).
- d. Overtopping Potential - Martindale Dam is a "Small" size - "High" hazard dam requiring evaluation for an SDF in the range of the 1/2 Probable Maximum Flood (1/2 PMF) to the Probable Maximum Flood (PMF). Since the dam is on the low end of the "Small" size category in terms of storage and height, the 1/2 PMF was selected as the SDF.

The hydraulic capacity of the dam, reservoir, and spillway was assessed by utilizing the U.S. Army Corps of Engineers Flood Hydrograph Package, HEC-1 DB. The hydrologic characteristics of the basin, specifically, the Snyder's unit hydrograph parameters, were obtained from a regionalized analysis conducted by the Baltimore District of the U.S. Army Corps of Engineers.

This analysis revealed that the dam will be overtopped by the SDF. The maximum depth and total duration of overtopping are 0.83 foot and 8.5 hours, respectively. The dam, reservoir, and spillway can safely pass only 16 percent of the PMF before overtopping begins.

As was mentioned in the previous section, the crest of the dam is lower than the design elevation of 2305.0 feet M.S.L. If the top of dam was raised to this elevation, the spillway capacity would be increased from its present capacity of 320 c.f.s. to approximately 640 c.f.s. Additional HEC-1 DB analysis indicates that this increase in capacity is not sufficient to prevent the dam from being overtopped during the SDF.

- e. Spillway Adequacy - As outlined in the above analysis, the spillway cannot pass the SDF before overtopping occurs. The next criteria for determining spillway adequacy requires an estimate of whether the dam will fail during the SDF. The following conditions, as well as the overall state of the dam, were estimated as the limiting criteria which are likely to cause failure of the dam:

- 1) Depth of overtopping of 1.0 feet or greater.
- 2) Duration of overtopping in excess of 2.0 hours.

The overtopping analysis for the dam yielded the following values for the 1/2 PMF:

- 1) Depth of overtopping equal to 0.83 foot.
- 2) Duration of overtopping equal to 8.5 hours.

Since the long duration of overtopping exceeds the estimated limiting criteria, it is judged that dam failure is likely during the required SDF.

To assess the impact of the dam's failure on downstream damage centers, the 1/2 PMF was routed through the dam for the failure and non-failure cases. This analysis indicated that there would be a significant increase in downstream damages from the non-failure to the failure case. Due to the increase in flow during the failure case and because this flow reaches downstream damage centers more rapidly than in the non-failure case, an

increase in loss of life is also likely. Therefore, the spillway is classified as being "seriously inadequate".

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observations. - There were no structural inadequacies noted during the visual inspection that cause immediate concern for the structural stability of the dam. The wet areas downstream from the embankment on the left half of the dam are considered to be the result of poor surface drainage. However, it is advisable to visually monitor these areas in the future and record their condition. The narrow crest width (5 feet in the field) and the number of animal burrows are causes for concern for the potential problem of seepage and piping through the embankment. Normally, animal burrows are not a major concern with thicker section embankments; however, because of the narrow crest width of this embankment, animal burrows could very easily cause a direct hole for seepage through the embankment. It is recommended that the animal burrows in the embankment be filled immediately and a rodent control program established. Further, it is advisable that the plans for increasing the embankment section be implemented as early as reasonably possible for the authority.
- b. Design and Construction Data - Calculations of slope and structural stability were not available for review. The current slopes and crest width of the embankment do not meet the empirical guidelines presented in "Design of Small Dams," 2nd edition, pages 261 to 267. However, the slopes have had a history of satisfactory performance including occasional drawdown of the reservoir during the summer season. In view of the modest height of the dam and history of satisfactory performance of its slopes, a quantitative assessment of the stability is not warranted at this time. However, it is advisable that the Portage Water Authority proceed with their plans for increasing the embankment section.
- c. Operating Records - Nothing in the procedures described by the owner's representative indicates concern relative to the structural stability of the dam.
- d. Post-Construction Changes - No changes adversely affecting the structural stability of the dam have been performed.

- e. Seismic Stability - The dam is located in Seismic Zone 1 of the "Seismic Zone Map of the Contiguous United States," Figure 1, page D-30, "Recommended Guidelines for Safety Inspection of Dams." This is a zone of minor seismic activity. Therefore, further consideration of the seismic stability is not warranted.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

- a. Safety - Martindale Dam was found to be in fair overall condition at the time of inspection. Martindale Dam is a "High" hazard - "Small" size dam requiring an SDF in the range of the 1/2 PMF to the PMF. The 1/2 PMF was chosen as the SDF because the dam is on the low side of the "Small" size category in terms of its height and storage capacity. As presented in Section 5, the spillway and reservoir were determined to have a capacity of only 16 percent of the PMF before overtopping of the dam will occur. During the 1/2 PMF, the maximum depth and total duration of overtopping are 0.83 feet and 8.5 hours, respectively. Due to the relatively narrow crest width of the dam and the long duration of overtopping, it was judged that failure of the dam is likely during the 1/2 PMF. To assess the increase in damages downstream from the non-failure to failure cases, the 1/2 PMF was routed through the dam and downstream for both conditions. It was determined that there would be a significant increase in possible loss of life and economic damages if the dam failed. The spillway is therefore categorized as being "seriously inadequate" and the dam is classified as being in an "Unsafe" - "Non-Emergency" condition.

The wet areas observed during the visual inspection are considered to be the result of poor surface drainage; however, these areas should be examined in future inspections and the condition recorded. Because of the narrow crest width of this embankment, it is recommended that all the animal burrows be filled immediately and a rodent control program established. Further, it is advisable that the plans for increasing the embankment section be implemented as soon as possible by the Portage Municipal Authority.

- b. Adequacy of Information - The information available and the observations and measurements made during the visual inspection are considered sufficient for this Phase I Inspection Report.
- c. Urgency - The owner should immediately initiate the further investigation discussed in paragraph 7.1.d.

- d. Necessity for Additional Data/Evaluation - The hydraulic/hydrologic analyses performed for this dam have indicated the need for additional spillway capacity. It is recommended that the owner of Martindale Dam immediately initiate an engineering study to further evaluate the spillway capacity and to develop recommendations for reducing the overtopping potential of this dam. This study should result in the implementation of the necessary remedial measures.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The inspection and review of information revealed certain items of work which should be performed immediately by the owner. Items 1 and 2 should be designed and completed under the guidance of a qualified professional engineer experienced in the design of earth dams and appurtenant structures.

- 1) The owner should immediately initiate an engineering study to further evaluate the spillway capacity in order to develop recommendations for remedial measures to reduce the overtopping potential of the dam.
- 2) Provide upstream closure for the intakes of the water supply line and blow-off pipe.
- 3) Repair the separated joint in the concrete extension to the blow-off pipe.
- 4) Repair the cracks in the spillway training walls.
- 5) Clean and seal the joints between the weir and the spillway training walls.
- 6) Remove the trees and brush growing in the downstream end of the spillway discharge channel.
- 7) Repair the cracks in the bottom slabs of the spillway discharge channel.
- 8) Repair the eroded areas along the upstream face of the embankment.
- 9) Fill the low areas along the crest of the dam.
- 10) Repair the animal burrows in the embankment.

In addition, the following operational measures are recommended to be undertaken by the owner:

- 1) Develop a detailed emergency operation and warning system.
- 2) During periods of unusually heavy rainfall, provide around-the-clock surveillance of the dam.
- 3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

It is further recommended that formal inspection, maintenance, and operational procedures and records be developed and implemented. The wet areas noted in this inspection report should be examined in all future inspections and the conditions recorded.

APPENDIX A

VISUAL INSPECTION CHECK LIST, FIELD SKETCH,
TOP OF DAM PROFILE, AND TYPICAL CROSS-SECTION

Phase 1
Visual Inspection
Check List

Name of Dam Martindale Dam County Cambria State PA Coordinates Lat. N 40°21.2'

NDI # PA 00444
PENNDER # 11-17

Long. W 78°37.5'

Date of Inspection 24 June 1980 Weather Sunny Temperature 80° F.

Pool Elevation at Time of Inspection 2302.1 ft.* M.S.L. Tailwater at Time of Inspection 2288.6 ft.* M.S.L.

*All elevations are referenced to the spillway crest, El. 2302.0 ft. M.S.L., as determined from plans available for the dam.

Inspection Personnel:

Michael Baker, Jr., Inc.:

James G. Ulinski
Wayne D. Lasch
Clifford E. Guindon

Field Review (8 August 1980):

John A. Dziubek
James G. Ulinski

Owner's Representatives:

Anthony Mignone, Superintendent
Borough of Portage Municipal
Authority

James G. Ulinski Recorder

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: MARTINDALE DAM

NDI # PA 00444

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
-----------------------	--------------	----------------------------

LEAKAGE

STRUCTURE TO
ABUTMENT/EMBANKMENT
JUNCTIONS

DRAINS

WATER PASSAGES

FOUNDATION

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: MARTINDALE DAM
NDI # PA 00444

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
-----------------------	--------------	----------------------------

SURFACE CRACKS
CONCRETE SURFACES

STRUCTURAL CRACKING

VERTICAL AND HORIZONTAL
ALIGNMENT

MONOLITH JOINTS

CONSTRUCTION JOINTS

EMBANKMENT

Name of Dam MARTINDALE DAM
 NDI # PA 00444

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed	

UNUSUAL MOVEMENT OR
 CRACKING AT OR BEYOND
 THE TOE

None observed

SLOUGHING OR EROSION OF
 EMBANKMENT AND ABUTMENT
 SLOPES

There is minor erosion of scattered areas along the upstream slope of the embankment from normal pool level to the crest of the dam. Animal burrows that have collapsed are permitting the run-off to concentrate and accelerate the erosion.

This erosion can be repaired as part of the Authority's proposed revision to the dam. If those plans are abandoned, the eroded areas should be repaired.

EMBANKMENT

Name of Dam MARTINDALE DAM
 NDI # PA 00444

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	There is a low area at Station 4+60 on the top of dam profile included at the end of this appendix. This area is only 1.9 ft. above the crest of the spillway weir. A large portion of the crest of the dam is irregular and below the design top of dam elevation.	The low areas should be repaired.
RIPRAP FAILURES	The upstream slope is partially eroded at and above pool level.	The eroded areas should be repaired.
ANIMAL BURROWS	Numerous animal burrows were observed in the embankment. Many of these holes have collapsed to form low areas.	These animal burrows should be filled.

EMBANKMENT

Name of Dam MARTINDALE DAMNDI # PA 00444

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	The junction of the embankment/abutment was in good condition. The junction of the embankment and right spillway training wall has low areas adjacent to the wall. Minor cracking is present on both training walls. The left training wall/embankment junction has a minor amount of water (less than 1 g.p.m.) flowing through the embankment, through the cracks in the left training wall, and into the spillway.	The low area should be filled. The seepage area should be repaired.
ANY NOTICEABLE SEEPAGE	Wet areas were present below the left side toe of the embankment from field Stations 5+50 to 7+00. These areas did not have any discernible flow and they reportedly dry up during later summer months. The spillway had minor seepage through the left training wall and the joints between the weir and walls.	The wet areas at the toe of the dam appear to be the result of poor surface drainage and not seepage through the embankment. These areas should be periodically observed and the condition recorded. The training wall should be repaired. The joints between the spillway weir and the training wall should be cleaned and sealed.

