

LEVEL



**SUSQUEHANNA RIVER BASIN
WEST BRANCH OF LACKAWANNA RIVER, SUSQUEHANNA COUNTY
PENNSYLVANIA**

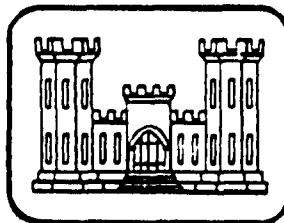
ROMOBE LAKE DAM

NDI No. PA 00051

PennDER No. 58-10

Dam Owner: Mr. Michael Puskas

**PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM**



prepared for

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

prepared by

MICHAEL BAKER, JR., INC.

**Consulting Engineers
4301 Dutch Ridge Road
Beaver, Pennsylvania 15009**

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April 1981

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SUSQUEHANNA RIVER BASIN

ROMOBE LAKE DAM
SUSQUEHANNA COUNTY, COMMONWEALTH OF PENNSYLVANIA
NDI No. PA 00051
PennDER No. 58-10

⑥ PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Romobe Lake Dam (NDI Number PA-00051
PennDER Number - 58-10). Susquehanna River
Basin. West Branch of Susquehanna River,
Susquehanna County, Pennsylvania. Phase I

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

Prepared by: MICHAEL BAKER, JR., INC.
Consulting Engineers
4301 Dutch Ridge Road
Beaver, Pennsylvania 15009

Contract DACW31-81-C-0011

⑪ Apr 81

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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.

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Romobe Lake Dam, Susquehanna County, Pennsylvania
NDI No. PA 00051, PennDER No. 58-10
West Branch of Lackawanna River
Inspected 1 November 1980

ASSESSMENT OF
GENERAL CONDITIONS

Romobe Lake Dam is owned by Mr. Michael Puskas and is classified as a "Significant" hazard - "Small" size dam. The dam was found to be in poor 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 spillway will not pass the 100-year flood without overtopping the dam. A spillway design flood (SDF) in the range of the 100-year flood to the 1/2 Probable Maximum Flood (1/2 PMF) is required for Romobe Lake Dam. Because the dam is on the low end of the "Small" size category in terms of height and storage capacity, the 100-year flood was chosen as the SDF. During the 100-year flood, the dam is overtopped by a maximum depth of 2.0 feet for a total duration of 40.3 hours. The spillway is therefore considered "Inadequate." It is recommended that the owner immediately develop recommendations for remedial measures to reduce the overtopping potential of the dam.

Several items of remedial work should be immediately initiated by the owner. Item 1 below should be completed under the guidance of a qualified professional engineer experienced in the design of hydraulic structures for dams. These include:

- 1) Develop remedial measures to ensure that the dam is not overtopped by the 100-year flood.
- 2) Remove the debris and silt at the entrance to the spillway.
- 3) Repair the dam where overtopping has occurred.
- 4) Cut the brush on the dam.

ROMOBE LAKE DAM

- 5) Cut the brush in the spillway discharge channel.
- 6) Clear the debris and cut the brush in the channel immediately downstream of the dam.
- 7) Provide means to draw down the reservoir during an emergency.

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 rain, provide around-the-clock surveillance of the dam.
- 3) When warning of a storm of major proportions is given by the National Weather Service, activate the emergency operation and warning system.

It is further recommended that formal inspection, maintenance, and operation procedures and records be developed and implemented. A plan for emergency drawdown of the reservoir should be developed in case an emergency drawdown should become necessary. These should be included in a formal maintenance and operations manual for the dam.

Submitted by:

MICHAEL BAKER, JR., INC.

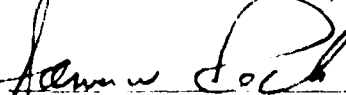


John A. Dziubek, P.E.
Engineering Manager-Geotechnical

Date: 24 April 1981

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS



JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 11 May 81

ROMOBE LAKE DAM



Overall View of Upstream Face of Dam (Looking Downstream)



Overall View of Downstream Face of Dam from Left Abutment

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
ROMOBE LAKE DAM
NDI No. PA 00051, PennDER No. 58-10

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 - Romobe Lake Dam is a dry masonry dam with a height of 8 feet and a crest length of 74 feet. The embankment has a crest width of 2.5 feet and an upstream side slope ranging from 6H:1V (Horizontal to Vertical) to 3H:1V. The downstream face of the dam was originally an 8-foot high vertical masonry wall. This wall was strengthened in 1919 or 1920 by dumping stones over the downstream wall to form a stone embankment. The stones have settled and the downstream embankment now drops 1.5 feet from the crest before the rock fill forms a stone embankment with a slope of 2.4H:1V. The dam has a minimum crest elevation of 1970.0 feet Mean Sea Level (ft. M.S.L.).

The spillway is a grass-lined trapezoidal channel located on the left abutment. It has a bottom width of approximately one foot, a maximum top width of five feet, and a maximum depth of approximately 1.5 feet. The channel entrance has a crest elevation of 1969.1 ft. M.S.L. The spillway has a slope of 5%. The discharge channel has a moderate slope and is well vegetated.

A 12-inch cast iron pipe (CIP) was originally laid through the dam to provide an outlet to drain the reservoir. A valve located on the upstream side of the wall was to be operated with a long handled

valve key. Stones used to strengthen the dam block the pipe outlet, and sediment has probably covered the inlet works. There was no evidence of this facility during the field inspection.

- b. Location - Romobe Lake Dam is located on the West Branch of the Lackawanna River, approximately 1.4 miles south-southeast of Ararat, Pennsylvania. The structure is located in Ararat Township, Susquehanna County, Pennsylvania. The coordinates for the dam are N 41° 48.6' and W 75° 30.9'. The dam and reservoir are shown on USGS 7.5 minute topographic quadrangle, Thompson, Pennsylvania.
- c. Size Classification - The height of the dam is 8 feet. The reservoir volume to the top of the dam, elevation 1970.0 ft. M.S.L., is 195 acre-feet. Therefore, the dam is in the "Small" size category.
- d. Hazard Classification - Hathaway Pond Dam is located 3000 feet downstream of Romobe Lake Dam. Hathaway Pond Dam is in the "Significant" hazard category. There are no areas between Romobe Lake and Hathaway Pond Dam which are likely to be damaged in the event of dam failure. However, a damage center of two houses, a trailer and road, located 1800 feet downstream of Hathaway Pond Dam, would be affected if Romobe Lake Dam were to fail. These structures range from less than 5 feet above the streambed to approximately 10 feet above the streambed. Therefore, Romobe Lake Dam is considered to be in the "Significant" hazard category.
- e. Ownership - The dam and reservoir are owned by Michael Puskas, 420 Lackawana Drive, Olyphant, Pennsylvania.
- f. Purpose of the Dam - The reservoir is used for recreational purposes.
- g. Design and Construction History - The original design, date of construction and the builder of the dam are unknown. The first record of the dam is an information survey report dated 1914. Around 1920, stones were placed against the vertical downstream face to increase the stability of the dam, as directed by the Water Supply Commission in 1919.
- h. Normal Operating Procedures - There is no formal operating procedure for the dam. The water level is normally maintained at or near the spillway crest, elevation 1969.1 ft. M.S.L.

1.3 PERTINENT DATA

a.	<u>Drainage Area (square miles) -</u>	0.98
b.	<u>Discharge at Dam Site (c.f.s.) -</u>	
	Maximum Flood	Unknown
	Spillway Capacity at Maximum Pool (El. 1970.0 ft. M.S.L.) -	5
c.	<u>Elevation* (feet above Mean Sea Level [ft. M.S.L.]) -</u>	
	Design Top of Dam -	Unknown
	Minimum Top of Dam -	1970.0
	Maximum Design Pool -	Unknown
	Spillway Crest -	1969.1
	Streambed at Toe of Dam	1962.3
	Maximum Tailwater of Record -	Unknown
d.	<u>Reservoir (feet) -</u>	
	Length of Maximum Pool (El. 1970.0 ft. M.S.L.) -	3050
	Length of Normal Pool (El. 1969.1 ft. M.S.L.) -	2800
e.	<u>Storage (acre-feet) -</u>	
	Top of Dam (El. 1970.0 ft. M.S.L.) -	195
	Normal Pool (El. 1969.1 ft. M.S.L.) -	162
f.	<u>Reservoir Surface (acres) -</u>	
	Top of Dam (El. 1970.0 ft. M.S.L.) -	36.9
	Normal Pool (El. 1969.1 ft. M.S.L.) -	35.6
g.	<u>Dam -</u>	
	Type - Dry masonry	
	Total Length Not Including Spillway (feet) -	74
	Height (feet) - Design -	Unknown
	Field -	8
	Top Width (feet) -	2.5
	Side Slopes - Upstream -	6H:1V to 3H:1V
	Downstream -	2.4H:1V
	Zoning -	None
	Impervious Core -	None
	Cut-off -	None
	Drains -	None

*All elevations are referenced to the minimum crest of the dam, El. 1970.0 ft. M.S.L., as estimated from the USGS 7.5 minute topographic quadrangle, Thompson, Pennsylvania.

- h. Diversion and Regulating Tunnels - None
- i. Spillway -
- Type - Grass-lined trapezoidal channel
Location - Left abutment
Bottom Width (feet) - 1
Top Width (feet) - 5
Crest Elevation (ft. M.S.L.) - 1969.1
Gates - None
Downstream Channel - Well vegetated with moderate slope
- j. Outlet Works - None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Information reviewed for the preparation of this report consisted of File No. 58-10 of the Pennsylvania Department of Environmental Resources (PennDER). This included:

- 1) An inspection report, dated 29 May 1919, requiring some alterations to the dam because of an inadequate spillway; various correspondence about the alterations; and photos taken before and after these alterations.
- 2) Post construction inspection reports, the latest dated 17 August 1965, filed by PennDER, Division of Dams and Encroachments. No serious problems were reported and the dam was found to be in good condition.

