SUSQUEHANNA RIVER BASIN
SINGERS GAP RUN, HUNTINGDON COUNTY
PENNSYLVANIA
LAKE MOUNT UNION DAM
NDS ID NO. PA-473
DER ID NO. 31-52
MOUNT UNION MUNICIPAL AUTHORITY
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

Prepared By
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG, PENNSYLVANIA
15931

Contract #DAEW 31-79-C-0009

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

JUNE, 1979
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Susquehanna River Basin, Singers Gap Run, Huntingdon County, Pennsylvania.

Prepared by Phase I Inspection Report.

L. ROBERT KIMBALL & ASSOCIATES
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EBENSBURG, PENNSYLVANIA
15931

FOR
DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS
BALTIMORE, MARYLAND
21203

29 P.
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 REPORT

NAME OF DAM: Lake Mount Union Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Huntingdon
STREAM: Singers Gap Run
DATE OF INSPECTION: April 16, 1979

ASSESSMENT

The assessment of Lake Mount Union Dam is based upon visual observations made at the time of inspection, review of available records and data, hydrologic and hydraulic computations, and past operational performance.

The dam appears to be in good condition.

The existing spillway and reservoir are capable of passing only 8% of the PMP (Probable Maximum Flood). Based upon criteria established by the Corps of Engineers, the spillway is termed seriously inadequate. If Lake Mount Union Dam should fail due to overtopping, the hazard to loss of life and property downstream from the dam would be significantly increased from that which would exist just prior to overtopping. As a result of the seriously inadequate spillway, the dam is considered an unsafe, non-emergency dam.

A detailed study and remedial modifications should begin immediately to increase the spillway capacity. For this dam, it will not be sufficient to merely increase spillway capacity. The stability of the structure will have to be analyzed for any modification of the spillway.

The following recommendations and remedial measures should be instituted.

1. Perform additional studies by a registered professional engineer knowledgeable in dam design for modification of the spillway and/or dam to increase spillway capacity. This study should begin immediately and remedial modifications begun immediately after the study is complete.

2. The flashboards should be immediately removed to increase the spillway capacity until recommendation 1 is completed.

3. A warning system should be instituted to warn downstream residences of high spillway discharges and during periods of heavy rainfall or high runoff, or failure of the dam.

4. Access to the dam should be improved so the dam is accessible during periods of flooding.
5. Institute a formal inspection program to be conducted at regular intervals.

6. Repair drain lines to a workable condition. Exercise all gates on the drain line and the supply line at regular intervals.

7. Perform a detailed structural analysis (including a stress analysis) using the PWH water level for all probable conditions and major sections of the dam.

SUBMITTED BY: L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS

R. Jeffrey Kimball, P.E.

Kuang-hwei Chuang, P.E.

APPROVED BY: G. K. WITHERS
Colonel, Corps of Engineers
District Engineer
Overview of dam from downstream.

Overview of dam from left abutment.
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APPENDIX D - HYDROLOGY AND HYDRAULICS
APPENDIX E - DRAWINGS
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APPENDIX G - STABILITY ANALYSIS
1.1 General.

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

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

1.2 Description of Project.

a. Dam and Appurtenances. Lake Mount Union Dam is a concrete buttress dam. Lake Mount Union Dam was built by the Ambursen Construction Company and is thus called an Ambursen type dam. Ambursen dams are articulated, reinforced concrete buttress dams with expansion joints between the decks and the buttresses. The deck consists of reinforced concrete water bearing slabs, separated by buttress tongues and supported by reinforced concrete haunches which are constructed monolithically with the buttresses.

Lake Mount Union Dam has seventeen vertical concrete buttresses constructed on eighteen foot centers. These buttresses are founded on shale and quartzite. The buttresses are of variable thickness with the bottom of each buttress 21 inches thick and the top of the buttress 14. inches thick. The concrete slab on the upstream of each buttress is also of variable thickness. The bottom of the slab is 41.5 inches thick with the top of the slab 24 inches thick. The concrete slab is sloped at an angle of 1R:1V. At the toe of the upstream slope of the dam a cutoff trench was excavated. This cutoff trench was backfilled with concrete. Steel reinforcing was placed in all buttresses and throughout the concrete slab. Between all expansion joints, asphalt putty was placed.

The dam consists of an overflow section and two abutment sections. The overflow section is located between buttresses 5 and 16. The spillway is approximately 193.5 feet long. The overflow section of the dam has wooden flashboards to raise the level of the reservoir. The right abutment section is approximately 81 feet long and the left abutment section is approximately 29 feet long. The dam is 51 feet high above the foundation. The foundation and abutment rock were extensively grouted during the construction.
The outlet works consist of three 16" pipes at various elevations on the upstream face of the dam. These three intakes are connected to a 12" cast iron supply line which flows to the Borough of Mount Union. Each 16" intake line has a gate valve to control flow through the line. The 12" supply line has a 12" blowoff line. The reservoir can be drained through a 30" cast iron drain line. The supply line is located between buttresses 4 and 5 and the drain line is located between buttresses 5 and 6.

b. Location. The dam is located on Singers Gap Run, approximately six miles southwest of Mount Union, Pennsylvania. Lake Mount Union Dam can be located on the Butler Knob, Pennsylvania U.S.G.S. 7.5 minute quadrangle.

c. Size Classification. Lake Mount Union Dam is an intermediate size structure (51 feet high-structural height, 211 acre-feet).

d. Hazard Classification. Lake Mount Union Dam is a high hazard dam. Downstream conditions indicate that loss of life is probable should failure of the structure occur (see Section 3.1.e for downstream exposure).

e. Ownership. Lake Mount Union Dam is owned by the Mount Union Borough Water Company. Correspondence should be addressed to:

Water Commissioner
Mount Union Borough Water Company
P. O. Box 90
Mount Union, Pennsylvania 17066
814—542—4051

f. Purpose of Dam. Lake Mount Union Dam is used for water supply for the Borough of Mount Union.

g. Design and Construction History. The dam was designed by D.W. Dillman and the Ambursen Construction Company. The dam was built over a two year period from 1926 to 1927 by the Ambursen Construction Company and the Pitt Construction Company. Continuous inspection was provided by the Commonwealth of Pennsylvania. Very good records, drawings and photographs are available of the construction. The date of the flashboard installation is unknown.

h. Normal Operating Procedures. The reservoir is maintained at the spillway crest elevation with the excess inflow discharging over the spillway crest. In recent years, only the top intake on the water supply line has been used. The middle valve on the water supply line is broken and the bottom intake is silted. The main drain line has not been opened for 27 years.