STAFF GAGE AND RECORDER None

DRAINS

There are no drains for the embankment. The spillway discharge aprons drains are located near the training walls on each side. The right drain at the end of the discharge apron was flowing approximately one-half full.

It is estimated the flow in the drain is coming from water entering cracks in the apron slab. These cracks should be sealed.

OUTLET WORKS

Name of Dam: MARTINDALE DAM

NDI # PA 00444

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	There is a 10 in. diameter C.I.P. used as a water supply line and a 20 in. diameter cast-iron blow-off pipe. A concrete pipe extension approximately 125 ft. long was added to the downstream end of the blow-off pipe 15 yrs. ago. This extension is in relatively good condition except for a joint in the pipe which has separated 1 to 2 in.	The separated joint should be repaired.
INTAKE STRUCTURE	The intake structure was submerged in the reservoir and could not be inspected.	Upstream closure should be installed on the water supply intake pipe.
OUTLET STRUCTURE	The 10 in. water supply line and 20 in. blow-off pipe were only visible in the valve house at the downstream toe of the dam. Both pipes and valves appeared to be in good condition.	
OUTLET CHANNEL	A concrete pipe extension was added to the blow-off pipe 15 yrs. ago. This extension leads to the natural stream channel downstream from the dam. This extension was added to improve drainage to the outlet channel.	
EMERGENCY GATE	The 20 in. blow-off pipe is operated by a 20 in. sliding gate valve located in a small valve house at the downstream toe of the dam. The valve appeared to be in good condition.	Upstream controls (closure) should be installed on the blow-off pipe.

UNGATED SPILLWAY

Name of Dam: MARTINDALE DAM
 NDI # PA 00444

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	The spillway weir is a concrete, broad-crested weir. There was a minor amount of seepage from the joints in the weir.	The concrete joints should be cleaned and sealed.
APPROACH CHANNEL	There is a concrete slab approach channel sloping up to the base of the weir from the reservoir. This channel was submerged and could not be observed. Photographs in the authority's office did not show any problems.	
DISCHARGE CHANNEL	The discharge channel is a rectangular, concrete channel extending approximately 75 ft. to the downstream toe of the dam. There are eleven concrete impact blocks at the downstream end of the channel which serve as energy dissipators. The channel was gunited several years ago; however, there are minor cracks in the bottom slabs. Trees and brush are growing at the downstream end and could eventually restrict the flow.	The cracks in the channel slabs should be repaired. The trees and brush should be removed.
BRIDGE AND PIERS	None	

GATED SPILLWAY - Not Applicable

Name of Dam: MARTINDALE DAM

NDI # PA 00444

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL		
APPROACH CHANNEL		
DISCHARGE CHANNEL		
BRIDGE AND PIERS		
GATES AND OPERATION EQUIPMENT		

A-10

INSTRUMENTATION - None

Name of Dam: MARTINDALE DAM

NDI # PA 00444

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
--------------------	--------------	----------------------------

MONUMENTATION/SURVEYS

OBSERVATION WELLS

WEIRS

PIEZOMETERS

OTHER

RESERVOIR

Name of Dam: MARTINDALE DAM
 NDI # PA 00444

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Slopes of the reservoir area are moderate. The watershed is primarily forested with some residential development.	

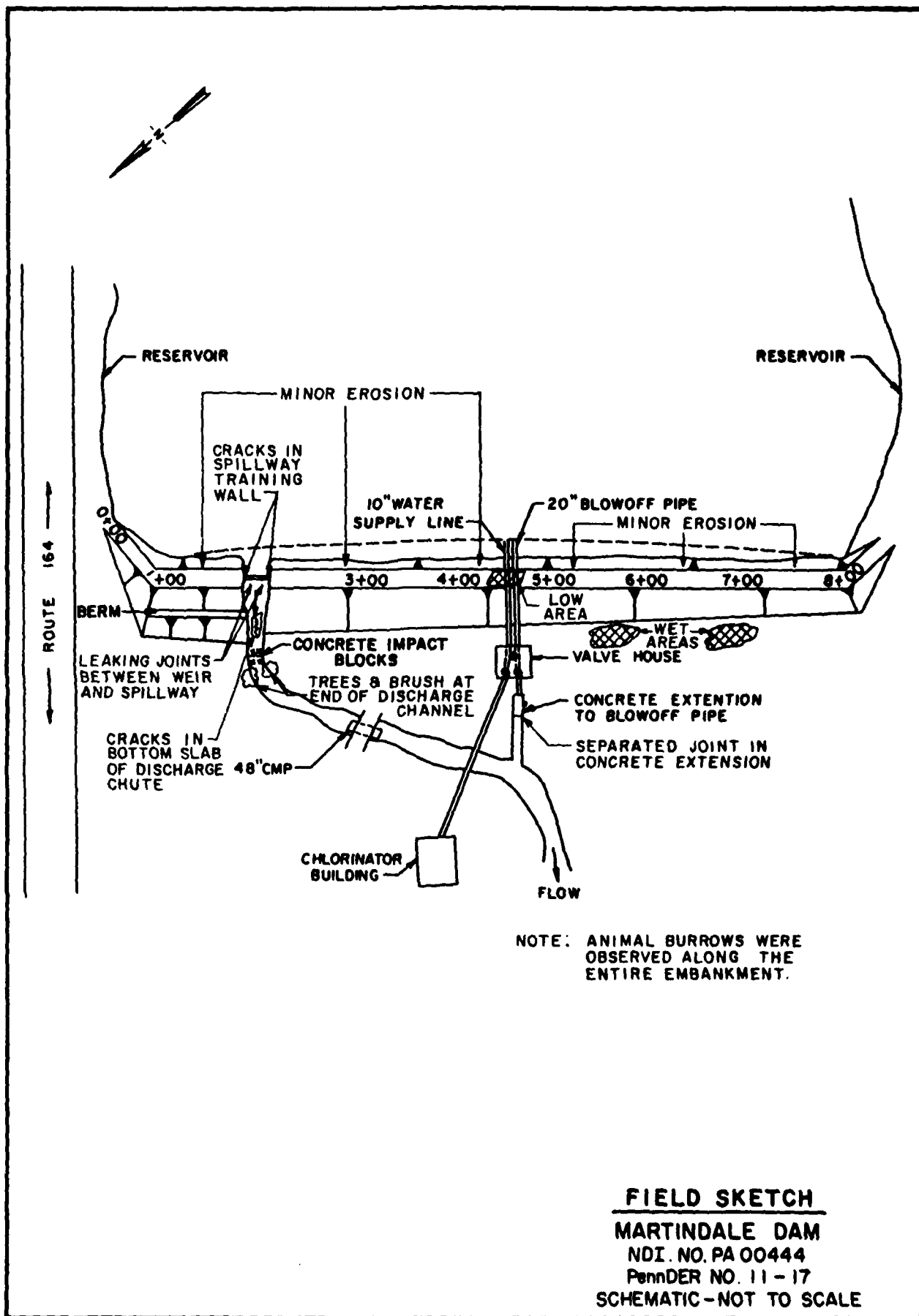
SEDIMENTATION

The storage volume of the reservoir has been reduced to approximately 55% of the original storage capacity by sedimentation. The reservoir was dredged in 1959. Plans were made to dredge it again in 1979 but were never undertaken.

DOWNSTREAM CHANNEL

Name of Dam: MARTINDALE DAM
 NDI # PA 00444

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Flow in the channel approximately 120 ft. downstream from the dam is carried by a 48 in. C.M.P. under an access road to the dam. The next obstruction is where the channel passes under Route 164 approximately 3300 ft. downstream from the dam.	These obstructions should not represent a significant restriction to flow in the downstream channel.
SLOPES	Slopes are moderate with woods and a few open fields along the downstream channel.	
APPROXIMATE NO. OF HOMES AND POPULATION	There are 3 homes located approximately 550 ft. downstream from the dam. There are 2 more homes 1700 ft. downstream from the dam. Loss of life and economic damage to these two areas is likely if the dam were to fail.	



MICHAEL BAKER, JR., INC.

THE BAKER ENGINEERS

1 July 1980

Box 280

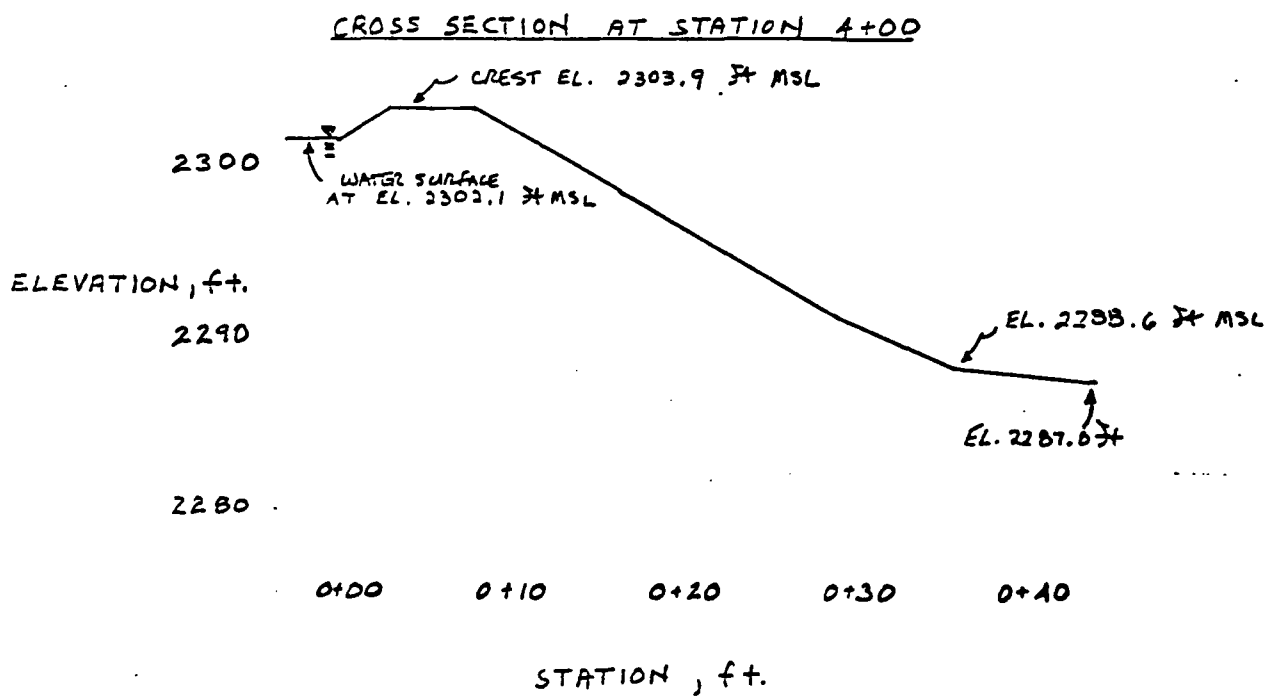
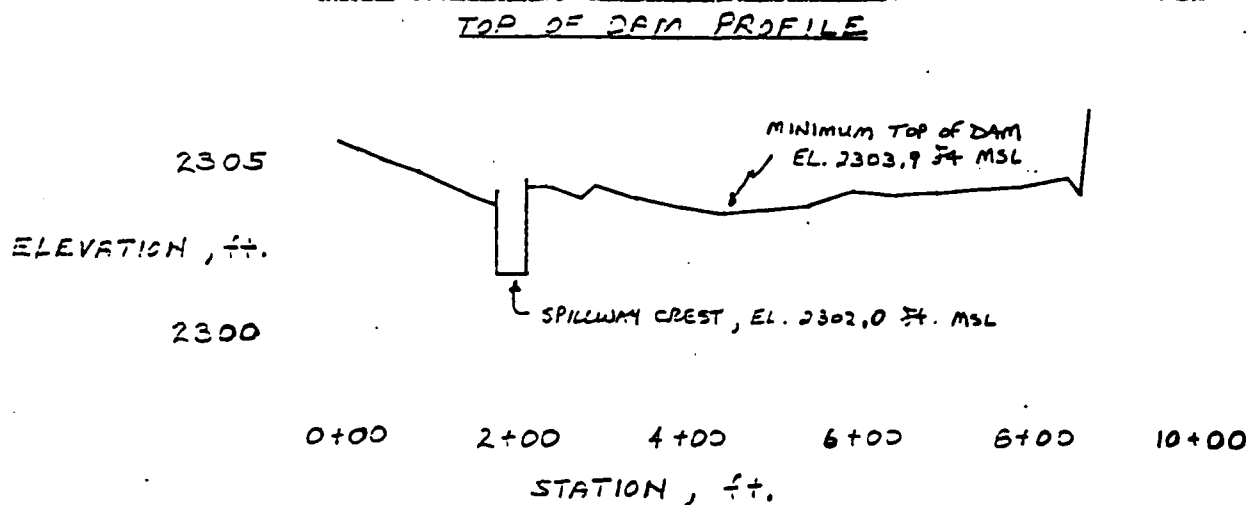
Beaver, Pa. 15009

