LOWER HUDSON RIVER BASIN

LAKE PEEKSKILL DAM

PUTNAM COUNTY, NEW YORK

INVENTORY NO. N.Y. 87

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

APPROVED FOR PUBLIC RELEASE;

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NEW YORK DISTRICT CORPS OF ENGINEERS

AUGUST 1981
**REPORT DOCUMENTATION PAGE**

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<td>Inventory No. 87</td>
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<td>Beaver, PA 15009</td>
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<td>Department of the Army</td>
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<td>New York, NY 10287</td>
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<td>UNCLASSIFIED</td>
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<td>Approved for public release; Distribution unlimited.</td>
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<td>Examination of available documents and a visual inspection of the dam and</td>
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<td>appurtenant structures did not reveal conditions which constitute an immediate</td>
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SECURITY CLASSIFICATION OF THIS PAGE (When One IsEntered)
Using the Corps of Engineers' screening criteria, it has been determined that the dam would be overtopped for all storms exceeding approximately 77 percent of the Probable Maximum Flood (PMF). Therefore, the spillway is adjudged "inadequate."

Structural stability analyses based on available information, indicate that the factors of safety against overturning are generally low, and the locations of the resultants fall outside the middle 1/3 (except for analyses of the normal loading conditions). When the dam is subjected to severe loading conditions such as an ice load or a PMF event, the factors of safety fall to critical levels. Therefore, it is recommended that further analyses of the structural stability be performed within three months of notification. These analyses will determine the appropriate remedial measures required.

Formal inspection and maintenance procedures should be developed with records maintained for future reference.

A formal warning system and emergency action plan should be developed and put into operation as soon as possible.

The seeps should be monitored at regular intervals for activity and increase in flow.
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 Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide 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 INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM  
LAKE PEEKSKILL DAM  
I.D. No. NY 87  
DEC DAM No. 213C-814 LOWER HUDSON RIVER BASIN  
PUTNAM COUNTY, NEW YORK

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Lake Peekskill Dam (I.D. No. NY 87)
State: New York
County: Putnam
Stream: Unnamed Tributary of Peekskill Hollow Brook
Date of Inspection: 6 March 1981

ASSESSMENT

Examination of available documents and a visual inspection of the dam and appurtenant structures did not reveal conditions which constitute an immediate hazard to human life or property.

Using the Corps of Engineers' screening criteria, it has been determined that the dam would be overtopped for all storms exceeding approximately 77 percent of the Probable Maximum Flood (PMF). Therefore, the spillway is adjudged "inadequate."

Structural stability analyses based on available information, indicate that the factors of safety against overturning are generally low, and the locations of the resultants fall outside the middle 1/3 (except for analyses of the normal pool loading conditions). When the dam is subjected to severe loading conditions such as an ice load or a PMF event, the factors of safety fall to critical levels. Therefore, it is recommended that further analyses of the structural stability be performed within three months of owner notification. These analyses will determine the appropriate remedial measures required.

Formal inspection and maintenance procedures should be developed with records maintained for future reference.

A formal warning system and emergency action plan should be developed and put into operation as soon as possible.

The seeps should be monitored at regular intervals for turbidity and increase in flow.
The following remedial measures must be completed within one year:

1. The far left bridge support should be underpinned and protected from future erosion.

2. The debris should be cleaned from the upstream side and bottom discharge area of the spillway.

3. The trees in the spillway discharge channel should be cut off at ground level.

4. Repair the spalled concrete on the spillway and dam.

5. Install a staff gage to monitor reservoir levels.

SUBMITTED:  Granville Kester, Jr., P.E.
Vice President
MICHAEL BAKER, JR. of New York, INC.

APPROVED:  
Colonel W.M. Smith, Jr.
New York District Engineer

DATE:  14 Aug 81
Overall View of Dam
Lake Peekskill Dam
I.D. No. NY 87
6 March 1981
PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE PEEKSKILL DAM
I.D. No. NY 87
DEC DAM No. 213C-814
LOWER HUDSON RIVER BASIN
PUTNAM COUNTY, NEW YORK

SECTION 1: PROJECT INFORMATION

1.1 GENERAL

a. Authority - The Phase I Inspection reported herein was authorized by the Department of the Army, New York District, Corps of Engineers, to fulfill the requirements of the National Dam Inspection Act, Public Law 92-367.

b. Purpose of Inspection - This inspection was conducted to evaluate the existing conditions of the dam, to identify deficiencies and hazardous conditions, to determine if these deficiencies constitute hazards to life and property, and to recommend remedial measures where required.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam - Lake Peekskill Dam is a concrete gravity dam 15.6 feet high measured from the crest to the toe of the dam. The dam is 120 feet long with a vertical upstream face and sloped downstream face (sloping 2V:1H). The crest of the dam is an abandoned highway bridge deck 16 feet wide with a new highway bridge built approximately 1.2 feet above the abandoned bridge deck. The spillway consists of two 3-foot high by 6-foot wide (perpendicular to flow) openings. The spillway crest has a breadth of 4 feet (parallel to flow).

The discharge channel is steep and contains rock outcrops. A small breached dam is located approximately 500 feet downstream.

b. Location - Lake Peekskill Dam is located on an unnamed tributary of Peekskill Hollow Brook and is 2-1/2 miles northeast of Peekskill, New York. The reservoir and dam are located in Putnam County, New York. The coordinates of the dam are N 41° 20.2' and W 73° 52.8'. The dam can be found on the
Peekskill, New York, USGS 7.5 minute topographic quadrangle. A Location Map is shown in Appendix E.

c. Size Classification - Lake Peekskill Dam is 15.6 feet high, and the reservoir storage capacity at the minimum top of the dam (Elevation 295.6 feet M.S.L.) is 1357 acre-feet. Therefore, the dam is in the "intermediate" size category as defined by the Recommended Guidelines for Safety Inspection of Dams (Reference 14, Appendix D).

d. Hazard Classification - Two houses are located 1600 feet downstream from the dam. Loss of life in the homes is likely if the dam were to fail. Lake Peekskill Dam is therefore considered in the "high" hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams.

e. Ownership - The dam and reservoir are owned and operated by Lake Peekskill Improvement District, Box 317, Lake Peekskill, New York. The contact person is Mr. A. Purdy (telephone 914-528-9745).

f. Purpose of the Dam - Lake Peekskill is used for recreational purposes.

g. Design and Construction - Allan Smith, Professional Engineer, Cold Spring, N.Y., designed the dam in 1928. No date or contractor for construction is known.

h. Normal Operating Procedure - The reservoir level is typically maintained at the spillway crest. The owner's representative reported that the dam is checked four or five times a year for leaks and debris, and the reservoir is lowered in the fall to clean around the shorelines.

1.3 PERTINENT DATA

a. Drainage Area (Acres) - 386.0

b. Discharge at Dam (c.f.s.)

| Spillway Capacity (at Minimum Top of Dam Elev. 295.6 ft. M.S.L.) | 589.0 |

c. Elevation (Feet Above M.S.L.)

| Minimum Top of Dam | 295.6 |
| Normal Pool (Spillway Crest) | 291.0 |
| Streambed at Toe of Dam | 280.0 |
d. Reservoir Surface (Acres) -
   Top of Dam (Elev. 295.6 ft. M.S.L.) 67.0
   Spillway Crest (Elev. 291.0 ft. M.S.L.) 52.0

e. Reservoir Storage Capacity (Acre-Feet) -
   Top of Dam (Elev. 295.6 ft. M.S.L.) 1357.0
   Spillway Crest (Elev. 291.0 ft. M.S.L.) 1074.0

f. Dam -
   Type: Concrete gravity
   Length (Feet) 120.0
   Height (Feet) 15.6
   Top Width (Feet) 16.0
   Side Slopes - Upstream Vertical
                Downstream 2V:1H

h. Reservoir Drain -
   The original 24-inch outlet pipe was plugged with concrete in 1948. Therefore, the outlet pipe is not operable.

1All elevations are referenced to the spillway crest, Elev. 291.0 ft. M.S.L., estimated from the USGS 7.5 minute topographic quadrangle, Peekskill, NY.
2.1 GEOLOGY

The Lake Peekskill Dam is located in the southern end of the "New England Uplands" physiographic province of New York State. This province is geologically complex and characteristically composed of a diverse group of igneous and metamorphic rocks which have been tectonically disturbed by a number of normal and thrust faults. Bedrock in the immediate vicinity of the dam is represented by Ordovician and Precambrian rocks. The Ordovician rocks are composed of a hornblende diorite and the Manhattan Formation, a sillimanite, garnet, muscovite, biotite, plagioclase, and quartz gneiss. The Precambrian rocks consist of an amphibolite and a biotite granitic gneiss. The contact between the Ordovician diorite and the Precambrian amphibolite is located just east of Lake Peekskill. Two major fault systems are present within approximately 2 miles of either side of the lake. The first and most extensive faulting runs northeast-southwest and is located north of the lake. The second set of faults are located southeast of the lake and trend northwest to southeast. In both cases, these faults are probably best classified as high angle reverse faults.