2.2 CONSTRUCTION

The original design, the builder and the exact date of construction are unknown. Around 1920, stones were placed against the vertical downstream face to increase the stability of the dam. No "as built" or other plans were available for review.

2.3 OPERATION

No formal records are available for operation of the dam and reservoir. The reservoir is typically maintained at the spillway crest elevation (1969.1 ft. M.S.L.) and does not fluctuate much from this level.

2.4 EVALUATION

- a. Availability - The information used is readily available from PennDER's File No. 58-10.
- b. Adequacy - The information available combined with the visual inspection measurements and observations is adequate for a Phase I Inspection of this dam.
- c. Validity - There is no indication at the present time to doubt the validity of the available information.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

- a. General - The dam was found to be in poor overall condition at the time of inspection on 1 November 1980. No unusual weather conditions were experienced during the inspection. Noteworthy deficiencies observed during the visual inspection are described briefly in the following paragraphs. The complete visual inspection checklist, field sketch, top of dam profile, and typical cross-section are given in Appendix A.
- b. Dam - The dam shows evidence of having been overtopped. A comparison of the dam with photographs from a 1965 inspection indicates this overtopping has occurred subsequent to 1965. The dam is overgrown with brush.
- c. Appurtenant Structures - The spillway is a trapezoidal channel located on the left abutment of the dam. There are no outlet works in the dam. The control section (entrance) to the spillway is well vegetated and has an accumulation of debris and sediment. The discharge channel is overgrown with thick brush.
- d. Reservoir Area - The reservoir slopes are moderate and forested with no signs of instability. There are several islands located in the reservoir. There was no evidence that sedimentation is a significant problem in the reservoir.
- e. Downstream Channel - The downstream channel is clogged with debris and vegetation. There are no damage centers between Romobe Lake Dam and Hathaway Pond Dam. Hathaway Lake is located 1400 feet downstream of Romobe Lake Dam. Hathaway Pond Dam (NDI No. PA 00050, PennDER No. 58-06) is located 3000 feet downstream of Romobe Lake Dam. Hathaway Pond Dam is a "Small" size - "Significant" hazard dam. In a Phase I Inspection Report currently being prepared by Michael Baker, Jr., Inc., Hathaway Pond Dam was analyzed for a spillway design flood (SDF) equal to the 100-year flood. During the SDF, Hathaway Pond Dam is overtopped by a maximum depth of 0.98 foot for a total duration of 4.0 hours. Failure of Romobe Lake Dam is likely to

have an effect on Hathaway Pond Dam and increase flooding in the damage center downstream, consisting of two houses, one trailer and a township road, located 1800 feet downstream of Hathaway Pond Dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no formal written instructions for lowering the reservoir or evacuating the downstream area in case of an impending failure of the dam. It is recommended that formal emergency procedures be adopted, prominently displayed, and furnished to all operating personnel.

4.2 MAINTENANCE OF DAM

There are no formal records of maintenance or formal procedures for evaluating the necessity of maintenance for the structure. It is recommended that formal inspection procedures be developed.

4.3 MAINTENANCE OF OPERATING FACILITIES

There were no operating facilities observed at the dam. An emergency drawdown plan should be developed in case there is need to draw down the reservoir.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

At the present time, there is no warning system or evacuation plan in operation. It is recommended that a formal emergency procedure be prepared.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

A formal maintenance and operations manual, including drawdown provisions, should be prepared for the dam.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

- a. Design Data - No hydrologic or hydraulic design calculations are available for Romobe Lake Dam.
- b. Experience Data - No information concerning the effects of significant floods on the dam is available.
- c. Visual Observations - During the visual inspection, no problems were observed which would indicate that the dam and appurtenant facilities could not perform satisfactorily during a flood event.

There is a small pond upstream from Romobe Lake which is formed by a railroad embankment. This pond is not believed to have a significant effect on Romobe Lake.

- d. Overtopping Potential - Romobe Lake Dam is a "Small" size - "Significant" hazard dam requiring evaluation for a spillway design flood (SDF) in the range of the 100-year flood to the 1/2 Probable Maximum Flood (1/2 PMF). Because the dam is on the low end of the "Small" size category in terms of height and storage capacity, the 100-year flood was chosen as the SDF.

Using material from "The Hydrologic Study - Tropical Storm Agnes", prepared by The Corps of Engineers in New York City, the peak inflow to the impoundment for the 100-year flood was calculated to be 955 c.f.s. 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. Using these parameters, a peak inflow of 905 c.f.s. was obtained for the 100-year flood. This peak flow is within 5 percent of the peak flow calculated; therefore, this hydrograph was used for the hydrologic analysis.

The hydraulic capacity of the dam, reservoir, and spillway was then assessed by utilizing the U.S. Army Corps of Engineers' Flood Hydrograph Package, HEC-1 DB.

Analysis of the dam and spillway shows that during the 100-year flood the dam will be overtopped by a maximum depth of 2.0 feet for a duration of 40.3 hours.

- e. Spillway Adequacy - As outlined in the above analysis, the spillway will not pass the required SDF without overtopping the dam; therefore, the spillway is considered "Inadequate."

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observations - The dam shows evidence of being overtopped previously. The dam should be repaired and adequate spillway capacity provided.
- b. Design and Construction Data - No design or construction data were available for review. The dam was originally constructed with a vertical downstream face. This was later revised with the addition of rockfill, forming a 2.4H:1V downstream slope. Because of the low height of the dam, history of satisfactory performance of the modest slopes, and because no signs of distress were observed, no further stability analysis is deemed necessary for this Phase I Inspection Report.
- c. Operating Records - Nothing in the available operational information indicates concern relative to the structural stability of the dam.
- d. Post-Construction Changes - The addition of rockfill against the vertical downstream face increased the stability of the dam. No other changes are known.
- 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 - Romobe Lake Dam was found to be in poor overall condition at the time of inspection. Romobe Lake Dam is a "Significant" hazard - "Small" size dam requiring a spillway capacity in the range of the 100-year flood to the 1/2 PMF. Because Romobe Lake Dam is on the low end of the "Small" size category in terms of height and storage capacity, the 100-year flood was chosen as the SDF. As presented in Section 5, the spillway and reservoir are not capable of passing the 100-year flood without overtopping the dam. During the 100-year flood, the dam is overtopped by a maximum depth of 2.0 feet for a total duration of 40.3 hours. Therefore, the spillway is considered "Inadequate."
- b. Adequacy of Information - The information available and the observations made during the visual inspection are considered sufficient for a Phase I Inspection Report.
- c. Urgency - The owner should immediately initiate the further evaluation discussed in paragraph 7.1.d.
- d. Necessity for Additional Data/Evaluation - The hydraulic/hydrologic analysis performed in connection with this Phase I Inspection Report has indicated the need for additional spillway capacity. It is recommended that the owner, under the guidance of a professional engineer, develop remedial measures to ensure that the dam will not be overtopped by the 100-year flood.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The inspection revealed certain items of remedial work which should be performed by the owner without delay. Item 1 below should be completed by a qualified professional engineer experienced in the design of hydraulic structures for dams. These include:

- 1) Develop remedial measures to ensure that the dam will not be overtopped by the 100-year flood.

- 2) Remove the debris and silt at the entrance to the spillway.
- 3) Repair the dam where overtopping has occurred.
- 4) Cut the brush on the dam.
- 5) Cut the brush in the spillway discharge channel.
- 6) Clear the debris and cut the brush in the channel immediately downstream of the dam.
- 7) Provide means to draw down the reservoir during an emergency.

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 rain, provide around-the-clock surveillance of the dam.
- 3) When warning of a storm of major proportions is given by the National Weather Service, activate the emergency operation and warning system.

It is further recommended that formal inspection, maintenance, and operation procedures and records be developed and implemented. An emergency drawdown plan should be developed in case an emergency drawdown should become necessary. These should be included in a formal maintenance and operations manual for the dam.

APPENDIX A

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

Check List
Visual Inspection
Phase 1

Name of Dam Romobe Lake Dam County Susquehanna State PA Coordinates Lat. N 41°48.6'

NDI # PA 00051
PennDER # 58-10

Long. W 75°30.9'

Date of Inspection 1 November 1980

Weather Overcast,
snow flurries

Temperature 40° F.

1969.7

Pool Elevation at Time of Inspection ft. 1962.3 M.S.L.* Tailwater at Time of Inspection ft. M.S.L.

*All elevations are referenced to the minimum top of dam, elevation 1970.0 ft. M.S.L., as estimated from the USGS 7.5 minute topographic quadrangle, Thompson, PA.

Inspection Personnel:

Michael Baker, Jr., Inc.:

Owner's Representatives:

James G. Ulinski
Wayne D. Lasch
Jeffrey S. Maze

James G. Ulinski Recorder

MASONRY DAMS

Name of Dam: ROMOBE LAKE DAM
NDI # PA 00051

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	No problems observed.	
DRAINS	None	
WATER PASSAGES	None	
FOUNDATION	No problem observed.	

MASONRY DAMS

Name of Dam: ROMOBE LAKE DAM
 NDI # PA 00051

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Not applicable	
STRUCTURAL CRACKING	Not applicable	
VERTICAL AND HORIZONTAL ALIGNMENT	The dam shows evidence of having been overtopped previously. This over- topping must have occurred since the last inspection photographs were taken (1965).	The dam should be repaired and an adequate spillway provided.
MONOLITH JOINTS	Not applicable	
CONSTRUCTION JOINTS	Not applicable	
VEGETATION	The dam is overgrown with brush.	Cut the brush.

