National Dam Safety Program

TORONTO RESERVOIR DAM.


PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NEW YORK DISTRICT CORPS OF ENGINEERS

JANUARY, 1980

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**Section 1: Title and Subtitle**

**Phase I Inspection Report**

**Toronto Reservoir Dam**

**Delaware River Basin, Sullivan County, New York**

**Inventory No. 506**

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**Section 2: Authors**

George Koch

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**Section 3: Performing Organization Name and Address**

New York Department of Environmental Conservation

50 Wolf Road

Albany, NY 12233

---

**Section 4: Controlling Office Name and Address**

New York State Department of Environmental Conservation

50 Wolf Road

Albany, NY 12233

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**Section 18: Supplementary Notes**

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**Section 20: Abstract**

This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization.

The examination of documents and visual inspection of Toronto Reservoir Dam and appurtenant structures did not reveal conditions which constitute an immediate hazard to human life or property. The dam, however, has a number of problem areas which require investigation and remedial action.
These areas are as follows:

1. Investigation and appropriate remedial repairs and required in connection with the observed seepage and deterioration of the concrete of the intake tower and the horseshoe outlet conduit. Since the reservoir level was approximately 40 feet below the normal pool elevation at the time of the inspection, raising the pool level could significantly increase the rate of seepage over that which was observed. Also the structural stability of the conduit must be analyzed to determine the influence of the observed seepage and deterioration. Concrete coring of the walls of the intake structure and conduit may be required to properly ascertain the structural integrity of the elements. These investigations should be conducted during reservoir filling.

2. Investigation and appropriate remedial measures are required in connection with the observed seepage encountered at the toe of the downstream slope on both sides of the outlet conduit. Construction of weirs and monitoring of flow at bi-weekly (or more frequently) intervals is necessary to properly ascertain the causes of the seepage. Monitoring of seepage should also be conducted during filling of the reservoir.

These investigations should be initiated immediately and completed within 1 year from notification to the owner.

The discharge capacity of the spillway is inadequate for all floods in excess of 82% of the Probable Maximum Flood (PMF=25,650 cfs). The maximum reservoir level during the PMF will be 1.9 feet over the top of dam and 3.5 feet below the top of dam during the 1/2 PMF.

The following remedial actions should be completed within 1 year from notification:

3. Repair the downstream channel weir.

4. Repair the leaking gates in the intake tower.

5. Remove the trees and brush on the embankment slopes, at the abutment contacts, and on the spillway outlet channel. Provide a program of periodic cutting and mowing of the embankment surfaces and the banks of the outlet channels.

6. Repair the deteriorated concrete at the waterline of the center pier in the downstream end or the outlet conduit.

7. Provide a program of periodic inspection and maintenance of the dam at appurtenances including yearly operation and lubrication of all gates. Document this information for future reference. Also develop an emergency action plan.
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
TORONTO RESERVOIR DAM (I.D. No. NY 506)
DEC #148D-199 DELAWARE RIVER BASIN
SULLIVAN COUNTY

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**APPENDIX**

A. PHOTOGRAPHS  
B. ENGINEERING DATA CHECKLIST  
C. VISUAL INSPECTION CHECKLIST  
D. HYDROLOGIC/HYDRAULIC ENGINEERING DATA AND COMPUTATIONS  
E. REFERENCES  
F. DRAWINGS
Name of Dam: Toronto Reservoir (I.D. No. NY 506)
State Located: New York
County Located: Sullivan
Stream: Black Lake Creek (tributary of Mongoup & Delaware River)

Assessment

The examination of documents and visual inspection of Toronto Reservoir Dam and appurtenant structures did not reveal conditions which constitute an immediate hazard to human life or property. The dam, however, has a number of problem areas which require investigation and remedial action. These areas are as follows:

1. Investigation and appropriate remedial repairs and required in connection with the observed seepage and deterioration of the concrete of the intake tower and the horseshoe outlet conduit. Since the reservoir level was approximately 40 feet below the normal pool elevation at the time of the inspection, raising the pool level could significantly increase the rate of seepage over that which was observed. Also the structural stability of the conduit must be analyzed to determine the influence of the observed seepage and deterioration. Concrete coring of the walls of the intake structure and conduit may be required to properly ascertain the structural integrity of the elements. These investigations should be conducted during reservoir filling.

2. Investigation and appropriate remedial measures are required in connection with the observed seepage encountered at the toe of the downstream slope on both sides of the outlet conduit. Construction of weirs and monitoring of flow at bi-weekly (or more frequently) intervals is necessary to properly ascertain the causes of the seepage. Monitoring of seepage should also be conducted during filling of the reservoir.

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The discharge capacity of the spillway is inadequate for all floods in excess of 82% of the Probable Maximum Flood (PMF=25,650 cfs). The maximum reservoir level during the PMF will be 1.9 feet over the top of dam and 3.5 feet below the top of dam during the 1/2 PMF.
The following remedial actions should be completed within 1 year from notification:

3. Repair the downstream channel weir.

4. Repair the leaking gates in the intake tower.

5. Remove the trees and brush on the embankment slopes, at the abutment contacts, and on the spillway outlet channel. Provide a program of periodic cutting and mowing of the embankment surfaces and the banks of the outlet channels.

