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NATIONAL DAM SAFETY PROGRAM. TOMAHAWK LAKE DAM (INVENTORY NUMBE--ETC(U)
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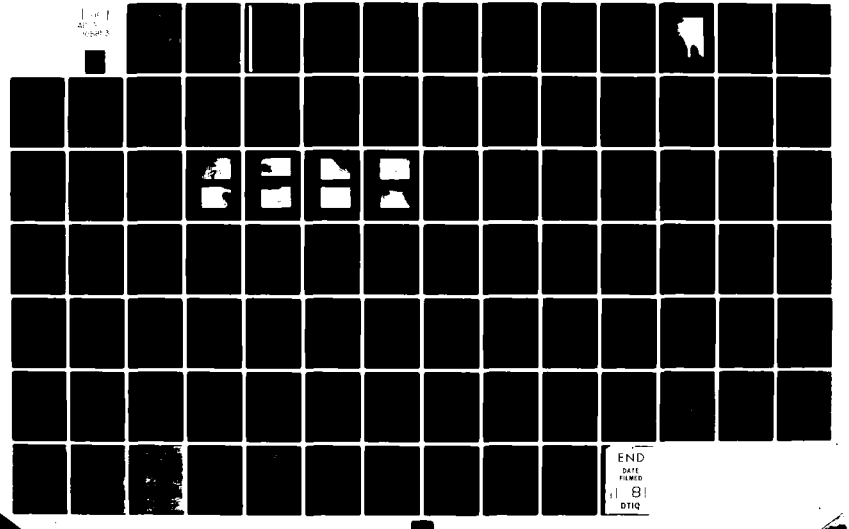

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety
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Lower Hudson River Basin

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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.

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

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Using the Corps of Engineers screening criteria, it has been determined that the dam would be overtopped for all storms exceeding approximately 32 percent of the Probable Maximum Flood (PMF). The spillway is, therefore, adjudged as "seriously inadequate" and the dam is assessed as unsafe, non-emergency.

The classification of "unsafe" applied to a dam because of a "seriously inadequate spillway" is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that, based on an initial screening and preliminary computations, there appears to be a serious deficiency in spillway capacity, so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream.

It is ~~therefore~~ recommended that, within 3 months of notification of the owner, detailed hydrologic and hydraulic investigations of the structure should be undertaken to more accurately determine the site-specific characteristics of the watershed and their effects upon the overtopping potential of the dam. The results of this investigation and analyses will determine the appropriate remedial measures which will be required. In the interim, a detailed emergency action plan must be developed and implemented during periods of unusually heavy precipitation. Also, around-the-clock surveillance must be provided during these periods.

Maintenance of the dam in the past has been inadequate. Regular inspections should be made of the dam and appurtenant structures. A thorough checklist should be compiled by the owner or owner's representative to follow as a guide for the inspections. Maintenance items should be corrected annually.

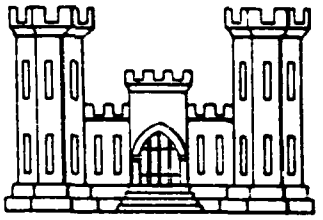
The seep at the right side of the stilling basin should be examined at regular intervals and after periods of heavy rain for turbidity and/or increase in flow, which may indicate the potential for piping of embankment material. If turbidity and/or increased flows are noted, a qualified geotechnical engineering firm should be retained to perform a stability check of the dam and plan remedial measures.

LOWER HUDSON RIVER BASIN

TOMAHAWK LAKE DAM

ORANGE COUNTY, NEW YORK
INVENTORY NO. N.Y. 618

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



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NEW YORK DISTRICT CORPS OF ENGINEERS

AUGUST 1981

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
TOMAHAWK LAKE DAM
I.D. No. NY 618
DEC DAM No. 195A-2507, LOWER HUDSON RIVER BASIN
ORANGE COUNTY, NEW YORK

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Tomahawk Lake Dam (I.D. No. NY 618)
State:	New York
County:	Orange
Stream:	Cromline Creek
Dates of Inspection:	5 March 1981, 9 March 1981

ASSESSMENT

Examination of available documents and a visual inspection of the dam and appurtenant structures did not reveal any 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 32 percent of the Probable Maximum Flood (PMF). The spillway is, therefore, adjudged as "seriously inadequate" and the dam is assessed as unsafe, non-emergency.

The classification of "unsafe" applied to a dam because of a "seriously inadequate spillway" is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that, based on an initial screening and preliminary computations, there appears to be a serious deficiency in spillway capacity, so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream.

It is therefore recommended that, within 3 months of notification of the owner, detailed hydrologic and hydraulic investigations of the structure should be undertaken to more accurately determine the site-specific characteristics of the watershed and their effects upon the overtopping potential of the dam. The results of this investigation and analyses will determine the appropriate remedial measures which will be required. In the interim, a detailed emergency action plan must be developed and implemented during periods of unusually heavy precipitation. Also, around-the-clock surveillance must be provided during these periods.

Maintenance of the dam in the past has been inadequate. Regular inspections should be made of the dam and appurtenant structures. A thorough checklist should be compiled by the owner or owner's representative to follow as a guide for the inspections. Maintenance items should be corrected annually.

The seep at the right side of the stilling basin should be examined at regular intervals and after periods of heavy rain for turbidity and/or increase in flow, which may indicate the potential for piping of embankment material. If turbidity and/or increased flows are noted, a qualified geotechnical engineering firm should be retained to perform a stability check of the dam and plan remedial measures.

The following remedial measures must be completed within one year:

1. The crest of the embankment must be filled and graded to a crest width not less than 13 feet. A good grass cover must then be established on the crest.

2. The eroded areas behind the spillway training wall must be filled, compacted and seeded.

3. The crack in the approach apron must be repaired.

4. The left upstream spillway wing wall must be repaired.

5. The outlet conduit must be repaired and rebuilt near the discharge end.

6. The outlet conduit stilling basin must be completely lined with riprap.

7. All trees and brush must be cut at ground level over the entire embankment. All trees with a trunk diameter greater than 3 inches must have their root systems removed. All resultant areas of erosion and cavities must be filled, graded, compacted and seeded.

8. The animal burrows in the embankment must be excavated, backfilled, compacted and seeded.

9. Install a staff gage to monitor reservoir levels.

10. After the brush and trees are cut, a qualified geotechnical firm should be retained to perform an additional visual inspection.

11. The operability of the valve should be checked and repairs, as necessary, performed to ensure future operation of the valve.

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
Tomahawk Lake Dam
I.D. No. NY 618
9 March 1981

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
TOMAHAWK LAKE DAM
I.D. No. NY 618
DEC DAM No. 195A-2507
LOWER HUDSON RIVER BASIN
ORANGE 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 - Tomahawk Lake Dam is an earthfill embankment. The dam is 1064 feet long and has a height of 25.3 feet measured from the streambed at the toe of the dam to the minimum top of dam. The crest width of the embankment varies from 0 to 13 feet. (Note: The crest actually forms a pinnacle in some areas.) The slope of the upstream face is 1V:2.5H (Vertical to Horizontal) and the slope of the downstream face is 1V:2.8H. The upstream face of the embankment is protected by riprap which extends about 2-1/2 feet above normal pool. The design plans show a concrete core wall, however, the presence of this core wall could not be determined during the visual inspection.

The spillway is located on the embankment 280 feet from the left abutment.[1] The spillway is a concrete trapezoidal weir with a crest length (perpendicular to flow) of 150 feet. The width of the weir (parallel to the direction of flow) is 3.2 feet

[1]Facing downstream.

The spillway and discharge channel have 7-foot high vertical concrete training walls. Water flowing over the spillway continues down a discharge apron 58.7 feet long. The flow has a final drop of 3.0 feet where it enters the discharge channel at the toe of the dam. The discharge channel is lined with riprap at the outfall.

The outlet works for the dam is a 4 foot by 4 foot square concrete conduit running through the base of the embankment near the right-center of the dam. This outlet is controlled by a gate valve operated from inside a valve house located on the crest of the embankment.

b. Location - Lake Tomahawk Dam is located on Cromline Creek, approximately 3.8 miles southwest of Washingtonville, New York. The dam and reservoir are in Orange County, New York. The coordinates of the dam are N 41° 24.7' and W 74° 13.1'. Tomahawk Lake Dam can be found on the Maybrook, New York, USGS 7.5 minute topographic quadrangle. A Location Plan is included with this report in Appendix E.

c. Size Classification - The height of Lake Tomahawk Dam is 25.3 feet and the reservoir storage capacity at the minimum top of dam is 3359 acre-feet. Therefore, the dam is in the "intermediate" size category as defined by the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification - Cherry Hill Road crosses the channel 1600 feet downstream from the dam and Tuthill Road crosses the channel 1.5 miles below the dam. A home is located within 5 feet of the stream elevation, about 10 feet from the stream, and approximately 500 feet below Tuthill Road. In the event of a dam failure, loss of life at the house and economic damage to both the house and roads are considered possible. Tomahawk Lake 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 by David Plotkin, 401 South Water Street, Newburgh, N.Y. 12550. The contact person is David Plotkin (telephone 914-562-0860).

f. Purpose of Dam - The reservoir is used for recreational purposes.

g. Design and Construction History - Lake Tomahawk Dam was built in 1929 and designed by Blake and Woodhall of Newburgh, New York. The contractor is unknown. In 1956, a permit was issued and repairs were made to the concrete spillway.

h. Normal Operating Procedures - The reservoir is normally maintained by the crest of the spillway. The owner walks the crest and visually inspects the dam every month. According to the owner, the reservoir level is lowered 2 or 3 feet every few years by opening the sluice gate. There are no formal operating procedures or records kept for this structure.

1.3 PERTINENT DATA

a. Drainage Area (Square Miles) - 28.24

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

Spillway at Top of Dam (Minimum)	7495.0
Reservoir Drain at Normal Pool	306.0

c. Elevations (Feet M.S.L.) -

Top of Dam (Average)	345.0
Top of Dam (Minimum)	344.5
Spillway Crest	338.5
Streambed at Toe of Dam	319.2
Reservoir Drain Inlet Invert	Unknown
Outlet Invert	318.7

d. Reservoir Surface Area (Acres) -

Top of Dam (Minimum)	212.0
Spillway Crest	174.5

e. Reservoir Storage Capacity (Acre-Feet) -

Top of Dam (Minimum)	3359.0
Spillway Crest	2199.0

*All elevations are referenced to the spillway crest, Elevation 338.5 feet Mean Sea Level (M.S.L.), as shown on the original design plans.

f. Dam -

Type: Earthfill with Concrete Core Wall		
Length (Feet)		1064.0
Height (Feet)		25.3
Crest Width (Feet)	Design	10.0
	Field	0 to 13
Side Slopes Upstream -	Design	1V:2.5H
	Field	1V:2.5H
Downstream -	Design	1V:2.0
	Field	1V:2.8H

g. Spillway -

Type: Trapezoidal concrete weir	
Length of Crest Perpendicular to Direction of Flow (Feet)	150.0
Width of Crest Parallel to Direction of Flow (Feet)	3.2
Crest Elevation Feet M.S.L.	338.5

h. Reservoir Drain -

Type: Square concrete conduit 4 feet by 4 feet.
Control: Gate valve with control located inside gate house on crest of embankment.

SECTION 2: ENGINEERING DATA

2.1 GEOLOGY

Tomahawk Lake Dam is located in the southern end of the "Appliachian Uplands" physiographic province of New York State. The bedrock in the immediate vicinity of the dam is represented by Middle Ordovician age shale, argillite, and siltstone of the Normanskill Formation.

The dam lies west of a northeast-southwest trending normal fault plane. The entire area has been repeatedly glaciated by the major ice sheet advances which occurred during the Pleistocence Epoch. The most recent ice advance ended approximately 11,000 years ago.

2.2 SUBSURFACE INVESTIGATIONS

Original subsurface information was not available for reference as a part of this investigation. According to the available soils report (preliminary) for Orange County, prepared by Soil Conservation Service, the majority of surface materials consist of "Albia-Eldery" association. These soils are stony, poorly to very poorly drained soils formed in gray slate and shale glacial till. There is a hardpan about 12 inches below the surface making the permeability low.

2.3 DAM AND APPURTENANT STRUCTURES

Plans for the dam by Blake and Woodhall for Matuka Bealty Development Corporation were available during this investigation. The drawings are dated April 1929. Plans for repairs to the spillway, dated August 1956, are also available. Lacking information to the contrary, the dam is assumed to be comprised of a homogeneous earth embankment. The plans show a concrete core wall, but no evidence of this was visible in the field. The spillway consists of a 150 foot, trapezoidal concrete weir. The crest has location holes for the placing of flashboards that are no longer used.

The gatehouse is located on the upstream side of the crest, 300 feet from the right abutment. The outlet consists of a sluice gate with a 4x4 outlet conduit.

2.4 CONSTRUCTION RECORDS

Construction records were not available for this investigation.

2.5 OPERATING RECORDS

The water level is normally kept at the reservoir crest. The lake is lowered every 2 or 3 years to clean the shoreline. The owner walks the crest once a month to locate any problem. No formal records of visits or maintenance are kept.

2.6 EVALUATION OF DATA

Background information obtained during this investigation was obtained from Mr. David Plotkin, the owner. Available engineering data are considered adequate and reliable for Phase I Inspection purposes, with the exceptions that foundation characteristics are not known. It is also unclear if a core wall is present in the embankment.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General - The inspection of Lake Tomahawk Dam was conducted on 5 March 1981. The weather was cloudy with some snow flurries and a temperature of about 33° F. At the time of inspection, there was a light dusting of snow on the ground. The water surface was at elevation 338.7 feet M.S.L. Deficiencies found during the inspection will require remedial treatment. A Field Sketch of conditions during the inspection is included in Appendix E. The complete Visual Inspection Checklist is presented as Appendix B. A follow-up inspection was conducted on 9 March 1981 to observe the embankment without snow cover and to take additional photographs.

b. Spillway - The right side of the spillway crest near the training wall has settled slightly (about 3 inches). The spillway crest has also been spalled at the left training wall and the upstream apron is cracked and settled at a point 25 feet from the left training wall. The left upstream wing wall has a 2 foot square piece of concrete cracked out of the wall. The spillway and spillway discharge apron are bounded by 7 foot high vertical concrete training walls. These walls have been covered by a layer of gunite. The discharge apron appeared to be in structuraly sound condition, however, the concrete surface was rough and irregular due to surface deterioration and minor spalling of the concrete. The junction of the training walls and spillway surface appeared to be in good condition with no signs of undercutting. At the outfall of the spillway, the channel is riprapped and without signs of significant erosion or scouring.

c. Embankment - The horizontal and vertical alignment is good and no surface cracks were observed. The crest width varies from 0 to 13 feet. The crest actually forms a pinnacle at the areas of 0 feet crest width. The cause of the crest being formed this way was not apparent to the visual inspection team. A foot path winds along the embankment crest. Riprap extends about 2-1/2 feet above normal pool on the upstream slope. The riprap appeared to be in good condition, however, trees and brush growing on the embankment hindered thorough visual riprap inspection. The entire embankment is overgrown with a dense growth of trees and brush. At station 7+75, about halfway

up the downstream slope, a large tree has overturned and created a 4 foot diameter hole about 18 inches deep where the root system has been pulled out of the ground. Animal burrows were observed near Station 1+10 and 9+50. There was embankment erosion behind both training walls on the upstream slope and some erosion on the downstream slope behind the right training wall. There is an overly steep area on the embankment above the outlet conduit. No evidence of an internal drainage system was found during the inspection.

d. Outlet Works - The outlet works consist of a 4-foot by 4-foot square concrete conduit extending through the base of the embankment. The concrete at the outlet is spalled and rebar is exposed on the inside walls of the outlet conduit. Five foot long pieces of rebar are extending from the end of the concrete conduit, indicating that the last 5 foot section of concrete conduit has deteriorated. The conduit discharges into a stilling basin that is partially lined with riprap. There is some sediment within the outlet conduit near the outlet. This outlet is controlled by a gate valve that is operated from inside a valve house, located on the crest of the embankment. The valve house was locked during the visual inspection and the owner could not readily locate a key to unlock the door. Therefore, the owner should check the operability of the valve and repair it if necessary. The inlet for the outlet works was covered by water and, therefore, unobservable during the inspection.