MARTINDALE DAM

A-14

TOP OF DAM PROFILE
TYPICAL CROSS-SECTION

DATE OF INSPECTION - 24 June 1980



APPENDIX B

ENGINEERING DATA CHECK LIST

ENGINEERING DATA
CHECK LIST

DESIGN, CONSTRUCTION, OPERATION

Name of Dam: MARTINDALE DAM
NDI # PA 00474

ITEM	REMARKS
PLAN OF DAM	See Plate 3 of this report.
REGIONAL VICINITY MAP	See Plate 1 of this report. Two USGS 7.5 minute topographic quadrangles, Beavertdale and Blueknob, PA were used to prepare this map.
CONSTRUCTION HISTORY	The dam was designed by Mr. Andrew B. Crichton, Civil and Mining Engineer of Johnstown, PA. The dam was constructed in 1909 and 1910 by using local labor under the supervision of Mr. Frank Weaver, Superintendent of the Portage Municipal Authority. Later revisions were completed in 1915.
TYPICAL SECTIONS OF DAM	See Plate 3 of this report.
HYDROLOGIC/HYDRAULIC DATA	None available
OUTLETS - PLAN, DETAILS, and CONSTRAINTS	See Plate 3 of this report.
- DISCHARGE RATINGS	No information available
RAINFALL/RESERVOIR RECORDS	None are available.

Name of Dam: MARTINDALE DAM

NDI # PA 00444

B-2

ITEM	REMARKS
DESIGN REPORTS	None available
GEOLOGY REPORTS	See Appendix F of this report for the regional geology.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	One test pit was performed on the left portion of the embankment foundation. It is shown on Plate 3 of this report. No other information is available.
POST-CONSTRUCTION SURVEYS OF DAM	Information for a proposed raising of the embankment to increase the storage capacity has been prepared on a set of design plans. These plans can be obtained from Eads Engineering of Altoona, PA.
BORROW SOURCES	No information available

Name of Dam: MARTINDALE DAM
NDI # PA 00444

B-3

ITEM	REMARKS
------	---------

MONITORING SYSTEMS

None

MODIFICATIONS

The embankment was raised 3 ft. in 1915. At the same time, the spillway crest was raised 2 ft. It is estimated that the berm on the right side of the spillway abutting the downstream toe of the embankment was installed at this time. The spillway discharge channel was gunitied in 1957.

HIGH POOL RECORDS

The high pool of record was 18 in. over the spillway crest in 1977.

POST-CONSTRUCTION ENGINEERING
STUDIES AND REPORTS

Numerous inspections have been performed by representatives of PennDER (and its predecessors). These are available in the PennDER file. Additional studies have been made concerning the proposed raising of the embankment and excavation of the reservoir area for increased storage capacity.

PRIOR ACCIDENTS OR FAILURE OF DAM
DESCRIPTION
REPORTS

None

MAINTENANCE
OPERATION
RECORDS

Formal maintenance and operation records are not kept. The embankment is examined approximately once a month. In addition, the chlorinator house just downstream from the dam is visited daily.

Name of Dam: MARTINDALE DAM

B-4

NDI # PA 00444

ITEM	REMARKS
------	---------

SPILLWAY PLAN,

SECTIONS,
and
DETAILS

See plate 3 of this report.

OPERATING EQUIPMENT
PLANS & DETAILS

See plate 3 of this report.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 1.15 sq.mi. (primarily forested with
some residential development)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 2302.0 ft. M.S.L.
(29 ac.-ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 2303.9 ft. M.S.L.
(47 ac.-ft.)

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 2303.9 ft. M.S.L. (minimum top of dam)

SPILLWAY: _____

- a. Crest Elevation 2302.0 ft. M.S.L.
- b. Type Concrete, broad-crested weir
- c. Width of Crest Parallel to Flow 1.0 ft.
- d. Length of Crest Perpendicular to Flow 37 ft.
- e. Location Spillover 180 ft. from right abutment
- f. Number and Type of Gates None

OUTLET WORKS: _____

- a. Type 1-10 in. water supply line and 1-20 in cast-iron blow-
- b. Location Center of dam off pipe
- c. Entrance Inverts Water supply line: El. 2285.4 ft. M.S.L.;
- d. Exit Inverts El. 2282.0 ft. M.S.L. blow-off pipe:
El. 2285.0 ft. M.S.L.
- e. Emergency Drawdown Facilities The 20 in. blow-off pipe and
10 in. water supply line can
serve as drawdown facilities

HYDROMETEOROLOGICAL GAGES: None

- a. Type _____
- b. Location _____
- c. Records _____

MAXIMUM NON-DAMAGING DISCHARGE 230 c.f.s.

APPENDIX C

PHOTOGRAPH LOCATION PLAN AND PHOTOGRAPHS

DETAILED PHOTOGRAPH DESCRIPTIONS

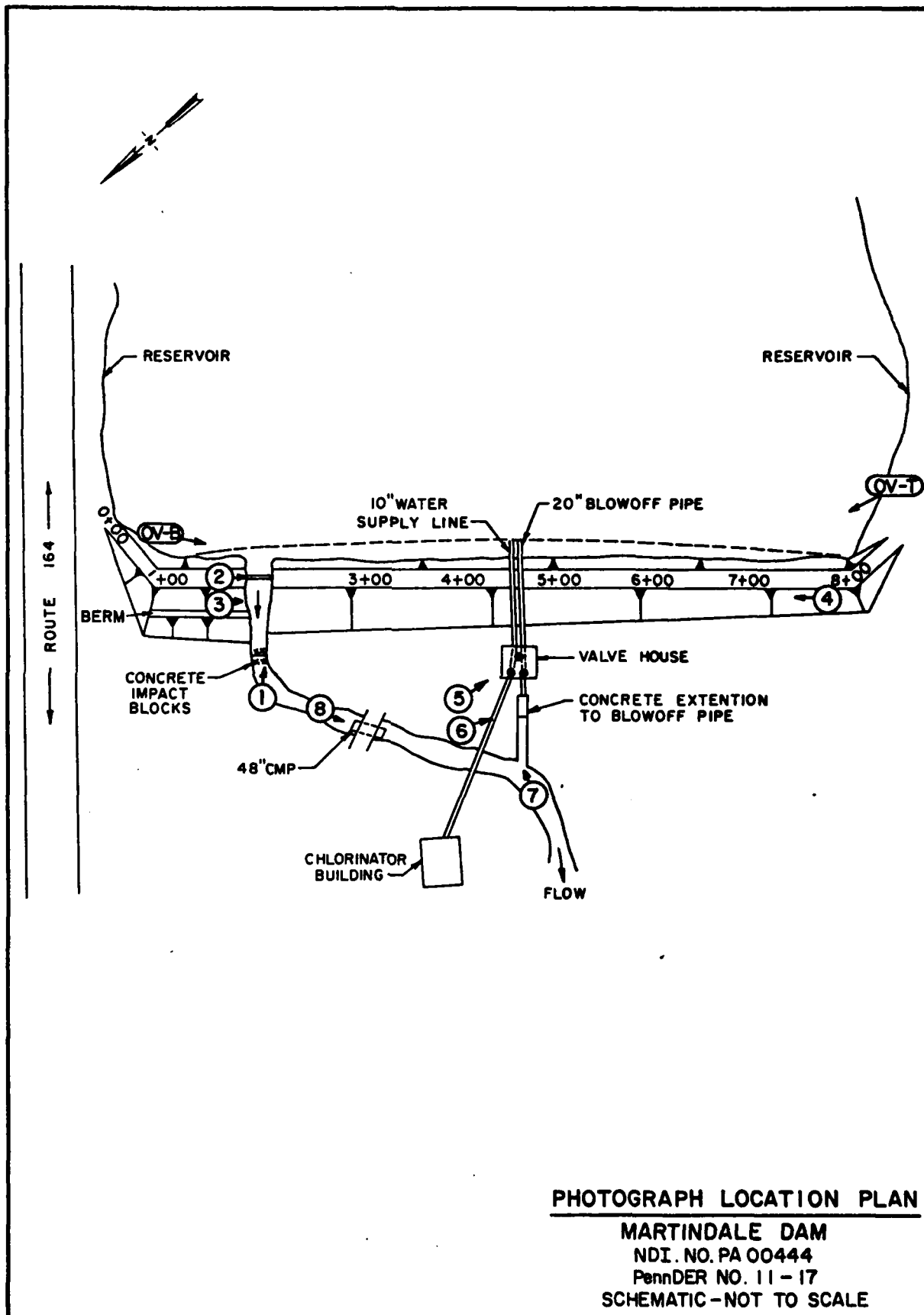
Overall View of Dam

Top Photo (OV-T)	Overall View of Upstream Face of Dam from Left Abutment
Bottom Photo - (OV-B)	Overall View of Upstream Face of Dam from Right Abutment

Photograph Location Plan

- Photo 1 - View of Spillway from Downstream Channel
- Photo 2 - View of Spillway from Right Spillway Training Wall
- Photo 3 - View along Downstream Face of Embankment from Right
Abutment
- Photo 4 - View along Downstream Face of Embankment from Left
Abutment
- Photo 5 - View of Downstream Valve House for Outlet Conduit
- Photo 6 - View of Transition of Outlet Pipe from Cast Iron
Pipe to Concrete Pipe
- Photo 7 - View of Concrete Pipe Outlet into Stream Channel
- Photo 8 - View of Reconstructed Stream Channel Crossing

Note: Photographs were taken on 24 June 1980.