6. Repair the deteriorated concrete at the waterline of the center pier in the downstream end or the outlet conduit.

7. Provide a program of periodic inspection and maintenance of the dam at appurtenances including yearly operation and lubrication of all gates. Document this information for future reference. Also develop an emergency action plan.

George Koch
Chief, Dam Safety Section
New York State Department of Environmental Conservation
NY License No. 45937

Approved By:

Col. W. M. Smith, Jr.
New York District Engineer

Date: 15 Aug 1980
Photo #1
Overview of Toronto Reservoir Dam
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
Evaluation of the existing conditions of the subject dam to identify deficiencies and hazardous conditions, determine if they constitute hazards to human life and property and recommend remedial measures where necessary.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances
Toronto Reservoir Dam consists of a 1645 feet long earth embankment, the maximum height of which is 91 feet above the original stream bed, and a 50 feet wide spillway constructed at the right abutment in a rock cut. The upstream slope of the earth embankment is 1 vertical on 3.5 horizontal, the downstream slope is 1 on 2.5, and the crest of the dam is 25 feet wide. A low concrete cut-off section was placed at the right abutment from the edge of the spillway to approximately 350 feet to the original stream channel. The cut-off is founded on bedrock. An intake tower located in the upstream slope of the dam controls the flow to Black Lake Creek. This flow augments the storage at Cliff Lake which in turn augments Swinging Bridge Reservoir, where hydroelectric generation is conducted. Two gates (a 4' x 5' at Elevation 1178 and a 3' x 5' at Elevation 1143) control the flow into the intake tower. An 8 feet by 8 feet concrete horseshoe conduit controls the flow from the intake tower beneath the dam.

b. Location
The dam is located on Black Lake Creek, a tributary of the Mongaup and Delaware Rivers, approximately 8 miles west southwest of the city of Monticello, New York.

c. Size
The dam is 91 feet high and impounds approximately 21,850 acre-feet. The dam is classified as "intermediate" in size (40 to 100 feet in height.)

d. Hazard Classification
The dam is classified as high hazard because of its location, about 14 miles north of the Village of Mongaup and upstream of 3 other significant dams.
e. Ownership
The dam is owned and operated by Orange and Rockland Utilities Inc.,
1 Blue Hill Plaza, Pearl River, New York 10965, Tel. (914) 627-2420.

f. Purpose of the Dam
The dam provides storage for the power development which is located
below Swinging Bridge Dam.

g. Design and Construction History
The dam was designed in 1925 by Charles H. Tenney & Co. Engineers,
200 Devanshire Road, Boston, Mass. for the Catskill Power Corporation,
Middletown, New York. The dam was constructed in 1925 by

h. Normal Operating Procedures
Water releases from Toronto Reservoir are passed over the spillway or
through either of the 2 gates located in the intake tower. Flow from
these gates is directed into Black Lake Creek. This break feeds Cliff
Lake where a conduit, connecting to Swinging Bridge Reservoir, supplies
flow to augment the storage for power development.

1.3 PERTINENT DATA

a. Drainage Area (sq. mi.) 23.20
Height of Dam (ft.) 91.

b. Discharge at Dam Site (cfs)
Maximum Recorded Elev. 1222. (Estimated Q) 530.
Spillway @ Top of Dam 8715.
Low Level Outlet @ Spillway Crest 1375.
Total Discharge at Top of Dam 10,090.

c. Elevation (ft. USGS)
Top of Dam 1230.
Top of Flashboards 1220.
Spillway Crest 1215.
Low Level Outlet 1143.
Original Streambed 1140.

d. Reservoir (acres)
Surface Area at Top of Dam 1075.
Surface Area at Top of Flashboards 930.
Surface Area at Spillway Crest 860.

e. Storage (acre-feet)
Top of Dam 33,250.
Top of Flashboards 25,300.
Spillway Crest 21,880.

f. Dam
Type: Homogenous earth with concrete cutoff and internal reinforced
concrete drain.
Length (ft.) 1645.
Upstream Slope 3.5 H:1 V.
Downstream Slope 2.5 H:1 V.
Crest Width (ft.) 25.

g. Spillway
Type: Channel cut to bedrock with concrete walls and five foot high flashboards.

Channel Width (ft.) 50.

h. Reservoir Drain
Type: Reinforced concrete tower inlet to eight foot horseshoe tunnel.

Control: Manually operated shoe gates, one 4' x 5' at elevation 1178 ft. and another 3' x 5' at elevation 1143 ft.
SECTION 2: ENGINEERING DATA

2.1 GEOLOGY

Toronto Reservoir Dam is located in the "Appalachian Uplands" physiographic province of New York State. This province (northern extreme of the Appalachian Plateau) was formed by dissection of the uplifted, but flat lying sandstones and shales of the middle and upper Devonian Catskill Delta. Relief is high to moderate. Maximum dissection occurs in the Catskill Mountain area, where only the mountain peaks approximate the original plateau surface. Drainage in the vicinity is southeastward and then south toward the Delaware River System.