A-4

EMBANKMENT - Not Applicable

Name of Dam ROMOBE LAKE DAM

NDI # PA 00051

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
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SURFACE CRACKS

UNUSUAL MOVEMENT OR
CRACKING AT OR BEYOND
THE TOE

SLOUGHING OR EROSION OF
EMBANKMENT AND ABUTMENT
SLOPES

EMBANKMENT - Not Applicable

Name of Dam ROMOBE LAKE DAM

NDI # PA 00051

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

VERTICAL AND HORIZONTAL
ALIGNMENT OF THE CREST

RIPRAP FAILURES

EMBANKMENT - Not Applicable

Name of Dam ROMOBE LAKE DAM

NDI # PA 00051

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM		

ANY NOTICEABLE SEEPAGE

STAFF GAGE AND RECORDER

DRAINS

OUTLET WORKS - Not Applicable

Name of Dam: ROMOBE LAKE DAM
 NDI # PA 00051

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT		

INTAKE STRUCTURE

OUTLET STRUCTURE

OUTLET CHANNEL

EMERGENCY GATE

A-8

UNGATED SPILLWAY

Name of Dam: ROMOBE LAKE DAM
NDI # PA 00051

VISUAL EXAMINATION OF		OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONTROL SECTION		The control section is well vegetated. Debris and an accumulation of sediment has been deposited at the entrance (control section) of the channel.	Remove the debris and sediment.

APPROACH CHANNEL The reservoir forms the approach channel.

DISCHARGE CHANNEL The discharge channel is overgrown with thick brush. Cut the brush.

BRIDGE AND PIERS None

GATED SPILLWAY - Not Applicable

Name of Dam: ROMOBE LAKE DAM

NDI # PA 00051

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

CONCRETE SILL

APPROACH CHANNEL

DISCHARGE CHANNEL

BRIDGE AND PIERS

GATES AND OPERATION
EQUIPMENT

INSTRUMENTATION

Name of Dam: ROMOBE LAKE DAM

NDI # PA 00051

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

A-11

RESERVOIR

Name of Dam: ROMOBE LAKE DAM
NDI # PA 00051

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The reservoir slopes are moderate (5°-15°) and forested.	

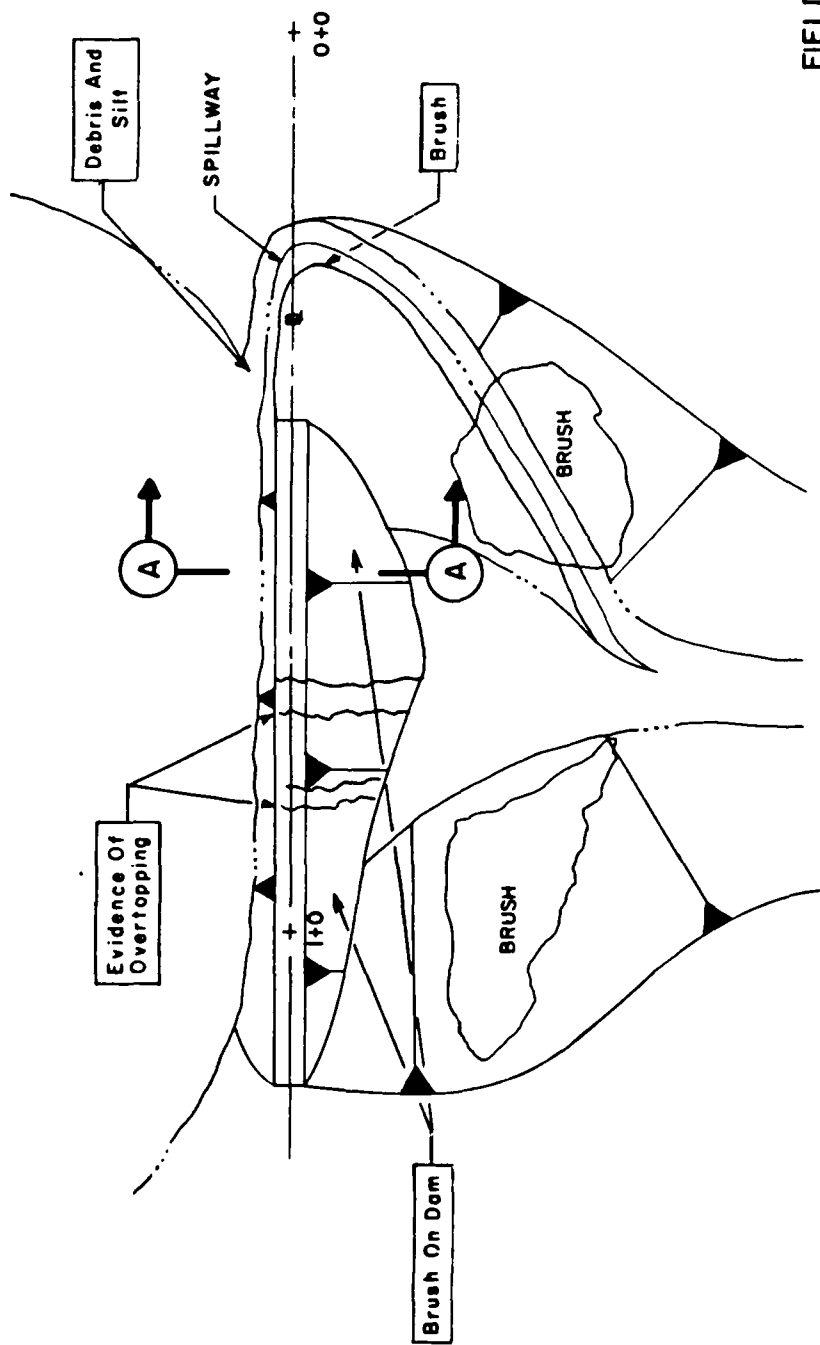
SEDIMENTATION

There is no evidence that sedimentation is a significant problem in the reservoir.

DOWNSTREAM CHANNEL

Name of Dam: ROMOBE LAKE DAMNDI # PA 00051

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel is obstructed with debris and vegetation.	Clear the debris and vegetation.
SLOPES	The downstream channel has a slope of approximately 1% to 2% to Hathaway Pond.	
APPROXIMATE NO. OF HOMES AND POPULATION	There are no damage areas between Romobe Lake Dam and Hathaway Pond Dam. Hath- away Lake is located 1400 ft. downstream of Romobe Lake Dam. Hathaway Pond Dam (NDI # PA 00050, PENNDER # 58-06) is located 3000 ft. downstream of Romobe Lake Dam. Failure of Romobe Lake Dam is likely to have an effect on Hathaway Pond Dam and the damage center of two houses, a trailer, and a township road, located 1800 ft. downstream of Hathaway Pond Dam. Michael Baker, Jr., Inc., is currently preparing a Phase I Inspec- tion Report on Hathaway Pond Dam.	



FIELD SKETCH
 ROMOBE LAKE DAM
 NDI NO. PA00051
 Penn DER NO. 58-10
 SCHEMATIC-NOT TO SCALE

CROSS SECTION TAKEN AT STA. 0+60

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Beaver, Pa. 15009

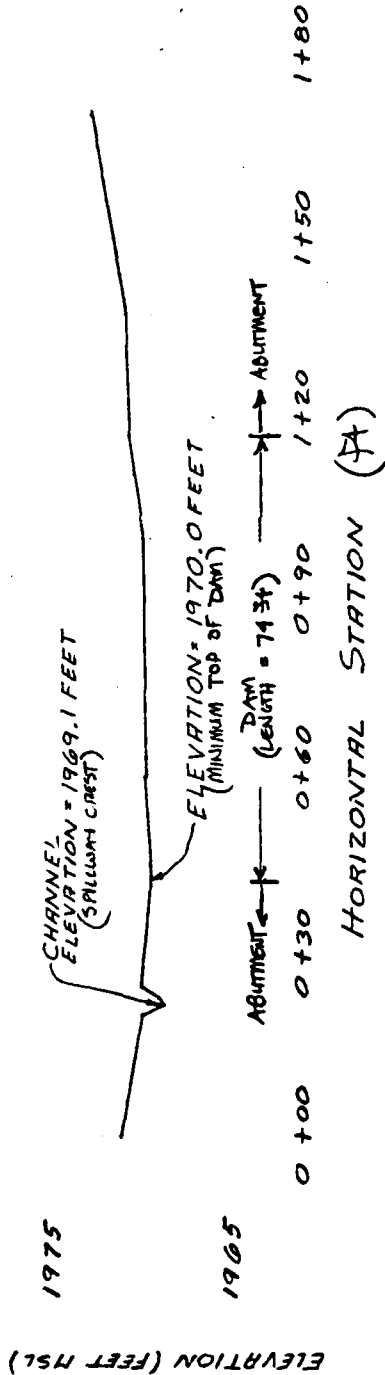
ROMOBE LAKE DAM

TOP OF DAM PROFILE
TYPICAL CROSS-SECTION

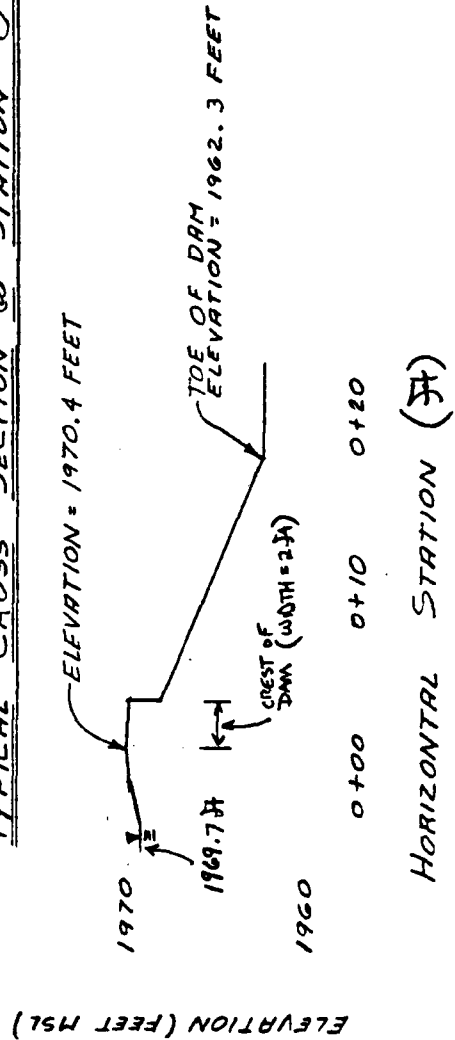
DATE OF INSPECTION: 1 November 1980

TOP OF DAM PROFILE (LOOKING DOWNSTREAM)