There was some seepage (approximately 1 g.p.m.) entering the right side of the stilling basin. The flow appeared to be clear with no turbidity. However, iron color staining indicates long term, steady state seepage.

e. Downstream Channel - The downstream channel has a very low gradient, approximately 0.3 percent and the banks are heavily wooded 1/2 mile downstream of the dam. The channel then winds through farmland consisting of both wooded and cleared areas, before discharging into the Moodna Creek about 2 miles below the dam.

Cherry Hill Road crosses the channel 1600 feet downstream of the dam and Tuthill Road crosses the channel 1.5 miles below the dam. A home is located within 5 feet of the stream elevation, about 10 feet from the stream, and approximately 500 feet below Tuthill Road.

f. Reservoir - The slopes immediately adjacent to the reservoir are moderate and mostly wooded. There were no signs of slope instability, and sedimentation is not expected to be a significant problem. There were no reservoir monitoring instruments observed.

3.2 EVAULATION

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

1. Seepage was entering the right side of the stilling basin (approximately 1 g.p.m.).
2. The crest of the embankment varies in width from 0 to 13 feet.
3. The embankment above the outlet is overly steep.
4. The embankment is eroded behind both training walls on the upstream side.
5. The embankment is eroded behind the right training wall on the downstream side.
6. The right side of the spillway crest has settled 3 inches.
7. The concrete approach apron has settled and cracked, 25 feet from the left training wall.
8. An area of concrete 2 feet square has fallen out of the left upstream wing wall.
9. The discharge apron is rough and irregular due to surface deterioration.
10. The spillway crest is spalled.
11. The outlet conduit is spalled and deteriorated with rebar exposed on the downstream end.
12. The stilling basin below the outlet pipe is partially lined with riprap.
13. There is an uprooted tree on the downstream embankment slope at station 7+75.
14. Trees and brush are growing on the embankment.
15. There are several animal burrows in the embankment.

SECTION 4: OPERATION AND MAINTENANCE PROCEDURES

4.1 PROCEDURES

There are no formal operating procedures. The operation of the dam is normally an automatic function controlled by the crest of the weir in the service spillway at elevation 338.5 feet M.S.L.

4.2 MAINTENANCE OF THE DAM

Maintenance of the dam is the responsibility of David Plotkin. An inspection or maintenance schedule has not been instituted.

4.3 WARNING SYSTEM

There was no warning system or emergency action plan in operation at the time of inspection.

4.4 EVALUATION

Maintenance of the dam in the past has been inadequate. Regular inspections should be made of the dam and appurtenant structures. A thorough check list should be compiled for use by the owner or the owner's representative as a guide for the inspections. Maintenance items should be corrected annually. In addition, a formal warning system and emergency action plan should be developed and put into operation as soon as possible.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 DRAINAGE AREA CHARACTERISTICS

Delineation of the Tomahawk Lake Dam watershed was made using the Maybrook, Monroe, Warwick and Goshen, New York, USGS 7.5 minute quadrangles. The drainage basin consists of moderate to steep slopes, well covered by forests and ground vegetation, and some residential development. No significant storage facilities exist upstream of the reservoir. The total drainage area for the reservoir is 28.24 square miles.

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 15, Appendix D. 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 capacity at the minimum top of dam is 7495 cubic feet per second (c.f.s.). There is no auxiliary or emergency spillway at Tomahawk Lake Dam.

5.4 RESERVOIR CAPACITY

The storage capacity of Tomahawk Lake Dam at normal pool is 2199 acre-feet. The storage capacity at the minimum top of dam is 3359 acre-feet. Therefore, flood control storage of the reservoir between the spillway crest and top of dam is 1160 acre-feet. This volume represents a total of 0.77 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 7495 c.f.s. before overtopping would occur. The peak outflow of the PMF and 1/2 PMF is 23,346 c.f.s., and 11,570 c.f.s., respectively. This capacity results in the ability of the spillway to pass 32 percent of the PMF before the dam would be overtopped.

5.7 RESERVOIR EMPTYING POTENTIAL

The reservoir can be drawn down by means of a 4 foot by 4 foot square concrete conduit that extends through the base of the embankment. This outlet is controlled by a gate valve that is operated from inside the valve house, located on the crest of the dam. Neglecting inflow, the reservoir can be drawn down from normal pool in approximately 16 days. This is equivalent to an approximate drawdown rate of 1.1 feet per day, based on the hydraulic height measured from normal pool divided by the time to dewater the reservoir.

5.8 EVALUATION

Tomahawk Lake Dam is an "intermediate" size - "high" hazard dam requiring the spillway to pass a flood in the range of 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 32 percent of the PMF before overtopping the dam. Therefore, the spillway is judged to be "seriously 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 EMBANKMENT STABILITY

a. Visual Observations - No signs of instability were observed during the visual inspection. Minor problems relating to the stability of the structure include:

1. Variable width of the crest, ranging from 0 to 13 feet.

2. Erosion noticed behind spillway training walls.

3. Animal burrows and trees on the dam.

4. Seepage on right side of stilling basin.

b. Design and Construction Data - Design and construction information related to structural stability was not available.

c. Operating Records - According to the owner, the lake is lowered 3 or 4 feet a year to clean the shorelines. The dam crest is walked at least once a month.

d. Post Construction Changes - The spillway of the dam was repaired in 1956.

6.2 STABILITY ANALYSIS

The results of any previous stability analysis were unavailable for review during this investigation.

The dam is assumed to be generally homogeneous composed of CL or ML soils. The structure is 25.3 feet high with a crest width varying from 0 to 13 feet wide. The upstream embankment slopes at 1V:2.5H and the downstream embankment slopes at 1V:2.8H. The dam is subject to rapid drawdown (a reservoir level drop of more than 0.5 feet/day) in the event the 4 foot by 4 foot outlet is used for dewatering.

Because of the small height of the dam, moderate slopes, history of satisfactory performance of the slopes, and because no signs of instability or distress were noted in the field, no further stability analysis is deemed necessary.

6.3 SEISMIC STABILITY

Tomahawk Lake Dam is located in Seismic Zone 1 which presents no hazards 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.

SECTION 7: ASSESSMENT/RECOMMENDATIONS

7.1 ASSESSMENT

a. Safety - Examination of available documents and visual inspections of Tomahawk Lake Dam revealed no conditions which constitute an immediate hazard to human life or property.

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 32 percent of the PMF. The overtopping of the dam could result in dam failure, increasing the hazard to loss of life downstream. The spillway is, therefore, adjudged as "seriously inadequate" and the dam is assessed as unsafe, non-emergency.

The classification of "unsafe," applied to a dam because of a "seriously inadequate spillway," is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream of the dam.

b. Adequacy of Information - All evaluations and assessments in this report were based on field observations, conversations with the owner's representative, available engineering data and office analyses. The information collected is considered adequate for a Phase I Inspection.

c. Need for Additional Investigation - Detailed hydrologic and hydraulic investigations of the watershed and reservoir area are considered necessary to more accurately determine the overtopping potential of the dam and to determine appropriate mitigating measures in response to the spillway inadequacy.

d. Urgency - The detailed hydrologic and hydraulic investigations must be initiated within three months of notification to the owner. Within one

year, remedial measures as a result of 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. Also, around the clock surveillance must be provided during these periods. The problem areas listed below must be corrected within one year of notification.

7.2 RECOMMENDED MEASURES

The inspection and maintenance procedures presently being conducted by the owner's representative appear to be inadequate. 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

The seep at the right side of the stilling basin should be examined at regular intervals and after periods of heavy rain for turbidity and/or increase in flow, which may indicate the potential for piping of embankment material. If turbidity or increased flows are noted, a qualified geotechnical engineering firm should be retained to perform a stability check of the dam and plan remedial measures.

The following remedial measures must be completed within one year:

1. The crest of the embankment must be filled and graded to a crest width not less than 13 feet. A good grass cover should then be established on the crest.

2. The eroded areas behind the spillway training wall must be filled, compacted, and seeded.

3. The crack in the approach apron must be repaired.

4. The left upstream spillway wing wall must be repaired.

5. The outlet conduit must be repaired and rebuilt near the discharge end.

6. The outlet conduit stilling basin must be completely lined with riprap.

7. All trees and brush must be cut at ground level over the entire embankment. All trees with a trunk diameter greater than 3 inches should have their root systems removed. All resultant areas of erosion and cavities should be filled, graded, compacted and seeded.

8. The animal burrows in the embankment must be excavated, backfilled, compacted and seeded.

9. Install a staff gage to monitor reservoir levels.

10. After the brush and trees are cut, a qualified geotechnical firm should be retained to perform an additional visual inspection.

11. The operability of the outlet pipe valve should be checked and repairs, as necessary, performed to ensure future operation of the valve.

APPENDIX A

PHOTOGRAPHS

CONTENTS

Photo 1. View of Crest, Downstream Slope, and Valve House on Right Side of Spillway
9 March 1981

Photo 2. View of Upstream Slope on Right Side of Spillway
9 March 1981

Photo 3. View of Spillway From Right Training Wall
9 March 1981

Photo 4. View of Spillway Discharge Apron
9 March 1981

Photo 5. View of Damaged Left Spillway Approach
Training Wall
9 March 1981

Photo 6. Erosion Behind Right Spillway
Approach Training Wall
9 March 1981

Photo 7. View of Damaged Downstream Headwall
of Outlet Culvert
9 March 1981

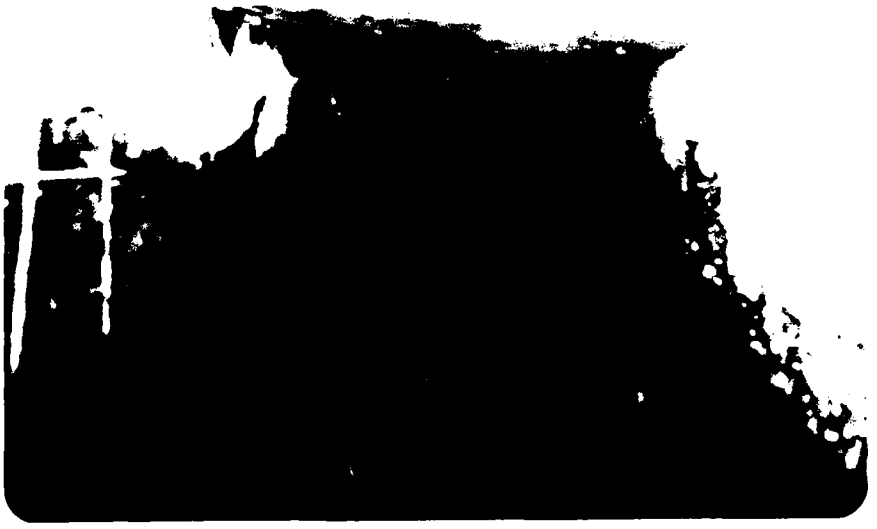


Photo 8. View Looking Upstream Inside of
Outlet Culvert
5 March 1981

APPENDIX B

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST

1) Basic Data

a. General

Name of Dam Tomahawk Lake

Fed. I.D. # NY 618 DEC Dam No. 195A-2507

River Basin Lower Hudson

Location: Town Washingtonville County Orange

Stream Name Cromline Creek

Tributary of Moodna Creek

Latitude (N) 41° 24.67' Longitude (W) 74°-13.1'

Type of Dam Earthfill embankment with concrete core wall.

Hazard Category High

Date(s) of Inspection 5 March 1981, 9 March 1981

Weather Conditions cloudy, snow flurries & 33°F

Reservoir Level at Time of Inspection 338.7 ft.

b. Inspection Personnel James G. Ulinski, Anthony P. Klimek, Steve M. Lockington

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

David Plotkin

401 South Water Street

Newburg, NY 12550

914/562-0860

d. History:

Date Constructed 1929 Date(s) Reconstructed Gunited in 1956

Designer Blake & Woodhall, Newburg, NY

Constructed By unknown

Owner David Plotkin

2) Embankment

a. Characteristics

(1) Embankment Material Earth embankment - CL to ML Soils

(2) Cutoff Type Core wall extends below embankment to firm material.

(3) Impervious Core Reported to be masonry core.

(4) Internal Drainage System None observed

(5) Miscellaneous ----------

b. Crest

(1) Vertical Alignment Satisfactory

(2) Horizontal Alignment Good

(3) Surface Cracks None observed at time of inspection.

(4) Miscellaneous Crest width varies from 0 to 13 ft. In some places the crest is in the form of a pinacle. A path winds along the embankment crest.

c. Upstream Slope

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

(2) Undesirable Growth or Debris, Animal Burrows Many trees and brush are growing on the upstream embankment.

(3) Sloughing, Subsidence, or Depressions There is minor erosion behind both training walls on the upstream side.

(4) Slope Protection Riprap protection extends about two feet above the normal pool.

(5) Surface Cracks or Movement at Toe Unobservable at time of inspection.

d. Downstream Slope

(1) Slope (Estimate - V:H) 1V : 2.8H

(2) Undesirable Growth or Debris, Animal Burrows Many trees and brush are on the enbankment. Animal burrows were observed 100 ft. from left abutment and 50 ft. left of the valve house.

(3) Sloughing, Subsidence or Depressions A large tree (approximately 10 in. in diameter) has overturned, creating a 4-ft. diameter hole 18 in. deep, halfway up the enbankment slope 225 feet left of the valve house.

(4) Surface Cracks or Movement at Toe None observed at time of inspection.

(5) Seepage None observed

(6) External Drainage System (Ditches, Trenches, Blanket) None observed

(7) Condition Around Outlet Structure There was minor erosion and an overly steep area above the outlet structure.