2.2 SUBSURFACE INVESTIGATION

No subsurface investigation could be located for the project. However, the "General Soil Map of New York State" prepared by Cornell University Agriculture Experiment Station indicates that the surficial soils are of the Lackawanna series. This soil series, of glacial till origin, has poor internal drainage characteristics. Boulders are common and depth to bedrock is variable. Sandstone bedrock was observed outcropping in the excavated spillway channel and in the bed of the original stream channel below the dam.

2.3 DAM AND APPURTENANT STRUCTURES

The dam was designed by Charles H. Tenny, 200 Devonshire Rd., Boston, Mass. Available drawings have been included in Appendix E. Drawings KK3-360 & 371 were proposed modifications which were not built, but are included for illustrative purposes. The design of the dam includes a core material extending from the crest centerline to the base and core trench area with the approximate limit of the core having a slope of 1:0:01 from the crest. A concrete cut-off section, founded on bedrock, extends from the spillway to the original stream channel. The upstream and downstream toes are rock fill. The spillway is located in a rock cut at the right abutment.

2.4 CONSTRUCTION RECORDS

Some construction information is on file with the owner, the exact content is unknown.

2.5 OPERATION RECORD

All information concerning operation and maintenance of the dam is in file with the maintenance staff. The extent of data is believed to be limited to monthly elevation recordings.

2.6 EVALUATION OF DATA

Some of the data presented in this report has been made available by representatives of Orange and Rockland Utilities Inc. This information has been invaluable in preparation of this report and appears adequate and reliable for Phase I inspection purposes.
3.1 FINDINGS

a. General
Visual inspection of Toronto Reservoir Dam and the surrounding watershed was conducted on November 15 and 16, 1979. The weather was partly cloudy and the temperature ranged in the twenties. The reservoir level at the time of the inspections was approximately Elevation 1180, or 40 feet below normal pool elevation due to repair work on the intake tower.

b. Embankment
The earth embankment shows no signs of major distress with the exception of the seepage noted below. The crest and the slopes are in good condition with no evidence of sloughing subsidence, cracking or erosion. The slopes are riprapped with sandstone and shale boulders. Trees and low brush were evident on the slopes and at the abutments. The maintenance staff was removing the large trees on the left side of the dam during the inspections. (See Photos #1, 16 & 18)

c. Seepage
Seepage was observed emanating from the downstream toe of the dam on both sides of the horseshoe conduit outlet. The seepage was evident at three concentrated locations on the right side of the conduit. (See Photos #4, 5, 6 & 7). The flow, estimated to be 10 gallons per minute (gpm), from each of the 3 locations was clear and no particle migration was observed. However, the areas immediately below the seepage points were rusty colored (algae and stained soil particles) and appeared to be distributed in a delta form shape in the backwater of the downstream channel.

Seepage was observed at the right abutment contact from an area approximately 10 feet wide. (See Photo #6 left of person in photo). This flow is estimated to be 10 gpm and did not appear to be as rusty as the concentrated areas. No migration of particles was noted.

On the left side of the conduit outlet a flow of about 2 gpm was observed emanating from a 4 inch diameter plastic pipe. (see Photo #8) The point of seepage is approximately 15 feet from the downstream end of the conduit and 5 feet above the water level of the downstream channel.

In the downstream channel immediately below the toe of the dam seepage was noted emanating from both sides or the channel for a distance of 75 feet. The seepage was clear, no evidence of particle migration observed, and the rate of flow estimated to be a total of 10 gpm. (5 gpm each side).

A 4 inch diameter plastic pipe was noted at the left abutment contact about 100 feet left of the conduit. No flow was observed from the pipe or in the area of the abutment.

At the right abutment contact, approximately 200 feet right of the conduit, a 1/2 inch diameter pipe was observed. A valve at the end of the pipe was restricting any inspection of the interior of the pipe.
The purpose of the pipe is unknown.

The total flow of seepage observed at and along the toe of the dam is estimated to be in excess of 50 gpm. Maintenance personnel reported observing the seepage as described above for at least several years. A weir was noted across the downstream channel about 300 feet below the dam. (see Photo #3). No flow was observed over the weir due to the permeable nature of the soil surrounding it. This weir was reported to be used for flow measurements in the past. These records were not available at the time of the inspection. An additional weir was monitored in the outlet conduit and these readings were subtracted from the downstream weir to achieve a flow rate for the seepage. Seepage in the outlet conduit will be discussed in a following section. It should be noted that the estimated flow rate of 50 gpm, with the reservoir level 40 feet below normal pool, may be substantially increased when the reservoir is returned to normal operating levels.

d. Spillway

The spillway, located at the right abutment of the dam is excavated into and founded on bedrock. Five feet high flashboards were in place at the time of the inspection. The spillway is considered to be in good condition. (See Photo #20). The outlet channel of the spillway is riprapped and heavily vegetated. (see Photo #19)

e. Regulating Outlets

The concrete of the intake tower is deteriorated in some places to the point where reinforcing is exposed. In addition, ice loading has cracked the concrete walls about 44 feet below the upper floor of the intake tower. At the time of the inspection repairs were in progress to clean, patch, and bolt across the cracks with 10 inch wide 6 feet long channels. (See photos #16 & 17).