LENGTH OF DAM = 74 FEET



TYPICAL CROSS SECTION @ STATION 0+60



APPENDIX B
ENGINEERING DATA CHECK LIST

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

Name of Dam: ROMOBE LAKE DAM
 NDI # PA 00051

<u>ITEM</u>	<u>REMARKS</u>
PLAN OF DAM	No information available. See Field Sketch (Plate 3) of this report for a general plan of the dam.
REGIONAL VICINITY MAP	A USGS 7.5 minute topographic quadrangle of Thompson, Pennsylvania, was used to prepare the vicinity map which is enclosed in this report as the Location Plan (Plate 1).
CONSTRUCTION HISTORY	The original design, builder and date of construction are unknown. The dam was strengthened around 1920 by building up the vertical downstream face with stones, as requested by the Water Supply Commission of Pennsylvania.
TYPICAL SECTIONS OF DAM	None available
HYDROLOGIC/HYDRAULIC DATA	No information available.
OUTLETS - PLAN	No information available.
- DETAILS	No information available.
- CONSTRAINTS	No information available.
- DISCHARGE RATINGS	No information available.
RAINFALL/RESERVOIR RECORDS	None available

Name of Dam: ROMOBE LAKE DAM

NDI # PA 00051

B-2

ITEM	REMARKS
DESIGN REPORTS	None available
GEOLOGY REPORTS	No geology reports are available for the dam. See Appendix F for the Regional Geology.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	No design computations are available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None available
POST-CONSTRUCTION SURVEYS OF DAM	None performed.
BORROW SOURCES	No information available.

Name of Dam: ROMOBE LAKE DAM

NDI # PA 00051

B-3

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

MONITORING SYSTEMS

None

MODIFICATIONS

The dam was strengthened around 1919 by placing rocks on the downstream side of the embankment.

HIGH POOL RECORDS

No information available.

POST-CONSTRUCTION ENGINEERING
STUDIES AND REPORTS

The latest recorded inspection by PennDER, conducted on 4 August 1965, found the dam to be in good condition. The Water Supply Commission conducted inspections on 20 May 1920, 17 May 1919 and 30 July 1917. These inspection reports are available in the PennDER File No. 58-10.

PRIOR ACCIDENTS OR FAILURE OF DAM
DESCRIPTION
REPORTS

None reported in the information available.

MAINTENANCE
OPERATION
RECORDS

No formal maintenance records are kept.

Name of Dam: ROMOBE LAKE DAM

NDI # PA 00051

B-4

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

SPILLWAY PLAN,

SECTIONS
and
DETAILS

No information available.

OPERATING EQUIPMENT
PLANS & DETAILS

There is no operating equipment.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 0.98 sq.mi. (primarily forests and
pastures)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1969.1 ft. M.S.L.
(162 ac.-ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1970.0 ft. M.S.L.
(195 ac.-ft.)

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1970.0 ft. M.S.L. (minimum top of dam elevation)

SPILLWAY: Trapezoidal earth channel.

- a. Crest Elevation 1969.1 ft. M.S.L.
- b. Type Trapezoidal channel
- c. Bottom Width 1 ft.
- d. Top Width 5 ft.
- e. Location Spillover Left abutment
- f. Number and Type of Gates None

OUTLET WORKS: None

- a. Type _____
- b. Location _____
- c. Entrance Inverts _____
- d. Exit Inverts _____
- e. Emergency Drawdown Facilities _____

HYDROMETEOROLOGICAL GAGES: None

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

MAXIMUM NON-DAMAGING DISCHARGE Unknown

APPENDIX C
PHOTOGRAPH LOCATION PLAN AND PHOTOGRAPHS

DETAILED PHOTOGRAPH DESCRIPTIONS

Overall View of Dam

Top Photo - Overall View of Upstream Face of Dam
(OV-T) (Looking Downstream)

Bottom Photo - Overall View of Downstream Face of Dam
(OV-B) from Left Abutment

Photograph Location Plan

Photo 1 - View of Upstream Face of Dam from Left Abutment

Photo 2 - View of Downstream Face of Dam (Looking Upstream)

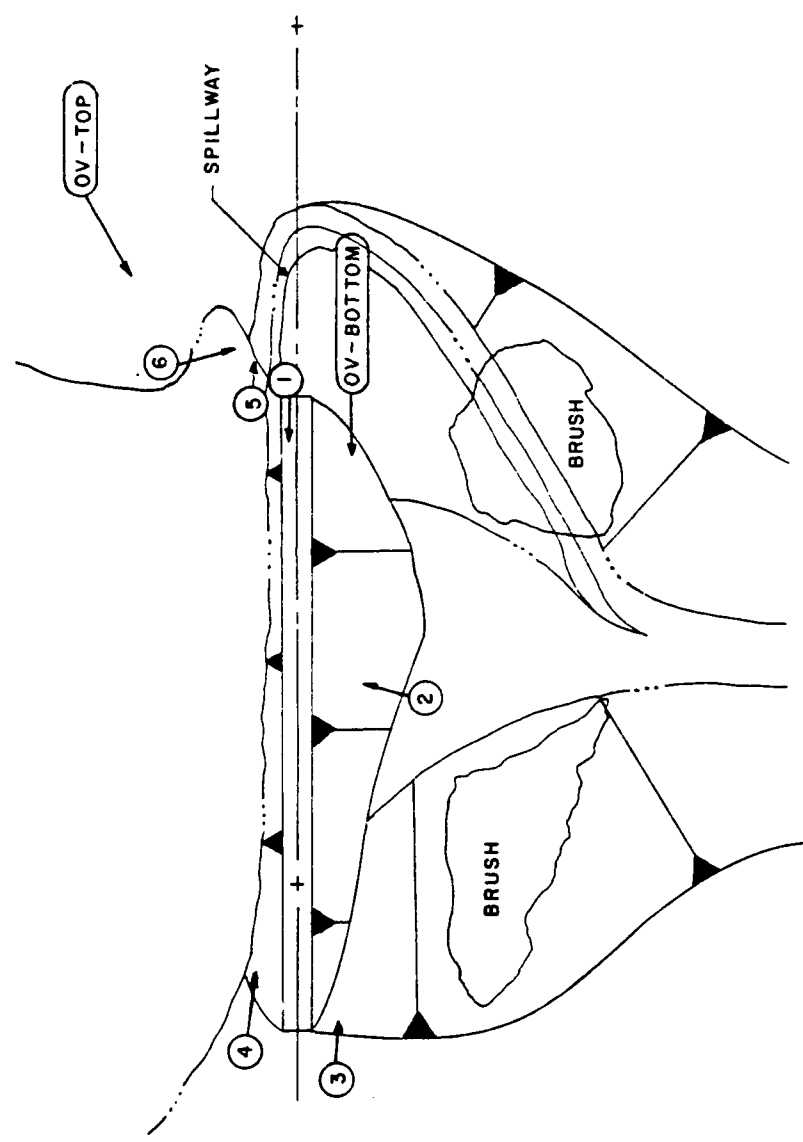
Photo 3 - View of Downstream Face of Dam from Right Abutment

Photo 4 - View of Upstream Face of Dam from Right Abutment
(Note: Spillway Channel Located to Left of Fence
in Upper Left Portion of Photograph)

Photo 5 - View of Spillway Channel Entrance and Crest

Photo 6 - View of Spillway Channel (Looking Downstream)

Note: Photographs were taken on 1 November 1980.



PHOTOGRAPH LOCATION PLAN

ROMOBE LAKE DAM

NDI NO. PA00051
PENNER NO. 58-10

Photographs Taken 1 November 1980

ROMOBE LAKE DAM



PHOTO 1. View of Upstream Face of Dam from Left Abutment



PHOTO 2. View of Downstream Face of Dam (Looking Upstream)

ROMOBE LAKE DAM



PHOTO 3. View of Downstream Face of Dam from Right Abutment



PHOTO 4. View of Upstream Face of Dam from Right Abutment
(Note: Spillway Channel Located to Left of Fence in Upper Left Portion
of Photograph)

ROMOBE LAKE DAM



PHOTO 5. View of Spillway Channel Entrance and Crest



PHOTO 6. View of Spillway Channel (Looking Downstream)

APPENDIX D
HYDROLOGIC AND HYDRAULIC COMPUTATIONS

MICHAEL BAKER, JR., INC.

THE BAKER ENGINEERS

Box 280

Beaver, Pa. 15009

Subject POMORE LAKE DAM

S.O. No. _____

APPENDIX D - HYDROLOGIC AND
HYDRAULIC CALCULATIONS.