1.3 Pertinent Data.

a. Drainage Area. 3.29 square miles
b. **Discharge at Dam Site (cfs).**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum known flood at dam site</td>
<td>June 1972, flow unknown</td>
</tr>
<tr>
<td>12&quot; water supply line</td>
<td>Unknown</td>
</tr>
<tr>
<td>30&quot; drainline</td>
<td>Unknown</td>
</tr>
<tr>
<td>Spillway capacity with present configuration (with flashboards)</td>
<td>659</td>
</tr>
<tr>
<td>Spillway capacity without flashboards</td>
<td>2,957</td>
</tr>
</tbody>
</table>

c. **Elevation (U.S.G.S. Datum) (feet).** - All field survey elevations based on spillway crest shown on construction drawings.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top of dam - field survey</td>
<td>1235.0</td>
</tr>
<tr>
<td>Design top of dam</td>
<td>1235.0</td>
</tr>
<tr>
<td>Maximum pool - design surcharge</td>
<td>Unknown</td>
</tr>
<tr>
<td>Full flood control pool</td>
<td>N/A</td>
</tr>
<tr>
<td>Normal pool</td>
<td>1231.0</td>
</tr>
<tr>
<td>Spillway crest</td>
<td>1231.0</td>
</tr>
<tr>
<td>Upstream portal - bottom intake on 12&quot; water supply line</td>
<td>1201.0</td>
</tr>
<tr>
<td>Downstream portal - 12&quot; water supply line</td>
<td>1201.0</td>
</tr>
<tr>
<td>Upstream portal - 30&quot; drainline</td>
<td>1200.75</td>
</tr>
<tr>
<td>Downstream portal - 30&quot; drainline</td>
<td>1200.75</td>
</tr>
<tr>
<td>Streambed at centerline of dam</td>
<td>1184.0</td>
</tr>
<tr>
<td>Maximum tailwater</td>
<td>Unknown</td>
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</table>

d. **Reservoir (feet).**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of maximum pool</td>
<td>800</td>
</tr>
<tr>
<td>Length of normal pool</td>
<td>800</td>
</tr>
<tr>
<td>Length of flood control pool</td>
<td>N/A</td>
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</tbody>
</table>

e. **Storage (acre-feet).**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Normal pool</td>
<td>153</td>
</tr>
<tr>
<td>Flood control pool</td>
<td>N/A</td>
</tr>
<tr>
<td>Top of dam</td>
<td>211</td>
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</table>

f. **Reservoir Surface (acres).**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top of dam</td>
<td>13</td>
</tr>
<tr>
<td>Maximum pool</td>
<td>13</td>
</tr>
<tr>
<td>Flood control pool</td>
<td>N/A</td>
</tr>
<tr>
<td>Normal pool</td>
<td>10</td>
</tr>
<tr>
<td>Spillway crest</td>
<td>10</td>
</tr>
</tbody>
</table>

g. **Dam.**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Concrete buttress (Ambursen)</td>
</tr>
<tr>
<td>Length</td>
<td>303.5 feet</td>
</tr>
<tr>
<td>Height (structural height)</td>
<td>51 feet</td>
</tr>
<tr>
<td>Top width</td>
<td>0 feet</td>
</tr>
<tr>
<td>Component</td>
<td>Upstream</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Side slopes</td>
<td>1H:1V</td>
</tr>
<tr>
<td>Zoning</td>
<td>None</td>
</tr>
<tr>
<td>Impervious core</td>
<td>None</td>
</tr>
<tr>
<td>Cutoff</td>
<td>None</td>
</tr>
<tr>
<td>Grout curtain</td>
<td></td>
</tr>
</tbody>
</table>

h. Reservoir Drain.

<table>
<thead>
<tr>
<th>Type</th>
<th>30&quot; CIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>44 feet</td>
</tr>
<tr>
<td>Closure</td>
<td>Valve between buttresses 5 and 6</td>
</tr>
<tr>
<td>Access</td>
<td>Downstream between buttresses 5 and 6</td>
</tr>
<tr>
<td>Regulating facilities</td>
<td>Gate valve</td>
</tr>
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</table>

i. Spillway.

<table>
<thead>
<tr>
<th>Type</th>
<th>Uncontrolled over center of dam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>193.5 feet (without flashboards)</td>
</tr>
<tr>
<td>Crest elevation</td>
<td>1231.0</td>
</tr>
<tr>
<td>Gates</td>
<td>Flashboards</td>
</tr>
<tr>
<td>Upstream channel</td>
<td>Lake</td>
</tr>
<tr>
<td>Downstream channel</td>
<td>None</td>
</tr>
<tr>
<td>Weir shape</td>
<td>Sharp crested weir</td>
</tr>
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SECTION 2
ENGINEERING DATA

2.1 Design. Review of information in the files of the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER) and the Borough of Mount Union show that extensive data is available for review of the structure's original design. Information available consists of construction drawings, correspondence, permits, inspection reports, photographs, and test results. The construction drawings show provisions to raise the dam approximately 15 feet; however, this raising of the dam was never completed.

2.2 Construction. Considerable construction data is available in the PennDER files. Daily construction reports document progress of the construction. The construction inspector made as-built drawings of the buttresses and all completed work. In addition, photographs were taken at all critical areas. Test results of construction materials are available for review.

2.3 Operation. There are no formal operating records.

2.4 Evaluation.

a. Availability. Engineering data were provided by the Bureau of Dam Safety, Obstructions and Storm Water Management, Department of Environmental Resources, Commonwealth of Pennsylvania. The owner made available the borough manager and the water foreman to answer questions regarding operation and construction of the dam.

b. Adequacy. The type and amount of data available is adequate to complete a Phase I Report.
SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The onsite inspection of the Lake Mount Union Dam was conducted by personnel of L. Robert Kimball & Associates accompanied by Borough of Mount Union Water Department Staff, personnel from the Baltimore District U.S. Army Corps of Engineers and personnel from the Washington, D.C. Sewer and Sanitary Authority on April 16, 1979. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments and toe.
2. Examination of the spillway facilities, exposed portions of any outlet works, and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.
4. Evaluation of the downstream area hazard potential.

b. Dam. Visual inspection of the dam indicated the structure was in good condition. In general, the concrete in the dam appeared to be in good condition. Excess waste material from the foundation excavation has been placed beyond the toe of the dam. This waste material has trapped water between the waste material and the upstream slab of the dam. Detailed examination of the structure follows:

1. Between buttresses 1 and 2 a small wet area was noted at the edge of buttress 2. No water was flowing from any of the relief pipes. Some silica buildup has developed on the concrete slab. Some seepage was noted in the abutment rock in front of buttress 1.