MARTINDALE DAM



PHOTO 1. View of Spillway from Downstream Channel

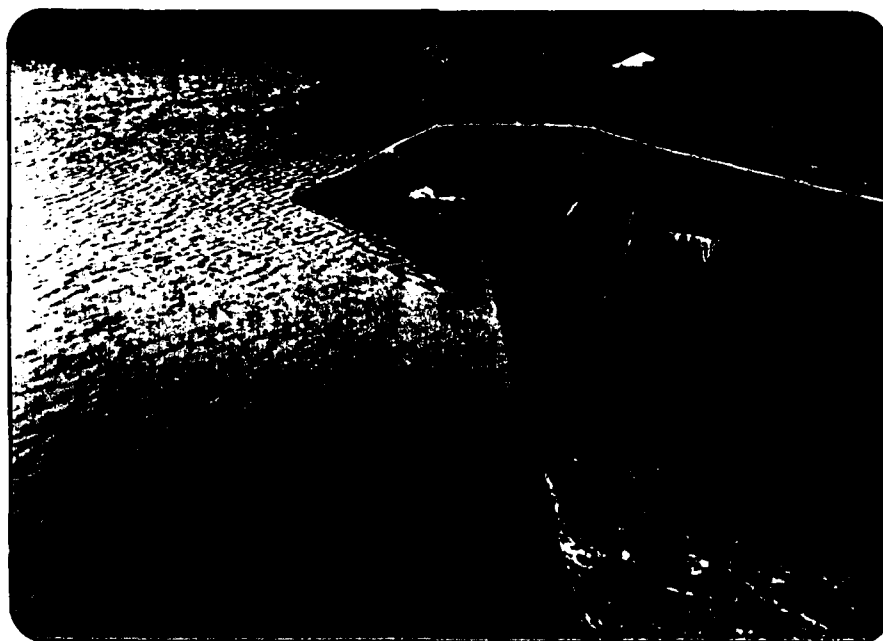
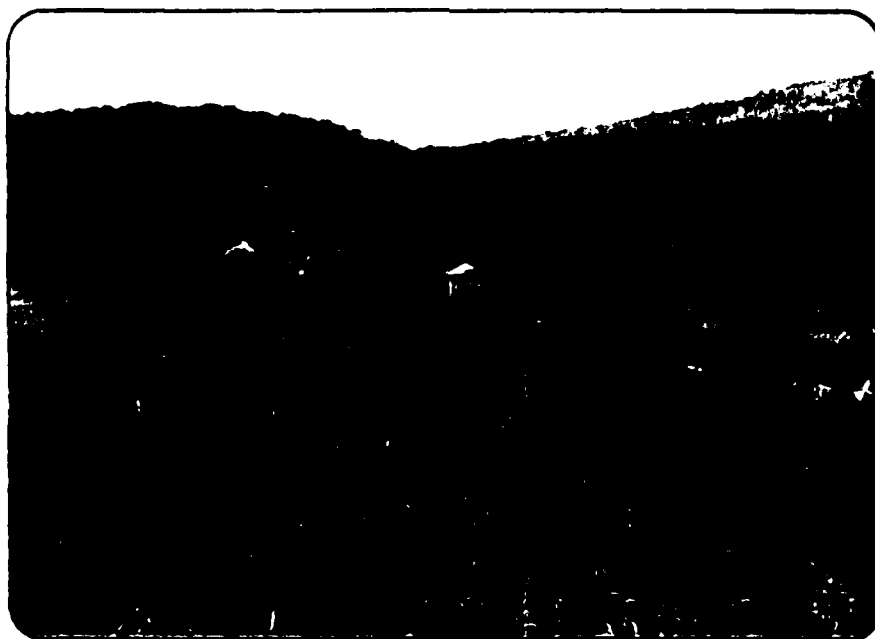
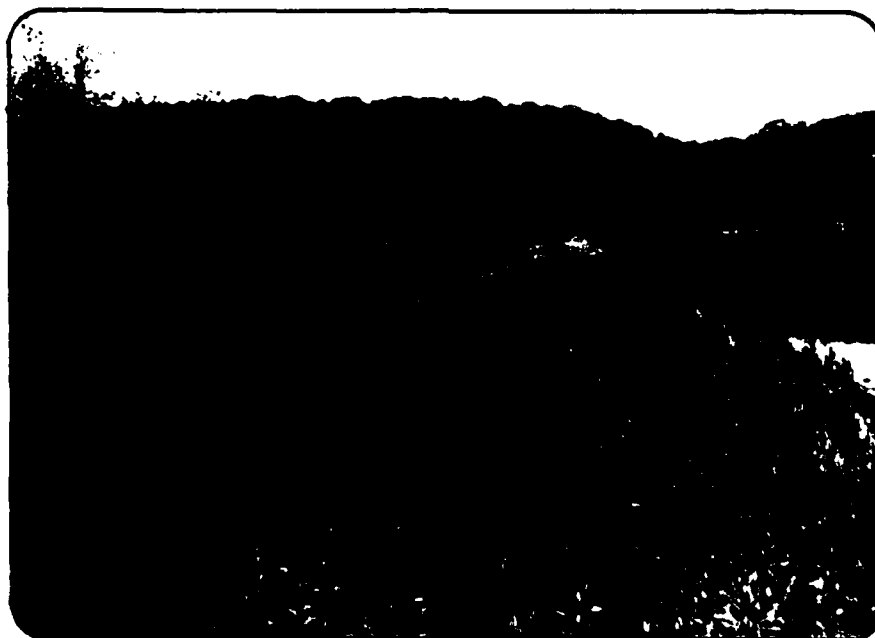


PHOTO 2. View of Spillway from Right Spillway Training Wall

MARTINDALE DAM



**PHOTO 3. View along Downstream Face of Embankment
from Right Abutment**



**PHOTO 4. View along Downstream Face of Embankment
from Left Abutment**

MARTINDALE DAM

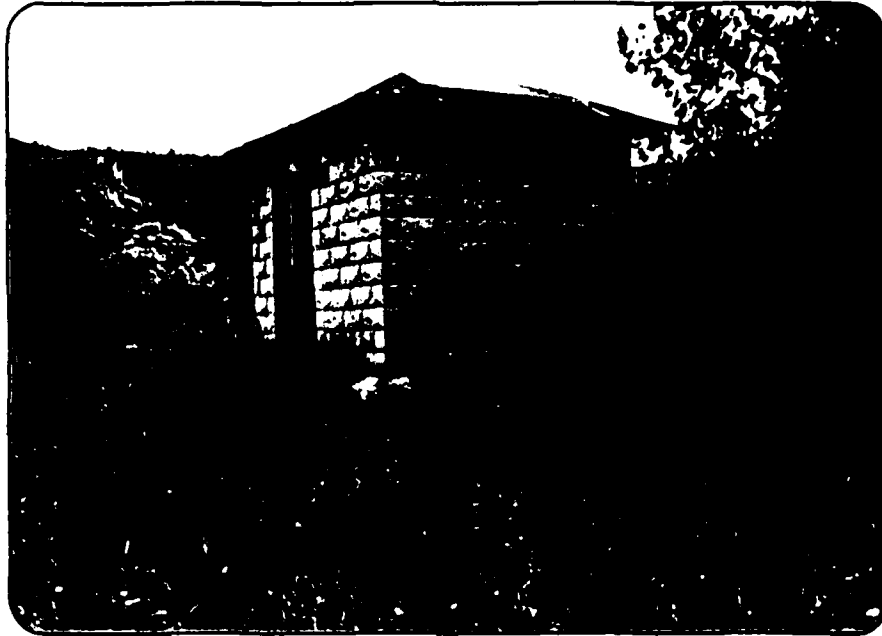


PHOTO 5. View of Downstream Valve House for Outlet Conduit



PHOTO 6. View of Transition of Outlet Pipe from Cast-Iron Pipe
to Concrete Pipe

MARTINDALE DAM



PHOTO 7. View of Concrete Pipe Outlet into Stream Channel



PHOTO 8. View of Reconstructed Stream Channel Crossing

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject MARTINDALE DAM S.O. No. _____
APPENDIX D - HYDROLOGIC AND Sheet No. _____ of _____
HYDRAULIC CALCULATIONS Drawing No. _____
Computed by _____ Checked by _____ Date _____

TABLE OF CONTENTS

<u>SUBJECT</u>	<u>PAGE</u>
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HYDROLOGY AND HYDRAULIC DATA BASE	1
DRAINAGE AREA AND CENTROID MAP	2
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HYDRAULIC DATA	4
HEC-1 SPILLWAY CAPACITY ANALYSIS	5
HEC-1 DAMBREAK ANALYSIS	10

PREFACE

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

The hydrologic determinations presented in this Phase I Inspection Report are based on the use of a Snyder's unit hydrograph developed by the U.S. Army Corps of Engineers. Due to the limited number of gaging stations available in this hydrologic region and the wide variations of watershed slopes, the Snyder's coefficients may yield results of limited accuracy for this watershed. As directed however, a further refinement of these coefficients is beyond the scope of this Phase I Investigation.

In addition, the conclusions presented pertain to present conditions, and the effect of future development on the hydrology has not been considered.

HYDROLOGY AND HYDRAULIC ANALYSIS DATA BASE

NAME OF DAM: MARTINDALE DAM

PROBABLE MAXIMUM PRECIPITATION (PMP) = 23.7 INCHES/24 HOURS⁽¹⁾

STATION	1	2	3	4	5
Station Description	MARTINDALE DAM				
Drainage Area (square miles)	1.15				
Cumulative Drainage Area (square miles)	1.15				
Adjustment of PMF for Drainage Area (%) ⁽²⁾	Zone 7				
6 Hours	102				
12 Hours	120				
24 Hours	130				
48 Hours	140				
72 Hours	--				
Snyder Hydrograph Parameters					
Zone ⁽³⁾	24				
C_p/C_t ⁽⁴⁾	0.45/1.6				
L (miles) ⁽⁵⁾	1.78				
L_{ca} (miles) ⁽⁵⁾	0.72				
$t_p = C_t (L \cdot L_{ca})^{0.3}$ (hours)	1.72				
Spillway Data					
Crest Length (ft)	37				
Freeboard (ft)	1.9				
Discharge Coefficient	(Rating curve developed on sheet 4)				
Exponent					

(1) Hydrometeorological Report 33 (Figure 1), U.S. Army, Corps of Engineers, 1956.