2.2 SURFACE INVESTIGATION

Original subsurface information was not available for reference as a part of this investigation. Four borings were performed in 1968 in conjunction with the design of the new bridge structure. The location of these four borings is shown on Plate 2 (Appendix E) of this report. The boring logs are presented in Appendix F, Background Documents. Borings on the right abutment (S-1 and S-2) indicate approximately 4 feet of soil overlying greenish gray gneiss. The soil was logged as "brown coarse-fine sand with little-to-some silt and a trace of med.-fine gravel." The left abutment borings (S-3 and S-4) indicate 3.0 feet and 6.5 feet, respectively, of soil overlying greenish gray gneiss. Boring S-3 was logged as "brown coarse-fine sand, little silt, trace coarse-fine gravel." Boring S-4 was logged as "brown coarse-fine sand, little coarse-fine gravel, little silt."

According to the available soils report (interim) for Putnam County prepared by the Putnam County Soil and Water Conservation District, the soils in the vicinity
of the dam are of the Hollis-Charlton Association. These soils are described as "shallow, excessively-to-well drained, sandy loam soils and deep, well-drained stony, sandy loam soils that have a permeable subsoil and substratum."

2.3 DAM AND APPURTEANANT STRUCTURES

Plans for the dam and original bridge prepared by Allan Smith, P.E., Cold Spring, New York, circa 1928, were obtained from Mr. Ron Kobbe, Putnam County Highway Department, 351 Fair Street, Carmel, New York 10512. Design drawings for the new bridge, circa 1969, were also obtained from Mr. Kobbe.

The dam is a concrete semi-gravity dam with a vertical upstream face, crest width of 16 feet and a sloped downstream face (sloping 2V:1H). The spillway consists of two 3-foot high by 6-foot wide openings. A highway bridge has been built above the dam.

2.4 CONSTRUCTION RECORDS

No construction records were available for this investigation.

2.5 OPERATION RECORDS

Formal operation records are not maintained by the owner. The dam is checked four or five times annually for leaks and debris, and the reservoir is lowered in the fall to clean around the shorelines.

2.6 EVALUATION OF DATA

The background information collected during this investigation was obtained primarily from the New York State Department of Environmental Conservation files. Supplementary information was acquired through conversations with Mr. A. Purdy, representing the Lake Peekskill Improvement District. Design drawings were obtained through Mr. Kobbe of the Putnam County Highway Department. The available data are considered adequate and reliable for Phase I Inspection purposes.
3.1 FINDINGS

a. General - The inspection was performed on 6 March 1981. The weather was sunny with a temperature of 30°F. One to two inches of snow had fallen two days previously, but the dam and structures were not covered during the inspection. The water surface was 0.5 feet above the crest. Deficiencies found during the inspection will require remedial treatment. A Field Sketch of conditions found during the inspection is included in Appendix E. The complete Visual Inspection Checklist is presented as Appendix B.

b. Spillway - The spillway consists of two 3-foot x 6-foot openings and is located 25 feet from the left abutment. The two openings were 4 feet wide. Debris was located on the upstream side of the spillway and where the spillway junctions with the discharge channel.

c. Dam - The dam is a concrete structure 120 feet long with a height of 15.6 feet. An abandoned bridge deck is the top of the dam, and a new bridge is located 1.2 feet above this structure. Seepage was observed exiting from the right downstream buttress near the spillway. This concrete buttress is also spalled and partially deteriorated. Seepage was also observed 2 feet from the left bridge column of the abandoned bridge. The owner's representative reported seeing seepage exiting from the right toe of the dam near the spillway. The inspection team was unable to locate this seepage because of the debris present at this location. The abandoned bridge deck is spalled. The far left downstream (abandoned) bridge support has been undermined. No major cracking of the dam was observed.

d. Outlet Works - The outlet works for the dam are no longer operable, as they are filled with concrete. The only means of lowering the reservoir level is by two 6-inch PVC pipes (used as siphons) placed over the spillway crest.

e. Downstream Channel - The downstream channel is steep and contains rock outcrops. Trees are located in the channel.
A small breached dam structure is located approximately 500 feet downstream. This dam is currently non-impounding but would impound water if excessively heavy flows in the creek were greater than the capacity of the breached portion. This structure is of masonry construction and is in need of repair.

Two houses and a road are located 1600 feet downstream from the dam. The stream flows through a 48-inch diameter culvert under the road.

f. Reservoir - The slopes of the reservoir are moderate and covered by homes and vegetation. There were no signs of instability, and sedimentation was not reported to be a problem.

3.2 EVALUATION

The visual inspection revealed several deficiencies in this structure. The following items were noted:

1. Seepage was observed exiting the right downstream buttress near the spillway.
2. Seepage was observed exiting near the downstream left bridge column of the abandoned bridge.
3. Seepage was observed at the right toe of the dam.
4. The far left bridge support has been undermined.
5. Debris was located on the upstream side of the spillway.
6. Debris was located at toe of the spillway discharge area.
7. The outlet works have been sealed and are no longer operable.
8. Trees are located in the discharge channel.
9. The spillway and dam have minor spalling on its concrete surfaces.
SECTION 4: OPERATION AND MAINTENANCE PROCEDURES

4.1 PROCEDURES

There are no formal written instructions for operating the reservoir. The normal water surface elevation is at the spillway crest, but because of recent precipitation, the water surface was 0.5 feet above the crest at the time of the inspection. The reservoir is used for recreation. Two 6-inch PVC pipes (used as siphons) were on the spillway crest.

4.2 MAINTENANCE OF THE DAM

Maintenance of the dam is the responsibility of the Lake Peekskill Improvement District. The maintenance foreman checks the dam four or five times a year. He visually inspects it for cracks and seepage. Maintenance is performed when funds are available.

4.3 WARNING SYSTEM

At the time of the inspection, there was no warning system or emergency action plan in operation.

4.4 EVALUATION

Past maintenance of the dam and operating facilities appears to have been adequate, but the past activities have gone undocumented. A checklist should be compiled by the owner's representative to document the findings made during the periodic inspections and the maintenance items completed. A warning system and emergency action plan should be developed and put into operation.
SECTION 5: HYDRAULIC/HYDROLOGY

5.1 DRAINAGE AREA CHARACTERISTICS

Delineation of the watershed of Lake Peekskill Dam was made using the USGS quadrangle for Peekskill, New York. The drainage basin has steep slopes near the reservoir with extensive lakeside development in the 386-acre drainage area. No storage exists upstream of the reservoir.

5.2 ANALYSIS CRITERIA

A hydrologic analysis of the watershed and hydraulic analysis of the dam was conducted using the U.S. Army Corps of Engineers' Flood Hydrograph Package HEC-1 DB computer program (Reference 12, Appendix D). The unit hydrograph was defined using the Snyder's Unit Hydrograph Method. Estimates of Snyder's hydrograph coefficients were developed from average coefficients from the Hydrologic Flood Routing Model for Lower Hudson River Basin (Reference 16, Appendix E). Precipitation data was taken from Hydrometeorological Report No. 33 (Reference 8, Appendix D). Rainfall losses were estimated at an initial loss of 1.0 inch and a constant loss rate of 0.1 inch per hour thereafter. The hydraulic capacity of the dam, reservoir and spillway was determined by incorporating the Modified Puls Routing Method. All flood routings were begun with the reservoir at normal pool level. Outlet discharge capacity was computed by hand. The Probable Maximum Flood (PMF) and 1/2 Probable Maximum Flood (1/2 PMF) were developed and routed through the reservoir.

5.3 SPILLWAY CAPACITY

The spillway consists of two 3-foot by 6-foot openings near the center of the dam. The spillway has a capacity of 589 cubic feet per second (c.f.s.) at the top of the dam. There is no auxiliary or emergency spillway at Lake Peekskill Dam.

5.4 RESERVOIR CAPACITY

The storage capacity of Lake Peekskill Dam at normal pool is 1074 acre-feet. The storage capacity of the reservoir at the minimum top of dam is 1357 acre-feet. Therefore, flood control storage of the reservoir between the spillway crest and top of dam is 283 acre-feet. This volume represents a total of 8.80 inches of runoff from the watershed.
5.5 **FLOODS OF RECORD**

No information concerning the effects of significant floods on the dam is available.