(8) Seepage Beyond Toe Approximately 1.0 gpm was entering the right side of the stilling basin of the outlet works. The flow appeared to be clear with no turbidity. However, iron color staining indicates long term, steady state seepage.

e. Abutments - Embankment Contact Appeared good at time of inspection. A large abandoned house (probably a former club house), and patio is located at the junction of the embankment and the right abutment.

(1) Erosion at Contact None observed at time of inspection.

(2) Seepage Along Contact None observed at time of inspection.

3) Drainage System

a. Description of System None

b. Condition of System None

c. Discharge from Drainage System None

4) Instrumentation (Monumentation/Surveys, Observation Wells, Weirs, Piezometers, Etc.)

None observed.

5) Reservoir

a. Slopes Moderate to steep slopes, wooded with a few scattered residences.

b. Sedimentation Sedimentation was not directly observed, however, it is not expected to be significant

c. Unusual Conditions Which Affect Dam None

6) Area Downstream of Dam

a. Downstream Hazard (No. of Homes, Highways, etc.) Cherry Hill Road crosses the channel 1600 ft. downstream from the dam, and Tut Hill Road crosses the channel 1.5 mi. below the dam. A home is located within 5 ft. of the stream elevation, about 10 ft. from the stream, approximately 500 ft. below Tut Hill Road.

b. Seepage, Unusual Growth None observed at time of inspection.

c. Evidence of Movement Beyond Toe of Dam None observed at time of inspection.

d. Condition of Downstream Channel Downstream channel wonders through both heavily wooded and cleared farm areas.

7) Spillway(s) (Including Discharge Conveyance Channel)

Spillway is located on embankment 280 feet from left abutment.

a. General Spillway is a trapezoidal weir, 150 ft. wide with a breadth of 3.2 ft. The spillway and spillway discharge apron are bound by 7-ft. high vertical concrete training walls. These training walls have been covered by a layer of gunite.

b. Condition of Service Spillway The upstream wing wall on the left side of the spillway has a two-ft. square chunk of concrete cracked out of the wall. There was erosion noted behind both spillway training walls. The training walls have been gunited and, except for the cracked chunk on the left wing wall, they appear to be in good condition. The right side of the crest near the training wall has settled slightly (about 3 in.). The crest has also been spalled at the left training wall and the upstream apron is cracked and has settled at a point 25 ft. from the left training wall.

c. Condition of Auxiliary Spillway None

d. Condition of Discharge Conveyance Channel The discharge apron appeared to be in structurally sound condition, however, the concrete surface was rough and irregular due to surface deterioration and minor spalling of the concrete.

8) Reservoir Drain/Outlet

Type: Pipe _____ Conduit X Other _____

Material: Concrete X Metal _____ Other _____

Size: 4 ft. x 4 ft. Length 125 ft.

Invert Elevations: Entrance 321.2 ft. (estimated)

Exit 319.2 ft.

Physical Condition (Describe): Unobservable

Material: The inside walls of the outlet were badly spalled with many exposed rebars. Rebar extended 5 ft. from the concrete of the outlet, indicating that the last section of outlet conduit has completely deteriorated.

Joints: Unobservable Alignment: Unobservable

Structural Integrity: The sidewalls at the outlet are badly spalled with exposed rebar. The structural integrity of the conduit, 15 ft. above the outlet, was unobservable.

Hydraulic Capability: There was some sediment at the outlet and, due to sidewall spalling, the channel was wider than the designed 4 ft. width. However, the control section of the conduit was assumed to be 4 ft. by 4 ft.

Means of Control: Gate X Valve _____ Uncontrolled _____

Operation: Operable X Inoperable _____ Other _____

Present Condition (Describe): According to the owner, the gate is operated every two or three years.

9) Structural - Not Applicable

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 The control for the outlet conduit is located inside a valve house. The valve house is a 10 ft. by 10 ft. stone building located on the crest of the dam above the outlet conduit. This building was locked at the time of inspection.

APPENDIX C

HYDROLOGIC/HYDRAULIC DATA AND COMPUTATIONS

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject TOMAHAWK LAKE DAM S.O. No.
APPENDIX C Sheet No. of
Drawing No.
Computed by APK Checked by Date

TABLE OF CONTENTS

CHECK LIST FOR DAMS
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

AREA-CAPACITY DATA:

		Elevation (ft.)	Surface Area (acres)	Storage Capacity (acre-ft.)
1)	Top of Dam	344.5	212	3,359
2)	Design High Water (Max. Design Pool)	Unknown	--	--
3)	Auxiliary Spillway Crest	--	--	--
4)	Pool Level with Flashboards	--	--	--
5)	Service Spillway Crest	338.5	174.5	2,199

DISCHARGES

		Volume (cfs)
1)	Average Daily	Unknown
2)	Spillway @ Maximum High Water - Top of Dam -	7,495
3)	Spillway @ Design High Water	Unknown
4)	Spillway @ Auxiliary Spillway Crest Elevation	N/A
5)	Low Level Outlet	361
6)	Total (of all facilities) @ Maximum High Water	7,856
7)	Maximum Known Flood	Unknown
8)	At Time of Inspection	45.6

* All elevations are referenced to the spillway crest, elevation 338.5 ft. M.S.L. This was the crest elevation stated on the original design plans.

CREST: ELEVATION: 344.5 ft.

Type: Earthfill embankment with concrete core wall

Width: 0 ft. to 13 ft. Length: 1,064 ft.

Spillover Trapezoidal weir

Location Spillway starts 280 ft. left of right abutment

SPILLWAY:

SERVICE		AUXILIARY
338.5	Elevation	None
Trapezoidal weir	Type	--
150	Width	--
	Type of Control	
X	Uncontrolled	--
	Controlled:	
--	Type (Flashboards; gate)	--
--	Number	--
--	Size/Length	--
	Invert Material	--
	Anticipated Length of Operating Service	--
58.7 ft.	Chute Length	--
0	Height Between Spillway Crest & Approach Channel Invert (Weir Flow)	--

HYDROMETEROLOGICAL GAGES:

Type: None

Location:

Records:

Date:

Max. Reading:

FLOOD WATER CONTROL SYSTEM:

Warning System: None

Method of Controlled Releases (mechanisms):

Gate valve on 4' X 4' square concrete conduit.

DRAINAGE AREA: 28.24 sq. mi.

DRAINAGE BASIN RUNOFF CHARACTERISTICS:

Land Use - Type: About 60% forested, 30% cleared, 10% residential

Terrain - Relief: Steep to 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 the time of inspection.

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

No problem areas observed. All slopes are well-vegetated.

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

None observed at time of inspection.

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

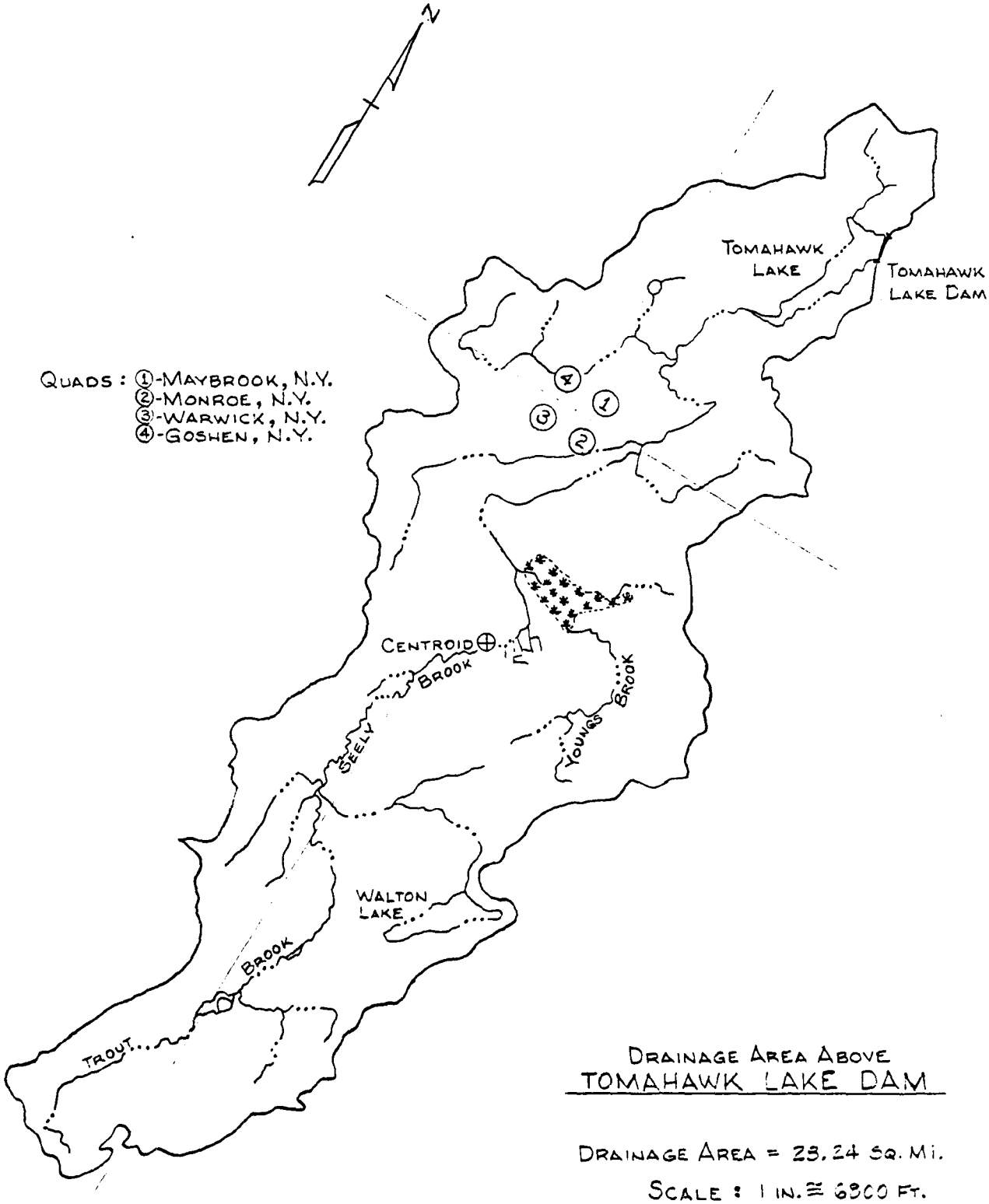
Location: None

Elevation:

Reservoir:

Length @ Maximum Pool 8,500 ft. (1.61 mi.)

Length of Shoreline (@ Spillway Crest) 22,800 ft. (4.32 mi.)



DRAINAGE AREA ABOVE
TOMAHAWK LAKE DAM

DRAINAGE AREA = 23.24 SQ. MI.

SCALE : 1 IN. ≅ 6800 FT.

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject NEW YORK DAMS — S.O. No.
TOMAHAWK LAKE DAM — Sheet No. 6 of 27
Drawing No.
Computed by WLS — Checked by — Date 1/15/81

HYDROLOGIC AND HYDRAULIC DATA

DRAINAGE AREA ABOVE DAM = 196.84 SQ. IN. (MEASURED ON MAYBROOK, MONROE, WARWICK AND GOSHEN, N.Y. QUADS) = 28.24 SQ. MI. = 18,075.3 AC.

L = 86,800 FEET = 16.44 mi

L_{CA} = 40,100 FEET = 7.59 mi

DRAINAGE AREA ABOVE WALTON LAKE DAM, WHICH IS IN THE TOMAHAWK LAKE WATERSHED = 6.15 SQ. IN (MEASURED ON MONROE, N.Y. QUAD) = 0.88 SQ. MI. = 564.7 AC.

SURFACE AREA VS. ELEVATION MEASUREMENTS (TAKEN FROM QUAD)

ELEVATION (FT.)	AREA (ACRES)
340±	174.5
360	329.7
380	574.8

$T_p = C_T (L \times L_{CA})^{.3}$ $\quad C_p = 0.63$

$= 2.0(16.44 \times 7.59)^{.3}$ $\quad C_T = 2.0$

$T_p = 8.51$

ADJUSTMENT TO T_p FOR INTERVAL

$T_{pR} = T_p + \frac{T_R - T_n}{4}$ $\quad T_n = \frac{T_p}{5.5} =$ 1.55 HR USE 1 HR

$= 8.51 + \frac{1.55 - 1.0}{4}$

$T_{pR} = 8.65$

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject NEW YORK DAMS — S.O. No.
TOMAHAWK LAKE DAM — Sheet No. 6 of 27
Drawing No.
Computed by WLS — Checked by — Date 1/15/81

HYDROLOGIC AND HYDRAULIC DATA

DRAINAGE AREA ABOVE DAM = 196.84 SQ. IN. (MEASURED ON MAYBROOK, MONROE, WARWICK AND GOSHEN, N.Y. QUADS) = 28.24 SQ. MI. = 18,075.3 AC. ✓

L = 86,800 FEET ✓ = 16.44 mi ✓

L_{CA} = 40,100 FEET ✓ = 7.59 mi ✓

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340±	174.5 ✓
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$= 8.51 + \frac{1.55 - 1.0}{4}$

$T_{pR} = 8.65$

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject NEW YORK DAMS — S.O. No.
TOMAHAWK LAKE DAM — Sheet No. 7 of 27
RAINFALL DATA — Drawing No.
Computed by WLS — Checked by JE — Date 1/15/81

RAINFALL DATA

FROM HMR-33 —

DAM AND DRAINAGE AREA ARE IN ZONE 1

PMP (24 HOURS) 200 mi² = 21.5 IN. ✓

DRAINAGE AREA = 28.24 SQ. MI. ✓

PMP 6 HR, 28.24 mi² = 99% PMP (24 HR) 200 mi² =
" 12 HR " = 112% " " " "
" 24 HR " = 122% " " " "
" 48 HR " = 131% " " " "