2. Between buttresses 2 and 3, there is some silica buildup on the side of buttress 2. On the concrete slab there is a wet area on the left side and on the right side at the junction of the slab and buttress 3. The concrete slab also shows a small area of spalling. At the junction of the slab and buttress 3, there is a small hole in the concrete.

3. Between buttresses 3 and 4, water is ponded at the foundation. In the concrete slab, there is some seepage through the top horizontal joint. There is some silica buildup in the lower portions of the slab.

4. Between buttresses number 4 and 5, water is ponded due to spillway overflow. Water supply lines are housed in this section. In the lower portions of buttress 4 some honeycombing of the concrete was noted. The aggregate is exposed and slight
hammering indicated little or no cement in the concrete. In addition, the steel was exposed during hammering. No appreciable rust was noted on the reinforcing. Buttress 5 showed similar signs of poor concrete on the downstream vertical face. Several portions of buttress 5 also have exposed reinforcing.

5. Between buttresses 5 and 6, the 30" drainline is housed.

6. Between buttresses 6 and 7, the concrete slab has a small deteriorated spot approximately 2 to 3 feet long. In addition, spalling of the concrete slab above the first joint was noted. Buttress 6 shows some concrete deterioration with 1 to 2 feet of steel reinforcing exposed.

7. A large amount of water was flowing over the dam between buttresses 7 and 8. This area was unobservable. Buttress 7 did show a notch in the concrete with bare steel exposed. Buttress 8 showed similar erosion of the concrete.

8. Between buttresses 9 and 10 some seepage was noted at the lower joint of the concrete slab. Buttress 9 showed some concrete deterioration with steel reinforcing exposed. Most of the bays between buttresses 5 and 16 were wet due to flow over the top of the dam or through the flashboards. Some honeycombing of the concrete slab between buttresses 9 and 10 below the top joint was noted. Buttress 10 on the left side showed a hole in the concrete just above the key cut and a crack that extends to the front of the buttress. This hole appears to extend through to the right side of the buttress.

9. Buttress 11 on the left side shows a small 6" hole with steel exposed.

10. Buttress 12 showed deterioration of the concrete below the haunch on the downstream face. Some steel is exposed.

11. Buttress 13 showed minor deterioration of the concrete with some silica buildup on the inside of buttress number 12.

12. No serious problems were noted between buttresses 14, 15 and 16. Some seepage was noted at the left abutment, at the abutment water level, through the abutment rock.

c. Appurtenant Structures. The spillway is located between buttresses 5 and 16 in the center portion of the dam. Between buttresses 6 and 16, the concrete sill is at elevation 1231.0. Between buttress 5 and 6, the spillway is at elevation 1232.0. Wooden flashboards with pipe sockets were placed over the spillway to raise the water level in the reservoir. A low point in the flashboards was made between buttresses 6 and 8 to confine the flow over this area. During tropical storm Agnes in June, 1972, several of the flashboards failed. Between buttresses 7 and 8, the flashboards were completely removed. The flashboards were severely bent in the area between buttresses 6 and 7 and 8 and 9.
The remainder of all the other flashboards have bent. The valve on the middle intake of the 12" supply line has reportedly been broken. The bottom intake reportedly is silted. The 30" drain-line has not been operated in the last 27 years. None of the valves were exercised during the inspection. Most of the two lines, the 12" supply line and the 30" drainline, were below water level and were unobserved during the inspection.

d. Reservoir Area. The watershed is predominantly covered with steep woodland. Reservoir slopes are moderately steep, but are not considered susceptible to massive landsliding.

e. Downstream Channel. The downstream channel of Singers Gap Run is very narrow and confined for the first three quarters of a mile below the dam. The channel becomes moderately wide below this point where there are several houses located very close to the stream. Approximately ten houses and one church are located very close to the stream within three miles of the dam.

3.2 Evaluation. The visual inspection did not reveal any immediate signs of instability. The dam appears to be in good condition. The spillway flashboards, the 12" water supply line and the 30" drainline appear to be in rather poor condition.
SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures. The reservoir is maintained at as high a level as possible (spillway crest - with flashboards in place). No operation is conducted on the water supply intakes or the drainline.

4.2 Maintenance of the Dam. No planned maintenance schedule is utilized. Maintenance of the dam is considered fair.

4.3 Maintenance of Operating Facilities. Maintenance of the operating facilities is severely lacking. Maintenance of the operating facilities is considered poor.

4.4 Warning System in Effect. There is no warning system in effect.

4.5 Evaluation. Maintenance of the dam is considered fair. Maintenance of the operating facilities is considered poor. There is no warning system in effect to warn downstream residences of large spillway discharges or failure of the dam. The dam is not accessible during periods of flooding.
SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. No calculations or design data pertaining to hydrology were available.

b. Experience Data. No rainfall, runoff or reservoir level data exists. During June 1972, the flashboards partially failed and have not been repaired.

c. Visual Observations. The concrete in the spillway area appeared to be good condition. All the flashboards have bent or have partially failed. Discharge through the spillway is currently confined to where the flashboards have failed between buttresses 7 and 8.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway.

The Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, Davis, California, July, 1978. The major methodologies or key input data for this program are discussed briefly in Appendix D.

5.2 Evaluation Assumptions. To enable us to complete the hydraulic and hydrologic analysis for this structure, it was necessary to make the following assumptions.

1. The water level in the reservoir prior to flood was at the spillway crest elevation 1231.0.

2. Overtopping potential of the dam was analyzed for the existing conditions (flashboards in place under current configuration) and with no flashboards in the spillway.

3. Dam breach analysis was analyzed for two conditions (maximum water level at 1237.0); (1) flashboards failing and (2) with the flashboards and two sections (32 feet) of the dam failing.