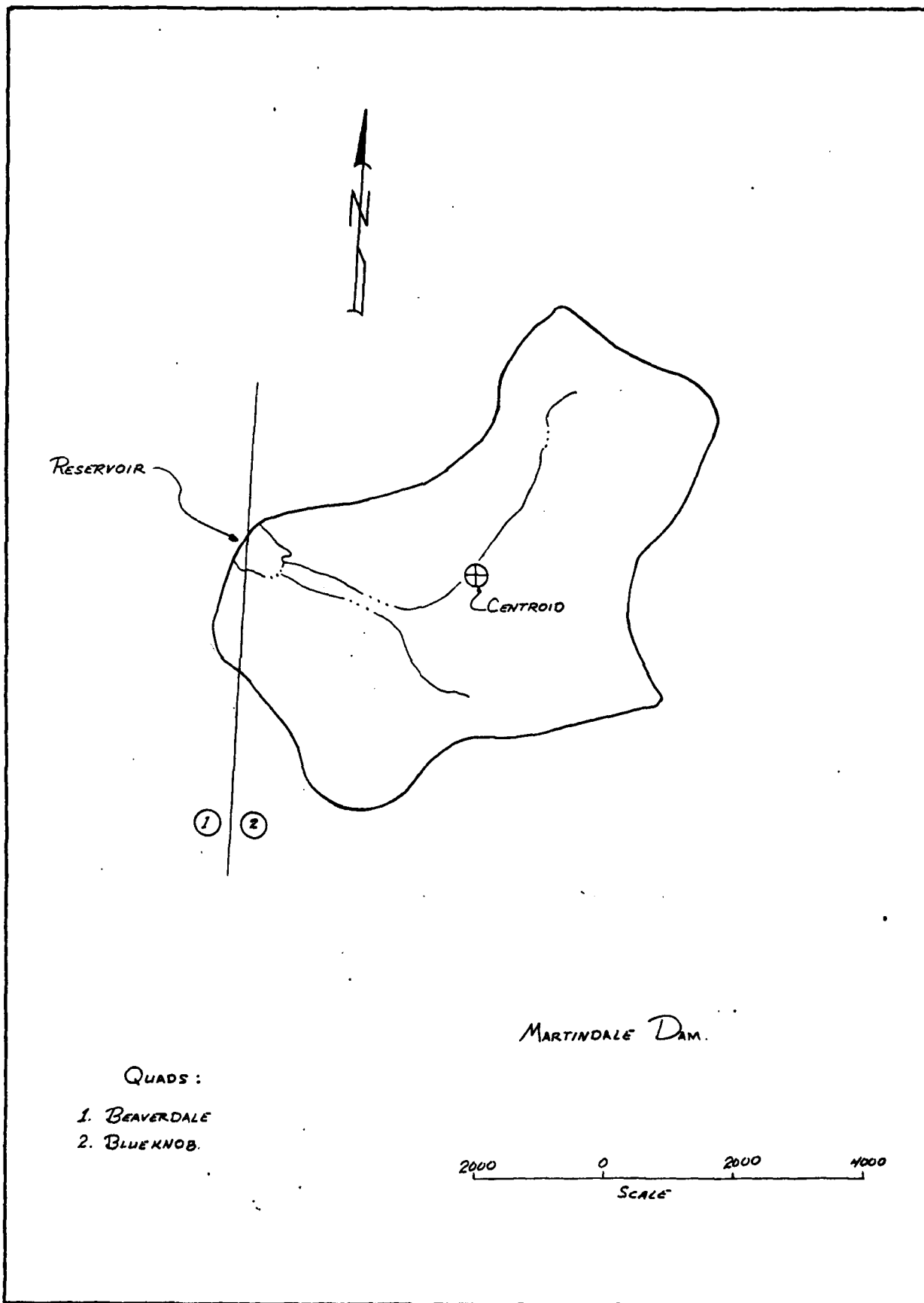
(2) Hydrometeorological Report 33 (Figure 2), U.S. Army, Corps of Engineers, 1956.

(3) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (C_p and C_t).

(4) Snyder's Coefficients.

(5) L = Length of longest water course from outlet to basin divide.

L_{ca} = Length of water course from outlet to point opposite the centroid of drainage area.



RESERVOIR

CENTROID

1 2

MARTINDALE DAM.

QUADS:

1. BEAVERDALE
2. BLUEKNOB.

2000 0 2000 4000
SCALE

MICHAEL BAKER, JR., INC.

THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject MASTINDOLE DAM

S.O. No. _____

TOP OF DAM PROFILE AND

Sheet No. 3 of 16

TYPICAL CROSS SECTION

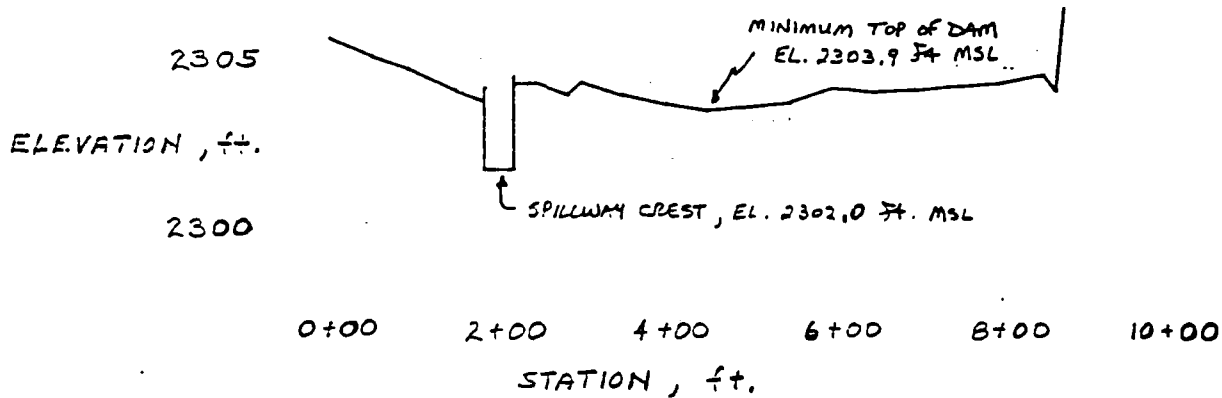
Drawing No. _____

Computed by LAD

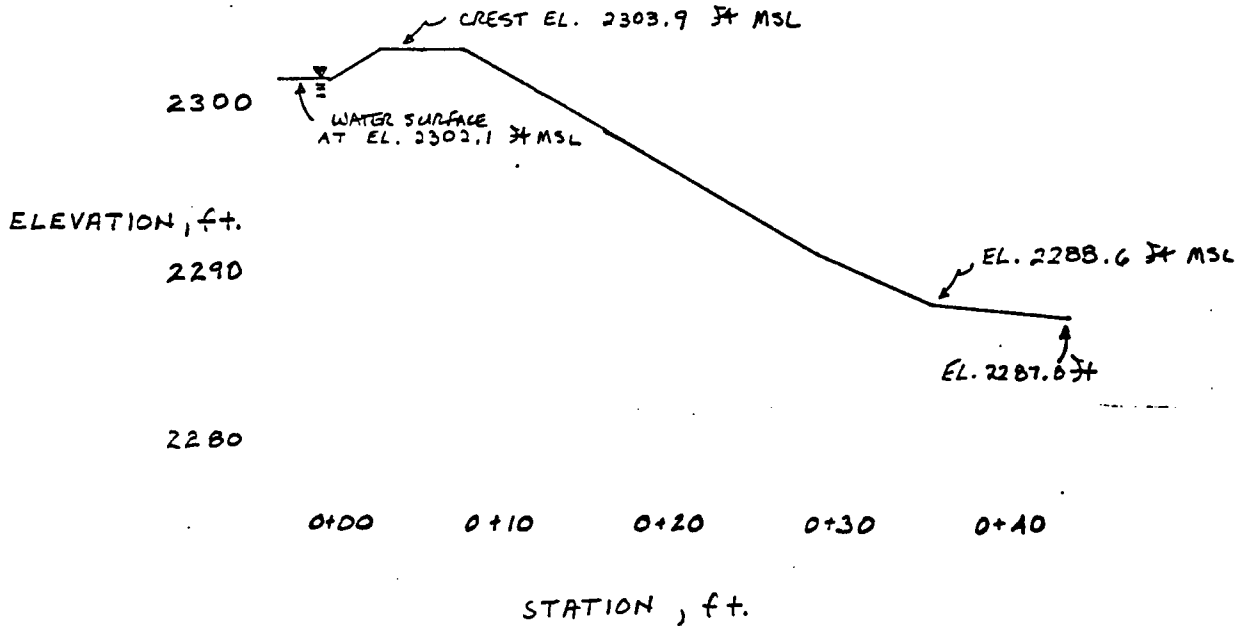
Checked by WDL

Date 7/1/80

TOP OF DAM PROFILE



CROSS SECTION AT STATION 4+00



MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject MARTINDALE DAM S.O. No. _____
HYDRAULIC DATA Sheet No. 4 of 16
Drawing No. _____
Computed by WDL Checked by LTH Date 7/1/80

STORAGE DATA :

ELEVATION V.S. SURFACE AREA

ELEVATION, FT.	AREA, ACRES	(MEASURED ON U.S.G.S. QUADS FOR AREA)
2302.0	8.88	(NORMAL POOL LEVEL)
2320	31.22	
2340	44.69	

ORIGINAL STORAGE AT NORMAL POOL = 17 M.G. (52.17 AC-FT)

CURRENT NORMAL POOL STORAGE IS ONLY 55% OF THE
ORIGINAL STORAGE BECAUSE OF SEDIMENTATION ;
CURRENT STORAGE IS 28.7 AC-FT AT EL. 2302 FT.

THIS STORAGE VALUE WAS DERIVED FROM OBSERVATIONS
MADE DURING THE INSPECTION, DISCUSSIONS WITH THE
OWNER'S REPRESENTATIVE, AND PICTURES TAKEN OF THE
RESERVOIR DURING DRY PERIODS. BASED ON THIS STORAGE VALUE
AND FIELD OBSERVATIONS, THE AVERAGE DEPTH OF THE RESERVOIR IS
ESTIMATED TO BE 5.6 FT ; RESERVOIR BOTTOM AREA ESTIMATED TO BE 2.1 AC.

SPILLWAY RATING CURVE DATA :

THE SPILLWAY WEIR IS A CONCRETE, BROAD-CRESTED WEIR .
WEIR LENGTH = 37 FT
WEIR BREADTH = 1.0 FT.