5.6 **OVERTOPPING POTENTIAL**

The maximum capacity of the spillway is 589 c.f.s. before overtopping would occur. The peak outflows of the PMF and 1/2 PMF are 693 c.f.s. and 316 c.f.s., respectively. Therefore, the spillways are capable of passing 77 percent of the PMF before overtopping would occur.

5.7 **RESERVOIR EMPTYING POTENTIAL**

The reservoir can be drawn down by two 6-inch P.V.C. siphon pipes. The maintenance foreman stated that it takes one month to lower the reservoir 4 to 5 feet.

5.8 **EVALUATION**

Lake Peekskill Dam is an "intermediate" size - "high" hazard dam requiring the spillway to pass the PMF. The PMF and 1/2 PMF were routed through the watershed and dam. It was determined that the spillway is capable of passing 77 percent of the PMF before overtopping the dam. Therefore, the spillway is judged "inadequate."

Conclusions pertain to present conditions and the effect of future development on the hydrology has not been considered.
SECTION 6: STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - No signs of instability were observed during the field inspection. Minor problems observed which may affect the stability of the structure include:

1. Clear seepage was observed exiting the right downstream buttress near the spillway.

2. Clear seepage was observed exiting near the left downstream bridge column of the abandoned bridge.

3. The spillway and dam have minor spalling, especially at the point of seepage exiting on the right downstream buttress, on its concrete surfaces. No major cracks were observed.

4. The owner's representative reported seepage exiting at the right toe of the spillway. However, this seepage was not observed due to the amount of debris present at this location.

5. The left downstream abandoned bridge column footing is partially undermined.

b. Design and Construction Data - Design information regarding the stability of the structure is unavailable.

c. Operating Records - Operating records are unavailable. The reservoir is typically at the same elevation as the spillway crest, except during the 1 October to 31 December period when the reservoir is drawn down 4 to 5 feet to facilitate shoreline and dock maintenance.

d. Post Construction Changes - The structure was built circa 1928. The outlet drain pipe was plugged with concrete in 1948. Around 1970, a new bridge was installed spanning over the dam to replace the existing bridge deck founded on the crest of the dam. The previous bridge deck was then left in place and abandoned.
6.2 STABILITY ANALYSIS

The results of any previous stability analyses were unavailable for reference during this evaluation. A structural stability analysis was conducted at the spillway location which coincides with the maximum section of the dam. The cases analyzed and respective results are as follows:

<table>
<thead>
<tr>
<th>Case</th>
<th>Description of Loading Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normal operating conditions with the reservoir at the spillway crest (Elev. 291 ft. M.S.L.), full uplift, and with a tailwater of 1.0 foot.</td>
</tr>
<tr>
<td>2</td>
<td>Same as Case 1 with additional ice loading of 5000 pounds per lineal foot at normal pool level.</td>
</tr>
<tr>
<td>3</td>
<td>Reservoir level during the 1/2 PMF (Elev. 294.4 ft. M.S.L.), full uplift, with a tailwater of 1.5 feet.</td>
</tr>
<tr>
<td>4</td>
<td>Reservoir level during the PMF (Elev. 296.5 ft. M.S.L.), full uplift, with a tailwater of 2.0 feet.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Case</th>
<th>Factor of Safety</th>
<th>Location of Resultant from Toe (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overturning</td>
<td>Sliding</td>
</tr>
<tr>
<td>1</td>
<td>1.89</td>
<td>6.15</td>
</tr>
<tr>
<td>2</td>
<td>0.83</td>
<td>2.90</td>
</tr>
<tr>
<td>3</td>
<td>1.26</td>
<td>3.81</td>
</tr>
<tr>
<td>4</td>
<td>1.04</td>
<td>3.06</td>
</tr>
</tbody>
</table>

Notes: Location of middle 1/3 is 7.0 to 3.5 feet from the downstream toe.

A negative (-) above indicates that the location of the resultant is downstream from the toe.

A value of 2 ksf was used as a conservative approximation of the shear strength of weathered rock.
In all cases analyzed, the factors of safety against sliding are near or exceed a recommended value of three. The factors of safety against overturning are low, and the locations of the resultants (except Case 1) fall outside of the middle 1/3. Therefore, the dam is considered unsafe against overturning. However, the structure has withstood normal loading conditions in the past without apparent damage, and the analyses may not indicate the true field conditions or proper loading conditions. Because overturning during the SDF would result in a probable loss of life downstream of the dam, a detailed stability analysis of the dam should be performed by a qualified engineering firm within three months of owner notification.

6.3 SEISMIC STABILITY

Lake Peekskill Dam is located in Seismic Zone 1 which presents no hazard from earthquakes according to the Recommended Guidelines for Safety Inspection of Dams by the Department of the Army, Office of the Chief of Engineers. This determination is contingent on the requirements that static stability conditions are satisfactory, and conventional safety margins exist. As presented in Paragraph 6.2, conventional safety margins against overturning were not indicated by the analyses. If the detailed stability analysis indicates conventional safety margins, then there should be no hazard due to potential earthquakes. However, if the detailed stability analysis indicates low factors of safety against overturning, then a seismic stability evaluation should be performed as a part of the detailed stability analysis.
SECTION 7: ASSESSMENT/RECOMMENDATIONS

7.1 ASSESSMENT

a. Safety - Examination of available documents and visual inspections of Lake Peekskill Dam did not reveal any conditions which are considered to be hazardous.

Using the Corps of Engineers' screening criteria for review of spillway adequacy, it has been determined that the dam would be overtopped for all storms exceeding approximately 77 percent of the PMF. The overtopping of the dam could result in dam failure, increasing the hazard to loss of life downstream. Therefore, the spillway is adjudged "inadequate."

The stability analyses of the dam performed for this investigation indicate that the factors of safety against overturning may be inadequate.

b. Adequacy of Information - The information available and the observations and measurements made during the visual inspection are considered sufficient for this Phase I Inspection Report.

c. Need for Additional Investigation - A detailed stability analysis of the dam is considered necessary to determine actual stability conditions.

d. Urgency - The stability analyses must be initiated within three months of notification to the owner. Within one year, remedial measures resulting from these investigations must be initiated, with completion of these measures during the following year. In the interim, a detailed emergency action plan must be developed and implemented during periods of unusually heavy precipitation. Around-the-clock surveillance must also be provided during these periods. The problem areas listed below must be corrected within one year of notification.

7.2 RECOMMENDED MEASURES

The regular inspections and maintenance procedures presently conducted by the owner's representative appear to be adequate, although some form of documentation is needed. A thorough checklist should be compiled by the owner's representative and completed during each
inspection. Maintenance items should be completed annually. Monitoring of the reservoir level should be expanded to include reservoir levels above normal pool.

A formal warning system and emergency action plan should be developed and put into operation as soon as possible. Monitor the seeps at regular intervals for turbidity and increase in flow. If increased flow from the seep area or turbidity is noted, a qualified geotechnical engineering firm should be retained to recommend remedial measures.

The following remedial measures must be completed within one year:

1. The far left bridge support must be underpinned and protected from future erosion.
2. The debris must be cleaned from the upstream side of the spillway.
3. The trees in the spillway discharge channel must be cut off at ground level.
4. Repair the spalled concrete on the spillway and dam.
5. Install a staff gage to monitor reservoir levels.
APPENDIX A

PHOTOGRAPHS
CONTENTS

Photo 1: View of Left Downstream Half and Abutment of Dam
Photo 2: View of Right Downstream Half and Abutment of Dam
Photo 3: View of Upstream Face of Dam and Spillway Entrance
Photo 4: View of Downstream Face of Dam and Spillway
Photo 5: View of Upstream Side of Bridge
Photo 6: View of Downstream Side of Bridge
Photo 7: View of Right Downstream Buttress
Photo 8: View of Small Masonry Dam Downstream

Note: Photographs were taken on 6 March 1981
LAKE PEESKILL DAM

Photo 1. View of Left Downstream Half and Abutment of Dam
6 March 1981

Photo 2. View of Right Downstream Half and Abutment of Dam
6 March 1981
LAKE PEESKILL DAM

Photo 3. View of Upstream Face of Dam and Spillway Entrance
6 March 1981

Photo 4. View of Downstream Face of Dam and Spillway
6 March 1981
Photo 5. View of Upstream Side of Bridge
6 March 1981