A 4' x 5' high level gate at Elevation 1178 and a 3' x 5' low level gate at Elevation 1143 serve to control the flow to the intake tower. The high level gate was leaking at a rate of about 10 gpm and the low level gate was leaking at a rate of 5 to 10 gpm. (See photo #15)

The 8 feet by 8 feet horseshoe outlet conduit is deteriorated and seepage was evident at all joints. Approximately 2 gpm was noted seeping from the roof or the fourth joint from the downstream end or the conduit (75 feet). (See Photo #14). An additional 1 to 2 gpm was observed emanating from the roof of the first joint from the upstream end of the conduit. (See Photo #15) Calcification was also present at all joints. The concrete at the first joint from the downstream end is severely deteriorated. The maximum depth of deterioration was measured to be 12 inches on the left side of the conduit and 8 inches on the right side. Reinforcing was exposed on both sides. (See photos 11 & 12).

The concrete or the outlet conduit at the downstream end is also deteriorated. (See Photos #9, 10 & 13). The center pier in the outlet works is severly deteriorated at the water line (See Photo #13) and reinforcing is exposed.

The remainder of the conduit appears to be in good condition with no
evidence of movement, or misalignment. The gates are reported to be operational.

f. Downstream Channel
The downstream channel appears to be in good condition. (See Photos #2 & 3). The channel bed is riprapped. Flow in the channel is used to augment the power generating capability at Swinging Bridge Reservoir.

g. Reservoir
There are no visible signs of instability or sedimentation problems in the reservoir area.

3.2 EVALUATION OF OBSERVATIONS
Significant conditions were observed which require immediate investigation to determine the type of extent of corrective action necessary to insure the stability of the dam and appurtenances. The following is a summary of the problem areas encountered, in order of importance, with the appropriate recommended action:

1. The seepage and deterioration of the intake structure and outlet conduit must be investigated immediately. The seepage investigation should be conducted during filling of the reservoir. Coring of the concrete may be required to investigate the structural integrity of the conduit.

2. The seepage observed at the toe of the downstream slope on both sides of the outlet conduit must be investigated immediately. This investigation should also be conducted during reservoir filling. Construction of weirs and monitoring at bi-weekly intervals during filling is required. The level of the reservoir must be used to correlate this information.

3. Repair the downstream channel weir which is leaking.

4. Repair the leaking gates in the intake tower. Provide a program of periodic inspection and maintenance of the dam and appurtenances including yearly operation and lubrication of the gate system.

5. Remove the trees and brush on the embankment slopes, at the abutment contacts and in the outlet channel of the spillway. Provide a program of periodic cutting and mowing of the embankment surfaces and outlet channels.

6. Repair the deteriorated center pier of the outlet works.

7. Develop an emergency action plan.
SECTION 4: OPERATION AND MAINTENANCE PROCEDURE

4.1 Procedures
The normal water surface is approximated by the top of the flashboards (5 feet in height), Elevation 1220. The reservoir surface may be lower due to the demand for water to generate power at Swinging Bridge Reservoir. This demand is supplied by either of 2 gates in the intake tower, a 4' x 5' high level gate at Elevation 1178, and a 3' x 5' low level gate at Elevation 1143, the flow from which is transmitted beneath the dam by an 8' x 8' horseshoe conduit.

4.2 Maintenance of the Dam
The dam is maintained by the owner, Orange and Rockland Utilities, Inc. Maintenance of the dam is not considered satisfactory as evidenced by the deteriorated concrete elements of the intake tower and conduit system, the uncontrolled seepage at the toe, the leaking gates, and the extensive growth of trees and brush on the slopes of the dam and the abutments.

4.3 Warning System
An excellent warning system has been developed by the owner, in accordance with the federal Energy Regulating Commission standards. This system was updated (Dec. 7, 1978) and is included in Appendix E.

4.4 Evaluation
The dam and appurtenances have not been maintained in satisfactory condition as noted in "Section 3: Visual Inspection."
SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Drainage Area Characteristics
The Toronto Reservoir Dam is located on the Black Lake Creek, a tributary of the Mongaup River. The Drainage Area at the dam site is 23.20 square miles. The topography is characterized by moderate to steep slopes interspersed by lakes and swamps. The lakes and swamps combine to create a large amount of upstream storage.

5.2 Analysis Criteria
The analysis of the spillway capacity of the dam and storage of the reservoir was performed using the Corps of Engineers HEC-1 computer model. The unit hydrograph was defined by the Snyder Synthetic Unit Hydrograph method, and the Modified Puls routing procedure was incorporated. The Probable Maximum Precipitation (PMP) was 21.0 inches (24 hrs., 200 sq. miles) from Hydrometeorological Report #33. The floods selected for analysis were the PMF and the 1/2 PMF in accordance with recommended guidelines of the Corps of Engineers. The PMF inflow of 25650 cfs was routed through the reservoir and the peak outflow was determined to be 21,563 cfs.

5.3 Spillway Capacity
The spillway is a 50' long channel cut to bedrock with 5' flashboards. The height from the spillway crest to top of dam is 15'; it is assumed that flashboards will fail at 3' over the top of flashboards. The capacity at the top of dam is 8715 cfs.