ELEVATION, FT	H, FT	C*	Q, cfs
2302.0	0	—	0
2302.4	0.4	2.72	25.5
2302.8	0.8	2.85	75.5
2303.2	1.2	3.08	149.8
2303.6	1.6	3.28	245.6
2304.0	2.0	3.30	345.4
2305.0	3.0	3.32	638.3

* DISCHARGE COEFFICIENT, FROM BRATER & KING, HANDBOOK OF HYDRAULICS,
TABLE 5-3, P. 5-40

 FLOOD HYDROGRAPH PACKAGE (HLL-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 26 FEB 79
 M&J UPDATE 04 JUN 79

RUN DATE 07/17/80
 TIME 13.38

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
 HYDROLOGIC AND HYDRAULIC ANALYSES OF MARTINDALE DAM
 UNIT GRAPH BY SNYDER'S METHOD

JOB SPECIFICATION

HQ	MHR	NMIN	TDAY	THR	THIN	METRC	IPLT	IPRT	INSTAN
300	0	30	0	0	0	0	0	-4	0
JOPER				NWT	LROPT	TRACE			
5				0	0	0	0		

MULTI-PLAN ANALYSES TO BE PERFORMED

RTIUS= 0.50 0.40 0.25 0.10
 NPLAN= 1 NRTIU= 4 LRTIU= 1

***** SUB-AREA RUNOFF COMPUTATION *****

RJNDFF HYDROGRAPH TO DAM

ISTAQ	ICOMP	TECON	ITAPE	JPLT	JPRY	IRAVE	ISTAGE	IAUID
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

INHYG	IUNG	TAREA	SNAP	IRSDA	IRSPC	RATIU	ISNOW	ISAME	LUCAL
1	1	1.15	0.0	1.15	0.0	0.0	0	0	0

PRECIP DATA

SPEE	PMS	R6	R12	R24	R48	R72	R96
0.0	23.70	102.00	120.00	130.00	140.00	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LGSS DATA

LROPT	STRKR	ULTR	RTIOL	ERAIN	STRAS	RTIUK	STRIL	CNSTL	ALSAR	RTIMP
0	0.0	0.0	1.00	0.0	0.0	1.00	1.00	0.05	0.0	0.0

UNIT HYDROGRAPH DATA

IP= 1.72 CP=0.45 NTA= 0

RECESSION DATA

STRIU= -1.50 ORCSH= -0.05 RTIUR= 2.00

UNIT HYDROGRAPH 31 END-OF-PERIOD ORDNATES, LAG= 1.70 HOURS, CP= 0.45 VUL= 1.00

27.	96.	167.	189.	167.	140.	116.	97.	81.	67.
56.	47.	39.	32.	27.	23.	19.	16.	13.	11.
9.	3.	6.	5.	4.	4.	3.	3.	2.	2.
1.									

SHEET 6 OF 14

SHEET 7 OF 10

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 FEET (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN RATIO	RATIO 1	RATIO 2	RATIO 3	RATIO 4
HYDROGRAPH AT	1	1.15	1	1234.	987.	617.	247.
		2.98		34.95	27.96	17.47	6.99
ROUTED TO	2	1.15	1	1232.	985.	613.	236.
		2.98		34.89	27.89	17.37	6.81

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 2302.00 29. 0.	SPILLWAY CREST 2302.00 29. 0.	TOP OF DAM 2303.90 47. 320.	RATIO OF PMF	MAXIMUM RESERVOIR A.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME UP MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
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21												
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39												
40												
41												
42												
43												
44												
45												
46												
47												
48												
49												
50												
51												
52												
53												
54												
55												
56												
57												
58												
59												
60												

THE DAM, RESERVOIR, AND SPILLWAY CAN PASS 16% OF THE PMF WITHOUT OVERTOPPING THE DAM.

DAM BREACH ANALYSIS

ELJUD HYDROGRAPH PACKAGE (REV-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 26 FEB 79
 ABL UPDATE 04 JUN 79

PLAN 1 - NON-FAILURE CASE									
PLAN 2 - FAILURE CASE									
NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS									
HYDROLOGIC AND HYDRAULIC ANALYSES OF MARTINVALE DAM									
UNIT GRAPH BY SNYDER'S METHOD									
1	A1	300	0	5	0	0	0	0	0
2	A2	300	0	5	0	0	0	0	0
3	A3	300	0	5	0	0	0	0	0
4	B1	300	0	5	0	0	0	0	0
5	J1	2	1	1	1	1	1	1	1
6	J1	0.5	1	1	1	1	1	1	1
7	K1	1	1	1	1	1	1	1	1
8	K1	1	1	1	1	1	1	1	1
9	K1	1	1	1	1	1	1	1	1
10	M1	1	1	1	1	1	1	1	1
11	P1	23.7	102	120	130	140	140	140	140
12	T1	1.72	0.45	2.0	1.0	0.05	1.0	0.05	1.0
13	X1	1.72	0.45	2.0	1.0	0.05	1.0	0.05	1.0
14	X1	-1.5	-0.05	2.0	1.0	0.05	1.0	0.05	1.0
15	K1	1	1	1	1	1	1	1	1
16	K1	1	1	1	1	1	1	1	1
17	Y1	1	1	1	1	1	1	1	1
18	Y1	1	1	1	1	1	1	1	1
19	Y1	1	1	1	1	1	1	1	1
20	Y1	1	1	1	1	1	1	1	1
21	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
22	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
23	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
24	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
25	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
26	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
27	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
28	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
29	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
30	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
31	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
32	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
33	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
34	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
35	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
36	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
37	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
38	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
39	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
40	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
41	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
42	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7
43	SA	2.1	8.9	31.2	46.7	46.7	46.7	46.7	46.7

 FLUJIC HYDROGRAPH PACKAGE (HLC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 26 FEB 79
 HBJ UPDATE 04 JUN 79

RUN DATE 07/21/80
 TIME 16.03

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
 HYDROLOGIC AND HYDRAULIC ANALYSES OF MARTINDALE DAM
 UNIT GRAPH BY SNYDER'S METHOD

JOB SPECIFICATION
 NJ NIK NMIN LUAY THR INTH METIC IPLI IPKI NSTAN
 300 0 5 0 0 0 0 0 0 0 0 0
 JUPER NWI LKUPI ISADE U
 5 0 0 0 0

MULTI-PLAN ANALYSES TO BE PERFORMED
 NPLAN= 2 NRTIU= 1 LRTIU= 1

RTIUS= 0.50

SUB-AREA RUNOFF COMPUTATION

KJNUIF HYDROGRAPH TO DAM

ISTAJ ICOMP ILCON ITAPE JPLT JPKI INAME ISAGE IAUU
 1 0 0 0 0 0 1 0 0

HYDROGRAPH DATA

IHYDU IUNG TAREA SNAP TRSDA TRSPL NATIU ISNUM ISADE LOCAL
 1 1 1.15 0.0 0.0 0.0 0.0 0 1 0

PRECIP DATA

SPEL PMS R6 R12 R24 R48 R72 R96
 0.0 23.70 102.00 120.00 130.00 140.00 0.0 0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LESS DATA

LKOPT STAKA ULTKR RTIUL ERAIN STAKS KTIUK SIKIL L-51L ALMAA NLTMP
 0 0.0 0.0 1.00 0.0 0.0 1.00 1.00 0.02 0.0 0.0

UNIT HYDROGRAPH DATA

IP= 1.72 CP=0.45 HIA= 0

RECESSION DATA

SIKIU= -1.50 URUSH= -0.02 RTIUK= 2.00

UNIT HYDROGRAPH LLOU END-OF-PERIOD ORIGINATES, LAUT 1.73 HUKAS, LPS 0.73 VUL= 0.93
 2. 7. 15. 24. 35. 47. 60. 73. 87. 102.
 117. 131. 145. 157. 168. 177. 185. 192. 197. 199.
 200. 197. 192. 186. 180. 173. 162. 149. 135. 118.
 150. 146. 141. 137. 133. 127. 125. 121. 116. 114.

[illegible]

BEGIN UAM FAILURE AT 40.17 HOURS

PEAK OUTFLOW IS 1862. AT TIME 40.67 HOURS

HYDROGRAPH ROUTING														
ROUTING OF FLOW TO SECTION 550 FEET U/S FROM JAM														
ISTAQ	ICUMP	ICUN	ITAPE	JVLT	JPKT	INAME	ISTAGE	IAUTU						
2	1	0	0	0	0	1	0	0						
ALL PLANS HAVE SAME ROUTING DATA														
CLS5	CLS5	AVG	RES	ISAME	LOPI	IPMP	LSIK							
0.0	0.0	0.0	1	1	0	0	0							
NSTPS	NSTOL	LAG	AMSK	A	ISK	STOKA	LSPRAT							
1	0	0	0.0	0.0	0.0	0.0	0.0							
NORMAL DEPTH CHANNEL ROUTING														
QML1	QML2	ELNVI	ELMAX	RLNTH	SEL									
0.0550	0.0450	2291.0	2340.0	550.0	0.00910									
CHUSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC														
0.0	2340.00	250.00	2300.00	650.00	2294.00	653.00	2291.00	650.00	2291.00					
650.00	2294.00	710.00	2300.00	1050.00	2340.00									
STORAGE	0.0	0.18	1.21	4.33	9.53	10.03	25.59	36.43	49.13	63.70				
	80.14	98.44	118.62	140.66	164.56	190.56	218.00	247.52	276.91	312.16				
OUTFLOW	0.0	56.81	113.78	183.82	250.59	310.74	368.90	425.00	480.00	534.13	587.45			
	86333.56	11378.25	145388.06	182365.56	224703.86	272669.31	326600.19	386108.38	452681.50	526519.38	60642.05			
STAGE	2291.00	2293.28	2298.16	2298.74	2301.32	2303.89	2305.97	2308.00	2309.02	2311.03	2314.21			
	2316.79	2319.37	2321.95	2324.53	2327.10	2329.68	2332.26	2334.84	2337.42	2340.00	2342.58			
ELUM	0.0	56.81	113.78	183.82	250.59	310.74	368.90	425.00	480.00	534.13	587.45	63.70		
	86333.56	11378.25	145388.06	182365.56	224703.86	272669.31	326600.19	386108.38	452681.50	526519.38	60642.05			
MAXIMUM STAGE IS 2297.6														
MAXIMUM STAGE IS 2298.6														
HYDROGRAPH ROUTING														
ROUTING OF FLOW TO SECTION 1700 FEET U/S FROM JAM														
ISTAQ	ICUMP	ICUN	ITAPE	JVLT	JPKT	INAME	ISTAGE	IAUTU						
3	1	0	0	0	0	1	0	0						

SHEET 13 of 16

ALL PLANS HAVE SAME

[illegible]