Sheet No. _____ of _____

Drawing No. _____

Computed by _____ Checked by _____ Date _____

<u>SUBJECT</u>	<u>PAGE</u>
PREFACE	i
HYDROLOGY AND HYDRAULIC DATA BASE	1
HYDRAULIC DATA	2
DRAINAGE AREA AND CENTROID MAP	3
TOP OF DAM PROFILE AND CROSS SECTION	4
SPILLWAY DISCHARGE RATING	5
100-YEAR STORM DISTRIBUTION	6
100-YEAR DISCHARGE CALCULATION	7
HEC-1 CAPACITY ANALYSIS	8

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: ROMOBE LAKE DAM

100-YEAR STORM = 6.4 INCHES/24 HOURS⁽¹⁾

STATION	1	2	3	4	5
Station Description	ROMOBE LAKE DAM				
Drainage Area (square miles)	0.98				
Cumulative Drainage Area (square miles)	0.98				
Adjustment of PMF for Drainage Area (%) ⁽¹⁾	100-YEAR STORM DISTRIBUTION ON SHEET 6				
6 Hours					
12 Hours					
24 Hours					
48 Hours					
72 Hours					
Snyder Hydrograph Parameters					
Zone (3)	11				
C_p/C_t (4)	0.62/1.50				
L (miles) (5)	1.70				
L_{ca} (miles) ⁽⁵⁾	0.89				
$t_p = C_t (L \cdot L_{ca})^{0.3}$ (hours)	1.70				
Spillway Data					
Crest Length (ft)	SPILLWAY DISCHARGE				
Freeboard (ft)	RATING DEVELOPED				
Discharge Coefficient	ON SHEET 5				
Exponent					

(1) Technical Paper No. 40, Cooperative Studies Section, U.S. Weather Bureau, Washington, D.C., 1961.

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

(3) Snyder's Coefficients.

(4) 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.

STORAGE CALCULATIONSAREA VS. ELEVATION DATA (MEASURED FROM QUADS)

<u>ELEVATION (FT)</u>	<u>SURFACE AREA (ACRES)</u>
1969.1	35.55
1980	51.34
2000	132.31

NORMAL POOL STORAGE

$$\text{STORAGE VOLUME} = V_{NP} = \frac{h}{3} (A_1 + A_2 + \sqrt{A_1 A_2})$$

h = ESTIMATED AVERAGE DEPTH = 4.9 FT.

A_1 = SURFACE AREA OF NORMAL POOL = 35.55 AC.

A_2 = SURFACE AREA OF RESERVOIR BOTTOM = 30.67 AC.

(ESTIMATED FROM AVERAGE DEPTH
AND RESERVOIR SIDE SLOPE)

$$\text{NORMAL POOL STORAGE} = V_{NP} = \frac{4.9}{3} (35.55 + 30.67 + \sqrt{35.55 \times 30.67})$$

$$V_{NP} = 162.09 \text{ AC.-FT.}$$

TOP OF DAM STORAGE

195 AC.-FT. (FROM HEC-1 ANALYSIS)

SNYDER'S UNIT HYDROGRAPH PARAMETERS

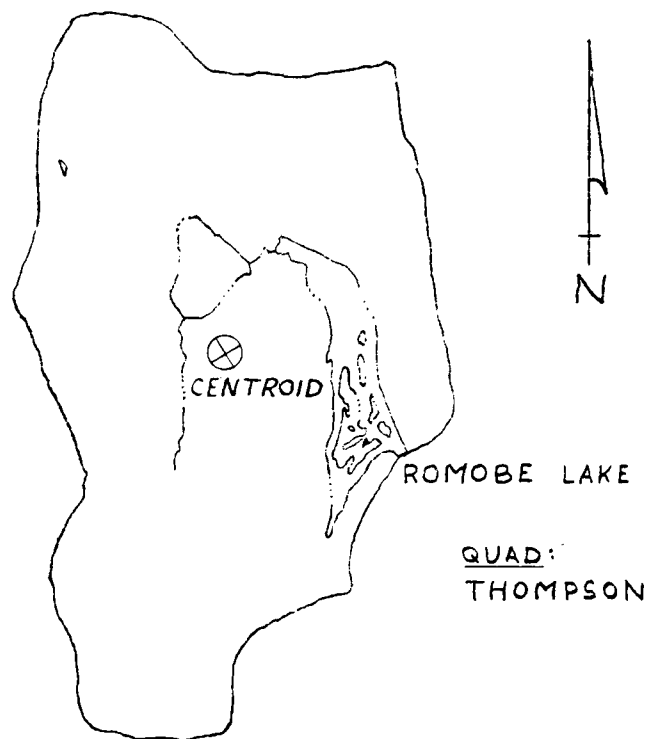
$$L = 1.70 \text{ Mi.}, L_{CP} = 0.89 \text{ Mi.}$$

WATERSHED IS IN ZONE II

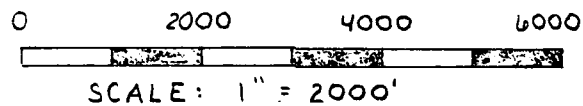
$$C_p = 0.62, C_r = 1.50$$

$$t_p = 1.50 (L \times L_{CP})^{0.3} = 1.70 \text{ HR.}$$

DRAINAGE AREA ABOVE DAM - 0.98 SQ. MI.



ROMOBE LAKE DAM:
DRAINAGE AREA AND
CENTROID MAP



MICHAEL BAKER, JR., INC.

THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject RODOLFE LAKE DAM

S.O. No. 123-7-22-44-100

TOP OF DAM PROFILE

Sheet No. 4 of 12

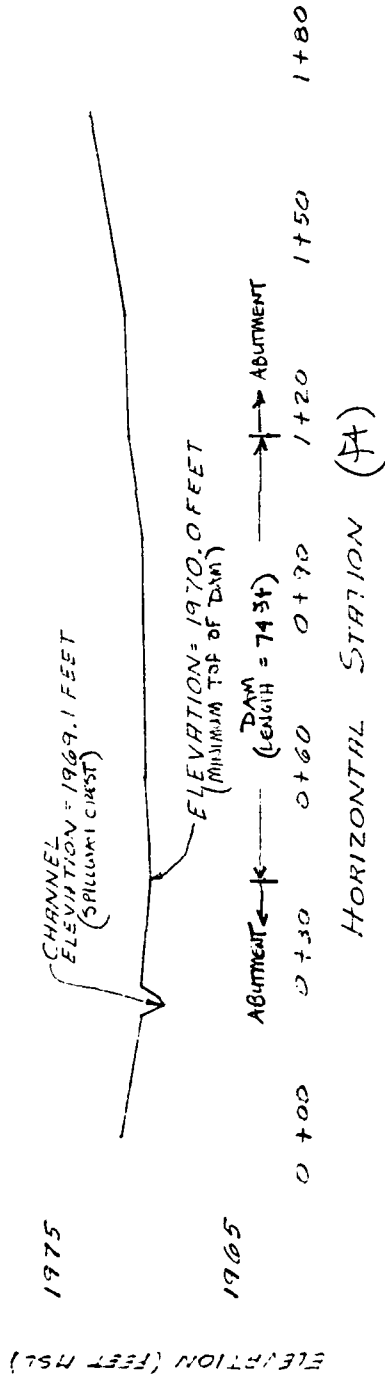
TYPICAL CROSS SECTION

Drawing No. _____

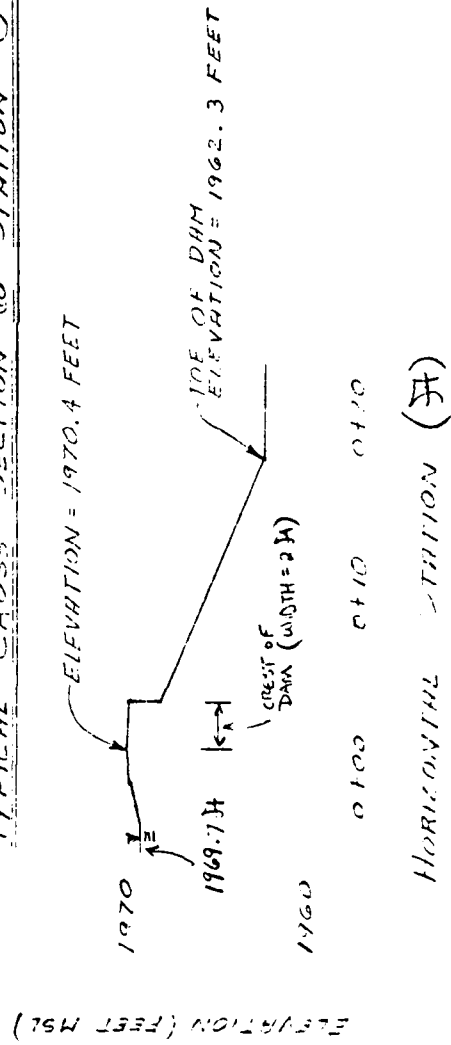
Computed by SUT Checked by WLL

Date 11-12-30

TOP OF DAM PROFILE (LOOKING DOWNSTREAM)
LENGTH OF DAM = 74 FEET



TYPICAL CROSS SECTION @ STATION 0+60



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THE BAKER ENGINEERS

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Beaver, Pa. 15009

Subject ROMOBE LAKE DAM

SPILLWAY CROSS SECTION
AND DISCHARGE RATING

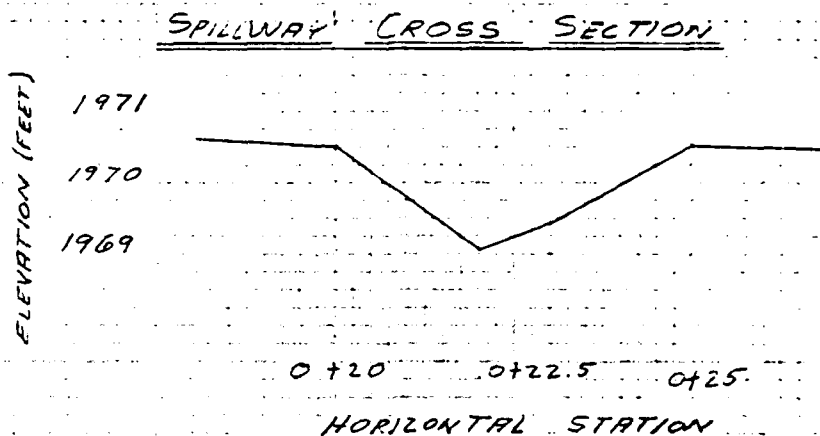
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Sheet No. 5 of 12

Drawing No.