5.4 Reservoir Capacity
The reservoir capacities at the crest of the spillway, and at the top of the flashboards are 21,850 acre-feet and 25300 acre-feet respectively. Total storage capacity to top of dam is 33,250 acre feet. Surcharge storage, spillway crest to top of dam, is 11,400 acre feet or equivalent to a runoff depth of 9.2 inches over the drainage area.

5.5 Floods of Record
Maximum elevation recorded was on July 20, 1945, elevation 1222.0 or 2' over the flashboards. The estimated discharge at this time was 540 cfs.

5.6 Overtopping Potential
The maximum capacity of the spillway assuming the flashboards fail is 8715 cfs. Hence, it will adequately pass the 1/2 PMF event but the dam will be overtopped by approximately 1.9' during the PMF inflow of 25,650 cfs. The routed outflow for the 1/2 PMF and PMF are 6850 cfs and 21,563 cfs respectively.

5.7 Evaluation
The spillway is inadequate to pass the routed PMF outflow of 21,563 cfs without overtopping, however, the spillway will pass the 1/2 PMF outflow of 6850 cfs with approximately 2 feet of freeboard. The spillway is inadequate for all storms in excess of 75% of the PMF.
SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations
No signs of major distress were observed in connection with the earth embankment or the spillway section. However, seepage was observed at the toe of the dam and within the outlet conduit estimated to be in excess of 50 gpm with the reservoir at a level 40 feet below normal pool. In addition, the intake tower and the outlet conduit is severely deteriorated (reinforcing is exposed) and the intake tower experienced cracking due to ice loading.

b. Design and Construction Data
No design or construction data could be located concerning the structural stability of the dam.

c. Operating Records
No operational problems were reported which would affect the structural stability of the dam.

d. Post-Construction Changes
During the time of the inspections channels were being bolted across the cracked areas of the intake tower to insure the stability of the tower. Also, monitoring of the seepage at the toe of the dam has been recorded in the past. Unfortunately, these records could not be located.

e. Seismic Stability
The dam is located in seismic Zone 1. Seismic forces in this zone are not considered to be of significant magnitude to influence the stability of the structure. A detailed stability analysis of the earth embankment is beyond the scope of this report. The "Preliminary Brittle Structures Map of New York", by Isachsen and McKendree, indicates that no faulting or slides are present within the watershed area or near the dam.
SECTION 7: ASSESSMENT/RECOMMENDATIONS

7.1 **Assessment**

a. **Safety**
The Phase I Inspection of Toronto Reservoir Dam did not reveal conditions which constitute an immediate hazard to human life or property. The embankment and horseshoe outlet conduit have a number of problem areas which require immediate attention.

b. **Adequacy of Information**
Information reviewed for the purposes of the Phase I Inspection report is considered adequate.

c. **Urgency**
The investigations listed below require immediate attention. All investigations and remedial actions described below should be completed within 1 year of notification to the owner.

d. **Need for Additional Investigation**
Additional investigations are required in the following areas:

1. Seepage and deterioration of the intake tower and the outlet conduit must be investigated. Coring of the conduit walls and intake tower may be required to determine the structural integrity of the conduit. Investigation of the seepage at the joints of the conduit should be conducted during reservoir filling operations to correlate seepage rate with reservoir level.

2. Seepage at the toe or the dam on both sides of the outlet conduit must be investigated. Construction of weirs and monitoring of flow at bi-weekly intervals (more frequent readings may be required depending upon reservoir level increases) during reservoir filling, is required to properly ascertain if the rate of seepage is dependent upon the reservoir level, and any consequences thereof.

7.2 **Recommended Measures**

1. Results of the aforementioned investigations will determine the type and extent of remedial measures required.

2. Repair the downstream channel weir.

3. Repair the leaking gates in the intake tower.

4. Remove the trees and brush on the embankment slopes, at the abutment contacts and on the spillway outlet channel banks. Provide a program of periodic cutting and mowing of the embankment surfaces and the banks of the outlet channels.

5. Repair the deteriorated concrete at the water line of the center pier in the downstream end of the outlet conduit.

6. Provide a program of periodic inspection and maintenance of the dam and appurtenances, including yearly operation and lubrication of all gates. Document this information for future reference.
APPENDIX A

PHOTOGRAPHS
Photo #2
Downstream Face of Dam

Photo #3
Weir in Downstream Channel
Immediately below Photo #2
Photo #4
Toe of Downstream Slope
Note Rusty Areas

Photo #5
Close-Up of Seepage
(Location: Slightly to the right of person in Photo #4)
Photo #6
Seepage at Toe of Right Abutment Contact

Photo #7
Close-Up of Seepage
(Location: at extreme right of Photo #6)
Photo #8
Seepage on Left Side of Horseshoe Conduit

Photo #9
Outlet of Conduit
(Note deterioration & calcification)
Photo #12
Deterioration of Right Wall of Conduit
(Opposite Photo #11)

Photo #13
Outlet of Conduit Looking Downstream
(Note deterioration of center wall)
Photo #14
Seepage from Conduit Joint
(Approx. 75 feet from downstream end)