Photo 6. View of Downstream Side of Bridge
6 March 1981
LAKE PEEKSKILL DAM

Photo 7. View of Right Downstream Buttress
6 March 1981

Photo 8. View of Small Masonry Dam Downstream
6 March 1981
APPENDIX B

VISUAL INSPECTION CHECKLIST
1) Basic Data
   a. General
      Name of Dam: Lake Peekskill Dam
      Fed. I.D. #: NY 87, DEC Dam No. 213C-814
      River Basin: Lower Hudson
      Location: Town Lake Peekskill, County Putnam
      Stream Name: Unnamed
      Tributary of: Peekskill Hollow Brook
      Latitude (N): 41° 20.2', Longitude (W): 73° 52.8'
      Type of Dam: Concrete
      Hazard Category: High
      Date(s) of Inspection: 6 March 1981
      Weather Conditions: Cold, clear and 30° F.
      Reservoir Level at Time of Inspection: 291.5
   b. Inspection Personnel: James Ulinski, Anthony Klimek and Steve Lockington
   c. Persons Contacted (Including Address & Phone No.): Mr. A. Purdy
      Lake Peekskill Improvement District
      Box 317
      Lake Peekskill, NY
   d. History:
      Date Constructed: about 1928
      Date(s) Reconstructed: __________________
      Designer: Allan Smith, P.E., Cold Spring, NY
      Constructed By: Unknown
      Owner: Village of Lake Peekskill, New York
2) **Embankment** - Not Applicable

a. Characteristics

(1) Embankment Material

(2) Cutoff Type

(3) Impervious Core

(4) Internal Drainage System

(5) Miscellaneous

b. Crest

(1) Vertical Alignment

(2) Horizontal Alignment

(3) Surface Cracks

(4) Miscellaneous

c. Upstream Slope

(1) Slope (Estimate) (V:H)

(2) Undesirable Growth or Debris, Animal Burrows
(3) Sloughing, Subsidence, or Depressions

____________________________________________________

____________________________________________________

(4) Slope Protection

____________________________________________________

____________________________________________________

(5) Surface Cracks or Movement at Toe

____________________________________________________

____________________________________________________

d. Downstream Slope

(1) Slope (Estimate - V:H)

____________________________________________________

____________________________________________________

(2) Undesirable Growth or Debris, Animal Burrows

____________________________________________________

____________________________________________________

(3) Sloughing, Subsidence or Depressions

____________________________________________________

____________________________________________________

(4) Surface Cracks or Movement at Toe

____________________________________________________

____________________________________________________

(5) Seepage

____________________________________________________

____________________________________________________

(6) External Drainage System (Ditches, Trenches, Blanket)

____________________________________________________

____________________________________________________

(7) Condition Around Outlet Structure

____________________________________________________
(8) Seepage Beyond Toe


e. Abutments - Embankment Contact


(1) Erosion at Contact


(2) Seepage Along Contact


3) Drainage System

a. Description of System  None


b. Condition of System  Not applicable


c. Discharge from Drainage System  Not applicable


4) Instrumentation (Monumentation/Surveys, Observation Wells, Weirs, Piezometers, Etc.)  None
5) **Reservoir**
   
a. **Slopes** Slopes at reservoir are moderate and developed.

   
   
b. **Sedimentation** Sedimentation is not reported to be a problem.

   
   
c. **Unusual Conditions Which Affect Dam** None observed.

6) **Area Downstream of Dam**

   
a. **Downstream Hazard (No. of Homes, Highways, etc.)** Two homes and a road are located 1600 ft. downstream. Loss of life in homes is likely if the dam were to fail.

   
   
b. **Seepage, Unusual Growth** No unusual growth was observed. Seepage near right downstream buttress near spillway (0.5 gpm, estimated), seep (0.5 gpm) 2 ft. from far left bridge column support, small seeps on right side bottom. Erosion from storm sewer downstream of right abutment.

   
   
c. **Evidence of Movement Beyond Toe of Dam** None observed.

   
   
d. **Condition of Downstream Channel** The channel is narrow and steep with rock outcrops. Structure (8 ft. high and 51 ft. long) is 50 ft. downstream and is currently breached (non-impounding).

7) **Spillway(s) (Including Discharge Conveyance Channel)**
a. General  The spillway consists of two 3 ft. high x 6 ft. wide (perpendicular to flow) openings which are 4 ft. wide (parallel to flow).

b. Condition of Service Spillway  Spillway is in fair condition. Debris found at the spillway entrance and spillway bottom. Two 6 in. PVC pipes over spillway are used to siphon water from the lake. Spillway has minor spalling, 1/4-way up face.

c. Condition of Auxiliary Spillway  None

d. Condition of Discharge Conveyance Channel  Rock outcrops extend the length of the discharge channel. Debris and trees are located in the discharge channel.

8) Reservoir Drain/Outlet
Type: Pipe  2  Conduit  Other
Material: Concrete  Metal  Other PVC
Size:  6 inches  Length
Invert Elevations: Entrance  Unknown
Exit  Unknown
Physical Condition (Describe): Unobservable
Material: PVC

Joints: ___________________ Alignment ___________________

Structural Integrity: ________________________________

Hydraulic Capability: ________________________________

Means of Control: Gate ______ Valve ______ Uncontrolled ______

Operation: Operable ______ X ______ Inoperable ________ Other ________

Present Condition (Describe): Used to syphon water from the reservoir in fall. Takes one month to lower the reservoir 5 ft. Broken in places. A 24 in. outlet pipe was plugged with concrete in 1948.

9) Structural

a. Concrete Surfaces Abandoned bridge deck (top of dam) is spalled. Right downstream buttress is seeping through deteriorated concrete. Far left downstream bridge (abandoned) support is undermined.

b. Structural Cracking No major cracking.

c. Movement - Horizontal & Vertical Alignment (Settlement) None observed.

d. Junctions with Abutments or Embankments No problems observed.
e. Drains - Foundation, Joint, Face  None observed.

f. Water Passages, Conduits, Sluices  None observed.

g. Seepage or Leakage  Seepage exists near right downstream buttress near spillway and 2 ft. from far left bridge column. The seepage is estimated at 0.5 gpm. The owner's representative reported seeing seepage exiting the right toe area near the spillway. The inspection team did not observe this seepage because of the amount of debris at this location.

h. Joints - Construction, etc.  No problems observed.

i. Foundation  The dam is estimated to be founded on tight, high RQD gneissic rock.

j. Abutments  No problems observed.

k. Control Gates  None
1. Approach & Outlet Channels  Good Condition

m. Energy Dissipators (Plunge Pool, etc.)  None

n. Intake Structures  None

o. Stability  No signs of instability were noted during the visual inspection.

p. Miscellaneous

10) Appurtenant Structures (Power House, Lock, Gatehouse, Other)

a. Description and Condition  None
APPENDIX C

HYDROLOGIC/HYDRAULIC DATA AND COMPUTATIONS
TABLE OF CONTENTS

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Check List for Dams                        1
Drainage Area Map                          5
Hydraulic Data                             6
Top of Dam Profile                        9
Typical Cross Section                      10
Upstream Profile                           11
Rating Curve                               12
Spillway Capacity Analysis                 13
HEC-1 Analysis                             14
CHECK LIST FOR DAMS
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

AREA-CAPACITY DATA:

<table>
<thead>
<tr>
<th></th>
<th>Elevation (ft.)</th>
<th>Surface Area (acres)</th>
<th>Storage Capacity (acre-ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Top of Dam</td>
<td>295.6</td>
<td>67</td>
<td>1,357</td>
</tr>
<tr>
<td>2) Design High Water (Max. Design Pool)</td>
<td>Unknown</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>3) Auxiliary Spillway Crest</td>
<td>None</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>4) Pool Level with Flashboards</td>
<td>N/A</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>5) Service Spillway Crest</td>
<td>N/A</td>
<td>--</td>
<td>1,074</td>
</tr>
</tbody>
</table>

DISCHARGES

<table>
<thead>
<tr>
<th></th>
<th>Volume (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Average Daily</td>
<td>Unknown</td>
</tr>
<tr>
<td>2) Spillway @ Maximum High Water - Top of Dam -</td>
<td>589</td>
</tr>
<tr>
<td>3) Spillway @ Design High Water</td>
<td>Unknown</td>
</tr>
<tr>
<td>4) Spillway @ Auxiliary Spillway Crest Elevation</td>
<td>N/A</td>
</tr>
<tr>
<td>5) Low Level Outlet</td>
<td>N/A</td>
</tr>
<tr>
<td>6) Total (of all facilities) @ Maximum High Water</td>
<td>589</td>
</tr>
<tr>
<td>7) Maximum Known Flood</td>
<td>Unknown</td>
</tr>
<tr>
<td>8) At Time of Inspection</td>
<td>15</td>
</tr>
</tbody>
</table>
CREST:  ELEVATION:  295.6 ft.