Date 1-1-50



SPILLWAY DISCHARGE RATING

DEVELOPE RATING CURVE BASED UPON CRITICAL FLOW OVER SPILLWAY:

$$V = \sqrt{gD} \quad (\text{CHOW, OPEN CHANNEL HYDRAULICS, P. 43})$$

$$D = \text{MEAN HYDRAULIC DEPTH} = \frac{\text{FLOW AREA}}{\text{FREE SURFACE TOP WIDTH}} = \frac{A}{T}$$

$$g = 32.2 \text{ FT/SEC}^2$$

$$V = \text{MEAN FLOW VELOCITY}$$

$$Q = AV$$

SPILLWAY ELEV., FT.	FLOW DEPTH, FT.	AREA FT ²	TOP WIDTH, FT.	A/T	V, FT/SEC.	Q, CFS	V/\sqrt{gD}	RESERVOIR SURFACE, FT.
1969.1	0	0	0	0	0	0	0	1969.1
1969.4	0.3	0.23	1.5	0.15	2.20	0.51	.07	1969.47
1970.0	0.9	1.69	3.4	0.50	4.01	6.78	.25	1970.25
1970.5	1.4	3.79	5.0	0.76	4.95	18.76	.38	1970.88
1971.0	1.9	6.29	5.0	1.26	6.37	40.07	.63	1971.63
1971.5	2.4	8.79	5.0	1.76	7.53	66.19	.88	1972.38
1972.0	2.9	11.29	5.0	2.26	8.53	96.30	1.13	1973.13

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject ROMOBE LAKE DAM

100-YEAR STORM DISTRIBUTION

S.O. No. _____

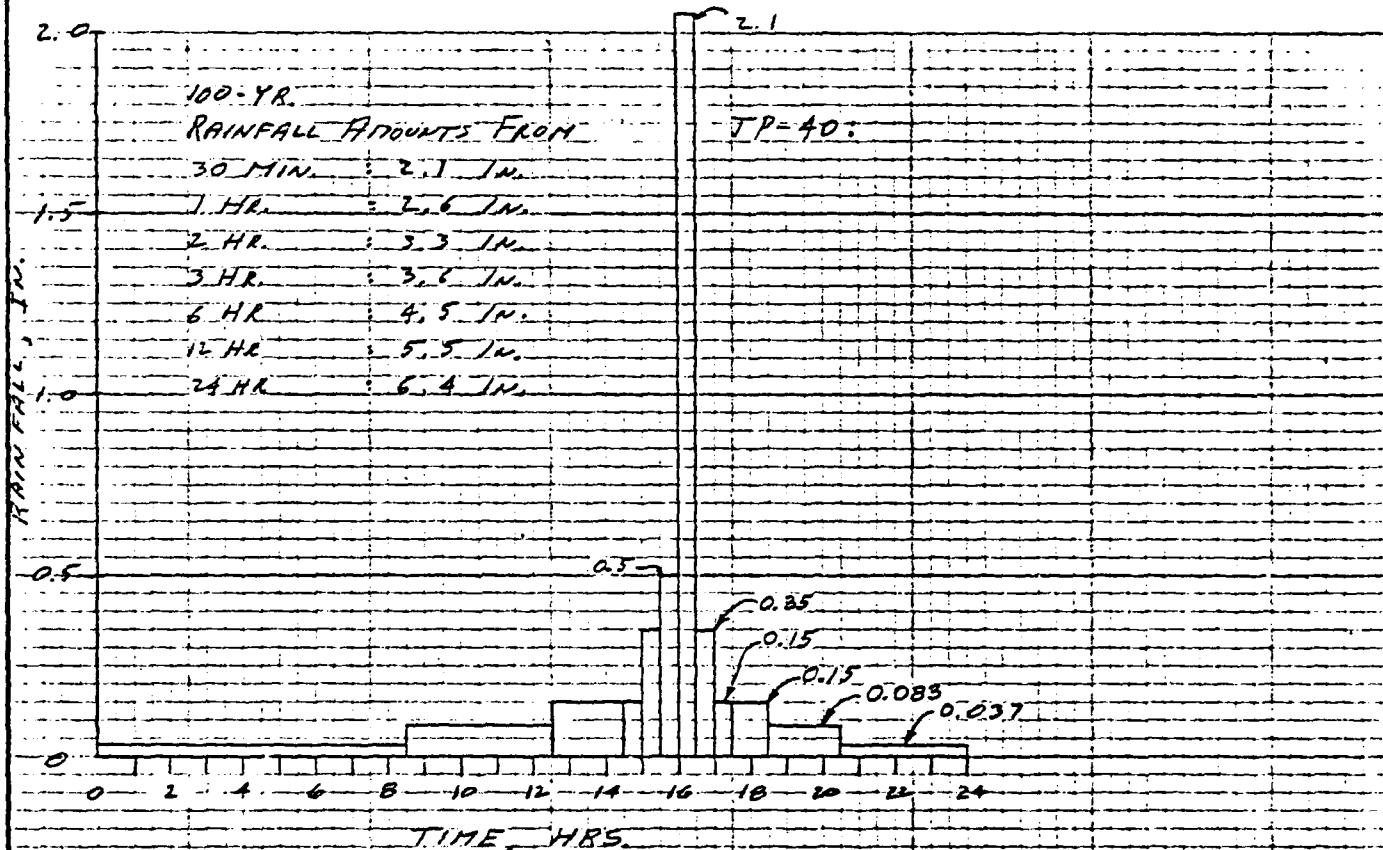
Sheet No. 6 of 12

Drawing No. _____

Computed by GUNT

Checked by WDL

Date 11-25-80



RAINFALL DISTRIBUTION:
(30 MINUTE INTERVALS)

INTERVAL NUMBERS	% TOTAL RF OCCURRING IN EACH INTERVAL
1-17	0.6
18-25	1.3
26-29	2.3
30	2.3
31	3.4
32	7.8
33	32.8
34	5.4
35	2.9
36-37	2.4
38-41	1.3
42-48	0.6

TOTAL = 100%

THE INFLOW TO THE IMPOUNDMENT FOR THE 100-YEAR FLOOD WAS CALCULATED USING MATERIAL FROM "THE HYDROLOGIC STUDY - TROPICAL STORM AGNES" PREPARED BY THE SPECIAL STUDIES BRANCH, PLANNING DIVISION, NORTH ATLANTIC DIVISION, CORPS OF ENGINEERS, IN NEW YORK CITY.

DRAINAGE AREA - 0.98 SQ. MI.

① COMPUTE THE MEAN LOGARITHM

$$\text{LOG}(Q_m) = C_m + 0.75 (\text{LOG } A)$$

LOG(Q_m) = MEAN LOGARITHM OF ANNUAL FLOOD PEAKS.

A = DRAINAGE AREA, SQ. MI. = 0.98 SQ. MI.

C_m = MAP COEFFICIENT FOR MEAN LOG OF ANNUAL PEAKS FROM FIG. 21 = 2.15

$$\begin{aligned}\text{LOG}(Q_m) &= 2.15 + 0.75 (\text{LOG } 0.98) \\ &= 2.1434\end{aligned}$$

② COMPUTE STANDARD DEVIATION

$$S = C_s - 0.05 (\text{LOG } A)$$

S = STANDARD DEVIATION OF THE LOGARITHMS OF THE ANNUAL PEAKS.

C_s = MAP COEFFICIENT FOR STANDARD DEVIATION FROM FIG. 22 = 0.341

A = DRAINAGE AREA, SQ. MI. = 0.98 SQ. MI.

$$\begin{aligned}S &= 0.341 - 0.05 (\text{LOG } 0.98) \\ &= 0.3414\end{aligned}$$

③ SELECT SKEW COEFFICIENT FROM FIG. 23 = 0.16

$$\text{LOG}(Q_{100}) = \text{LOG}(Q_m) + K(P, g) S$$

K(P, g) = STANDARD DEViate FOR A GIVEN EXCEEDENCE FREQUENCY PERCENTAGE (P) AND SKEW COEFFICIENT (g) FROM EXHIBIT 39 OF BEARD'S "STATISTICAL METHODS IN HYDROLOGY" = 2.45

$$\begin{aligned}\text{LOG}(Q_{100}) &= 2.1434 + 2.45 (0.3414) \\ &= 2.9798\end{aligned}$$

$$Q_{100} = 954.6 \text{ CFS}$$

514 10.41 0.41 0.0 12500.

HYDROGRAPH ROUTING

ROUTING FOR RUMBE LAKE DAM

ISTAQ	ILUMP	IECON	ITAPE	JPLI	JPRI	INANE	ISTAGE	IAUTG
2	1	0	0	0	0	1	0	0

ROUTING DATA

WLOSS	AVG	IRIS	ISAME	ILPT	IPMP	LSIR
0.0	0.0	1	1	0	0	0

WIPS	NSDOL	LAG	ANSKK	X	ISK	STURA	ISPRAT
1	0	0	0.0	0.0	0.0	-1969.	-1

STAGE	1969.10	1969.20	1970.20	1970.40	1971.60	1972.40	1973.10
FLOW	0.0	0.30	6.80	18.80	40.10	66.20	96.30

SURFACE AREA	31.	36.	51.	132.
CAPACITY	0.	162.	633.	2407.