Photo #15
Seepage from Conduit Joint
(First Joint from Upstream End)
Photo #18
Crest of Dam & Right Abutment
(Spillway in background)

Photo #19
Outlet channel of spillway
Photo #20
Spillway
(looking upstream)
Construction Photos July 1, 1925

Above: Downstream End of Outlet Conduit
Below: Construction of Cut-Off (Right Side of Conduit.)
APPENDIX B

VISUAL INSPECTION CHECKLIST
VISUAL INSPECTION CHECKLIST

1) Basic Data

a. General

Name of Dam: Torrata Reservoir
Fed. I.D. #: N/A DEC
DEC Dam No.: 1975-199
River Basin: Delaware
Location: Town Bethel, County Sullivan
Stream Name: Black Lake Creek
Tributary of: A Delware River
Latitude (N): 41° 37' 16'' Longitude (W): 74° 4' 28''
Type of Dam: 
Hazard Category: C
Date(s) of Inspection: 11/15/1978
Weather Conditions:
Reservoir Level at Time of Inspection: 

b. Inspection Personnel: 

J.C. Van Rens 

J.P. Mccollum 

J.O. Aker 


c. Persons Contacted (Including Address & Phone No.): 

D.K. Van Rens 

J.P. Mccollum 

J.O. Aker 


d. History:

Date Constructed: 
Date(s) Reconstructed:
Designer:
Constructed By:
Owner:
2) **Embankment**

   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) 1:3

   (2) Undesirable Growth or Debris, Animal Burrows

   (3) Sloughing, Subsidence or Depressions
d. Downstream Slope

(1) Slope (Estimate - V:H) 1:2.5

(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
   b. Condition of System
   c. Discharge from Drainage System

4) Instrumentation (Monumentation/Surveys, Observation Wells, Weirs, Piezometers, Etc.)
5) **Reservoir**
   a. Slopes
   
   b. Sedimentation
   
   c. Unusual Conditions Which Affect Dam

6) **Area Downstream of Dam**
   a. Downstream Hazard (No. of Homes, Highways, etc.)
   
   b. Seepage, Unusual Growth
   
   c. Evidence of Movement Beyond Toe of Dam
   
   d. Condition of Downstream Channel

7) **Spillway(s) (Including Discharge Conveyance Channel)**
   a. General
   
   b. Condition of Service Spillway
c. Condition of Auxiliary Spillway


d. Condition of Discharge Conveyance Channel


8) Reservoir Drain/Outlet

Type: Pipe __________ Conduit __________ Other __________

Material: Concrete ________ Metal ________ Other ________

Size: ________ Length ________

Invert Elevations: Entrance ________ Exit ________

Physical Condition (Describe): Unobservable ________

Material: ________

Joints: ________ Alignment ________

Structural Integrity: ________

Hydraulic Capability: ________

Means of Control: Gate ________ Valve ________ Uncontrolled ________

Operation: Operable ________ Inoperable ________ Other ________

Present Condition (Describe): ________
9) **Structural**

a. Concrete Surfaces

b. Structural Cracking

c. Movement - Horizontal & Vertical Alignment (Settlement)

d. Junctions with Abutments or Embankments

e. Drains - Foundation, Joint, Face

f. Water Passages, Conduits, Sluices

g. Seepage or Leakage
h. Joints - Construction, etc.

i. Foundation

j. Abutments

k. Control Gates

l. Approach & Outlet Channels

m. Energy Dissipators (Plunge Pool, etc.)

n. Intake Structures

o. Stability

p. Miscellaneous
10) **Appurtenant Structures** (Power House, Lock, Gatehouse, Other)

a. Description and Condition

[Handwritten text]

\[\text{Handwritten text continued...}\]
APPENDIX C

HYDROLOGIC / HYDRAULIC

ENGINEERING DATA AND COMPUTATIONS
### AREA-CAPACITY DATA

<table>
<thead>
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<th>Elevation (ft.)</th>
<th>Surface Area (acres)</th>
<th>Storage Capacity (acre-ft.)</th>
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<td>1) Top of Dam</td>
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<td>1275.0</td>
<td>33250.0</td>
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<td>2) Design High Water</td>
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<tr>
<td>(Max. Design Pool)</td>
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<tr>
<td>3) Auxiliary Spillway</td>
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<td>4) Pool Level with</td>
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<td>70 350.0</td>
<td>25300.0</td>
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<td>5) Service Spillway</td>
<td>1215.0</td>
<td>660.0</td>
<td>21850.0</td>
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<td>Crest</td>
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### DISCHARGES