5.3 Summary of Overtopping Analysis. Complete summary sheets from the computer output are presented in Appendix D.

Peak inflow: 10,416 cfs
Spillway capacity (present configuration with flashboards in place): 695 cfs
Spillway capacity without flashboards: 2,957 cfs
a. Spillway Adequacy Rating. The Spillway Design Flood (SDF) for this dam is the PMF. The SDF is based upon hazard and size classification. Based on the following definition provided by the Corps of Engineers, the spillway for this dam is rated seriously inadequate as a result of our hydrologic analysis.

Seriously Inadequate - High hazard classification dams not capable of passing 50% of the PMF without failure when there is a significant increase in the hazard potential for loss of life downstream due to overtopping failure.

The spillway and reservoir are capable of controlling approximately 82% of the PMF with its present configuration with the flashboards. With the flashboards removed, the spillway may be inadequate and not seriously inadequate.

5.4 Summary of Dam Breach Analysis. As the subject dam cannot satisfactorily pass 50% of the PMF (based on our analysis) it was necessary to perform a dam breach analysis and downstream routing of the flood wave. This analysis determines the degree of increased flooding due to dam failure.

Results of the Dam Breach Analysis indicate that downstream flooding is significantly increased. With the flashboards failing the flooding downstream of the dam is not significantly increased (0.5 feet increase in water level with an increase of 1003 cfs). When the flashboards fail and two sections (each section 18 feet wide) failing, flooding downstream is significantly increased. Flood level was analyzed between 0.8 and 2.0 miles downstream of the dam. The flood level increase ranged from 2.9 feet to 3.8 feet with the flow increase ranging from 785 cfs to 8715 cfs. These results indicate that failure due to overtopping will significantly increase downstream potential for loss of life. Detailed results of the flood wave routing are included in Appendix D.

Note: Future development within the watershed, at the dam, or downstream may change the characteristics and assumptions made for this study and different results are likely. Future development downstream may also greatly increase the potential for loss of life due to failure of the structure.
6.1 Evaluation of Structural Stability.

a. Visual Observations. Visual inspection did not reveal any signs of immediate instability. The dam appears to be well constructed and conforms to the construction drawings.

b. Design and Construction Data. No record of design data, stability analysis or stress analysis for the original structure was available for review.

c. Operating Records. There are no operating records.

d. Post-Construction Changes. There have been no post-construction changes.

e. Seismic Stability. The dam is located in seismic zone 1. No seismic stability analysis has been performed. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake loading.

f. Check of Stability Analysis. An approximate check of the stability of the dam was performed. The assumptions were as follows:

1. Cross section through the spillway.
2. Cross section used as shown on the construction drawings.
4. Water level at 1239.5 (PMF).
5. Tailwater pressure and silt loads neglected.

Using the above assumptions the stability analysis indicated a safety factor of 2.0 against overturning and a sliding factor of 0.75. This indicates that the dam is probably stable during the PMF with the conditions analyzed. It is believed that the flashboards will fail before the water level in the reservoir reaches 1239.5.

Because of the nature of this type of dam, a stress analysis is more pertinent than a stability analysis from overturning. Because of the many different sections in this type of dam and the many assumed conditions, it is recommended that a more detailed structural analysis (including a stress analysis) be conducted.
SECTION 7

ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The dam appears to be in good condition. The visual observations, review of available information, hydrologic calculations, and past operational performance indicate that Lake Mount Union Dam's spillway is seriously inadequate. The spillway in its present configuration is capable of controlling approximately 8% of the PMF without overtopping the dam. As a result of the seriously inadequate spillway, the dam is considered to be an unsafe non-emergency dam. No stability analysis has been performed. An approximate stability analysis for the structure was conducted and the dam appears to be stable within the assumptions made for this study.

b. Adequacy of Information. The information available appears to be adequate to complete a Phase I report.

c. Urgency. The recommendations suggested below should be implemented immediately.

d. Necessity for Further Investigation. In order to accomplish some of the recommendations/remedial measures outlined below, further investigations will be required.

7.2 Recommendations/Remedial Measures.

1. Perform additional studies by a registered professional engineer knowledgeable in dam design for modifications of the spillway and/or dam to increase spillway capacity. This study should begin immediately and remedial modifications begun immediately after the study is complete.

2. The flashboards should be immediately removed to increase the spillway capacity until recommendation 1 is completed.

3. A warning system should be instituted to warn downstream residences of high spillway discharges and during periods of heavy rainfall or high runoff, or failure of the dam.

4. Access to the dam should be improved so the dam is accessible during periods of flooding.

5. Institute a formal inspection program to be conducted at regular intervals.

6. Repair drain lines to a workable condition. Exercise all gates on the drain line and the supply line at regular intervals.

7. Perform a detailed structural analysis (including a stress analysis) using the PMF water level for all probable conditions and major sections of the dam.
APPENDIX A

CHECKLIST, VISUAL INSPECTION, PHASE I
## CHECK LIST
### VISUAL INSPECTION
#### PHASE I

<table>
<thead>
<tr>
<th>NAME OF DAM</th>
<th>Lake Mount Union Dam</th>
</tr>
</thead>
<tbody>
<tr>
<td>COUNTY</td>
<td>Huntington</td>
</tr>
<tr>
<td>STATE</td>
<td>Pennsylvania</td>
</tr>
<tr>
<td>ID#</td>
<td>PA 473</td>
</tr>
<tr>
<td>TYPE OF DAM</td>
<td>Concrete buttress (Amburser)</td>
</tr>
<tr>
<td>DATE(s) INSPECTION</td>
<td>April 16, 1979</td>
</tr>
<tr>
<td>WEATHER</td>
<td>Cloudy</td>
</tr>
<tr>
<td>TEMPERATURE</td>
<td>50°F</td>
</tr>
<tr>
<td>POOL ELEVATION AT TIME OF INSPECTION</td>
<td>1231.1 M.S.L.</td>
</tr>
<tr>
<td>TAILWATER AT TIME OF INSPECTION</td>
<td>None M.S.L.</td>
</tr>
</tbody>
</table>

**INSPECTION PERSONNEL:**
- R. Jeffrey Kimball, L. Robert Kimball & Associates
- James T. Hockensmith, L. Robert Kimball & Associates
- Kuang-hwei Chuang, L. Robert Kimball & Associates
- John Pierchoski, L. Robert Kimball & Associates
- Howard Kass, Baltimore District Corps of Engineers
- Boyd Runk, Water Foreman, Borough of Mount Union