ELEVATION	1964.	1969.	1980.	2000.
LKEL	SPMID	CUOM	EXPM	ELEV

COUL	CAREA	EXPL
1969.1	0.0	0.0

DAY DATA

TOPEL	COUJ	EXPJ	DAMHID
1970.0	3.1	1.5	69.

CREST LENGTH	0.	75.	96.	135.	150.	159.
AT OR BELO	1970.0	1970.5	1971.0	1971.5	1972.0	1972.5

PEAK OUTFLOW IS 746. AT TIME 13.00 HOURS

F

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ELONGATIC COMPUTATIONS
 FLJMS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

RAYS APPLIED TO FLOWS

OPERATION	STATION	AKLA	PLAN	RATIO	1
					1.00

HYDROGRAPH AT	1	J. 3d	1	864.
			2.547	24.487

ROUTED TO	2	0.9d	1	746.
	1	2.541	1	21.1211

SHEET 11 OF 12

11

SHEET 12 OF 12

APPENDIX E

PLATES

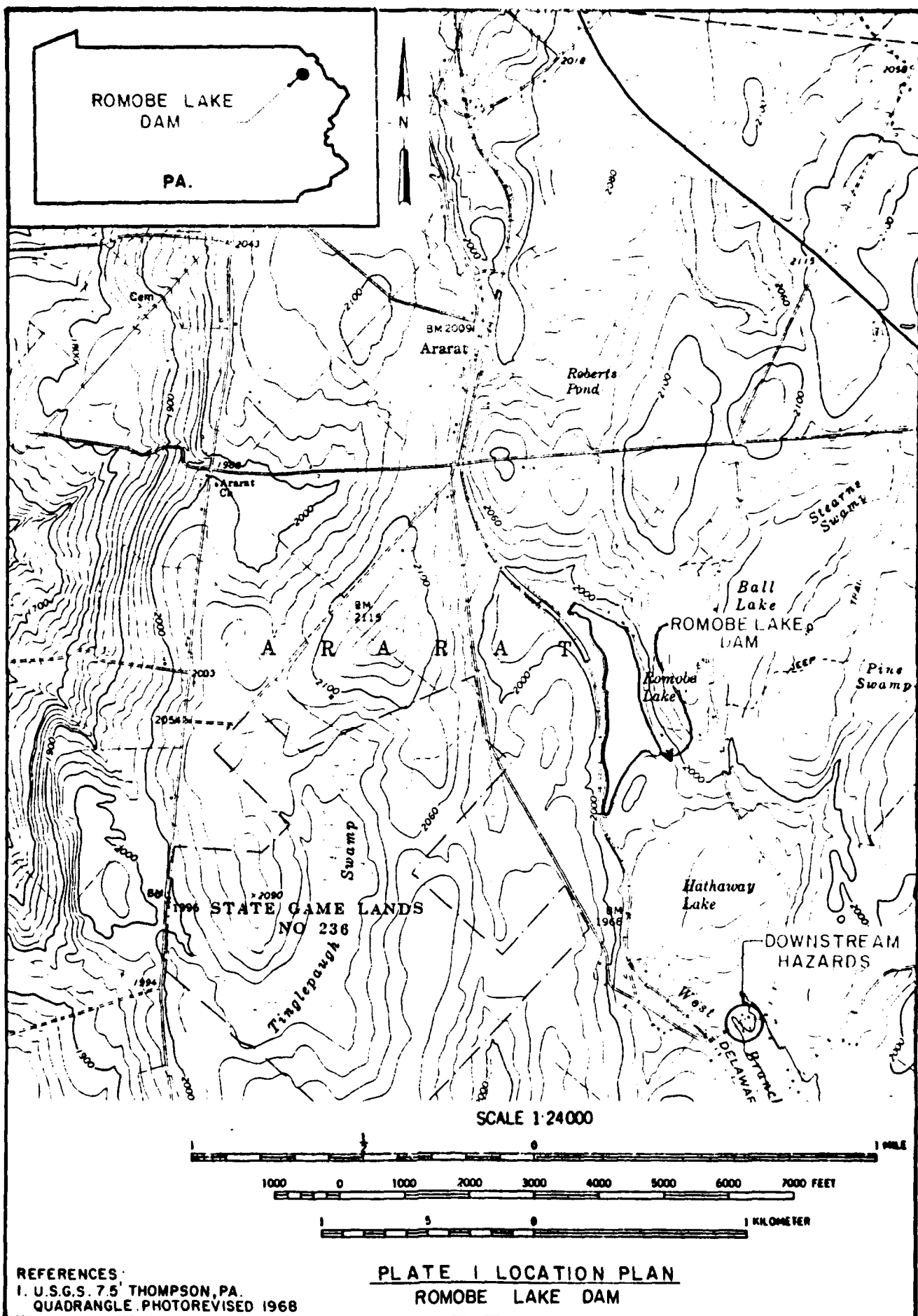
CONTENTS

Plate 1 - Location Plan

Plate 2 - Watershed Map

Plate 3 - Field Sketch from Visual Inspection

Plate 4 - Top of Dam Profile and Typical Cross Section
From Visual Inspection



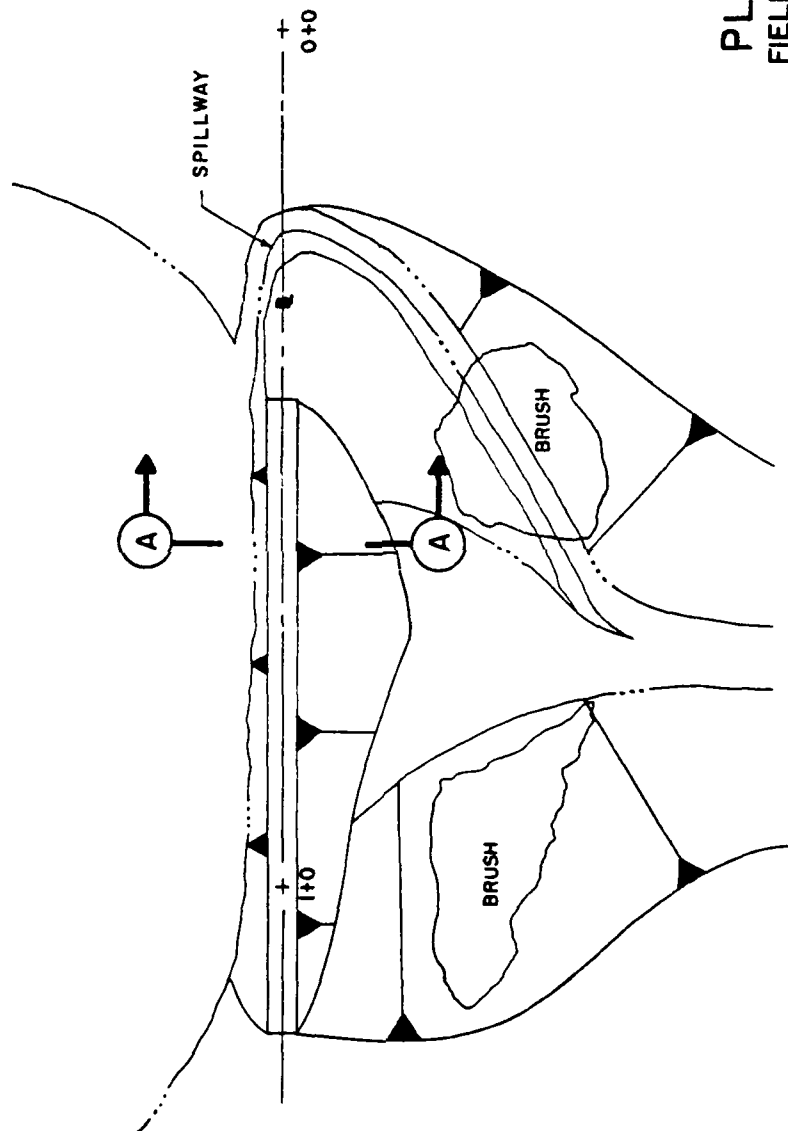


PLATE 3
FIELD SKETCH
ROMOBE LAKE DAM
NDI NO. PA00051
Penn DER NO. 58-10
SCHEMATIC - NOT TO SCALE

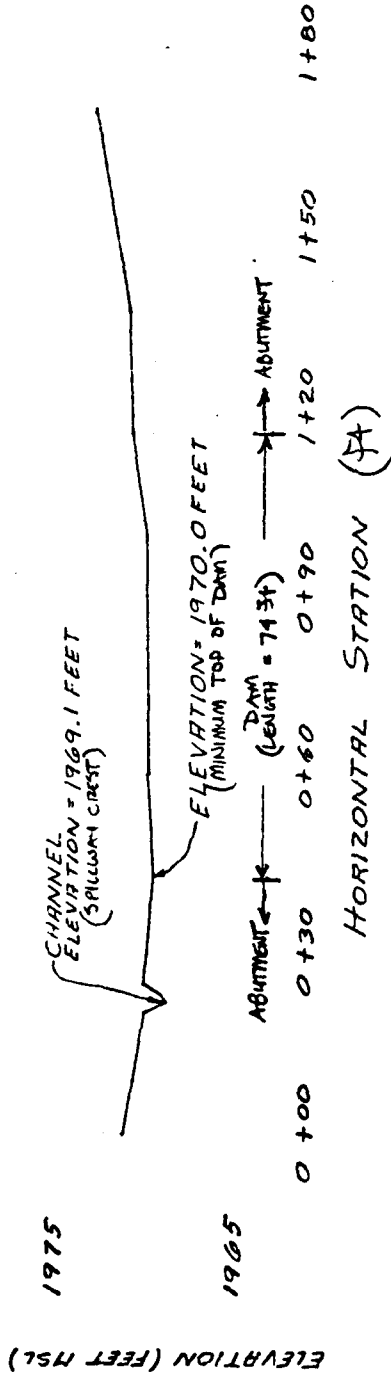
CROSS SECTION TAKEN AT STA. 0+60

MICHAEL BAKER, JR., INC.