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS				
FLOWS IN CUBIC FEET PER SECOND (CULC. METERS PER SECOND)				
AREA IN SQUARE MILES (SQUARE KILOMETERS)				
OPERATION	STATION	AREA	PLAN RATIO 1	RATIOS APPLIED TO FLOWS
			0.50	
HYDROGRAPH AT	1	1.15	1	1235.
	1	2.98	1	34.96
			2	1235.
			1	34.96
ROUTED TO	2	1.15	1	1235.
	1	2.98	1	34.50
			2	1862.
			1	52.73
ROUTED TO	2	1.15	1	1235.
	1	2.98	1	34.90
			2	1803.
			1	51.07
ROUTED TO	3	1.15	1	1235.
	1	2.98	1	34.50
			2	1766.
			1	50.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.83	56.	1233.	8.33	51.33	6.0				
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 2											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.61	54.	1862.	2.29	40.61	40.11				
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 3											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 4											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 5											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 6											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 7											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 8											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 9											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 10											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 11											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 12											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 13											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 14											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 15											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 16											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 17											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 18											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 19											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 20											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 21											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 22											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 23											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 24											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 25											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 26											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
STORAGE		2302.00	2302.00	2303.90							
OUTFLOW		29.	29.	47.							
		0.	0.	320.							
RATIO OF PHE											
MAXIMUM DEPTH OVER DAM		0.50	1232.	2291.6	41.42						
MAXIMUM STORAGE AC-FT											
MAXIMUM UOIFLOW CFS											
DURATION OVER TOP											
TIME OF FAILURE											
PLAN 27											
ELEVATION		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM							
ST											

APPENDIX E

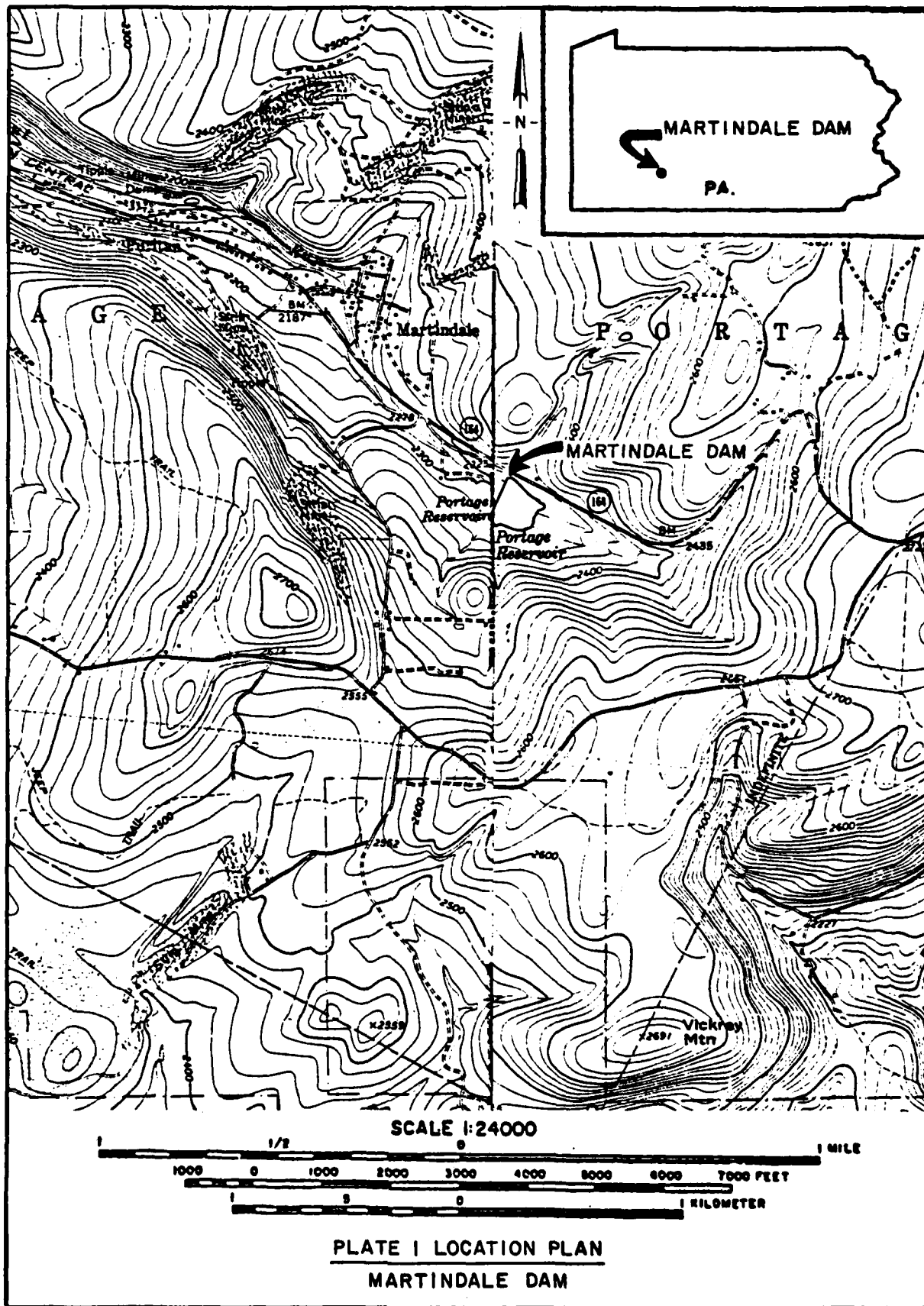
PLATES

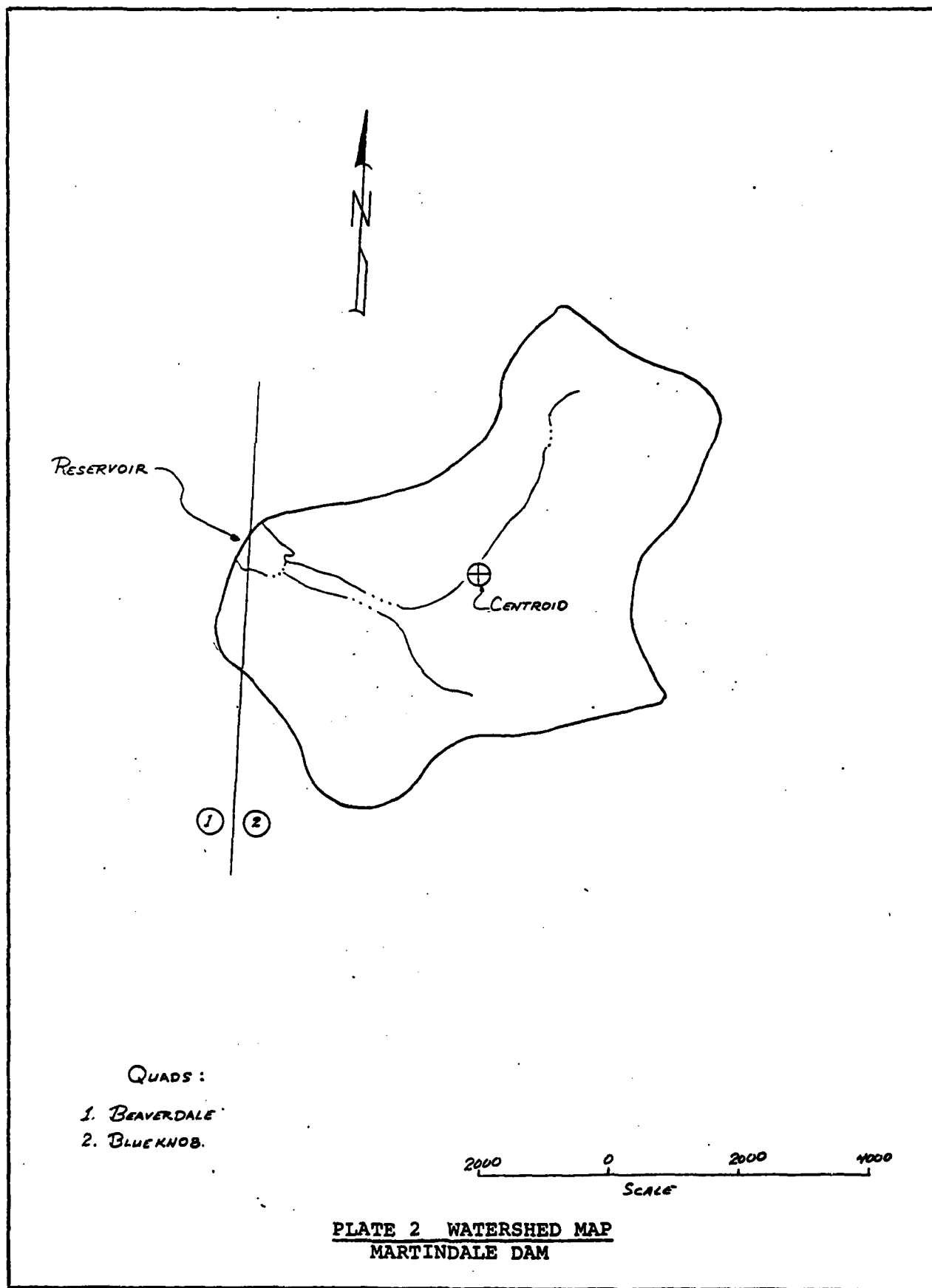
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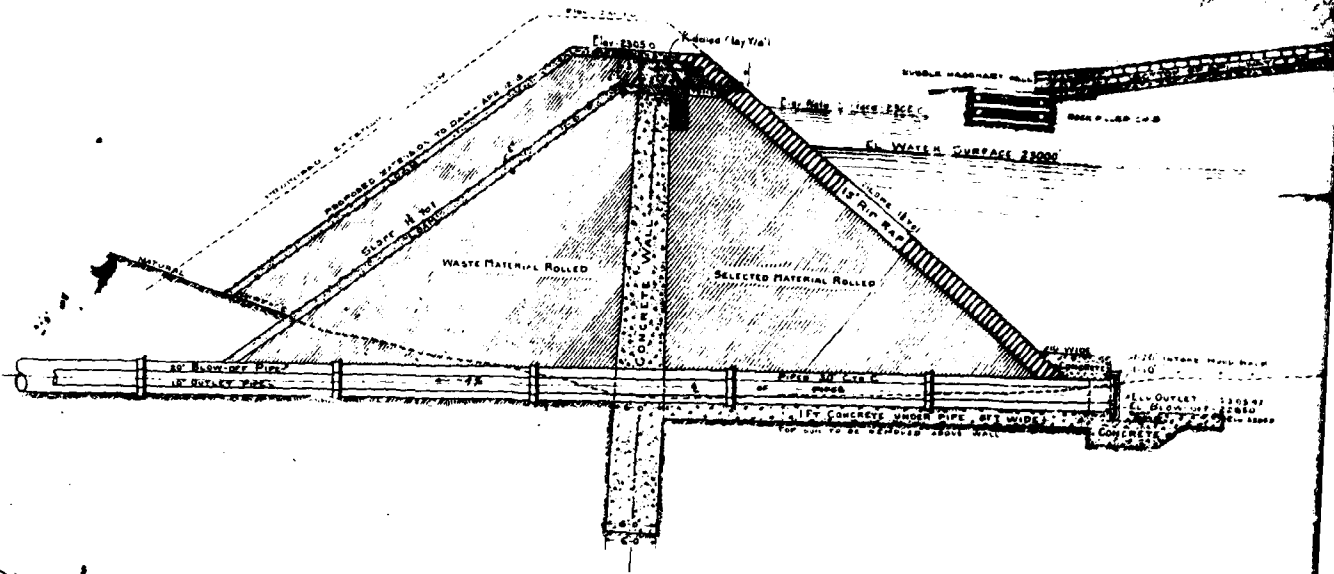
Plate 1 - Location Plan