Type:  Concrete (two 3' X 6' openings)
Width:  16 ft. (abandoned bridge deck)  Length:  120 ft.
Spillover  Broad-crested weir
Location  Spillway is located 25 ft. from left abutment

SPILLWAY:

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>AUXILIARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>291.0</td>
<td>Elevation</td>
</tr>
<tr>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Two broad-crested weirs</td>
<td>Type</td>
</tr>
<tr>
<td>4 ft. ea.</td>
<td>Width</td>
</tr>
<tr>
<td>Uncontrolled</td>
<td>Type of Control</td>
</tr>
<tr>
<td>Uncontrolled</td>
<td></td>
</tr>
<tr>
<td>-controlled:</td>
<td></td>
</tr>
<tr>
<td>(Flashboards; gate)</td>
<td></td>
</tr>
<tr>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td></td>
</tr>
<tr>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Size/Length</td>
<td></td>
</tr>
<tr>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Invert Material</td>
<td></td>
</tr>
<tr>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Anticipated Length</td>
<td></td>
</tr>
<tr>
<td>of Operating Service</td>
<td></td>
</tr>
<tr>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Approximately 12 ft.</td>
<td></td>
</tr>
<tr>
<td>Chute Length</td>
<td></td>
</tr>
<tr>
<td>--</td>
<td></td>
</tr>
<tr>
<td>11 ft. Height Between Spillway Crest</td>
<td></td>
</tr>
<tr>
<td>&amp; Approach Channel Invert</td>
<td></td>
</tr>
<tr>
<td>(Weir Flow)</td>
<td></td>
</tr>
<tr>
<td>--</td>
<td></td>
</tr>
</tbody>
</table>
HYDROMETEROLOGICAL GAGES:

<table>
<thead>
<tr>
<th>Type</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>Records:</td>
<td>Date:</td>
</tr>
<tr>
<td></td>
<td>Max. Reading:</td>
</tr>
</tbody>
</table>

FLOOD WATER CONTROL SYSTEM:

<table>
<thead>
<tr>
<th>Warning System:</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method of Controlled Releases (mechanisms):</td>
<td>None</td>
</tr>
</tbody>
</table>
DRAINAGE AREA: 0.60 sq. mi. (386 acres)

DRAINAGE BASIN RUNOFF CHARACTERISTICS:

Land Use - Type: Forests and lake development

Terrain - Relief: Moderate slopes

Surface - Soil: Well-drained

Runoff Potential (existing or planned extensive alterations to existing surface or subsurface conditions)

No known plans to change runoff patterns at time of inspection.

Potential Sedimentation problem areas (natural or man-made; present or future)

No problem areas observed. Slopes were developed or well vegetated.

Potential Backwater problem areas for levels at maximum storage capacity including surcharge storage:

Flooding of homes on the lake shoreline could occur.

Dikes - Floodwalls (overflow & non-overflow) - Low reaches along the Reservoir perimeter:

Location: None

Elevation:

Reservoir:

Length @ Maximum Pool 3,400 ft.

Length of Shoreline (@ Spillway Crest) 8,800 ft. (1.67 mi.)
QUAD: Peekskill, N.Y.
Drainage Area = 0.60 Sq. Mi.

CENTROID

LAKE PEEKSKILL DAM

DRAINAGE AREA ABOVE
LAKE PEEKSKILL DAM

Scale: 1 in. = 2000 ft.
INDUSTRY AND HYDRAULIC DATA

Drainage Area above Dam = 4.21 sq. mi. (measured on Peekskill, N.Y. Quad) = 0.604 sq. mi.

\[ L_{ca} = 3700 \text{ ft} = 0.70 \text{ mi.} \]
\[ L = 9300 \text{ ft} = 1.76 \text{ mi.} \]

STORAGE CALCULATIONS

Surface Area vs. Elevation Measurements (taken from Quad)

<table>
<thead>
<tr>
<th>Elevation (FT)</th>
<th>Area (Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>291</td>
<td>58.16</td>
</tr>
<tr>
<td>300</td>
<td>72.24</td>
</tr>
<tr>
<td>330</td>
<td>86.77</td>
</tr>
<tr>
<td>340</td>
<td>112.64</td>
</tr>
</tbody>
</table>

\[ C_p = 0.63 \quad C_r = 2.0 \]
\[ T_p = C_r (1 \times L_{ca})^{0.5} \]
\[ = 2.0 (1.76 \times 0.70)^{0.5} \]
\[ T_p = 2.12 \]

Adjustment for Duration

\[ T_0 = T_p / 1.5 = 2.12 / 1.5 = 0.39 \text{ hr} \]

\[ T_{hr} = T_p + \frac{T_0 - T_0}{4} \]
\[ = 2.12 + \frac{0.39 - 0.39}{4} \]
\[ T_{hr} = 2.14 \text{ hr} \]

NOTE: Normal Pool Assumed to Be ELEV. 291 (Listed on Quad)
Surface Area Reservoir Bottom

Surface Area Elevation 291 58.16 Acres
Equivalent Circle Radius \( r = 898.01 \) ft -
Average Side Slope \( S = 5.39 \) H:V
Average Reservoir Depth \( D = 21 \) ft (From Maintenance Fogram)
Radius Bottom of Reservoir
\[ 898.01 - 2(5.39) = 784.82 \text{ ft} \]
Surface Area Bottom 44.42 Acres
RAINFALL DATA (FROM HIR-33)

DAM AND DRAINAGE AREA ARE IN ZONE 1

PUP (24 HR) = 200.0 m^2 = 21.3 in. /

DRAINAGE AREA = 0.604 sq. mi.

PUP (0-48 HR) = 111% PUP (24 HR) = 200 m^2

" (12 HR) = 123% " " "

" (24 HR) = 132% " " "

" (48 HR) = 142% " " "

100-YEAR, 24 HR PAINFALL (FROM TR-19) = 7.8 in.

" " 12 HR " " = 6.5 in.

" " 6 HR " " = 5.3 in.
The two 3 ft x 4 ft outlets were assumed to be end groined weirs across the top of dam. For weir flow the equation is

$$Q = CAH^{3/2}$$

When the lake surface seals the top of the culvert then the flow becomes orifice flow. The equation becomes

$$Q = CA(2g)$$

Between the old dam and the new bridge an average width of 1.2 ft and an average length of 7 ft was used.

<table>
<thead>
<tr>
<th>TYPE OF FLOW</th>
<th>C</th>
<th>H (FT)</th>
<th>Q (CFS)</th>
<th>TYPE OF FLOW</th>
<th>C</th>
<th>H (FT)</th>
<th>Q (CFS)</th>
<th>COMBINED FLOW (CFS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
<td>None</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
</tr>
<tr>
<td>Weir</td>
<td>2.69</td>
<td>0.6</td>
<td>15</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>15</td>
</tr>
<tr>
<td>Weir</td>
<td>2.67</td>
<td>1.0</td>
<td>32</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>32</td>
</tr>
<tr>
<td>Weir</td>
<td>2.68</td>
<td>2.0</td>
<td>91</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>91</td>
</tr>
<tr>
<td>Weir</td>
<td>2.72</td>
<td>2.5</td>
<td>129</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>129</td>
</tr>
<tr>
<td>Weir</td>
<td>2.73</td>
<td>2.9</td>
<td>162</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>162</td>
</tr>
<tr>
<td>Orifice</td>
<td>0.57</td>
<td>2.5</td>
<td>219</td>
<td>Weir</td>
<td>2.66</td>
<td>1.0</td>
<td>2.44</td>
<td>5.23</td>
</tr>
<tr>
<td>&quot;</td>
<td>4.10</td>
<td></td>
<td>357</td>
<td>Orifice</td>
<td>0.61</td>
<td>0.98</td>
<td>3.86</td>
<td>6.99</td>
</tr>
<tr>
<td>&quot;</td>
<td>5.0</td>
<td>394</td>
<td>&quot;</td>
<td>&quot;</td>
<td>1.3</td>
<td>416</td>
<td>1.95</td>
<td>1010</td>
</tr>
<tr>
<td>&quot;</td>
<td>6.0</td>
<td>432</td>
<td>&quot;</td>
<td>&quot;</td>
<td>2.3</td>
<td>820</td>
<td>2.75</td>
<td>1252</td>
</tr>
<tr>
<td>&quot;</td>
<td>8.0</td>
<td>498</td>
<td>&quot;</td>
<td>&quot;</td>
<td>4.3</td>
<td>1121</td>
<td>5.03</td>
<td>1619</td>
</tr>
<tr>
<td>&quot;</td>
<td>10</td>
<td>557</td>
<td>&quot;</td>
<td>Orifice</td>
<td>0.61</td>
<td>6.3</td>
<td>1352</td>
<td>1913</td>
</tr>
</tbody>
</table>

Weir coefficients: King + Brater PS-40 Table 5-3

Orifice coefficients: King + Brater PA-31 Table 4-5
Subject: LAKE BEEKMILL DAM
S.O. No.          ---
SPILLWAY CAPACITY ANALYSIS
Sheet No. 13 of 15

Box 280
Beaver, Pa. 15009

Drawing No.          ---

Computed by        SMH
Checked by         GUT
Date: 3/6/81

MINIMUM
TOP OF DAM
ELEV 295.6 FT.