FROM TP-40 —

100 YR, 6 HOUR RAINFALL = 5.3 IN. ✓
" 12 HOUR " = 6.4 IN. ✓
" 24 HOUR " = 7.5 IN. ✓

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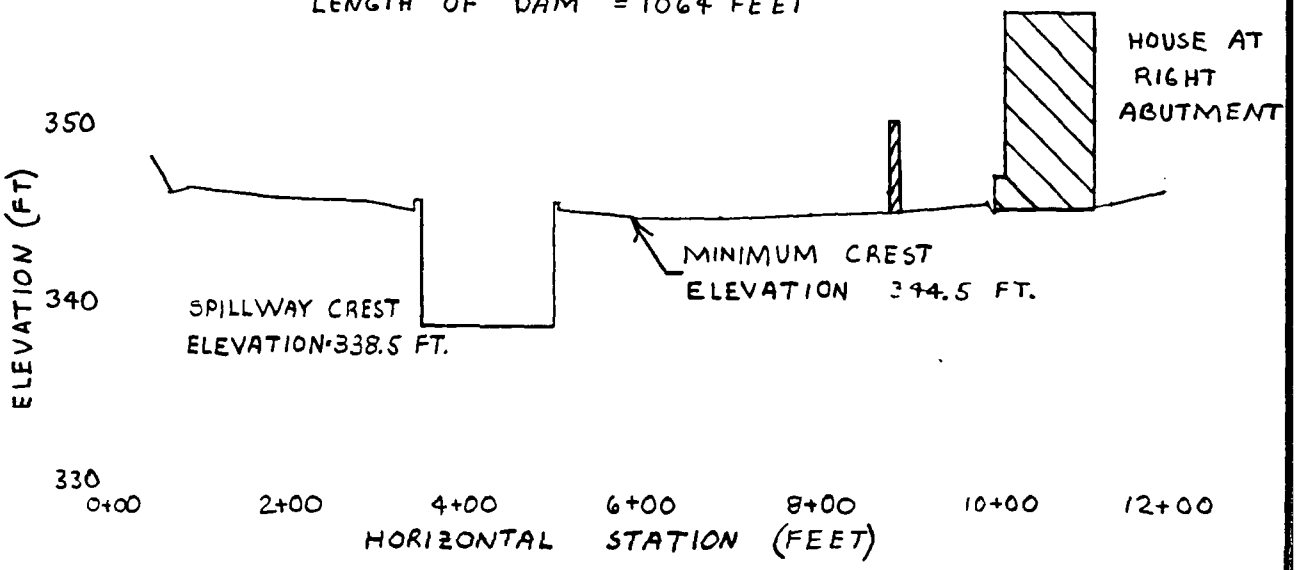
Beaver, Pa. 15009

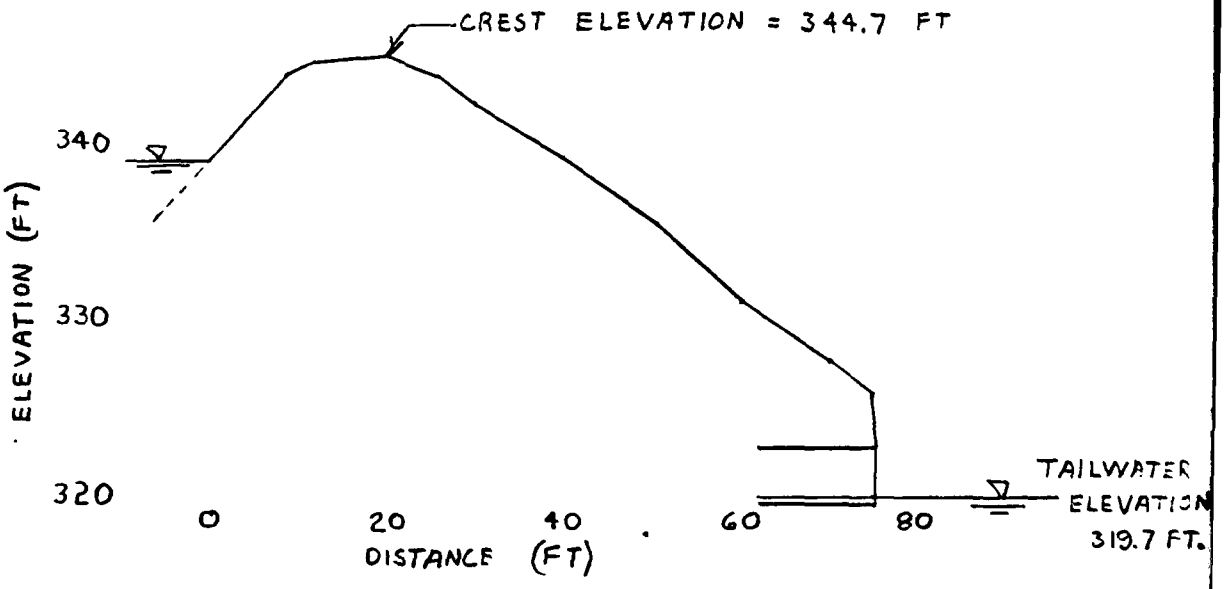
Subject TOMAHAWK LAKE DAM S.O. No.
Top of Dam Profile and Sheet No. 8 of 27
Typical Cross Section Drawing No.
Computed by APK Checked by [illegible] Date 3-11-81

TOP OF DAM PROFILE (LOOKING DOWNSTREAM)

LENGTH OF DAM = 1064 FEET



TYPICAL CROSS SECTION (AT STATION 9+00)



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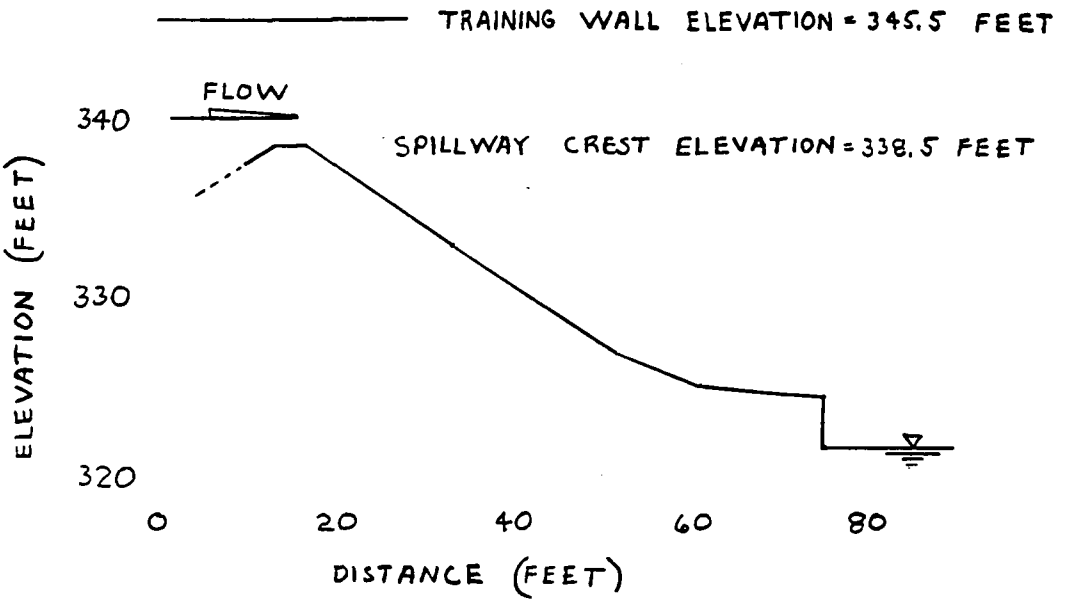
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject TOMAHAWK LAKE DAM S.O. No.
SPILLWAY PROFILE Sheet No. 9 of 27
Drawing No.
Computed by APK Checked by ## Date 3-11-61

SPILLWAY PROFILE



SPILLWAY IS A BROAD-CRESTED WEIR 32 FEET WIDE.

MICHAEL BAKER, JR., INC.
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Box 280
Beaver, Pa. 15009

Subject TOMAHAWK LAKE DAM S.O. No.
WEIR FLOW THROUGH SPILLWAY Sheet No. 10 of 27
Drawing No.
Computed by APK Checked by Date 3-11-81

WEIR FLOW

$Q = C L H^{3/2}$

$Q = C(150) H^{3/2}$

L = 150 feet

H varies from 0 to 10 feet and is measured from the crest of the broad crested weir

C varies WITH H FR COMPARISON OF TABLES 5-3 AND 5-9, KIN AND BRATER

ELEVATION (FT)	H (FT)	C	Q (cfs)
338.5	0	—	0
339.5	1.0	2.7	405.0
340.5	2.0	2.9	1230.4
341.5	3.0	3.1	2416.2
342.5	4.0	3.4	4080.0
343.5	5.0	3.4	5702.0
344.5	6.0	3.4	7495.4
345.5	7.0	3.4	9,445.3
346.5	8.0	3.4	11,540.0
347.5	9.0	3.4	13,770.0
348.5	10.0	3.4	16,127.6
349.5	11.0	3.4	18,606.3

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject TOMAHAWK LAKE DAM S.O. No.
OUTLET CONDUIT RATING Sheet No. 11 of 27
Drawing No.
Computed by APK Checked by [illegible] Date 3-12-81

ORIFICE FLOW

$Q = CA(2gH)^{0.5}$

$Q = (0.61)(16)(64.4H)^{0.5}$

$Q = 78.3\ H^{0.5}$

$A = h \times w = 4' \times 4' = 16 ft^2$

$g = 32.2$ ft/sec

$c = 0.61$ King and Brater Handbook Table 4-6, Pg 4-32

H varies from 2.3 ft to 21.3ft and is measured from the center of the conduit at the inlet This centerline was estimated to be at Elevation 323.2 ft

Elevation (Ft)	H (Ft)	Q (cfs)
325.5	2.3	119.0
327.5	4.3	162.4
329.5	6.3	196.6
331.5	8.3	225.6
333.5	10.3	251.4
335.5	12.3	274.7
337.5	14.3	296.2
339.5	16.3	316.2
341.5	18.3	335.1
343.0	19.8	348.5
344.5	21.3	361.5

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THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject TOMAHAWK LAKE DAM S.O. No.
OUTLET CONDUIT RATING Sheet No. 12 of 27
Drawing No.
Computed by APK Checked by JE Date 3-12-81

PIPE FLOW

$$Q = \frac{A(2gH)^{1/2}}{[1 + k_c + k_b + k_c(L)]^{1/2}}$$

$$Q = \frac{16(64.4\,H)^{1/2}}{[1 + 0.78 + 0 + (0.00746)(125)]^{1/2}}$$

$$Q = 78.0\,H^{1/2}$$

ELEVATION (Ft)	H (Ft)	Q (cfs)
325.5	2.8	131.0
327.5	4.8	171.0
329.5	6.8	203.3
331.5	8.8	231.3
333.5	10.8	256.2
335.5	12.8	278.9
337.5	14.8	299.9
339.5	16.8	319.5
341.5	18.8	338.0
343.0	20.3	351.3
344.5	21.8	364.0

$A = h \times w = 4' \times 4' = 16\ ft^2$

$g = 32.2\ ft/sec^2$

$L = 125\ ft$

H varies from 2.8 ft. to 21.8 ft. and is measured from the top of the conduit at the outlet. This was at Elevation 322.7 ft.

$K_c(K_o) = 0.78$ pg 5.5-6 SCS NEH-5

$K_b(K_s) = 0$ pg. 5.5-10 SCS NEH-5

$K_c(K_p) = 0.00746$ pg 5.5-4 SCS NEH-5

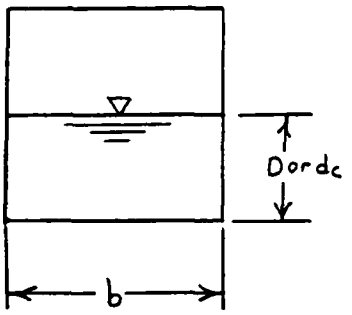
$n = 0.016$

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject TOMAHAWK LAKE DAM S.O. No.
4' x 4' Square Concrete Conduit Sheet No. 13 of 27
Rating Drawing No.
Computed by APK Checked by JE Date 3-12-81

"DESIGN OF SMALL DAMS" Page 553 and 555



CRITICAL FLOW

$$Q_c = d_c^{3/2}\sqrt{\frac{g(b+zd_c)^3}{b+2zd_c}}$$

d_c = critical depth

b = bottom width = 4

z = side slope ratio $\frac{\text{Horizontal}}{\text{Vertical}}$ = 0

g = 32.2

$$Q_c = d_c^{3/2}\sqrt{\frac{32.2(4)^3}{4}}$$

$$Q_c = d_c^{3/2}(22.7)$$

$d_c = 1$	$Q_c = 22.7$ cfs ✓	D=1	Q = 28.8 cfs
$d_c = 2$	$Q_c = 64.2$ cfs ✓	D=2	Q = 105 cfs
$d_c = 3$	$Q_c = 118$ cfs ✓	D=3	Q = 207 cfs

CHEZY'S FORMULA

$$Q = \frac{1.486}{n} a r^{2/3} s^{1/2}$$

a = cross sectional area

n = roughness coefficient = 0.016

r = hydraulic radius = $\frac{\text{area (a)}}{\text{wetted perimeter (p)}}$

s = slope = 0.02

$$Q = \frac{1.486}{0.016} a r^{3/2} 0.02^{1/2}$$

$$Q = 13.1 a r^{3/2}$$

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

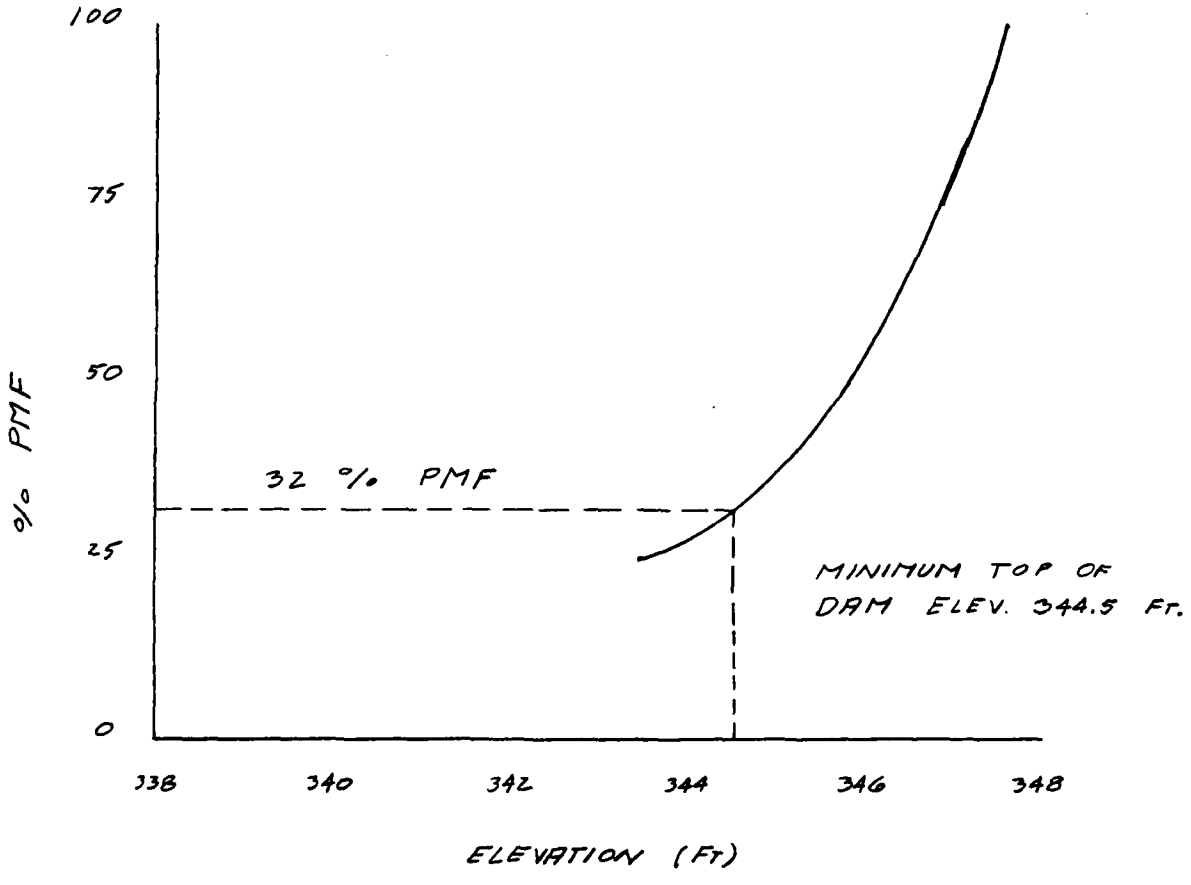
Subject TOMAHAWK LAKE DAM S.O. No.
SUMMARY RATING Sheet No. 14 of 27
4'x4' OUTLET PIPE Drawing No.
Computed by GWT Checked by [illegible] Date 5/26/81