Plate 2 - Watershed Map

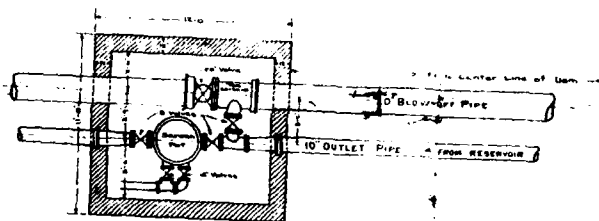
Plate 3 - Original Design Plan and Typical Cross-Section



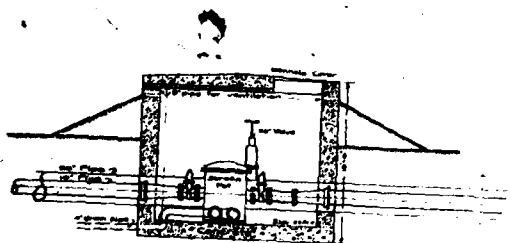




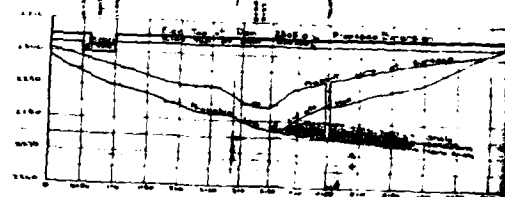
SECTION AT OUTLET PIPE
STA. 2+27
SCALE - 1"=4'



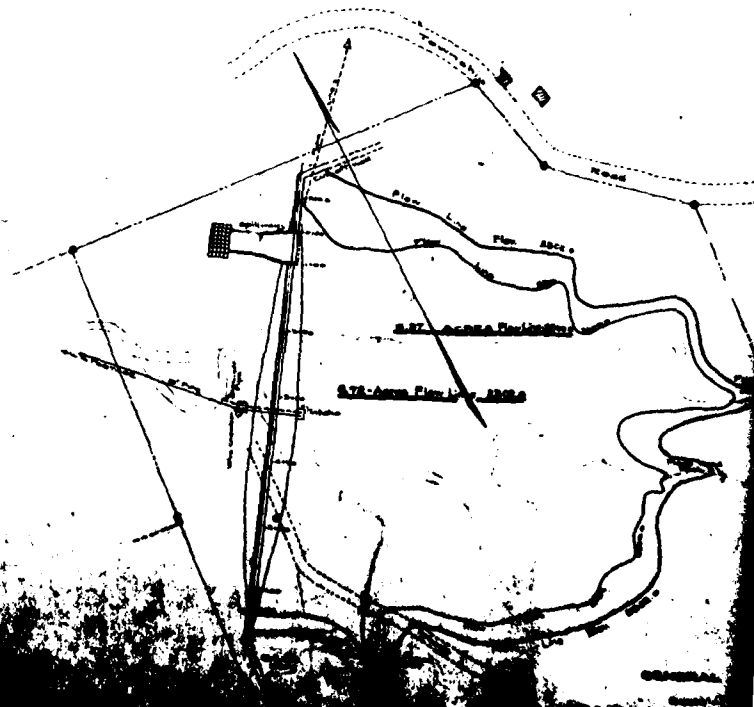
PLAN OF VALVE CHAMBER
Scale - 1"=4'

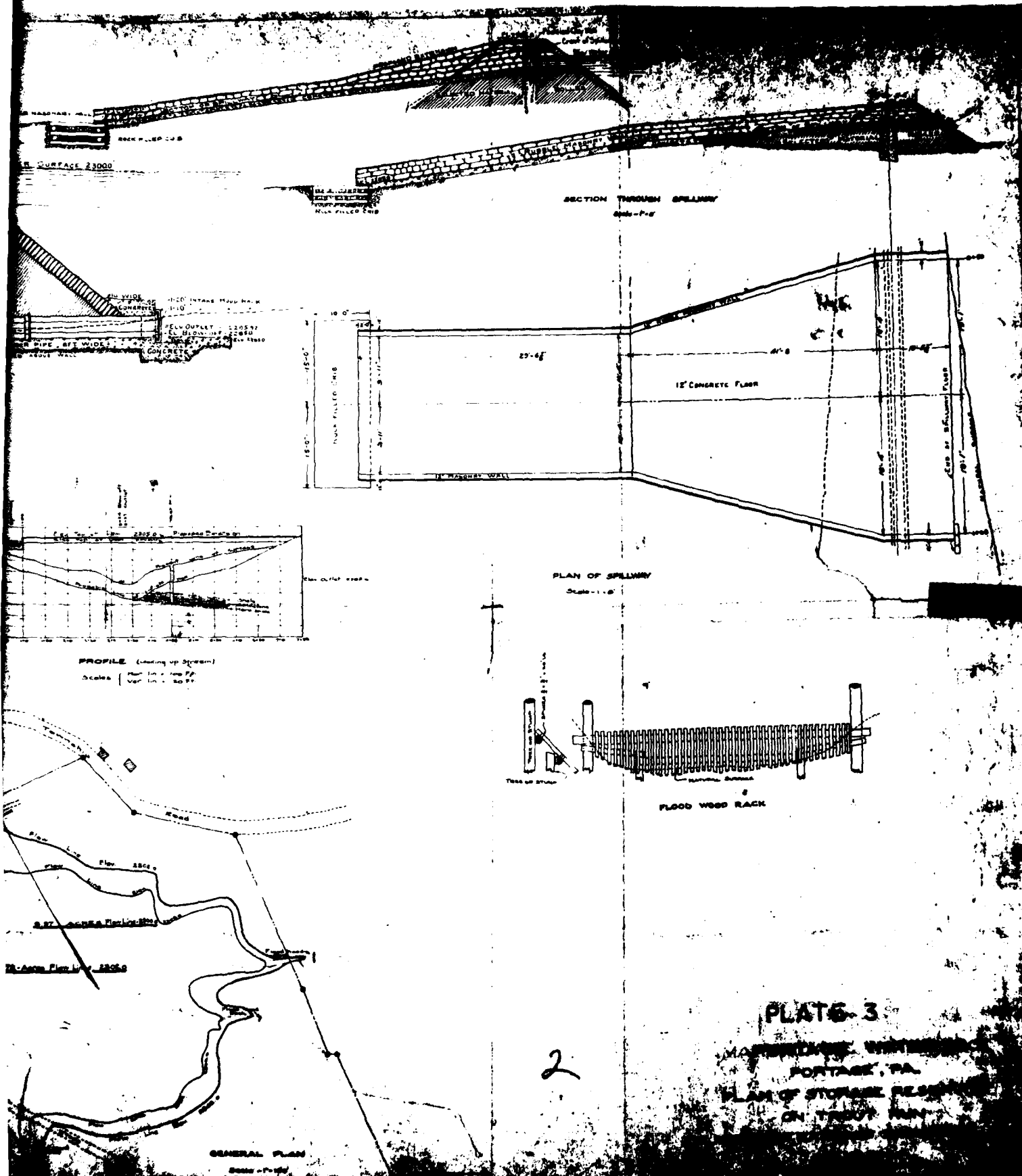


SECTION OF VALVE CHAMBER
Scale - 1"=4'



PROFILE (Looking up Stream)
Scale - 1"=100' H
1"=50' V





APPENDIX F

REGIONAL GEOLOGY

MARTINDALE DAM
NDI PA 00444, PennDER No. 11-17
CAMBRIA COUNTY

REGIONAL GEOLOGY

Martindale Dam is located in an unglaciated section of the Appalachian Plateaus physiographic province. Bedrock units below the dam are members of the Mauch Chunk formation, Mississippian system. This formation consists primarily of red shale and claystone with gray to greenish-gray sandstone and siltstones.

No major coal seams are located beneath the dam even though the mining of the Upper and Lower Kittanning seams has taken place just west of the Borough of Martindale.



LEGEND

PERMIAN



Greene Formation

Cyclic sequences of sandstone, shale, red beds, limestone and coal, base at the top of the Upper Washington Limestone.

PERMIAN AND PENNSYLVANIAN



Washington Formation

Cyclic sequences of sandstone, shale, limestone and coal, some red shale, some mineable coal, base at the top of the Waynesburg Coal.

PENNSYLVANIAN

APPALACHIAN PLATEAU



Monongahela Formation

Cyclic sequences of sandstone, shale, limestone and coal; limestone prominent in northern outcrop areas, shale and sandstone increase southward, commercial coals present, base at the bottom of the Pittsburgh Coal.



Conemaugh Formation

Cyclic sequences of red and gray shales and siltstones with thin limestones and coals, massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of section, Brush Creek Limestone in lower part of section.



Allegheny Group

Cyclic sequences of sandstone, shale, limestone and coal, numerous commercial coals, limestones thicken westward; Vanport Limestone in lower part of section, includes Freeport, Kittanning, and Clarion Formations.



Pottsville Group

Predominantly sandstones and conglomerates with thin shales and coals, some mineable locally.

ANTHRACITE REGION



Post-Pottsville Formations

Brown or gray sandstones and shales with some conglomerate and numerous mineable coals.



Pottsville Group

Light gray to white, coarse grained sandstones and conglomerates with some mineable coal, includes Sharp Mountain, Schuylkill, and Tumbling Run Formations.

MISSISSIPPIAN



Mauch Chunk Formation

Red shales with brown to greenish gray flaggy sandstones, includes Greenbrier Limestone in Fayette, Westmoreland, and Somerset counties, Loyalhanna Limestone at the base in southwestern Pennsylvania.



Pocono Group

Predominantly gray, hard, massive, cross-bedded conglomerates and sandstone with some shale, includes in the Appalachian Plateau, Harp, Shenando, Cumber, Cussewago, Corry, and Keokuk Formations, includes part of "Onondaga" of M. L. Fuller in Potter and Tioga counties.

WESTERN PENNSYLVANIA



Onaway Formation

Greenish gray to gray shales, siltstones and sandstones becoming increasingly shaly westward, considered equivalent to type Onaway, Riceville Formation Dr in Erie and Crawford Counties; probably not distinguishable north of Corry.



Cattaraugus Formation

Red, gray and brown shale and sandstone with the proportion of red decreasing westward, includes Venango, much of drillers and Salamanca sandstone and conglomerate, some limestone in Crawford and Erie counties.



Conneaut Group

Alternating gray, brown, greenish and purplish shales and siltstones, includes "pink rock" of drillers and "Chemung" and "Givens" Formations of northwestern Pennsylvania.



Canadaway Formation

Alternating brown shales and sandstones, includes "Putage" Formation of northwestern Pennsylvania.