ELEVATION (FT)
<table>
<thead>
<tr>
<th>STAGE</th>
<th>241.00</th>
<th>241.00</th>
<th>242.00</th>
<th>243.00</th>
<th>245.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLOW</td>
<td>393.00</td>
<td>412.00</td>
<td>419.00</td>
<td>457.00</td>
<td>469.00</td>
</tr>
</tbody>
</table>

**Surface Area:** 40, 50, 60, 70, 80

**Capacity:** 12, 15, 18, 20, 25

**Elevation:** 215, 219, 223, 227, 231

**Peak Discharge:**
- 413.0 at 4:30, 415.0 at 4:30, 417.0 at 4:30, 419.0 at 4:30, 421.0 at 4:30.
REFERENCES


8. HMR 33, "Seasonal Variations of Probable Maximum Precipitation, East of the 105th Meridian for Areas 10 to 1000 Square Miles and Durations of 6 to 48 Hours," (1956).


APPENDIX E
DRAWINGS
CONTENTS

Location Plan
Watershed Map
Plate 1: Field Sketch
Plate 2: General Plan from Replacement Bridge Design Drawings
Plate 3: Original Dam Design Profile and Section
REFERENCES:
1. U.S.G.S. 7.5' PEEKSKILL, N.Y.
   QUADRANGLE. 1957
2. U.S.G.S. 7.5' MONHEGAN LAKE, N.Y.
   QUADRANGLE. 1956

LOCATION PLAN
LAKE PEEKSKILL DAM
LAKE PEEKSKILL DAM,
Lake Peekskill Dam
Field Sketch
Plate 1
APPENDIX F

BACKGROUND DOCUMENTS
SOILS CLASSIFICATION SYSTEM

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>FROM</th>
<th>TO</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOULDERS</td>
<td>8&quot;</td>
<td>+</td>
</tr>
<tr>
<td>COBBLES</td>
<td>2-1/2</td>
<td>8&quot;</td>
</tr>
<tr>
<td>COARSE GRAVEL</td>
<td>1&quot;</td>
<td>2-1/2</td>
</tr>
<tr>
<td>MEDIUM GRAVEL</td>
<td>3/8&quot;</td>
<td>1&quot;</td>
</tr>
<tr>
<td>FINE GRAVEL</td>
<td>2mm</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>COARSE SAND</td>
<td>0.5mm</td>
<td>2mm</td>
</tr>
<tr>
<td>MEDIUM SAND</td>
<td>0.25mm</td>
<td>0.5mm</td>
</tr>
<tr>
<td>FINE SAND</td>
<td>.125</td>
<td>0.25mm</td>
</tr>
<tr>
<td>VERY FINE SAND</td>
<td>0.62</td>
<td>.125</td>
</tr>
<tr>
<td>SILT &amp; CLAY</td>
<td>Less than 0.62mm</td>
<td></td>
</tr>
</tbody>
</table>

Proportions Used –

| Trace   | 0 to 10% | Little | 10 to 20% | Some | 20 to 35% and 35 to 50% |

EXAMPLES –

- "Brown fine sand Medium gravel" ) Equal amounts of sand and gravel
- "Brown medium to fine sand and gravel" ) Sample predominantly sand with 35 to 50% gravel
- Some silt ) 20 to 35% silt
- Boulders" ) Various percentages –
## PENETRATION RESISTANCE & SOIL PROPERTIES

<table>
<thead>
<tr>
<th>Predominant sand and gravel</th>
<th>Predominant silt and clay</th>
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<tr>
<td>COHESIONLESS SOILS</td>
<td>COHESIVE SOILS</td>
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<tr>
<td>Blows per foot</td>
<td>Blows per foot</td>
</tr>
<tr>
<td>Relative Density</td>
<td>Consistency</td>
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<tr>
<td>Strength (qu*)</td>
<td></td>
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<tr>
<td>0 to 4</td>
<td>0 to 2</td>
</tr>
<tr>
<td>very loose</td>
<td>very soft</td>
</tr>
<tr>
<td>4 to 10</td>
<td>2 to 4</td>
</tr>
<tr>
<td>loose</td>
<td>soft</td>
</tr>
<tr>
<td>10 to 30</td>
<td>4 to 8</td>
</tr>
<tr>
<td>medium</td>
<td>medium</td>
</tr>
<tr>
<td>30 to 50</td>
<td>8 to 15</td>
</tr>
<tr>
<td>dense</td>
<td>stiff</td>
</tr>
<tr>
<td>over 50</td>
<td>15 to 30</td>
</tr>
<tr>
<td>very dense</td>
<td>very stiff</td>
</tr>
<tr>
<td></td>
<td>over 30</td>
</tr>
<tr>
<td></td>
<td>hard</td>
</tr>
</tbody>
</table>

### NOTES:
Above based on 2" O.D. sampler x 1-3/8" i.d. 140# Wt. x 30" Fall (qu*) = Tons per Square Foot

### STATE OF CONNECTICUT BASIC BUILDING CODE

#### TABLE 15. PRESumptive Surface Bearing Values of Foundation Materials

<table>
<thead>
<tr>
<th>CLASS OF MATERIAL</th>
<th>Tons per Square Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Massive crystalline bed rock including granite, diorite, gneiss, trap rock hard</td>
<td>100</td>
</tr>
<tr>
<td>limestone and dolomite.</td>
<td></td>
</tr>
<tr>
<td>2 Foliated rock including bedded limestone, schist and slate in sound condition.</td>
<td>40</td>
</tr>
<tr>
<td>3 Sedimentary rock including hardshales, sandstones, and thoroughly cemented</td>
<td>25</td>
</tr>
<tr>
<td>conglomerates.</td>
<td></td>
</tr>
<tr>
<td>4 Soft or broken bed rock (excluding shale) and soft limestone.</td>
<td>10</td>
</tr>
<tr>
<td>5 Compacted, partially cemented gravels, sand and hardpan overlying rock.</td>
<td>10</td>
</tr>
<tr>
<td>6 Gravel and sand-gravel mixtures.</td>
<td>6</td>
</tr>
<tr>
<td>7 Loose gravel, hard dry clay, compact coarse sand, and soft shales.</td>
<td>4</td>
</tr>
<tr>
<td>8 Loose, coarse sand and sand-gravel mixtures and compact fine sand (confined).</td>
<td>3</td>
</tr>
<tr>
<td>9 Loose medium sand (confined), stiff clay.</td>
<td>2</td>
</tr>
<tr>
<td>10 Soft broken shale, soft clay.</td>
<td>1.5</td>
</tr>
</tbody>
</table>
# General Borings, Inc.

STRAITSVILLE ROAD  PROSPECT, CONN. 06712

REPORT OF AUGER BORINGS AND PIPE AND BAR PROBINGS

<table>
<thead>
<tr>
<th>TOWN</th>
<th>Putnam Valley</th>
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<td>LINE</td>
<td>Station 11+56</td>
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<table>
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<th>PROJECT NAME</th>
<th>Peeksskill Lake Bridge</th>
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<td>PROJECT NO.</td>
<td>72</td>
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<table>
<thead>
<tr>
<th>FOREMAN</th>
<th>R. Tuccillo</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSPECTOR</td>
<td>J. Ceresa</td>
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<table>
<thead>
<tr>
<th>DATE WORK DONE</th>
<th>FOR Goodkind &amp; O'Dea</th>
</tr>
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| CONTRACTING ENGINEER | |
|----------------------| |

<table>
<thead>
<tr>
<th>Station</th>
<th>Offset (FL)</th>
<th>Depth Probed (FL)</th>
<th>Soil Strata in Auger Holes</th>
<th>Remarks (Auger used, Description of Soil in Auger Holes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From L/FL</td>
<td>From C/FL</td>
<td></td>
<td>(Include: Groundwater depth, Size of)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(Auger Holes, Depth of Auger Samples)</td>
</tr>
</tbody>
</table>

## SOUNDINGS

| #1  | 5/8" Rod | 18'-L   |
|     |          |         |
|     | Drove Rod 4'6" |         |

| #2  | 1/2" Rod | 14'-L   |
|     |          |         |
|     | Drove rod 6'7" |         |
### General Borings, Inc.