ELEVATION (FT)	Q (C.F.S.)
321.2	0
322.2	22.7
323.2	64.2
324.2	118.0
325.5	119.0
327.5	162.4
329.5	196.6
331.5	225.6
333.5	251.4
335.5	274.7
337.5	296.2
339.5	316.2
341.5	335.1
343.0	348.5
344.5	361.5

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject TOMAHAWK LAKE DAM S.O. No.
SPILLWAY CAPACITY ANALYSIS Sheet No. 15 of 27
Drawing No.
Computed by GWT Checked by WDL Date 5-27-81



```
**************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  26 FEB 79
  MAJ UPDATE         04 JUN 79
**************************************
    1        A1   NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
    2        A2   HYDROLOGIC AND HYDRAULIC ANALYSIS OF TOMAHAWK LAKE DAM
    3        A3   UNIT HYDROGRAPH BY SNYDERS METHOD
    4        B    300      0     60      0      0      0      0      0     -4      0
    5        B1     5
    6        J      1      4      1
    7        J1   1.0   0.75    0.5   0.25
    8        K      0      1                                   1
    9        K1     RUNOFF HYDROGRAPH TO DAM
   10        M      1      1  26.24
   11        P          21.5     95    112    122    131
   12        T                                                1.0   0.10
   13        W   5.65   0.63
   14        X   -1.5  -0.05    2.0
   15        K      1      2                                   1
   16        K1     ROUTING FOR TOMAHAWK LAKE DAM
   17        Y                          1      1
   18        Y1     1                                      -338.5     -1
   19        Y4 338.5  339.5  340.5  341.5  342.5  343.5  344.5  345.5  346.5  347.5
   20        Y4 348.5  349.5
   21        Y5     0  405.0 1230.4 2416.2 4026.0 5702.0 7455.4 9345.3 11540.0 13770.0
   22        Y5 16128 18606.3
   23        $A  85.0  174.5  329.1  574.8
   24        $E 321.2  338.5  360.0  380.0
   25        $$ 338.5
   26        $D 344.5    2.6    1.5
   27        $L     0    375    600    930   1130
   28        $V 344.5  345.0  346.0  347.0  348.0
   29        K     99
```

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1973
  LAST MODIFICATION  26 FEB 79
  ADJ UPDATE         14 JUN 79
**********************************

RUN  DATE 55/26/11
     TIME    17.11
```

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSIS OF TOMAHAWK LAKE DAM
UNIT HYDROGRAPH BY SNYDERS METHOD

JOB SPECIFICATION

NS	NSR	NMIN	IDAY	ITR	IHR	METRC	IPLT	IPRT	NSTAN
300	0	60	0	0	0	0	0	-4	0

JOPER	NAT	IKOPT	TRACE
5	0	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1

RTIOS= 1.00 0.75 0.50 0.25

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF HYDROGRAPH TO DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	28.24	0.0	28.24	0.0	0.0	0	0	0

PRECIP DATA

SPFE	P48	P6	P12	P24	P48	P72	P96
0.0	21.50	59.00	112.00	122.00	131.00	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.83

LOSS DATA

LKOPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMA	RTIMP
3	0.0	0.0	1.00	0.0	0.0	1.00	1.00	0.10	0.0	0.0

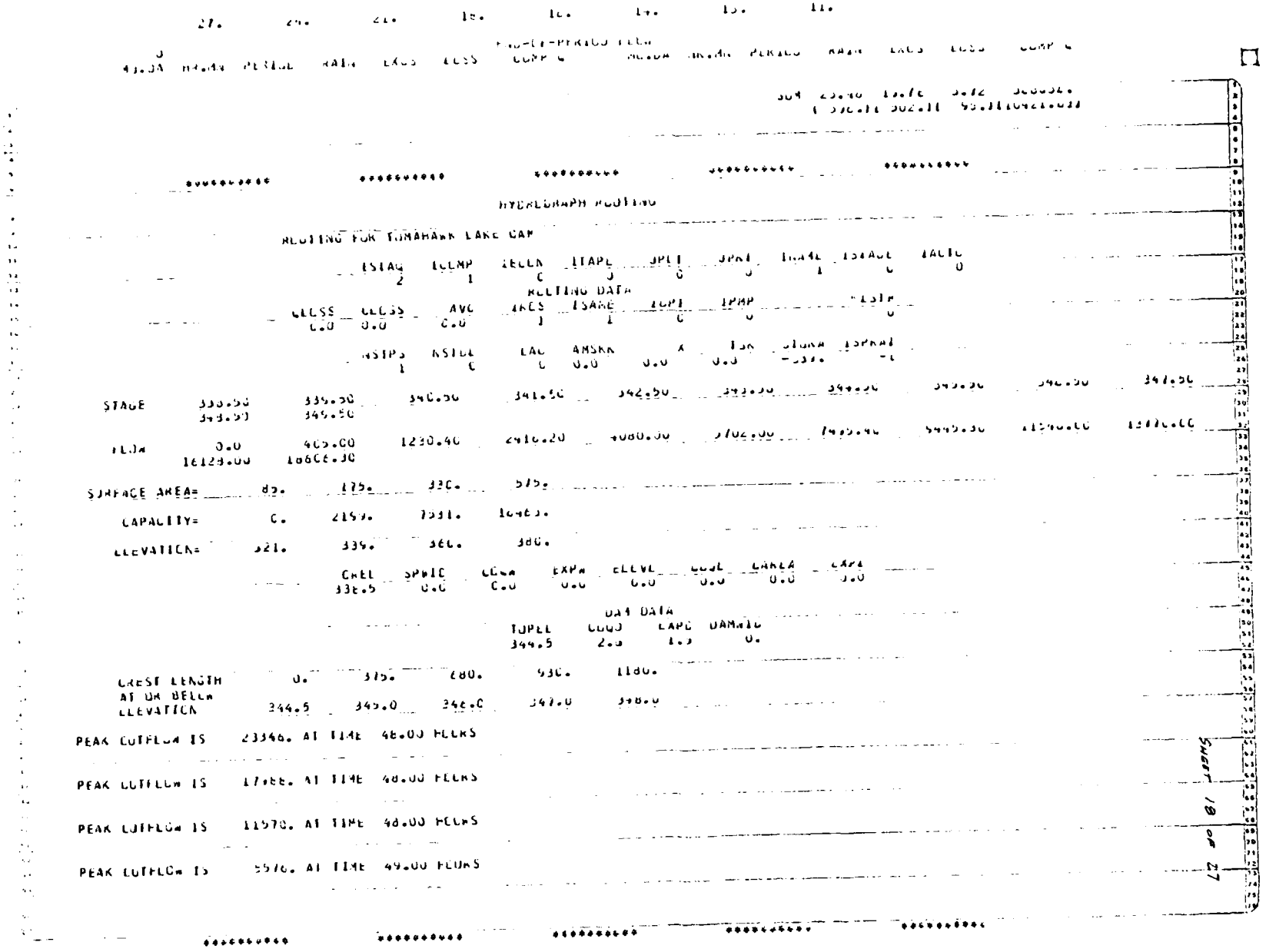
UNIT HYDROGRAPH DATA
TP= 8.05 CP=0.63 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH 48 END-OF-PERIOD ORDINATES, LAG= 8.59 HOURS, CP= 0.63 VOL= 1.00

50.	167.	370.	591.	822.	1039.	1207.	1312.	1332.	1267.
1134.	1043.	918.	810.	714.	629.	555.	489.	431.	380.
335.	295.	260.	229.	202.	178.	157.	138.	122.	107.
95.	83.	73.	65.	57.	50.	44.	39.	34.	30.

Sheet 17 of 27



27. 24. 21. 18. 16. 14. 13. 11.

PEAK-PERIOD FLOW

HYDROGRAPH ROUTING

ROUTING FOR TOMAHAWK LAKE DAM

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

CLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	*TSTM
0.0	0.0	0.0	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.0	0.0	0.0	-999.	-1

STAGE	338.50	339.50	340.50	341.50	342.50	343.50	344.50	345.50	346.50	347.50
	348.50	349.50								
FLOW	0.0	405.00	1230.40	2410.20	4080.00	5702.00	7495.40	9449.30	11560.00	13820.00
	16128.00	18626.30								
SURFACE AREA=	82.	175.	330.	575.						
CAPACITY=	0.	2157.	7331.	16463.						
ELEVATION=	321.	336.	366.	380.						

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPA
338.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
344.5	2.8	1.5	0.

CREST LENGTH	0.	375.	680.	930.	1180.
AT OR BELOW ELEVATION	344.5	345.0	346.0	347.0	348.0

PEAK OUTFLOW IS 23346. AT TIME 48.00 HOURS

PEAK OUTFLOW IS 17688. AT TIME 48.00 HOURS

PEAK OUTFLOW IS 11570. AT TIME 48.00 HOURS

PEAK OUTFLOW IS 5576. AT TIME 49.00 HOURS

Sheet 18 of 27

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

OPERATION	STATION	AREA	PLAN	RATIO 1 1.00	RATIO 2 0.75	RATIOS APPLIED TO FLOWS RATIO 3 0.50	RATIO 4 0.25
HYDROGRAPH AT	1	28.24	1	23332.	17499.	11666.	5833.
	(	73.14)	(	660.69)	(495.52)	(330.35)	(165.17)
ROUTED TO	2	28.24	1	23346.	17488.	11657.	5826.
	(	73.14)	(	661.05)	(495.20)	(330.07)	(165.01)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	338.50	338.50	349.50
STORAGE	2155.	2155.	5355.
OUTFLOW	0.	0.	49550.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	347.59	3.09	4330.	25340.	17.00	48.00	0.0
0.75	346.85	2.35	3877.	17436.	14.00	48.00	0.0
0.50	345.81	1.31	3264.	11573.	10.00	48.00	0.0
0.25	343.42	0.0	3134.	5570.	0.0	49.00	0.0

DEWATERING ANALYSIS