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<th>Volume (cfs)</th>
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<tr>
<td>1) Average Daily</td>
<td></td>
</tr>
<tr>
<td>2) Spillway @ Maximum High Water</td>
<td>27500 (acre-feet)</td>
</tr>
<tr>
<td>3) Spillway @ Design High Water</td>
<td></td>
</tr>
<tr>
<td>4) Spillway @ Auxiliary Spillway Crest Elevation</td>
<td></td>
</tr>
<tr>
<td>5) Low Level Outlet</td>
<td>1375</td>
</tr>
<tr>
<td>6) Total (of all facilities) @ Maximum High Water</td>
<td>16000</td>
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<tr>
<td>7) Maximum Known Flood</td>
<td>5300</td>
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<tr>
<td>8) At Time of Inspection</td>
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<tr>
<td></td>
<td>SERVICE</td>
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<tr>
<td>CREST: Type</td>
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<tr>
<td>Width:</td>
<td>53'</td>
</tr>
<tr>
<td>Length:</td>
<td>520'</td>
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<tr>
<td>Spillover</td>
<td></td>
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<tr>
<td>Location</td>
<td>LEFT</td>
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</table>

| SPILLWAY:      |         |           |
| Elevation:     | 121.5   |           |
| Channel Width: | 25'     |           |

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<thead>
<tr>
<th>Type of Control</th>
<th>Uncontrolled</th>
<th>Controlled:</th>
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<tr>
<td>Type:</td>
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<td>5' Flashboard (Flashboards; gate)</td>
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<td>Size/Length:</td>
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<td>Invert Material</td>
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<td>Anticipated Length of operating service</td>
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<td>Chute Length:</td>
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<tr>
<td>Height Between Spillway Crest &amp; Approach Channel Invert (Weir Flow)</td>
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HYDROMETEROLOGICAL GAGES:

Type: None Block Castle

Location: ________________________________

Records: Reserve USGS Water Resources

Date: July 20, 1975

Max. Reading: 1222.0

FLOOD WATER CONTROL SYSTEM:

Warning System: Updated Dec. 75 by Decider

Method of Controlled Releases (mechanisms):

Fire Alarms
### DRAINAGE AREA:

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<th>Drainage Basin Runoff Characteristics:</th>
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<td>Land Use - Type:</td>
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<tr>
<td>Terrain - Relief:</td>
</tr>
<tr>
<td>Surface - Soil:</td>
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</table>

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

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

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

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

**Reservoir:**

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<th>Length @ Maximum Pool (Miles)</th>
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<tr>
<td>Length of Shoreline (@ Spillway Crest) (Miles)</td>
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1/52 - 1. SAWER PARAMETERS

\( C = 7.1 \text{ mi} \)

\( L_0 = 8.5 \text{ mi} \)

\[ C_\theta = 2.3 \]

\[ L_\theta = C_\theta (L_0 + L_0) \]

\[ = 2.3 (7.1 + 8.5) \]

\[ = 5.15 \text{ hr} \]

\[ C_r = \frac{L_\theta}{L_0} = 1.60 \]

\[ T_0 = t_0 + 0.5(C_r) = 5.9 \text{ hrs.} \]

\[ T_0 = \frac{L_\theta}{L_0} = 1.60 \]

\[ T_0 = t_0 + 0.5(C_r) = 5.9 \text{ hrs.} \]

\[ \text{Hours of overtopping} \quad (10650 \text{ cfs} - 8775 \text{ cfs}) = 1975 \text{ cfs} \]

\[ C_0 = \frac{C_\theta \cdot L_\theta}{L_0} \]

\[ 1975 \text{ cfs} = \frac{1}{1.60} (1600 \text{ ') 30} \]

\[ k = 55' \]

\[ \text{Low level curve} \quad G = C_\theta \sqrt{agh} \]

\[ G_1 = C_\theta \sqrt{12(35.2)(1250 - 1093 + 2.5)} = 675 \text{ cfs} \]

\[ G_2 = C_\theta \sqrt{12(35.2)(1230 - 1195 + 2.5)} = 796 \text{ cfs} \]

\[ 1375 \text{ cfs} \]
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PLUNO HYDROGRAP PACKAGE (FCE-1)
DAN SAFETY VERSIINI JULY 1974
LAST MODIFICATION 26 FEB 74
MODIFIED FOR MINEWELL APX 79

=================================================================
THIS PROGRAM IS CURRENTLY BEING MODIFIED
TO RUN ON THE IIS MINEWELL SYSTEM
PLEASE REPORT ANY UNUSUAL OPERATING PROBLEMS
TO MIKE TILSTON (RM. 423) PHN 7-5646
=================================================================

RUN DATE 01/17/80
TORUHTO RESERVOIR
PHASE 1
PJF

JOB SPECIFICATION
NUM INH MTH IHR I-Day INIT MET RC IZLT IPRT NSTAT
200 0 30 0 0 0 0 0 0
JOPEH NWT LRUPT TRACE
5 0 0 0 0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLANC = 1 PRTI= 2 LRTI= 1

R14:5 = 0.50 1.00

==================  ==================
SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR
ISTAO ICMFE IFCON ITAPE JPLT JPRT INAME ISTAGE IAUTO
1 0 0 0 2 0 1 0 0

IMHYDG JUMP TAKEN SNAP TRESP RATIO ISNOW IASHE LOCAL
1 1 23.20 23.20 23.20 0 0 0 0

PRECIP DATA
SPFE PUSE R6 R12 R24 R48 R72 R96
0.21 0.00 101.00 114.00 124.00 131.00 0. 0.
TRSCP COMPUTED BY THE PROGRAM IS 0.828