__________  ________
James T. Hockensmith  RECORDER
<table>
<thead>
<tr>
<th>VISUAL EXAMINATION OF</th>
<th>OBSERVATIONS</th>
<th>REMARKS OR RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURFACE CRACKS</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>UNUSUAL MOVEMENT OR</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>CRACKING AT OR BEYOND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THE TOE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLOUGHING OR EROSION</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>OF EMBANKMENT AND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABUTMENT SLOPES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VERTICAL AND HORIZONTAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALIGNMENT OF THE CREST</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>RIPRAP FAILURES</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>VISUAL EXAMINATION OF</td>
<td>OBSERVATIONS</td>
<td>REMARKS OR RECOMMENDATIONS</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>VEGETATION</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>JUNCTION OF EMBANKMENT</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>AND ABUTMENT, SPILLWAY AND DAM</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>ANY NOTICEABLE SEEPAGE</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>STAFF GAUGE AND RECORDER</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>DRAINS</td>
<td>N/A</td>
<td></td>
</tr>
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</table>
### CONCRETE/MASONRY DAMS

<table>
<thead>
<tr>
<th>VISUAL EXAMINATION OF</th>
<th>OBSERVATIONS</th>
<th>REMARKS OR RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANY NOTICEABLE SEEPAGE</td>
<td>Minor amounts of seepage noted in construction drawings on concrete slab.</td>
<td></td>
</tr>
<tr>
<td>STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS</td>
<td>Both abutments appear to be good.</td>
<td></td>
</tr>
<tr>
<td>DRAINS</td>
<td>None.</td>
<td></td>
</tr>
<tr>
<td>WATER PASSAGES</td>
<td>None.</td>
<td></td>
</tr>
<tr>
<td>FOUNDATION</td>
<td>Unobserved. Shale and quartzite.</td>
<td></td>
</tr>
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</table>
## CONCRETE/MASONRY DAMS

<table>
<thead>
<tr>
<th>VISUAL EXAMINATION OF</th>
<th>OBSERVATIONS</th>
<th>REMARKS OR RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURFACE CRACKS</td>
<td>One minor crack in buttress 10. Concrete in general appears to be good. There has been some silica buildup in certain areas. Minor amount of concrete deterioration on buttresses. In several areas, the reinforcing steel on the buttresses is exposed. Some honeycombing of the concrete in several areas.</td>
<td></td>
</tr>
<tr>
<td>CONCRETE SURFACES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STRUCTURAL CRACKING</td>
<td>None noted.</td>
<td></td>
</tr>
<tr>
<td>VERTICAL AND HORIZONTAL ALIGNMENT</td>
<td>Both appear to be good.</td>
<td></td>
</tr>
<tr>
<td>MONOLITH JOINTS</td>
<td>Good.</td>
<td></td>
</tr>
<tr>
<td>CONSTRUCTION JOINTS</td>
<td>Good.</td>
<td></td>
</tr>
<tr>
<td>STAFF GAUGE OR RECORDER</td>
<td>None.</td>
<td></td>
</tr>
<tr>
<td>VISUAL EXAMINATION OF</td>
<td>OBSERVATIONS</td>
<td>REMARKS OR RECOMMENDATIONS</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT</td>
<td>The 12&quot; cast iron pipe - unobserved. Three intakes at different elevations with 16&quot; cast iron pipes. Water is currently drawn off the top intake. The valve on the center intake reportedly is broken. The bottom intake is reportedly silted shut.</td>
<td></td>
</tr>
<tr>
<td>INTAKE STRUCTURE</td>
<td>Three intakes on concrete slab on upstream face of dam. The intakes have screens. Unobserved.</td>
<td></td>
</tr>
<tr>
<td>OUTLET STRUCTURE</td>
<td>No outlet structure. The 12&quot; pipe runs directly to the borough.</td>
<td></td>
</tr>
<tr>
<td>OUTLET CHANNEL</td>
<td>None.</td>
<td></td>
</tr>
<tr>
<td>EMERGENCY GATE</td>
<td>30&quot; cast iron blow-off line located between buttresses 6 and 7. Condition unobserved - below water level.</td>
<td></td>
</tr>
</tbody>
</table>
**UNGATED SPILLWAY**

<table>
<thead>
<tr>
<th>VISUAL EXAMINATION OF</th>
<th>OBSERVATIONS</th>
<th>REMARKS OR RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONCRETE WEIR</td>
<td>Appears to be good. Concrete weir has 4' high wooden flashboards, many of which are bent and some are missing.</td>
<td></td>
</tr>
<tr>
<td>APPROACH CHANNEL</td>
<td>Lake.</td>
<td></td>
</tr>
<tr>
<td>DISCHARGE CHANNEL</td>
<td>None.</td>
<td></td>
</tr>
<tr>
<td>BRIDGE AND PIERS</td>
<td>None.</td>
<td></td>
</tr>
<tr>
<td>GATED SPILLWAY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>REMARKS OR RECOMMENDATIONS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONCRETE SILL</td>
<td>APPROACH CHANNEL</td>
<td>DISCHARGE CHANNEL</td>
</tr>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Visual Examination of</td>
<td>Remarks or Recommendations</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------------------</td>
<td></td>
</tr>
<tr>
<td>Channel Observations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition (obstructions, debris, etc.)</td>
<td>Very narrow and confined for the first three quarters of a mile. No homes located within this stretch.</td>
<td></td>
</tr>
<tr>
<td>Slopes</td>
<td>Steep to moderate.</td>
<td></td>
</tr>
<tr>
<td>Approximate No. of Homes and Population</td>
<td>Within three miles, approximately 10 homes and 1 church (approximately 40+ people).</td>
<td></td>
</tr>
</tbody>
</table>
### RESERVOIR

<table>
<thead>
<tr>
<th>VISUAL EXAMINATION OF</th>
<th>OBSERVATIONS</th>
<th>REMARKS OR RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLOPES</td>
<td>Moderately steep.</td>
<td></td>
</tr>
<tr>
<td>SEDIMENTATION</td>
<td>Considerable. Bottom intake on water supply line silted shut.</td>
<td></td>
</tr>
<tr>
<td>INSTRUMENTATION</td>
<td>OBSERVATIONS</td>
<td>REMARKS OR RECOMMENDATIONS</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>--------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>MONUMENTATION/SURVEYS</td>
<td>None.</td>
<td></td>
</tr>
<tr>
<td>OBSERVATION WELLS</td>
<td>None.</td>
<td></td>
</tr>
<tr>
<td>METERS</td>
<td>None.</td>
<td></td>
</tr>
<tr>
<td>PIEZOMETERS</td>
<td>None.</td>
<td></td>
</tr>
<tr>
<td>OTHER</td>
<td>None.</td>
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</tr>
</tbody>
</table>