```
********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  26 FEB 79
   LAST UPDATE       04 JUL 79
********************************
A1        NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
A2        HYDROLOGIC AND HYDRAULIC ANALYSIS OF TOMAHAWK LAKE DAM
A3        UNIT HYDROGRAPH BY SNYDERS METHOD
B     100       0       0       0       0       0       0       0       0       0
B1      5
J       1       1       1
J1    1.0
K       0       1                                                       1
K1        INFLOW RUNOFF HYDROGRAPH TO DAM
M      -1          28.24               28.24
N
N
N
N
N
N
N
N
N
N
K       1       2                                   1
K1        DEWATERING TOMAHAWK LAKE DAM
Y                                   1       1
Y1      1                                           -338.5      -1
Y4  321.2   322.2   323.2   324.2   325.5   327.5   329.5   331.5   333.5   335.5
Y5  337.5   339.5
Y5      0    22.7    64.2     119     119     162     197     226     251     275
Y5    276     306
$A   85.0   174.0   329.7   574.8
$E  321.2   338.5   360.0   380.0
$$  336.0
$D  344.0     2.0     1.5
K      99
```

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
[illegible] UPDATE 16 JUL 79

RUN DATE [illegible]
TIME [illegible]

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSIS OF TOMAHAWK LAKE DAM
UNIT HYDROGRAPH BY SNYDERS METHOD

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	0	0	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

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

RTIOS= 1.00

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH TO DAM 1

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
-1	0	28.24	0.0	28.24	0.0	0.0	0	0	0

INPUT HYDROGRAPH

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	0.	0.	0.	0.	0.
CMS	0.	0.	0.	0.	0.
INCHES		0.0	0.0	0.0	0.0
MM		0.0	0.0	0.0	0.0
AC-FT		0.	0.	0.	0.
THOUS CU M		0.	0.	0.	0.

SHEET 22 OF 27

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	0.	0.	0.	0.	0.
CMS	0.	0.	0.	0.	0.
INCHES		0.0	0.0	0.0	0.0
MM		0.0	0.0	0.0	0.0
AC-FT		0.	0.	0.	0.
THOUS CU M		0.	0.	0.	0.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

DIVERTING TOWNSHIP LAKE DAM

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

IRES	ISAME	IOPT	IPMP	LSTR
1	1	3	0	3

AMSKK	X	TSK	STORA	ISPRAT
0.0	0.0	0.0	-337.	-1

STOR	321.00	323.00	324.00	325.00	327.00	329.00	331.00	333.00	335.00
	337.00	338.00							
ELEV	0.0	22.00	64.00	118.00	119.00	162.00	197.00	220.00	251.00	275.00
	275.00	306.00							
SURFACE AREA=	0.	172.	330.	575.					
CAPACITY=	0.	2199.	7531.	16463.					
ELEVATION=	321.	339.	360.	380.					

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
338.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
344.0	2.6	1.5	0.

STATION 2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

AREA	HR+MN	PERIOD	HOURS	INFLOW	OUTFLOW	STORAGE	STAGE
1.91	0:00	1	0.00	0.	0.	0.	321.0

SHEET 24 OF 27

1.01	[illegible]	3	18.00	0.	277.	1763.	335.7
1.02	0.0	4	24.00	0.	[illegible]	1527.	335.0
1.02	6.00	5	30.00	0.	259.	1476.	334.2
1.02	12.00	6	36.00	0.	244.	1371.	333.3
1.02	18.00	7	42.00	0.	236.	1250.	332.4
1.03	0.0	8	48.00	0.	227.	1135.	331.6
1.03	6.00	9	54.00	0.	216.	1025.	330.8
1.03	12.00	10	60.00	0.	204.	921.	330.0
1.03	18.00	11	66.00	0.	191.	823.	329.2
1.04	0.0	12	72.00	0.	176.	731.	328.4
1.04	6.00	13	78.00	0.	165.	645.	327.7
1.04	12.00	14	84.00	0.	151.	568.	327.0
1.04	18.00	15	90.00	0.	137.	496.	326.3
1.05	0.0	16	96.00	0.	124.	431.	325.7
1.05	6.00	17	102.00	0.	117.	371.	325.2
1.05	12.00	18	108.00	0.	110.	312.	324.6
1.05	18.00	19	114.00	0.	108.	256.	324.0
1.06	0.0	20	120.00	0.	82.	233.	323.5
1.06	6.00	21	126.00	0.	62.	174.	323.1
1.06	12.00	22	132.00	0.	50.	146.	322.8
1.06	18.00	23	138.00	0.	40.	124.	322.6
1.07	0.0	24	144.00	0.	32.	106.	322.4
1.07	6.00	25	150.00	0.	25.	92.	322.3
1.07	12.00	26	156.00	0.	21.	81.	322.1
1.07	18.00	27	162.00	0.	19.	71.	322.0
1.08	0.0	28	168.00	0.	16.	62.	321.9
1.08	6.00	29	174.00	0.	14.	55.	321.8
1.08	12.00	30	180.00	0.	13.	48.	321.8
1.08	18.00	31	186.00	0.	11.	42.	321.7
1.09	0.0	32	192.00	0.	10.	37.	321.6
1.09	6.00	33	198.00	0.	9.	32.	321.6
1.09	12.00	34	204.00	0.	8.	28.	321.5
1.09	18.00	35	210.00	0.	7.	25.	321.5
1.10	0.0	36	216.00	0.	6.	22.	321.5
1.10	6.00	37	222.00	0.	5.	19.	321.4
1.10	12.00	38	228.00	0.	4.	17.	321.4
1.10	18.00	39	234.00	0.	4.	15.	321.4
1.11	0.0	40	240.00	0.	3.	13.	321.4
1.11	6.00	41	246.00	0.	3.	11.	321.3
1.11	12.00	42	252.00	0.	3.	10.	321.3
1.11	18.00	43	258.00	0.	2.	9.	321.3
1.12	0.0	44	264.00	0.	2.	8.	321.3
1.12	6.00	45	270.00	0.	2.	7.	321.3
1.12	12.00	46	276.00	0.	2.	6.	321.3
1.12	18.00	47	282.00	0.	1.	5.	321.3
1.13	0.0	48	288.00	0.	1.	4.	321.3
1.13	6.00	49	294.00	0.	1.	4.	321.2
1.13	12.00	50	300.00	0.	1.	3.	321.2
1.13	18.00	51	306.00	0.	1.	3.	321.2
1.14	0.0	52	312.00	0.	1.	3.	321.2
1.14	6.00	53	318.00	0.	1.	2.	321.2
1.14	12.00	54	324.00	0.	1.	2.	321.2
1.14	18.00	55	330.00	0.	0.	2.	321.2
1.15	0.0	56	336.00	0.	0.	1.	321.2
1.15	6.00	57	342.00	0.	0.	1.	321.2
1.15	12.00	58	348.00	0.	0.	1.	321.2
1.15	18.00	59	354.00	0.	0.	1.	321.2
1.16	0.0	60	360.00	0.	0.	1.	321.2
1.16	6.00	61	366.00	0.	0.	1.	321.2
1.16	12.00	62	372.00	0.	0.	1.	321.2
1.16	18.00	63	378.00	0.	0.	1.	321.2
1.17	0.0	64	384.00	0.	0.	0.	321.2
1.17	6.00	65	390.00	0.	0.	0.	321.2
1.17	12.00	66	396.00	0.	0.	0.	321.2
1.17	18.00	67	402.00	0.	0.	0.	321.2

1.18	0.0	68	0.	0.	0.	321.2
1.18	6.00	69	0.	0.	0.	321.2
1.18	12.00	70	0.	0.	0.	321.2
1.18	18.00	71	0.	0.	0.	321.2
1.19	0.0	72	0.	0.	0.	321.2
1.19	6.00	73	0.	0.	0.	321.2
1.19	12.00	74	0.	0.	0.	321.2
1.19	18.00	75	0.	0.	0.	321.2
1.20	0.0	76	0.	0.	0.	321.2
1.20	6.00	77	0.	0.	0.	321.2
1.20	12.00	78	0.	0.	0.	321.2
1.20	18.00	79	0.	0.	0.	321.2
1.21	0.0	80	0.	0.	0.	321.2
1.21	6.00	81	0.	0.	0.	321.2
1.21	12.00	82	0.	0.	0.	321.2
1.21	18.00	83	0.	0.	0.	321.2
1.22	0.0	84	0.	0.	0.	321.2
1.22	6.00	85	0.	0.	0.	321.2
1.22	12.00	86	0.	0.	0.	321.2
1.22	18.00	87	0.	0.	0.	321.2
1.23	0.0	88	0.	0.	0.	321.2
1.23	6.00	89	0.	0.	0.	321.2
1.23	12.00	90	0.	0.	0.	321.2
1.23	18.00	91	0.	0.	0.	321.2
1.24	0.0	92	0.	0.	0.	321.2
1.24	6.00	93	0.	0.	0.	321.2
1.24	12.00	94	0.	0.	0.	321.2
1.24	18.00	95	0.	0.	0.	321.2
1.25	0.0	96	0.	0.	0.	321.2
1.25	6.00	97	0.	0.	0.	321.2
1.25	12.00	98	0.	0.	0.	321.2
1.25	18.00	99	0.	0.	0.	321.2
1.26	0.0	100	0.	0.	0.	321.2

PEAK OUTFLOW IS 306. AT TIME 0.0 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	297.	233.	279.	236.	+131.
CMS	8.	6.	8.	7.	117.
INCHES		0.10	0.37	1.93	1.36
CM		2.49	9.33	49.07	34.56
AC-FT		145.	555.	1493.	2348.
THOUS CU M		179.	682.	1733.	2527.

********** ********** ********** ********** **********

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

OPERATION	STATION	AREA	PLAN	RATIO 1
				1.00
HYDROGRAPH AT	1	28.2+	1	0.
		(73.14)		(0.0)(
ROUTED TO	2	28.2+	1	297.
		(73.14)		(8.42)(

SHEET 26 OF 27

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	336.50	336.50	349.00
STORAGE	2199.	2199.	3359.
OUTFLOW	350.	350.	350.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	337.63	0.0	2199.	350.	0.0	0.0	0.0

APPENDIX D

REFERENCES

REFERENCES

1. University of the State of New York, Geology of New York, Education Leaflet 20, 1966.

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3. Dunbar, Carl O. and Waage, Karl M., Historical Geology, John Wiley and Sons, Inc., New York, 1969.

4. Soil Conservation Service, Soil Interpretations Report for Orange County, Orange County, New York, U.S. Department of Agriculture, January 1972.

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6. Chow, Ven Te, Handbook of Applied Hydrology, McGraw - Hill Book Company, New York, 1964.

7. Chow, Ven Te, Open Channel Hydraulics, McGraw - Hill Book Company, New York, First Edition, 1959.

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).

9. King, Horace Williams and Brater, Ernest F., Handbook of Hydraulics, Fifth Edition, McGraw - Hill Book Company, New York, 1963.