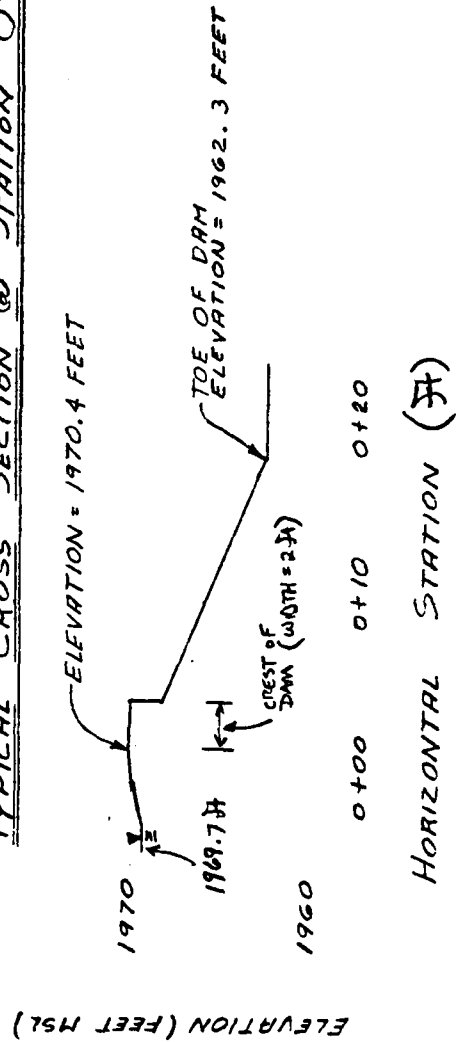
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

TOP OF DAM PROFILE (LOOKING DOWNSTREAM)
LENGTH OF DAM = 74 FEET



TYPICAL CROSS SECTION @ STATION 0+60



APPENDIX F
REGIONAL GEOLOGY

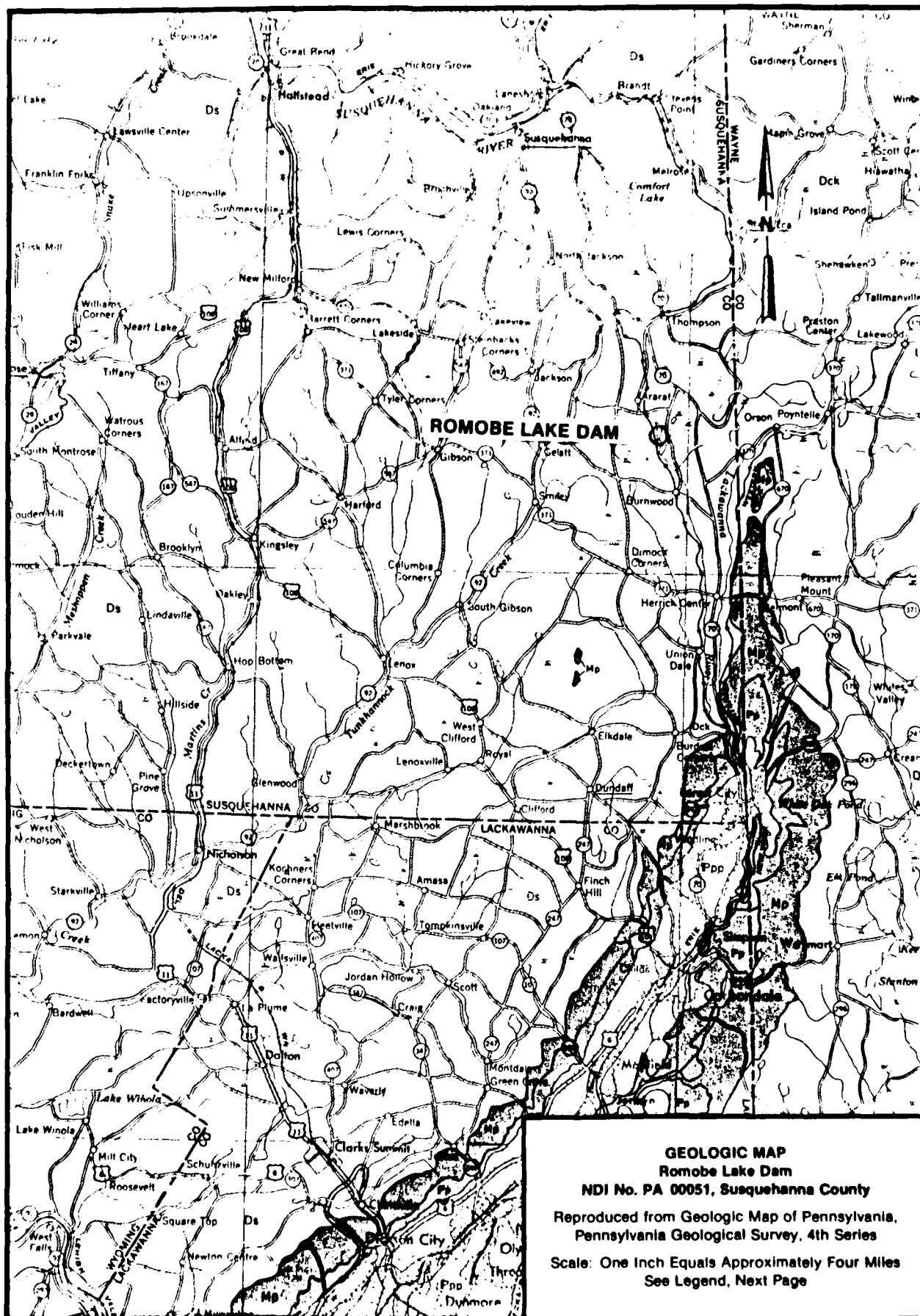
Romobe Lake Dam
NDI No. PA 00051, PennDER No. 58-10

REGIONAL GEOLOGY

Romobe Lake Dam is located in the Glaciated Low Plateaus section of the Appalachian Plateaus physiographic province. The area is drained to the south by the Lackawanna River and shows a maximum relief of approximately 100 feet. The impoundment sits on a plateau approximately 900 feet above the Tunkhannock Creek valley which lies 3 miles west of the dam.

The area has been glaciated at least three times and is presently covered with Wisconsin Stage deposits. According to the Soil Conservation Service's Soil Survey for Susquehanna County, the soils derived from this till consist of channery silt loams of the Volusia association. The soil has a unified classification of ML in the vicinity of the dam. No test boring data were available for review; thus, the thickness of overburden is difficult to ascertain.

Geologic references indicate that the bedrock underlying the dam consists of members of the Catskill formation in the Susquehanna Group. The Catskill is composed of bay and prodelta, red and gray shales and sandstones of Upper Devonian age but may contain scattered, thin coal seams and scattered fish remains. The strata remains essentially horizontal after the Appalachian Uplift.



GEOLOGY MAP LEGEND

DEVONIAN

UPPER

WESTERN PENNSYLVANIA



Oswayo Formation

Greenish gray to gray shales, siltstones and sandstones becoming increasingly shaly westward, considered equivalent to type Oswayo, Riceville Formation Or 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 sands 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 "Girard" Formations of northwestern Pennsylvania.



Canadaway Formation

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

CENTRAL AND EASTERN PENNSYLVANIA



Oswayo Formation

Brownish and greenish gray, fine and medium grained sandstones with some shales and scattered calcareous lenses, includes red shales which become more numerous eastward. Relation to type Oswayo not proved.



Catskill Formation

Chiefly red to brownish shales and sandstones, includes gray and greenish sandstone, limestones named Elk Mountain, Honesdale, Shohola, and Delaware River in the east.



Marine beds

Gray to olive brown shales, graywackes, and sandstones, contains "Chemung" beds and "Portage" beds including Burket, Brallier, Harrell, and Trimmers Rock; Tully Limestone at base.



Susquehanna Group

Barbed line in "Chemung-Catskill" contact of Second Pennsylvania Survey County reports; barbs on "Chemung" side of line.

MIDDLE AND LOWER



Hamilton Group



Mahantango Formation

Brown to olive shale with interbedded sandstones which are dominant in places (Montebello), highly fossiliferous in upper part; contains "Centerfield coral bed" in eastern Pennsylvania.

Marcellus Formation

Black, fossil, carbonaceous shale with thick, brown sandstone (Turkey Ridge) in parts of central Pennsylvania.



Onondaga Formation

Greenish blue, thin bedded shale and dark blue to black, medium bedded limestone with shale predominant in most places, includes Selkirk Limestone and Needmore Shale in central Pennsylvania and Butler Limestone and Enopus Shale in easternmost Pennsylvania; in Lehigh Gap area includes Palmerston Sandstone and Houmaestown Chert.



Oriskany Formation

White to brown, fine to coarse grained, partly aluminous, locally conglomeratic, fossiliferous sandstone (Ridgely) at the top; dark gray, cherty limestone with some interbedded shales and sandstones below (Shriver).



Helderberg Formation

Dark gray, calcareous, thin bedded shale (Mandata) at the top equivalent to Port Ewen Shale and Roca Limestone in the east; dark gray, cherty, thin bedded, fossiliferous limestone (New Scotland) with some local sandstones in the middle, and at the base dark gray medium to thick bedded, crystalline limestone (Columbus); sandy and shaly in places with some chert nodules.