A-11
INDEX B

CHECKLIST, ENGINEERING, DATA, DESIGN, CONSTRUCTION, OPERATION, PHASE I
APPENDIX B

CHECKLIST, ENGINEERING DATA, DESIGN, CONSTRUCTION, OPERATION, PHASE I
<table>
<thead>
<tr>
<th>ITEM</th>
<th>REMARKS</th>
</tr>
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<tbody>
<tr>
<td>AS-BUILT DRAWINGS</td>
<td>None available.</td>
</tr>
<tr>
<td>REGIONAL VICINITY MAP</td>
<td>U.S.G.S quadrangle.</td>
</tr>
<tr>
<td>CONSTRUCTION HISTORY</td>
<td>PennDER files, considerable.</td>
</tr>
<tr>
<td>TYPICAL SECTIONS OF DAM</td>
<td>Construction drawings.</td>
</tr>
<tr>
<td>OUTLETS - PLAN</td>
<td>Construction drawings.</td>
</tr>
<tr>
<td>- DETAILS</td>
<td>Construction drawings.</td>
</tr>
<tr>
<td>- CONSTRAINTS</td>
<td>None.</td>
</tr>
<tr>
<td>- DISCHARGE RATINGS</td>
<td>None.</td>
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<tr>
<td>RAINFALL/RESERVOIR RECORDS</td>
<td>None.</td>
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<tr>
<td>ITEM</td>
<td>REMARKS</td>
</tr>
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<td>------</td>
<td>---------</td>
</tr>
<tr>
<td>DESIGN REPORTS</td>
<td>None.</td>
</tr>
<tr>
<td>GEOLOGY REPORTS</td>
<td>None.</td>
</tr>
<tr>
<td>DESIGN COMPUTATIONS&lt;br&gt;HYDROLOGY &amp; HYDRAULICS&lt;br&gt;DAM STABILITY&lt;br&gt;SEEPAGE STUDIES</td>
<td>None.</td>
</tr>
<tr>
<td>MATERIALS INVESTIGATIONS&lt;br&gt;BORING RECORDS&lt;br&gt;Laboratory&lt;br&gt;Field</td>
<td>None.&lt;br&gt;None.&lt;br&gt;PennDER files.&lt;br&gt;PennDER files.</td>
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<tr>
<td>POST-CONSTRUCTION SURVEYS OF DAM</td>
<td>None.</td>
</tr>
<tr>
<td>BORROW SOURCES</td>
<td>Unknown.</td>
</tr>
<tr>
<td>ITEM</td>
<td>REMARKS</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------</td>
</tr>
<tr>
<td></td>
<td>None.</td>
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</tbody>
</table>

B-3
APPENDIX C

PHOTOGRAPHS
View of spillway crest and flashboards from right abutment.

View of spillway crest from left abutment.
Downstream view of buttresses looking toward right abutment.

View of right abutment and non-overflow section.
C-2
Downstream view of buttress looking toward left abutment. Note: waste rock downstream of buttresses.

Left abutment. Note: grout pipes.

C-3
Water flowing over spillway between buttresses 7 and 8. Note: deterioration of concrete buttresses.

Immediate downstream exposure.
First downstream residence.

Several homes adjacent to stream.
APPENDIX D

HYDROLOGY AND HYDRAULICS
**APPENDIX D**

HYDROLOGY AND HYDRAULICS

Methodology. The dam overtopping and breach analyses were accomplished using the systemized computer program HEC-1 (Dam Safety Investigation), September, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. **Precipitation.** The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Reports No. 40 prepared by the National Weather Service. The index rainfall is reduced from 10% to 20% depending on watershed size by utilization of what is termed the HOP Brook adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps.

2. **Inflow Hydrograph.** The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list gives these parameters their definition and how they were obtained for these analysis.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Where Obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>C&lt;sub&gt;t&lt;/sub&gt;</td>
<td>Coefficient representing variations of watershed slope and storage</td>
<td>From Corps of Engineers*</td>
</tr>
<tr>
<td>L</td>
<td>Length of main stream channel miles</td>
<td>From U.S.G.S. 7.5 minute topographic</td>
</tr>
<tr>
<td>L&lt;sub&gt;ca&lt;/sub&gt;</td>
<td>Length on main stream to centroid of watershed</td>
<td>From U.S.G.S. 7.5 minute topographic</td>
</tr>
<tr>
<td>C&lt;sub&gt;p&lt;/sub&gt;</td>
<td>Peaking coefficient</td>
<td>From Corps of Engineers*</td>
</tr>
<tr>
<td>A</td>
<td>Watershed size</td>
<td>From U.S.G.S. 7.5 minute topographic</td>
</tr>
</tbody>
</table>

*Developed by the Corps of Engineers on a regional basis for Pennsylvania.
3. **Routing.** Reservoir routing is accomplished by using Modified Plus routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input or sufficient dimensions input and the program will calculate an elevation discharge relationship.

Storage in the pool area is defined by an area - elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

4. **Dam Overtopping.** Using given percentages of the PMF the computer program will calculate the percentage of the PMF which can be controlled by the reservoir and spillway without the dam overtopping.

5. **Dam Breach and Downstream Routing.** The computer program is equipped to determine the increase in downstream flooding due to failure of the dam caused by overtopping. This is accomplished by routing both the pre failure peak flow and the peak flow through the breach (calculated by the computer with given input assumptions) at a given point in time and determining the water depth in the downstream channel. Channel cross-sections taken from U.S.G.S. 7.5 minute topographic maps were used in the downstream flood wave routing. Pre and post failure water depths are calculated at locations where cross-sections are input.
DAM NAME: Lake Mount Union

Drainage Area

Area = 3.5 sq. miles (from USGS 7.5 min. quad.)

Unit Hydrograph Parameters

Site located in zone 21, Susquehanna River Basin, from Corps of Engineers, Baltimore District Regional Study.