**STRAITSVILLE RD., PROSPECT, CT.**

**HOLE NO. 5-1**

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>DEPTH (FT)</th>
<th>CASING BLOWS PER 6&quot;</th>
<th>SAMPLE TIME PER FT</th>
<th>DENSITY OR CONSISTENCY</th>
<th>CORING TIME PER FT</th>
<th>STRATA CHANGE DEPTH</th>
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<tbody>
<tr>
<td>ss</td>
<td>0-3</td>
<td>12/16</td>
<td>4</td>
<td>7</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3-5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>END OF BORING</td>
</tr>
<tr>
<td></td>
<td>5-10</td>
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<td>10-20</td>
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</tr>
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<td></td>
<td>20-35</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>35-40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GROUND WATER OBSERVATIONS**

- **At 0-3 ft after 6 hours:**
  - **Casing:** Ss
  - **Sampler:** 13/8
  - **Coring Bar:** 140
  - **Hammer mt:** 140
  - **Hammer fall:** 140

**REMARKS:**

1. Brown coarse-fine sand, silt, gravel, trace root material.
2. Refusal 4' 1/2"-6' 1/2".
3. Run#1 Drilled 4'-6' 3/4".
4. Recovered 0'-7" fracture, greenish gray rock (soft).
5. Run#2 Drilled 6'-10' 3/4".
6. Recovered 2'-1" greenish gray gneiss, vertical and horizontal seam.
7. Run#3 Drilled 12'-12' 3/4".
8. Recovered 1'-5" greenish gray gneiss.

**END OF BORING**

- **4' Soil**
- **8' Rock**

**TOTAL FOOTAGE**

- **EARTH BORING:** 120 ft.
- **ROCK CORING:** 10 ft.

**TYPE OF SAMPLES**

- Dry
- Washed
- Cored
- Auger
- Undisturbed Piston
- Undisturbed Ball Check
- V + Y Tube Test

**EARTH BORING**

- **Trace:** 0-10%
- **Little:** 10-30%
- **Some:** 30-50%
- **Trace:** 50-55%
- **Little:** 50-55%

**TOTAL FOOTAGE**

- **EARTH BORING:** 120 ft.
- **ROCK CORING:** 10 ft.
<table>
<thead>
<tr>
<th>Depth (Ft.)</th>
<th>Sample Type</th>
<th>Penetration</th>
<th>Recorred</th>
<th>Depth @ Bot.</th>
<th>Blows per 6&quot;</th>
<th>Coring Time per Foot (Min.)</th>
<th>Density or Consist</th>
<th>Strata Change</th>
<th>Field Identification of Soil</th>
<th>Remarks</th>
<th>Color</th>
<th>Loss of Wash Water, Seams in Rock, Etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ss3 6-12</td>
<td>12</td>
<td>12 1/2</td>
<td>Ft. Lin.</td>
<td>3' 7&quot;</td>
<td>1.7</td>
<td>1/3</td>
<td></td>
<td>1) Brown coarse-fine sand, little silt, trace - fine gravel.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>2</td>
<td>4</td>
<td>Run#1</td>
<td>5' 7&quot;</td>
<td>4.0</td>
<td>1/3</td>
<td></td>
<td>Run#1 Drilled 3'7&quot;-5'7&quot; Recovered 0.7' greenish gray rock (fractured).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>3</td>
<td>5</td>
<td>Run#2</td>
<td>10'1&quot;</td>
<td>5.0</td>
<td>1/3</td>
<td></td>
<td>Run#2 Drilled 5'7&quot;-10'1&quot; Recovered 1.0' greenish gray soft rock.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>4</td>
<td>6</td>
<td>Run#3</td>
<td>11'7&quot;</td>
<td>6.0</td>
<td>1/3</td>
<td></td>
<td>Run#3 Drilled 10'1&quot;-13'7&quot; Recovered 2.4' greenish gray gneiss.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>5</td>
<td>7</td>
<td>Run#4</td>
<td>14'7&quot;</td>
<td>7.0</td>
<td>1/3</td>
<td></td>
<td>Run#4 Drilled 13'7&quot;-14'7&quot; Recovered 0'-5&quot; seamy fractured greenish gray gneiss.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>6</td>
<td>8</td>
<td>Run#5</td>
<td>18'7&quot;</td>
<td>8.0</td>
<td>1/3</td>
<td></td>
<td>Run#5 Drilled 14'7&quot;-18'7&quot; Recovered 2.0' greenish gray gneiss.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>10</td>
<td>10</td>
<td>Run#6</td>
<td>18'7&quot;</td>
<td>10.0</td>
<td>1/3</td>
<td></td>
<td>Run#6 Drilled 18'7&quot;-21'7&quot; Recovered 2.0' greenish gray gneiss.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL FOOTAGE**

- **EARTH BORING** 201'7"
- **ROCK CORING** 201'7"

**TYPE OF SAMPLES**

- D: DRY
- W: WASHED
- C: CORED
- A: AUGER
- U: UNDISTURBED PISTON
- V: UNDISTURBED BALL CHECK
- T: VIVANE TEST

**PROPORTIONS USED**

- TRACE: 0-10%
- LITTLE: 10-30%
- SOME: 30-50%
- AND: 50-100%
General Borings, Inc.
Straitsville Rd. Prospect, Conn.

CLIENT: Cockkind & C'Da.

CONTRACTOR:

PROJECT NAME: Lake Peekskill, Bridge

EMAN-DRILLER: R. Tuccillo

GENERAL LOCATION: Putnam County

INSTR.:

PROJECT NAME: Poughkeepsie, Bridge

LOCATION:

DESCRIPTION:

DATE: 10/31

STATION: 12+56

OFFSET: 18'

GROUND WATER OBSERVATIONS:

AT 2.5 FT. AFTER 0 HOURS

AT 5 FT. AFTER 0 HOURS

CASING SAMPLE CASING SAMPLER CORE BAR

TYPE: HA SS AX

SIZE ID: 1 3/4

HOLLOW WT: 140

HAMMER FALL: 30

DIAMOND

FIELD IDENTIFICATION OF SOIL, REMARKS INCL. COLOR, LOSS OF WATER, SEAMES IN ROCK, ETC.

Soil 81

Rock 25

30-

TYPE OF SAMPLES

TOTAL FOOTAGE:

EARTH BORING—FT.

PROPORTIONS USED: TRACE 0-10%, LITTLE 10-30%, SOME 20-50%, AND 35-90%
<table>
<thead>
<tr>
<th>DEPTH</th>
<th>CASING BLOWS PER FOOT</th>
<th>SAMPLE</th>
<th>BLOWS PER 6&quot; ON SAMPLER (FORCE ON TUBE)</th>
<th>CORING TIME PER FT (MIN)</th>
<th>DENSITY OR CONSIST</th>
<th>STRATA IDENTIFICATION</th>
<th>REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>18&quot; 8&quot; 1&quot;6&quot;</td>
<td>2 6 12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1) Brown coarse-fine sand, little coarse-fine gravel, little silt. 0'-1'6&quot;.</td>
</tr>
<tr>
<td>3-6</td>
<td>12&quot; 4&quot; 8'6&quot;</td>
<td>13 30 5/3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ref. 6'6&quot; Run#1 Drilled 6'-6&quot;. Recovered C'-4&quot; greenish gray rock fragments.</td>
</tr>
<tr>
<td>6-9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2) Gray-brown coarse-fine sand and silt, trace medium fine gravel. 5'-0&quot;-6'0&quot;</td>
</tr>
<tr>
<td></td>
<td>1&quot;2&quot; 1&quot;3&quot; 3&quot;6&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Run#2 8'-6&quot;-10'-6&quot; (drilled). Recovered C'-5&quot; greenish gray rock fragments.</td>
</tr>
<tr>
<td>9-12</td>
<td>22 3</td>
<td>1 2 2 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Run#3 Drilled 10'-6&quot;-13'-6&quot; Recovered 1'6&quot; greenish gray rock.</td>
</tr>
<tr>
<td>12-15</td>
<td>43 52 62 73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>END OF BORING 13'-6&quot; 6'6&quot; Soil 7'0&quot; Rock</td>
</tr>
<tr>
<td>15-18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>18-21</td>
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<td>30-33</td>
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Type of Samples:
- D = Dry
- W = Washed
- C = Cored
- A = Auger
- UN = Undisturbed Piston
- UU = Undisturbed Ball Check
- WT = Vane Test

Proportions Used:
- Trace: < 0 - 10%
- Little: 10 - 20%
- Some: 20 - 30%
- And: 30 - 50%
- Total Footage: 13'-6"
APPENDIX G

STABILITY COMPUTATIONS
(Over flow Section)