LOSS DATA
LROPT STRKR OLTRK RTIUI ERAIN STSRS RTUIM STRL CNSTL ALSMN RT1MP
0 0 0 0 1.00 0 0 1.00 0 0 0 0

UNIT HYDROGRAPH DATA
TP = 5.90 CP = 0.63 NTAH = 0

RECESSION DATA
STRTQ = -2.00 QRCSN = -0.05 RTIUR = 1.00
APPROXIMATE CLAHIJE COEFFICIENTS FROM GIVEN SIIUE TR AND TP ARE TE=12.01 AND R=11.11 INTERVALS

UNIT HYDROGRAPH 66 FHO-OF-PERIOD ORDINATES, LAG = 5.86 HOURS, CP = 0.62 VOL = 1.00
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**Hydrograph at STA 1 for Plan 1 & RTID 2**

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**Precipitation**

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**STAGE**

*PACIFIC ISLANDS* 2347 at TIDE 55.400 MILLIS

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**PEAK OUTFLUX IS 21361, AT TIME 47,000 DAYS.**

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*Note: The table shows the peak flow and storage calculations for different flow rates and ratios.*
## SUMMARY OF DAM SAFETY ANALYSIS

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APPENDIX D

REFERENCES
REFERENCES


APPENDIX E

DRAWINGS
Mr. Frank Kiernan
Director of Electrical Production
75 W. Rt. #59
Spring Valley, New York 10977

Re: Toronto Reservoir Dam
#148D-199
Delaware River Basin

Dear Frank:

As a result of our field inspection of the subject dam on November 15 and 16, 1979, certain problem areas were discovered which require your immediate attention. These areas are as follows:

1. Seepage was observed emanating from the downstream toe of the dam on both sides of the reservoir drain outlet. The seepage was evident at three concentrated locations on the right side of the reservoir drain and several points along the abutment contacts and the banks of the downstream channel. The seepage flow was clear. However, in two locations there appears to be rusty colored algae and particles spread out in a delta fan immediately below the seepage points. Seepage rate is estimated to be 10 gallons per minute from the three concentrated areas and approximately 20 gpm from the remaining areas. The water level in the reservoir at the time of the inspection was 40 feet below normal pool.

2. Inspection of the reservoir drain conduit revealed extensive concrete deterioration at the construction joints and at the downstream end of the conduit. Calcification and seepage was evident at all joints throughout the conduit. At two locations seepage at a rate of approximately 1-2 gpm was observed flowing through the joints.

In light of these conditions, you are requested to perform the following repair and monitoring programs:

Robert F. Flacke

December 10, 1979
A. Install weirs or other flow measuring devices at the seepage points described and monitor the discharge at weekly intervals. During filling of the reservoir if appreciable increases in reservoir levels are encountered monitor the seepage flow more frequently. Record flow rates in gallons per minute for all seepage points and indicate the corresponding reservoir and tailwater elevations.

B. Repair the deteriorated concrete of the reservoir drain conduit and seal the leaking construction joints. In addition, repair the center pier in the throat of the conduit outlet. These repairs should be accomplished before the reservoir level is raised so that the work may be accomplished under a low hydrostatic head.

If you have any further questions or comments, please contact me at (518) 457-5557.

Thank you for your cooperation.

Sincerely,

Robert P. McCarty
Senior Civil Engineer

RPM/ps

cc: Mr. Levers
    Mr. Hebson
    Mr. Danskin
TORONTO RESERVOIR DAM

List of Drawings

DAM - General Plan kk-3-1

Note: The following plans are for illustrative purposes. The proposed pipeline and appurtenances from Toronto to Swinging Bridge Reservoir was not constructed.

Toronto Pipeline Development
General Plan kk-3-360
Penstock Connection to Conduit kk-3-371
TOP OF EMBANKMENT ELEV. 1230

ELEV. 1215 CREST OF SPILLWAY

APPROX ROCK LINE

CONCRETE CUT-OFF

ELEV. 1141.79

ELEV. 1230.2

TOP OF FLASHBOARDS

SLOPE : 0.3

4'5' HIGH LEVEL GATE

UPSTREAM FACE TO

3'5' LOW LEVEL GATE

ROCK FILL TOE
PROFILE ON CENTER LINE OF PIPE

Scales: Horiz. - 1" = 500'
        Vert. - 1" = 250'
NOTE: Schedule includes reinf on Dwg. KK-3-373

Drilling of holes and cutting of key carefully with particular care to avoid cracking walls.

Chip old concrete to a new surface between these lines.

21 Al-12# Dowels 15" Ig - 3 lines of 7 each below each of conduit.
See Dwg. KK-3-374
(Housing similar to housing
shown on Dwg. KK-3-369)

8" Automatic Air Inlet Valve
1" Automatic Air Outlet Valve

ROCKLAND LIGHT & POWER CO.

TORONTO PIPE LINE
DEVELOPMENT
PENSTOCK CONNECTION TO COND
GENERAL PLAN

PREPARED BY CHARLES H. TENNEY & CO.
ENGINEERS BOSTON, MA

SCALES 1"=1'-0"
NOV. 12, 1981