Cp = 0.55  Cc = 1.50  (from C.O.E. Baltimore Dist.)

L = 2.2 miles, Lcu = 0.3 miles (from USGS 7.5 min. quad.)

Cp = Cc (L x Lcu)0.5 = 1.5 (2.2 x 0.34)0.5

Cp = 1.50 (0.98) = 1.47 hrs. (Snyders Lagoon (Cp) in hours)

Loss Rate and Base Flow Parameters

As recommended by Corps of Engineers, Baltimore District.

STRTL = 1 inch

CNSTL = 0.05 in/in.

STRTQ = 1.5 cfs/mi2

QRCN = 0.05 (5% of peak flow)

RT10R = 2.00

Probable Maximum Storm

From H.R. 40

PMP, Index Rainfall 22.2 (1.04) = 23.1 in.

R6 = 117%, R12 = 127%, R24 = 136%, R48 = 143%, R72 = 145%
ELEVATION-AREA-CAPACITY-RELATIONSHIPS

From USGS. 7.5 Min. Quads, D.E.R. Files and Field Inspection Data.

At spillway crest, ELEV. 1231'0"
Area = 10 acres
Initial Storage = 153 AC. FT.

At 1240', Area = 10 acres
At 1260', Area = 25 acres


$N = \frac{3y/A}{10} = \frac{3(153)}{10} = 45.9'$
Elev. at capacity equals zero; 1231' - 46' = 1185'

<table>
<thead>
<tr>
<th>ELEV. (FT)</th>
<th>1185</th>
<th>1231</th>
<th>1235</th>
<th>1240</th>
<th>1245</th>
<th>1250</th>
<th>1255</th>
<th>1260</th>
</tr>
</thead>
<tbody>
<tr>
<td>AREA (AC)</td>
<td>0</td>
<td>10</td>
<td>15</td>
<td>16</td>
<td>18</td>
<td>21</td>
<td>23</td>
<td>25</td>
</tr>
</tbody>
</table>

Discharge Rating Curves

Two discharge curves were calculated for two conditions. Condition number one - actual condition. Condition number two - all flashboards removed.

Concrete

Wooden Flashboards

Concrete

Top of Dam at elev. 1235' Not to Scale
### Condition No. 1

<table>
<thead>
<tr>
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<th>TRAPEZOIDAL FLOW</th>
<th>RECTANGULAR FLOW</th>
<th>Q TOTAL (CFS)</th>
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<tr>
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<td>Q (CFS)</td>
<td>k (FT.)</td>
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$c' = 0.95$  
$c = 3.3$  
$C = 173.5', J = 197.5'\

### Condition No. 2 (Flashboards Removed)

Discharge curve determined with HEC-1.

Length of Spillway = 193.5'  
$c = 3.3$  
Spillway Crest at Elev. 1231'
OVERTOP PARAMETERS

ELEV. TOP OF DAM = 1235'
LENGTH OF DAM = 116'
COEFFICIENT = 3.1 BROAD CREST WEIR

DISCHARGE CURVE WAS DETERMINED WITH (HEC-1).

DAM BREACH PARAMETERS

PLAN 1 (SECTION OF FLASHBOARDS AND STRUCTURE FAIL)

1235’
1281’
1194’
1136’

RATIO OF PMF = 0.4
BREACH WIDTH = 36'
SIDE SLOPE OF BREACH = 0
FAILURE TIME = 0.25 HRS.
ELEVATION
FAILURE BEGINS = 1237’

PLAN 2 (FLASHBOARDS FAIL)

1235’
1281’
1136’
193.5’

RATIO OF PMF = 0.4
BREACH WIDTH = 193.5'
SIDE SLOPE OF BREACH = 0
FAILURE TIME = 0.25 HRS.
ELEVATION
FAILURE BEGINS = 1237’
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 3.29 square miles, steep wooded

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1231.0 (164 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N/A

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1235.0

SPILLWAY CREST:

a. Elevation 1231.0
b. Type Sharp crested weir with wooden flashboards
c. Width

d. Length 193.5 feet
e. Location Spillover Center of dam
f. Number and Type of Gates Flashboards

OUTLET WORKS:

a. Type 12" cast iron pipe
b. Location Between buttress 4 and 5
c. Entrance inverts 1201.0
d. Exit inverts 1201.0
e. Emergency draindown facilities 30" cast iron pipe

HYDROMETEOROLOGICAL GAUGES:

a. Type NONE
b. Location

c. Records

MAXIMUM NON-DAMAGING DISCHARGE: June 1972, flow unknown, dam undamaged however, flashboards were damaged.
<table>
<thead>
<tr>
<th>HYDRO</th>
<th>IUHO</th>
<th>TAREA</th>
<th>SNAP</th>
<th>TRKPA</th>
<th>TRKPC</th>
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<th>TINOK</th>
<th>ISMAL</th>
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TR&P computed by the program 15.1800

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<th>ERAIN</th>
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<th>RTOK</th>
<th>STRTL</th>
<th>CNSTL</th>
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<th>RTIMP</th>
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**UNIT HYDROGRAPH**

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<th>END-OF-PERIOD PLOTTED</th>
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END-OF-PERIOD PLOTTED FOR DETERMINING END-OF-PERIOD HYDROGRAPH

SUM 26.80 24.16 2.64 208930
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<th>ICMP</th>
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<th>IAUTO</th>
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<td>COGN</td>
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</table>
# PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)

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<thead>
<tr>
<th>AREA IN SQUARE MILES (SQUARE KILOMETERS)</th>
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<tr>
<td>10</td>
</tr>
<tr>
<td>HYDROGRAPH AT</td>
</tr>
<tr>
<td>ROUTED TO</td>
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<tr>
<td>PLAN 1 **************</td>
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<tr>
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</tr>
<tr>
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<td>OUTFLOW</td>
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<table>
<thead>
<tr>
<th>RATIO OF RESERVOIR</th>
<th>MAXIMUM DEPTH</th>
<th>MAXIMUM STORAGE</th>
<th>MAXIMUM OUTFLOW</th>
<th>DURATION</th>
<th>TIME OF MAX OUTFLOW</th>
<th>TIME OF FAILURE</th>
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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79

RUN DATE 79/08/31
TIME 13:09:16

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PNF

HYDROLOGIC-HYDRAULIC ANALYSIS OF LAKE MOUNT UNION DAM PA 31-92
RATIOS OF PNF ROUTED THROUGH THE RESERVOIR. NO FLASHBOARDS!!!