10. Soil Conservation Service, "National Engineering Handbook - Section 4, Hydrology," U.S. Department of Agriculture, 1964.

11. Soil Conservation Service, "National Engineering Handbook - Section 5, Hydraulics," U.S. Department of Agriculture.

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13. U.S. Army, "Inventory of United States Dams," Corps of Engineers, 9 September 1978.

14. U.S. Army, Office of the Chief of Engineers, "Appendix D, Recommended Guidelines for Safety Inspection of Dams," National Program of Inspection of Dams, Volume 1, Corps of Engineers, Washington, D.C., May 1975.

15. George, Thomas S. and Taylor, Robert S., Hydrologic Flood Routing Model For Lower Hudson River Basin, Water Resources Engineers, Inc., 8001 Forbes Place, Suite 312, Springfield, Virginia, January 1977.

16. U.S. Army, Office of the Chief of Engineers, Engineering Circular EC-1110-2-163 (Draft Engineering Manual), "Spillway and Freeboard Requirements for Dams, Appendix C, Hydrometeorological Criteria and Hyetograph Estimates," (August 1975).

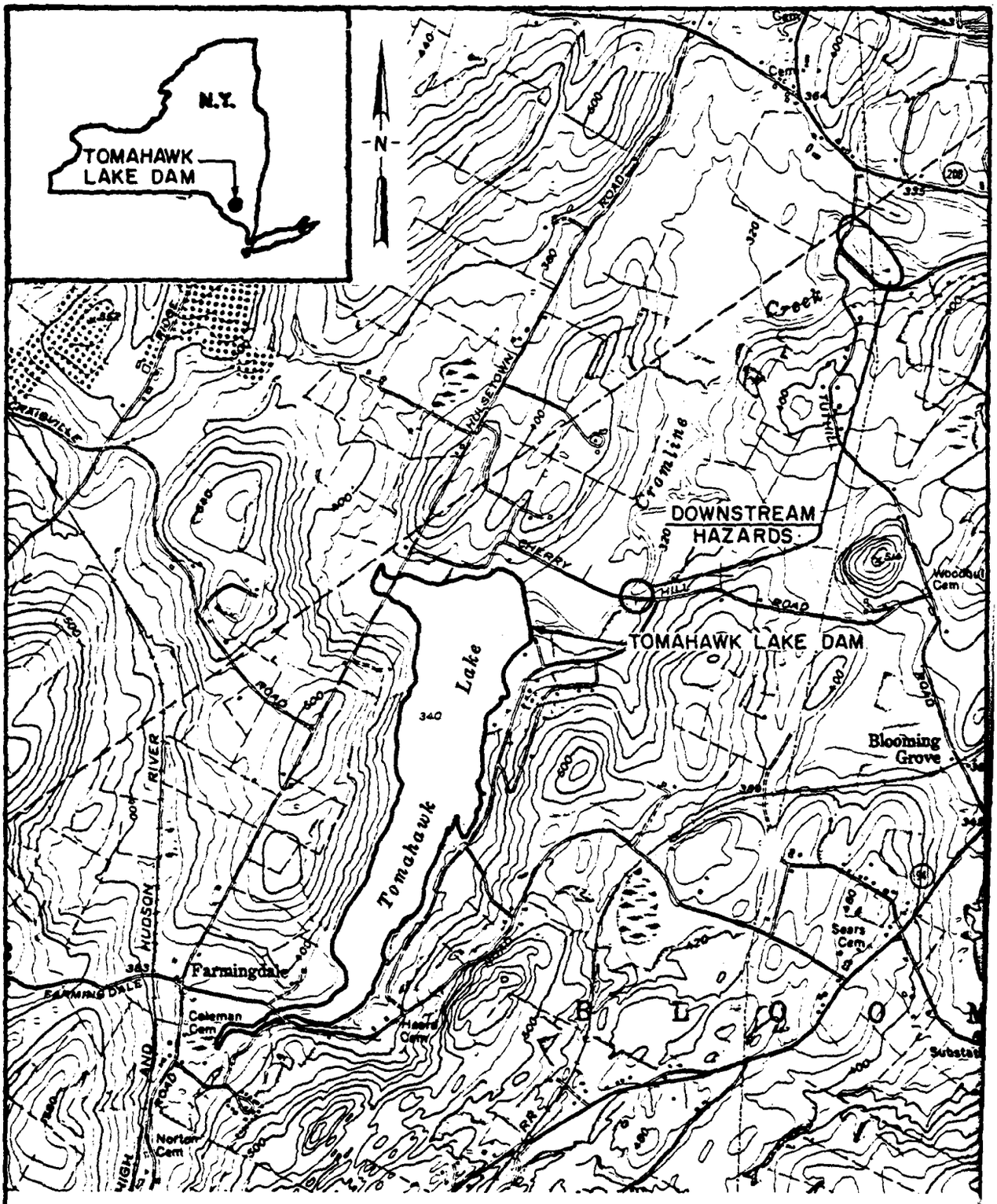
17. U.S. Army, Office of the Chief of Engineers, Engineering Circular EC-1110-2-188, "Engineering and Design, National Program of Inspection of Non-Federal Dams," Corps of Engineers, Washington, D.C., 30 December 1977.

18. U.S. Army, Office of the Chief of Engineers, Engineer Technical Letter No. ETL 1110-2-234, "Engineering and Design, National Program of Inspection of Non-Federal Dams, Review of Spillway Adequacy," Corps of Engineers, Washington, D.C., 10 May 1978.

APPENDIX E

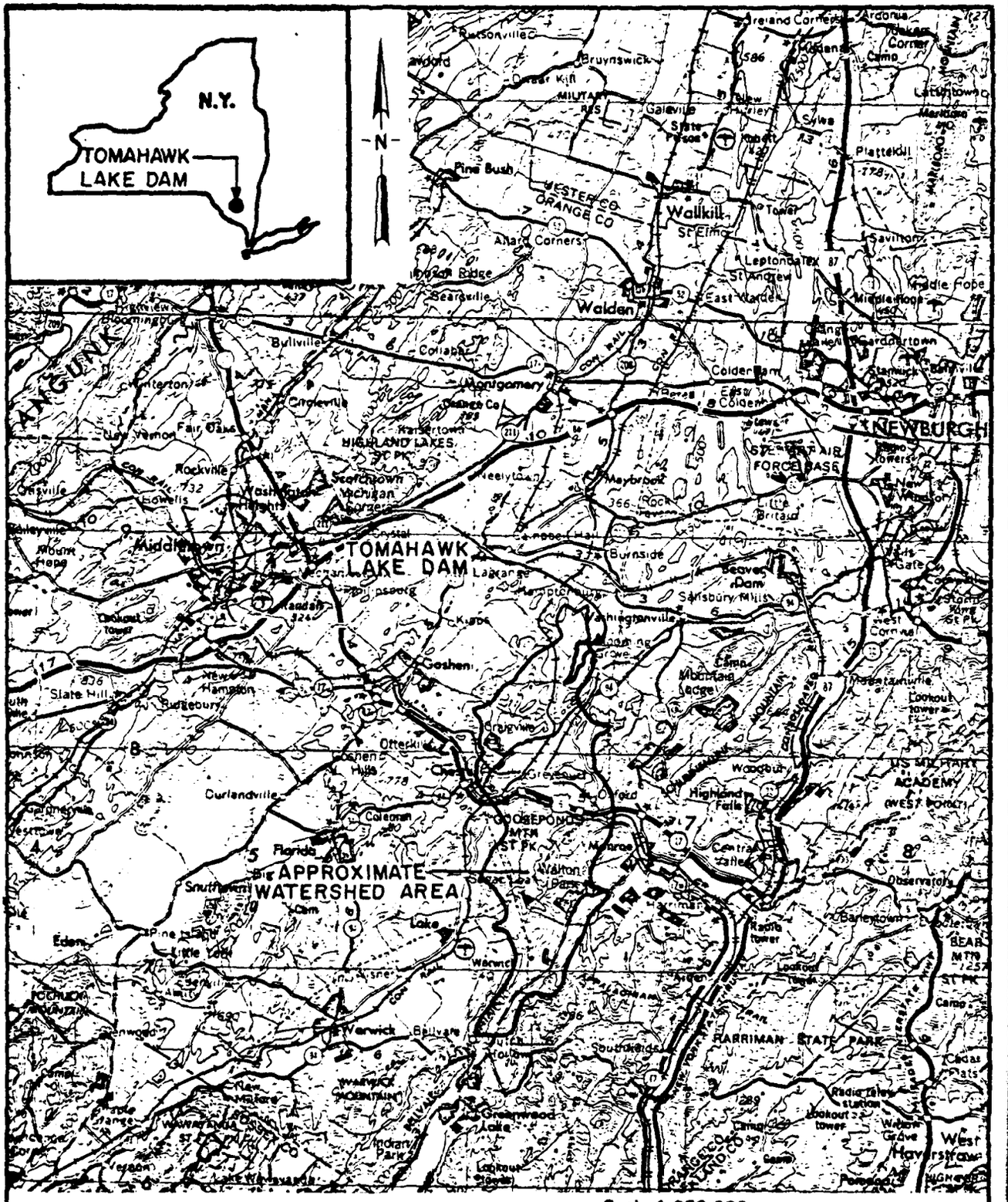
DRAWINGS

CONTENTS



REFERENCES:
1. U.S.G.S. 7.5' MAYBROOK, N.Y. QUADRANGLE, 1957

LOCATION PLAN
TOMAHAWK LAKE DAM



WATERSHED MAP

TOMAHAWK LAKE DAM

REFERENCES:

1. U.S.G.S. 1:250,000 SCRANTON, PA.-N.Y.-N.J. QUADRANGLE, PHOTOREVISED 1976

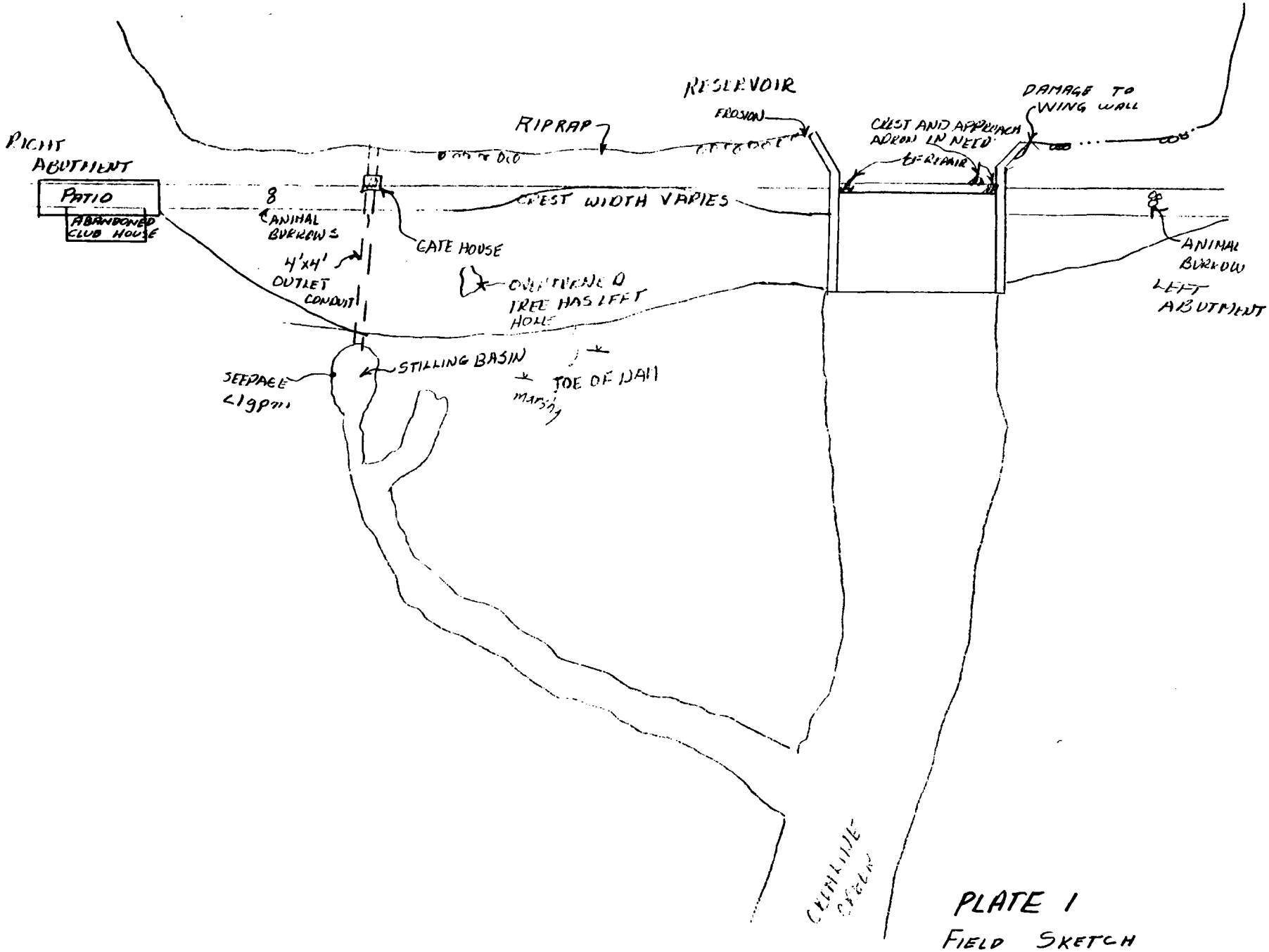
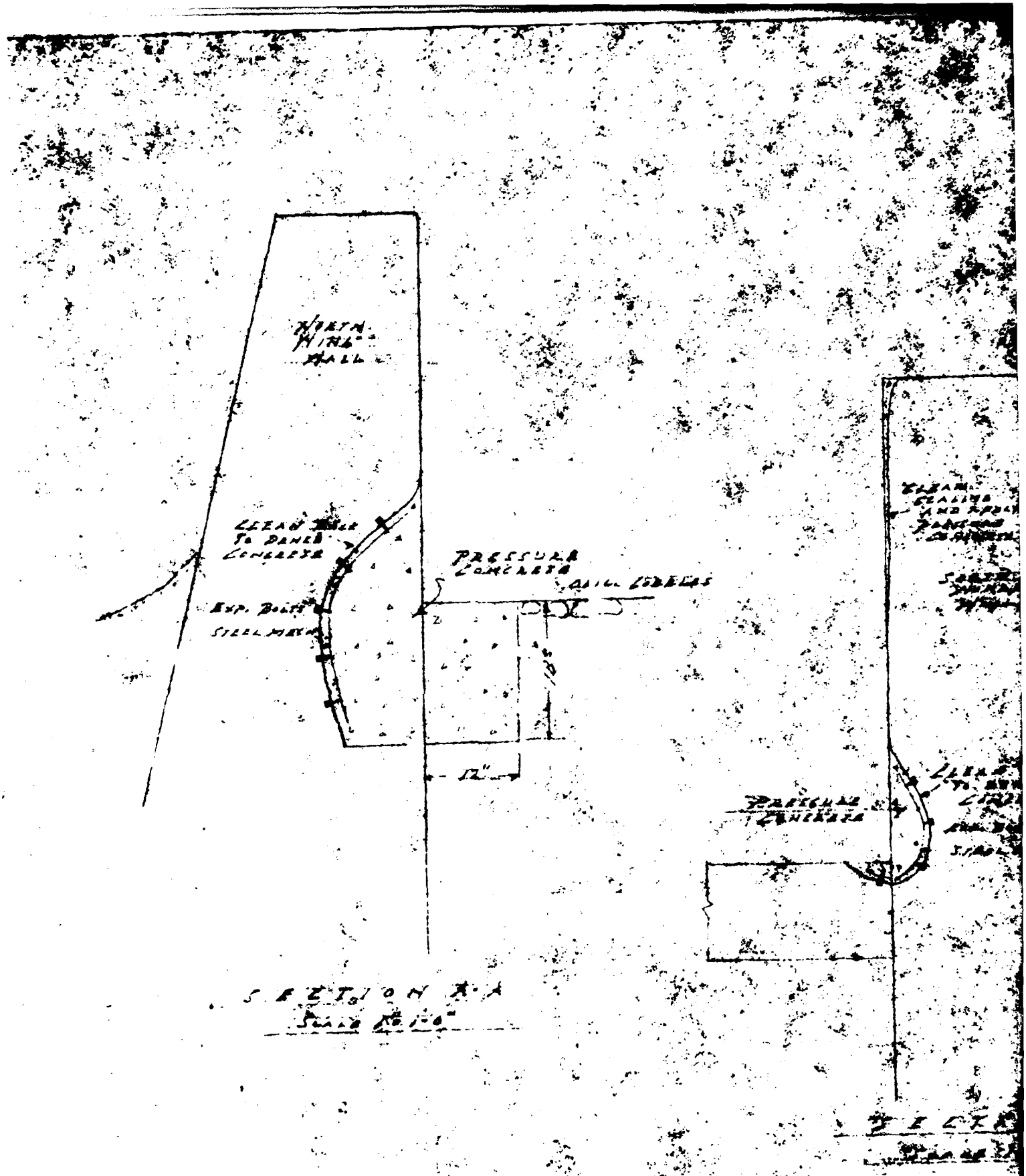
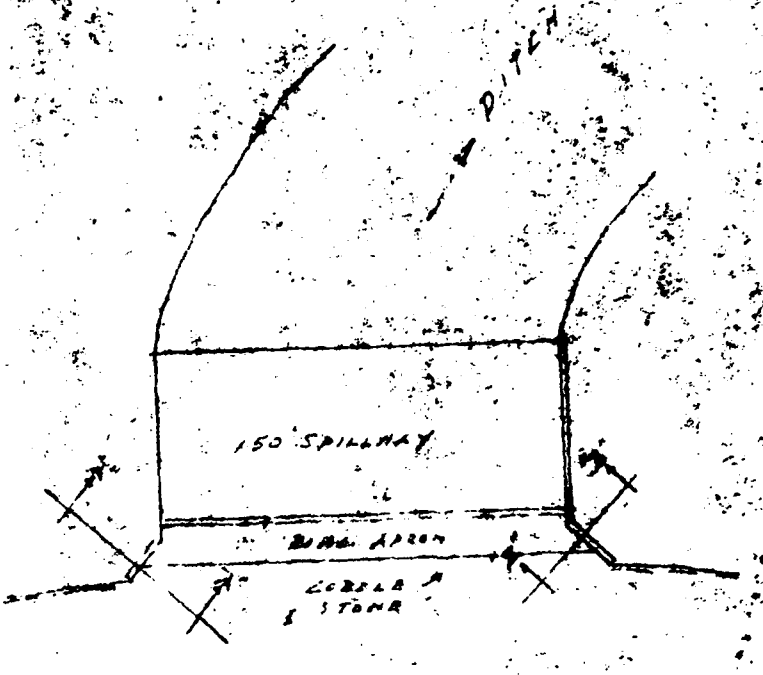


PLATE 1

FIELD SKETCH

TOMAHAWK LAKE DAM

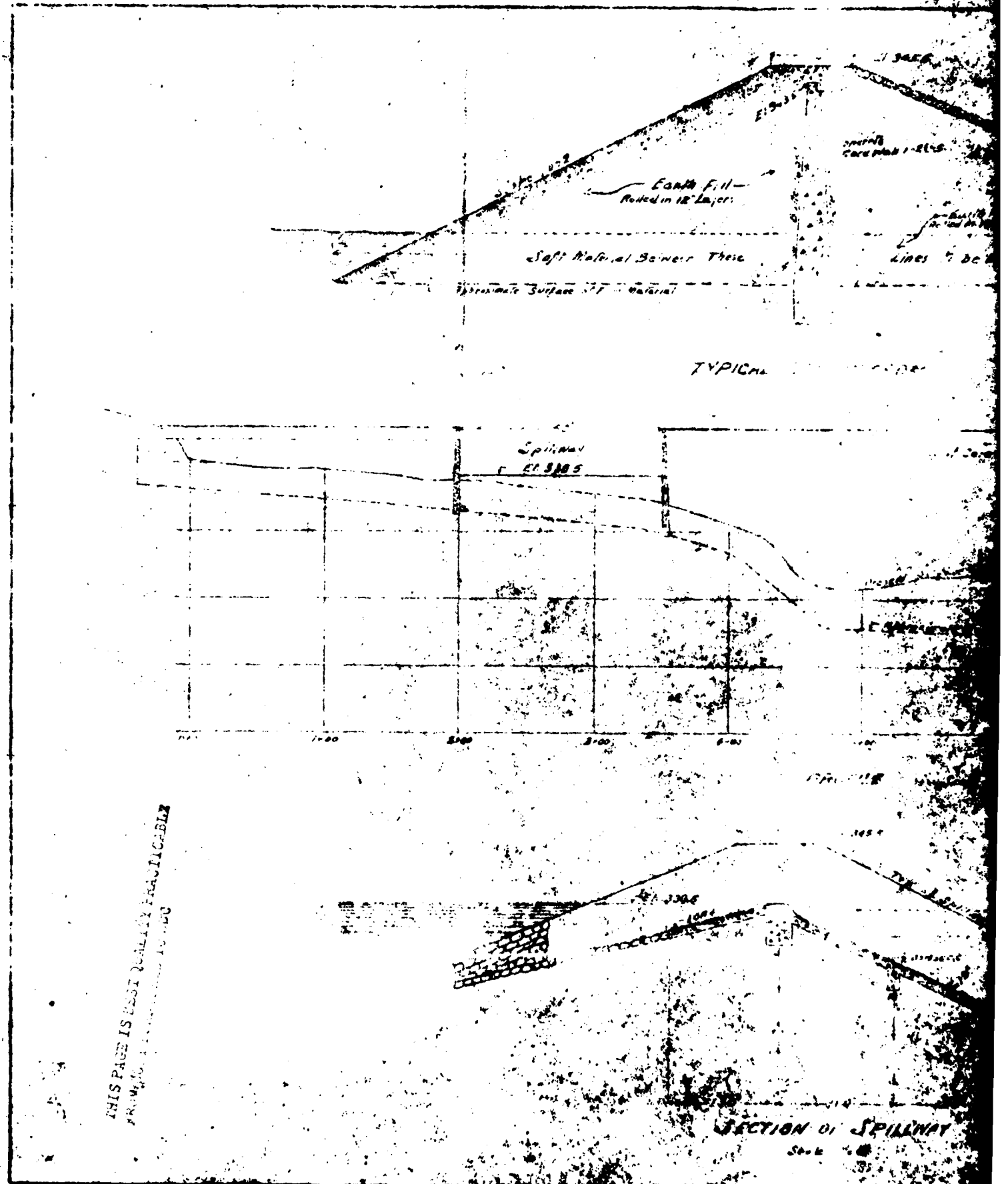

NORTH WING WALL
CLEAN TILE TO DANCE CONCRETE
EXP. BOLTS STEEL PLATE
PRESSURE CONCRETE
STEEL RODS
12"
SECTION A-A
SCALE 1/2" = 1'-0"

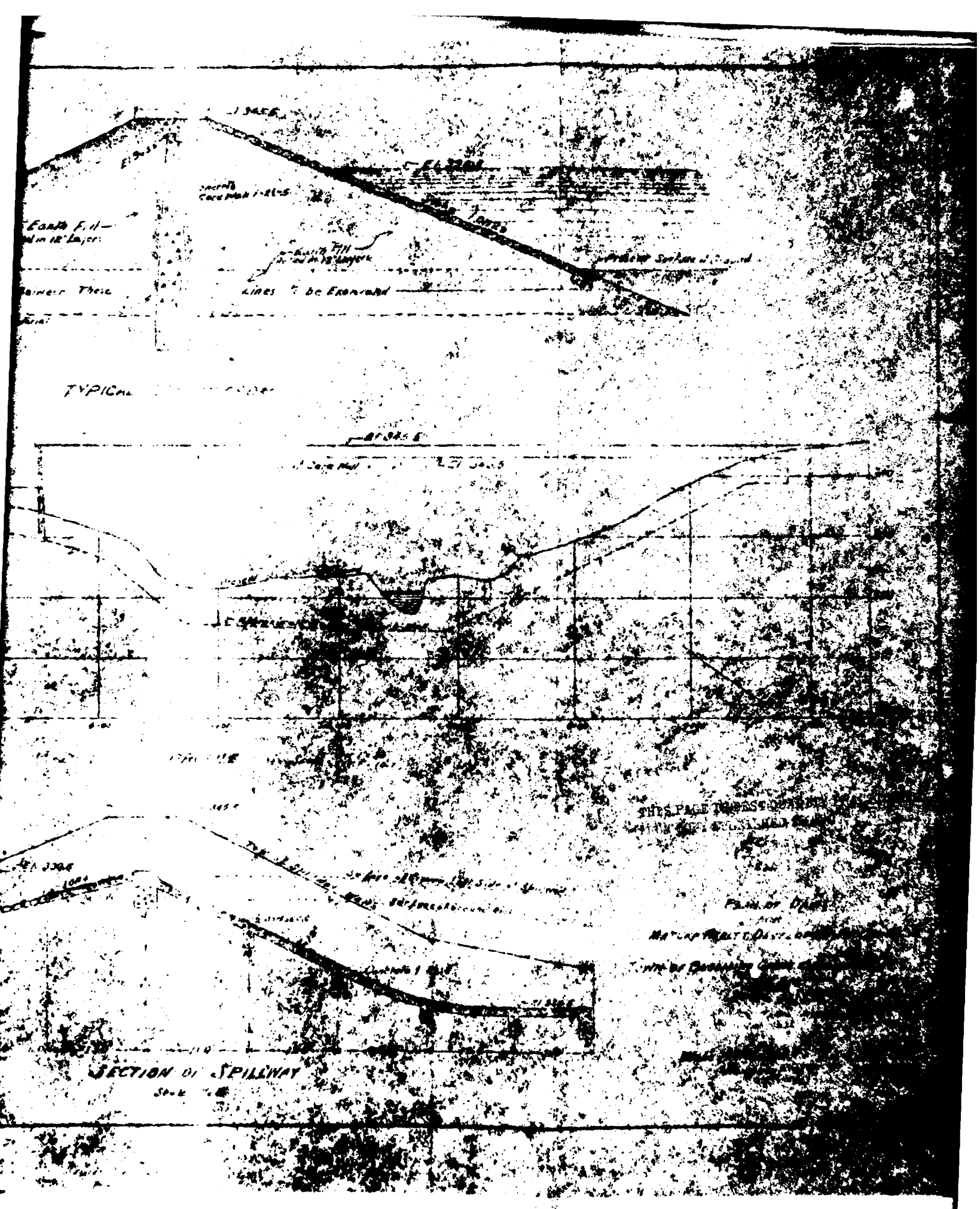


TOMAHAWK LAKE

PROPOSED REPAIRS
TO TOMAHAWK LAKE DAM
TOWN OF BLOOMING GROVE, DANE CO., WIS.

PLATE 2




Earth Fill
Lines to be Excavated
TYPICAL
SECTION OF SPILLWAY

APPENDIX F

BACKGROUND DOCUMENTS

Form E-61. 8-14-52-2M (2D-282)
Ord. 7-05-58

STATE OF NEW YORK

DEPARTMENT OF PUBLIC WORKS

ALBANY

Received 11/16/56 Dam No. 195-2507

Disposition appv. 11/16/56 Watershed Lower Hudson

Foundation inspected .....

Structure inspected .....

Application for the Construction or Reconstruction of a Dam

Application is hereby made to the Superintendent of Public Works, Albany, N. Y., in compliance with the provisions of Section 948 of the Conservation Law (see third page of this application) for the approval of specifications and detailed drawings, marked Repair of Tomahawk Lake Dam

herewith submitted for the { ~~construction~~ / reconstruction } of a dam REPAIR herein described. All provisions of law will be complied with in the erection of the proposed dam. It is intended to complete the work covered by the application about See their letter 11/16/56
(Date)

1. The dam will be on Cromline Creek flowing into Woodna Creek in the town of Town of Bloomin Grove County of Orange and 1 mile N.W. of Bloomin Grove Station
(Give exact distance and direction from a well-known bridge, dam, village, main cross-roads or mouth of a stream)

2. Location of dam is shown on the Schunemunk quadrangle of the United States Geological Survey.

3. The name of the owner is x Bowman Beach Corp.

4. The address of the owner is x 220 Madison Ave River Edge N.J.

5. The dam will be used for Recreation purposes

6. Will any part of the dam be built upon or its pond flood any State lands? No

7. The watershed above the proposed dam is 30 square miles.

8. The proposed dam will create a pond area at the spillcrest elevation of 165 acres and will impound 57059000 cubic feet of water.

9. The maximum height of the proposed dam above the bed of the stream is No Change inches.

10. The lowest part of the natural shore of the pond is no change feet vertically above the spillcrest, and everywhere else the shore will be at leastno change feet above the spillcrest.

11. State if any damage to life or to any buildings, roads or other property could be caused by any possible failure of the proposed dam Same as original (Highway bridges and Villages)

12. The natural material of the bed on which the proposed dam will rest is (clay, sand, gravel, boulders, granite, shale, slate, limestone, etc.) No change

13. Facing downstream, what is the nature of material composing the right bank? Same as original - no change

14. Facing downstream, what is the nature of the material composing the left bank?

15. State the character of the bed and the banks in respect to the hardness, perviousness, water bearing, effect of exposure to air and to water, uniformity, etc. No change

16. Are there any porous seams or fissures beneath the foundation of the proposed dam? no

17. WASTES. The spillway of the above proposed dam will be No Change feet long in the clear; the waters Repair of abutment only will be held at the right end by a the top of which will be feet above the spillcrest, and have a top width of feet; and at the left end by a the top of which will be feet above the spillcrest, and have a top width of feet.

18. The spillway is designed to safely discharge Same cubic feet per second.

19. Pipes, sluice gates, etc., for flood discharge will be provided through the dam as follows:

20. What is the maximum height of flash boards which will be used on this dam? none

21. APRON. Below the proposed dam there will be an apron built of feet long across the stream, feet wide and feet thick.

22. Does this dam constitute any part of a public water supply? no

who shall thereupon pay the same into the treasury. Any amount so levied shall thereupon become a lien upon the real property affected thereby, to the same extent as any tax levy becomes and is a lien thereon.

Any person in interest may, within thirty days from the service of any such order, appeal to the supreme court to determine the reasonableness of such order. At any time during such appeal to the supreme court upon at least three days' notice, the party appealing may apply for an order directing any question of fact to be tried and determined by a jury, and the court shall thereupon cause such question to be stated for trial accordingly and the findings of the jury upon such question shall be conclusive. Appeals may be taken from the supreme court to the appellate division of the supreme court and to the court of appeals in such cases, subject to the limitations provided in the civil practice act.

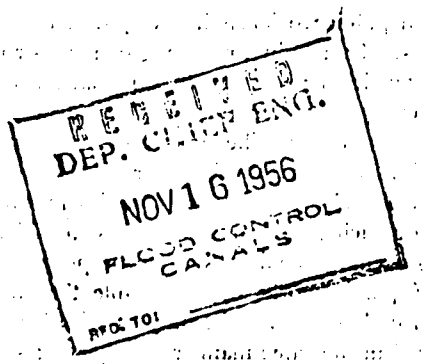
This section shall not apply to a dam where the area draining into the pond formed thereby does not exceed one square mile, unless the dam is more than ten feet in height above the natural bed of the stream at any point or unless the quantity of water which the dam impounds exceeds one million gallons; nor to a dock, pier, wharf or other structure under the jurisdiction of the department of docks, if any, in a city of over one hundred and seventy-five thousand population. This section as hereby amended shall not impair the effect of an order heretofore made by the conservation commission or commissioner under this section prior to the taking effect of chapter four hundred and ninety-nine of the laws of nineteen hundred and twenty-one, nor require the approval by the superintendent of public works, of plans and specifications theretofore approved by such commission or commissioner under this section.