Reservoir

\[ \begin{align*}
\text{Section} & \quad \text{Volume (cubic ft)} & \quad \text{W} & \quad \text{Distance} & \quad \text{M (x-foo)} \\
1 & \quad 4.5 \times 12 \times 61 & \quad 0.150 \text{ Kips} & \quad 8.1 \text{ kips} & \quad 5.25 \text{ ft} & \quad 66.825 \\
2 & \quad \frac{1}{2} \times 6 \times 12 \times 61 & \quad 0.150 \text{ Kips} & \quad 5.4 \text{ kips} & \quad 1.0 \text{ ft} & \quad 31.6 \\
\end{align*} \]

Resultant = 13.5 K

Location = \frac{98.425}{13.5} = 7.25 \text{ ft from toe}

Case 1 - Base flood, Full Uplift

Case 2 - Ice flood

Case 3 - PHF (irrigation), Full Uplift

Case 4 - Full PHF, Full Uplift
Reservoir level: 291 ft

Tailwater level: 280 ft

\[ H_1 = 12 \text{ ft} \]

\[ H_2 = 1 \text{ ft} \]

Reservoir height: 12 (0.625) = 7.5 \text{ ft}^3

Tailwater height: 1 (0.625) = 0.625 \text{ ft}^3

\[ \text{Resultant} = \left( \frac{7.5 + 0.625}{2} \right) \left[ 15 \right] = 4.266 \text{ ft}^3 \]

\[ \text{Location} = \sqrt{4.266} \approx 2.066 \]

Above the static line:

Reservoir level: \( \frac{1}{2} \) (12) (0.625) = 4.5 ft

Location = 15 = 4.5 ft from axis of dive (at 279)

Tailwater level: \( \frac{1}{2} \) (1) (0.625) = 0.31 ft

15\text{box} = \frac{1}{2} = 0.333 \text{ ft} from axis (low)
Subject: \[ S 5.0^2 \]
S.O. No.: \[ 177982 - 216 \]
Sheet No.: \[ 7 \] of \[ 9 \]

Drawing No.: \[ \]  
Composed by: \[ WH \]  
Checked by: \[ JGK \]  
Date: \[ May 14, 1981 \]

Additional sketch below 310 ft elevation

\[ \text{Position} = (1) \frac{12}{16} \times (0.0625) = 0.16 \text{ in} \]

\[ \text{Position} = (2) \times (0.0625) = 0.125 \text{ in} \text{ from} \text{ } 310 \]

\( 35^\circ \) \( I \) & \( II \) Loads

\[ \frac{13.5(6.55) + 0.16(163) + 0.27(1.75)}{4.54} \]

\[ \text{Resultant.} \]

\[ F_s = 1.913 \]

Slip:

\[ \begin{align*}
\lambda &= \frac{2v}{\tan \theta - 1} \quad C = 2 \pi \frac{c}{A} \\
C &= \frac{2\pi}{H} \\
A &= 10.6 \text{ in}^2 \\
\tan 5^\circ &= 0.087 \\
\theta &= 35^\circ \\
H &= 4.5 - 0.087 = 4.164 \\
F_s &= \frac{94}{4.164} \\
\end{align*} \]

\[ F_s = 6.148 \]
Case II

Overturning

\[ F_s = \frac{13.5(6.55) + 2.1(1.67) + 0.3(1.33)}{4.5(1) + 4.2(1.33) + 5(0.75)} \]

\[ F_s = 0.821 \]

Sliding

\[ R = 7.475 \]

\[ H = 4.464 + 5 = 7.464 \]

\[ F_s = \frac{7.475}{7.464} \]

Case III

Reservoir Pond level = 294.4 ft

Tailwater level = 280.5 ft

Uplift

Reservoir Slope = 15.4(0.625) = 0.963 ksf

Tailwater Slope = 1.5(0.625) = 0.94 ksf

Resultant = \( \frac{-0.262 + 0.049}{2} \times 10.5 = 5.549 \) kips

Location:

\[ \frac{(0.094)(10.5)^{\frac{125}{2}} + [(-0.263 - 0.049)(10.5)^{\frac{75}{2}}(105)]}{5.549} = 6.637 \text{ ft} \]
Hydrostatic Pressure

Reservoir
Bottom \( L_{1} = 15.4(0.025) = 0.385 \text{ ksf} \)
Top \( L_{2} = 3.4(0.025) = 0.085 \text{ ksf} \)
Resultant = \( \frac{(0.385 + 0.085)}{2} \times 12 = 2.7056 \text{ kips} \)

Location = \( \frac{(0.385)(11.0)}{2} + \frac{(0.085)(22.0)}{2} = 1.93 \text{ ft above base level} \)

Tailwater
Resultant = \( \frac{1}{2}(1.5)(0.025) = 0.0375 \text{ kips} \)

Location = \( \frac{1.5}{3} = 0.5 \text{ ft above base level} \)

Additional Nontidal Load: Due to Tailwater

Resultant = \( \frac{1}{2}(1.5)(0.025) = 0.0375 \text{ kips} \)

Location = \( \frac{(0.5)}{2} = 0.25 \text{ ft below base of dam} \)

Case III Loading
Overturning

\[ F_S = \frac{13.5(6.55) + 0.35(4.5) + 0.07(5.5)}{7.05(4.72) + 5.54(6.25)} \]

\[ F_S = 1.25 \]

Sliding

\[ h = (13.5 + 0.35 - 5.549) \times 0.5 \]

\[ h = 26.59 \times 0.5 \]

\[ h = 6.98 \times 10^{-3} \]

\[ F_S = \frac{1}{h} = \frac{1}{6.98} \]

Case III

Reservoir Pool Level = 296.5

Tailwater Level = 231.0

Upset

Reservoir Side = 17.5(0.0625) = 1.094 ksf

Tailwater Side = 2.0(0.0625) = 0.125 ksf

Resultant

\[ \text{Resultant} = \frac{1.094 \times 1.125}{2} \times 10.5 = 6.4 \text{ kips} \]

Location

\[ \text{Location} = \frac{(1.25)(0.5)^{1/2} + (0.049 - 1.25)(1/2) + 0.5}{3} \times 10.5(3) \]

\[ \text{Location} = 6.4 \text{ kips} \text{ from toe} \]
Hydrostatic Pressure

Top Dam = (17.5 * 12) * (0.825) = 175 * 0.825 = 78.125 kips

Bottom Dam = 17.5 * (11.25) = 196.875 kips

Resultant = \[ \frac{(1094 + 344)}{2} \times 12 \] = 8640 kips

Location = \[ \frac{[0.344(12)]^{1/2} + [(1094 - 344) \times (1/2)]^{1/2}}{8.628} \]

= 4.957 ft above base level

Tailwater:

Resultant = \( \frac{1}{2} \times 12 \times (0.625) = 1.875 \text{ kips} \)

Location = \( 9/12 = 0.667 \) ft above base level

Additional Vehicle Loading Due to Tailwater

Resultant = \( 2 \times \left( \frac{7}{12} \right) \times (0.625) = 0.625 \) kips

Location = \( \frac{7}{12} \) = 0.583 ft from face

Case III Loadings

[Diagram showing loadings with various forces and locations]
Overturning

\[
F_S = \frac{13.5(6.55) + (16.25)(1.25) + 0.25(1.65)}{8.625(4.907) + 6.9(6.51)}
\]

\[
F_S = 6.233
\]

Sliding

\[
K = (13.5 + 0.625 - 0.4) \times 7 + 0(10.5)
\]

\[
K = 26.014
\]

\[
H = (8.625 - 0.125) = 8.503
\]

\[
F.S. = \frac{H}{K} = \frac{26.014}{8.503}
\]

\[
F.S. = 3.059
\]
Resultant Location $\Rightarrow \frac{EH}{EV}$

**Case I**

Resultant Location = \[
\frac{13.5(6.55) + 0.016(127) + 0.031(333) - 4.5(4) - 4.266(731)}{13.5 + 0.016 - 4.266}
\]

= 4.511 ft from toe

**Case II**

Resultant Location = \[
\frac{13.5(6.55) + 0.016(167) + 0.031(333) - 4.5(4) - 4.266(731) - 5(12)}{13.5 + 0.016 - 4.266}
\]

= -10.976 ft

**Case III**

Resultant Location = \[
\frac{13.5(6.55) + 0.035(25) + 0.07(5) - 7.056(4.72) - 5.544(6.89)}{13.5 + 0.035 - 5.549}
\]

= 3.256 ft

**Case IV**

Resultant Location = \[
\frac{13.5(6.55) + 0.0625(333) + 0.125(667) - 6.28(4.95) - 6.4(5.04)}{13.5 + 0.0625 - 6.4}
\]

= 0.455 ft.
END DATE FILMED 11-81 DTIC