JOB SPECIFICATION

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<th>NMIN</th>
<th>IDAY</th>
<th>IHR</th>
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MULTI-PHASE ANALYSES TO BE PERFORMED

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<th>LOTION= 1</th>
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SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

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<th>ITAPE</th>
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<th>JPRT</th>
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HYDROGRAPH DATA
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<th>SNAP</th>
<th>TSBA</th>
<th>TRPC</th>
<th>RATIO</th>
<th>ISNOW</th>
<th>ISAME</th>
<th>LOCAL</th>
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**PRECIP DATA**

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**LOSS DATA**

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**UNIT HYDROGRAPH DATA**

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**UNIT HYDROGRAPH 3D END-OF-PERIOD ORDINATES (in cubic meter):**

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**END-OF-PERIOD FLOW:**

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**HYDROGRAPH ROUTING**
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<th>AMSTK</th>
<th>X</th>
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**Surface Area:** 0
**Capacity:** 0
**Elevation:** 1100
**REL:** 123
**SPWID:** COVE
**EXPW:** ELEV
**COSW:** COOL
**AREW:** AREA
**EnW:** EXPW

**Topo:**
**Coord:**
**Expo:**
**DAMWID:**

**Peak Outflow 1:** 80394 at Time: 4:10 PM Hours

**Peak Outflow 2:** 60394 at Time: 41:09 Hours

**Peak Outflow 3:** 10134 at Time: 41:09 Hours
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Flows in cubic feet per second (cubic meters per second)
Area in square miles (square kilometers)
### SUMMARY OF DAM SAFETY ANALYSIS

**PLAN 1 *******

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**K2** ROUTE THROUGH RESERVOIR

**K3** CHANNEL ROUTING - MUD PULLS REACH 2-3
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FLOOD HYDROGRAPH PACKAGE (HFC-1)
DAM SAFETY VERSION JULY 1976
LAST MODIFICATION 26 FEB 79

RUN DATE 79/05/14
TIME 13:08:33

RATIO OF PWF ROUTED THROUGH THE RESERVOIR AND DOWNSTREAM
DOWNSTREAM CONDITION DUE TO OVERTOP LAKE MOUNT UNION PA 31-52
PLANS 1 AND 2 ASSUME BREACH PLAN 2' ASSUMES NO BREACH

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MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 3 NRTIO= 1 LRTIO= 1

RT10S= 440

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SUB-AREA RUNOFF COMPUTATION

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**Unit Hydrograph**

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**BEGIN DAM FAILURE AT 40.75 HOURS**

**PEAK OUTFLOW IS 17202. AT TIME 41.00 HOURS**

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**BEGIN DAM FAILURE AT 40.75 HOURS**

**PEAK OUTFLOW IS 5712. AT TIME 40.76 HOURS**

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**PEAK OUTFLOW IS 4035. AT TIME 41.00 HOURS**

**HYDROGRAPH ROUTING**

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ALL PLANS HAVE SAME
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MAXIMUM STAGE 15 | 100711
MAXIMUM STAGE 15 | 100648

HYDROGRAPH ROUTING

CHANNEL ROUTING - MOD PULS BEACH 3-4

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ALL PLANS HAVE SAME ROUTING DATA

GLOSS GLOSS AVG IRES ISAME I OPT I PHP L SSR
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NPS NSTOL LAG AMSKR R TSK STOR A IPR
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### SUMMARY OF DAM SAFETY ANALYSIS

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APPENDIX E

DRAWINGS
APPENDIX F

GENERAL GEOLOGY
General Geology.

The Mount Union Dam is located within the Valley and Ridge Physiographic Province. This province is typified by numerous synclinal and anticlinal features. Structurally, the dam is located on the western limit of an anticline. No major faulting is associated with this feature. The dam is underlain by Ordovician aged sediments of the Juniata Formation. This formation is composed of red, fine grained, conglomeratic, quartzitic sandstones. The sandstones are cross-bedded and interbedded with red shale.
Geologic Map of Lake Mount Union Dam Area

**Mahanantango Formation**
- Brown to olive shale with interbedded sandstones which are dominant in plains
- Thickness: 120 feet in central
- Extends to eastern Pennsylvania

**Marcellus Formation**
- Black to greenish-black, interbedded shale with thick, brown sandstones (Turkey Hill) with thin shale in parts of central Pennsylvania

**Onondaga Formation**
- Gravelly shale, thin-bedded shale and sand
- Dark to black, medium-bedded limestone with shale predominant in most places, includes Silurian Age line 1 and Aestiva shale
- Some shale in core of Pennsylvania
- Extends east to opposite Pennsylvania:
- Lake Hop area includes Palisades Sandstone and Homestead Shale

**Scale:** 1:250,000
APPENDIX G

STABILITY ANALYSIS
SDF = PMF

Crest of flashboard:
E.I. 1234.5'

Max. H.W. 1237.5'

Section through spillway - A-A

(i) Headwater pressure:

\[ V_n = (475 + 674)(18)(3624) = 1290^k \]

\[ H_n = (1412 + 6446)(18) = 1418^k \]

\[ M(A) = 26.5 + 34185 \]

\[ M(A) = 16.5 - 23400 \]
(ii) Wt. of Structure:

Deck wt.:

\[ \frac{1}{2} \cdot (24 + 11.5) \cdot (12) \cdot (150) \cdot (56) = 412 \text{ k} \]

\[ M_{\text{Arm}} (\text{ton}) \]

\[ 23.5 \quad + \quad 9,680 \]

Buttress:

\[ 707 + 59.4 + 24 = 190.4 \text{ k} \]

\[ \frac{190.4 \text{ k}}{w = 602 \text{ k}} = 3.18 \]

\[ 13.8 \quad + \quad 2,630 \]

\[ 20.5 \quad + \quad 1,2310 \]

The headwater uplift pressure on an Ambursen dam is usually insignificant, neglected the tail-water pressure and soil load.

Sliding factor, \( f = \frac{1418}{1290 + 602} = 0.75 \)

(Ch. 118?)

Stability against overturning:

\[ F_o S. = \frac{34185 + 12,310}{23,400} = 2.0 \]

Pit. of resultant, from downstream face:

\[ d = \frac{23095}{1290 + 602} = 12.2 \quad \text{out of Middle Third} \]