The foregoing information is correct to the best of my knowledge and belief, and the construction will be carried out in accordance with the approved plans and specifications.

x Bowman Beach Corp., Owner

By George Kreiss Jr VP, authorized agent of owner.

Address of signer 265 N 14 St NYC Date Nov 13/56



3-27-29-500 (11E-6147)

STATE OF NEW YORK

DEPARTMENT OF PUBLIC WORKS

DIVISION OF ENGINEERING

ALBANY

Received Apr. 16, 1929 Dam No. 195 — 833

Disposition Apr. 25, 1929. Watershed Lower Hudson

Foundation inspected

Structure inspected

Superseded by 195-2507

Application for the Construction or Reconstruction of a Dam

Application is hereby made to the Superintendent of Public Works, Albany, N. Y., in compliance with the provisions of Section 948 of the Conservation Law (see last page of this application) for the approval of specifications and detailed drawings, marked [illegible] Town of Blooming Grove, Orange Co., New York. herewith submitted for the {construction / reconstruction} of a dam herein described. All provisions of law will be complied with in the erection of the proposed dam. It is intended to complete the work covered by the application about [illegible]
(Date)

1. The dam will be on [illegible] flowing into [illegible] in the town of Blooming Grove, County of [illegible] and [illegible] mile [illegible] of Blooming Grove Station
(Give exact distance and direction from a well-known bridge, dam, village main cross-roads or mouth of a stream)

2. Location of dam is shown on the Schunemunk quadrangle of the United States Geological Survey. Bowman Beach Corp - 220 Madison Ave. River Edge. N

3. The name of the owner is [illegible]

4. The address of the owner is [illegible]

5. The dam will be used for [illegible]

6. Will any part of the dam be built upon or its pond flood any State lands? [illegible]

7. The watershed above the proposed dam is [illegible] square miles.

8. The proposed dam will create a pond area at the spillcrest elevation of [illegible] acres and will impound [illegible] cubic feet of water.

[illegible]

9. The maximum height of the proposed dam above the bed of the stream is 20 feet 3 inches.

10. The lowest part of the natural shore of the pond is 70 feet vertically above the spillcrest, and everywhere else the shore will be at least 150 feet above the spillcrest.

11. State if any damage to life or to any buildings, roads or other property could be caused by any possible failure of the proposed dam Yes. Below the dam are highway bridges and Villages.

12. The natural material of the bed on which the proposed dam will rest is (clay, sand, gravel, boulders, granite, shale, slate, limestone, etc.) Clay, gravel and boulders mixed.

13. Facing down stream, what is the nature of material composing the right bank? Clay, gravel and boulders mixed.

14. Facing down stream, what is the nature of the material composing the left bank? Clay, gravel and boulders mixed.

15. State the character of the bed and the banks in respect to the hardness, perviousness, water bearing, effect of exposure to air and to water, uniformity, etc. Material is hard and impervious and becomes hard when exposed to the air.

16. Are there any porous seams or fissures beneath the foundation of the proposed dam? No.

17. WASTES. The spillway of the above proposed dam will be 150 feet long in the clear; the waters will be held at the right end by an earth embankment the top of which will be 7 feet above the spillcrest, and have a top width of 10 feet; and at the left end by a earth embankment the top of which will be 7 feet above the spillcrest, and have a top width of 10 feet.

18. The spillway is designed to safely discharge 9000 cubic feet per second.

19. Pipes, sluice gates, etc., for flood discharge will be provided through the dam as follows:
18" square sluice gate through dam as shown on the plans.

20. What is the maximum height of flash boards which will be used on this dam?

21. APRON. Below the proposed dam there will be an apron built of
feet long across the stream, feet wide and feet thick.

22. Does this dam constitute any part of a public water supply? No.

SECTION 948 OF THE CONSERVATION LAW

§ 948. **Structures for impounding water; inspection of docks; penalties.** No structure for impounding water and no dock, pier, wharf or other structure used as a landing place on waters shall be erected or reconstructed by any public authority or by any private person or corporation without notice to the superintendent of public works, nor shall any such structure be erected, reconstructed or maintained without complying with such conditions as the superintendent of public works may by order prescribe for safeguarding life or property against danger therefrom. No order made by the superintendent of public works shall be deemed to authorize any invasion of any property rights, public or private, by any person in carrying out the requirements of such order. The superintendent of public works shall have power, whenever in his judgment public safety shall so require, to make and serve an order directing any person, corporation, officer or board, constructing, maintaining or using any structure hereinbefore referred to, remove, repair or reconstruct the same within such reasonable time and in such manner as shall be specified in such order, and it shall be the duty of every such person, corporation, officer or board, to obey, observe and comply with such order and with the conditions prescribed by the superintendent of public works for safeguarding life or property against danger therefrom, and every person, corporation, officer or board failing, omitting or neglecting so to do, or who hereafter erects or reconstructs any such structure hereinbefore referred to without submitting to the superintendent of public works and obtaining his approval of plans and specifications for such structures when required so to do by his order or who hereafter fails to remove, erect or to reconstruct the same in accordance with the plans and specifications so approved shall forfeit to the people of this state a sum not to exceed five hundred dollars to be fixed by the court for each and every offense; every violation of any such order shall be a separate and distinct offense, and, in case of a continuing violation, every day's continuance thereof shall be and be deemed to be a separate and distinct offense. This section shall not apply to a dam where the area draining into the pond formed thereby does not exceed one square mile, unless the dam is more than ten feet in height above the natural bed of the stream at any point or unless the quantity of water which the dam impounds exceeds one million gallons; nor to a dock, pier, wharf or other structure under the jurisdiction of the department of docks, if any, in a city of over one hundred and seventy-five thousand population. This section as hereby amended shall not impair the effect of an order heretofore made by the conservation commission or commissioner under this section prior to the taking effect of chapter four hundred and nintey-nine of the laws of nineteen hundred and twenty-one, nor require the approval by the superintendent of public works of plans and specifications theretofore approved by such commission or commissioner under this section.

The foregoing information and accompanying plans and specifications are correct to the best of my knowledge and belief.

Mistuke Realty Development Co. owner.

By Charles E. Bowman, authorized agent of owner.

Address of signer Washingtonville N.Y. Date Apr. 12/29


DAT
FILM