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NATIONAL DAM SAFETY PROGRAM, FREDONIA RESERVOIR (INVENTORY NUMB--ETC(U)
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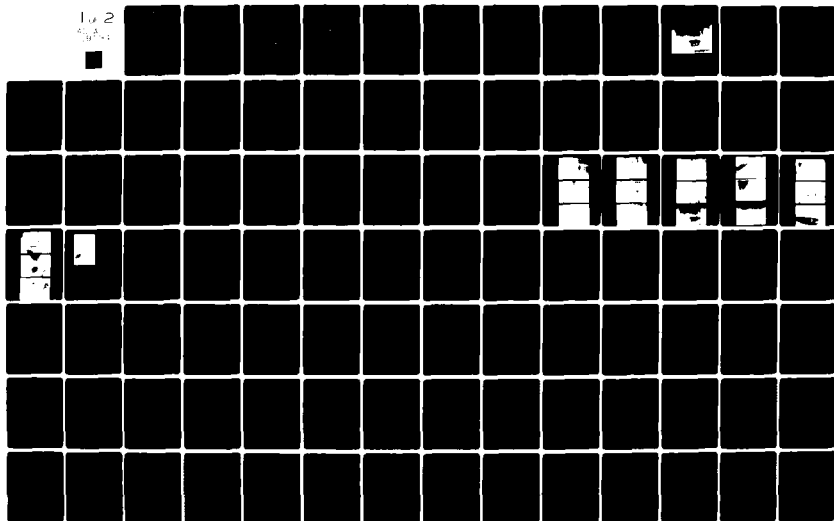
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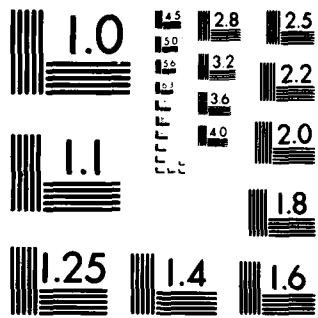
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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
		AD-A090 940
4. TITLE (and Subtitle) Phase I Inspection Report Fredonia Reservoir Lake Erie Basin, Chautauqua County Inventory No. ~~794~~ 749		5. TYPE OF REPORT & PERIOD COVERED Phase I Inspection Report National Dam Safety Program
7. AUTHOR(s) Bent L. Thomse		6. PERFORMING ORG. REPORT NUMBER
Gary L. Wood		8. CONTRACT OR GRANT NUMBER(s) ✓ DACW-51-79-C-0001
9. PERFORMING ORGANIZATION NAME AND ADDRESS Thomsen Associates 105 Corona Avenue Groton, NY 13073		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS New York State Department of Environmental Conservation 50 Wolf Road Albany, NY 12233		12. REPORT DATE 20 SEP 1980
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Department of the Army 26 Federal Plaza New York District, CofE New York, NY 10287		13. NUMBER OF PAGES
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; Distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) DTIC ELECTRIC OCT 30 1980		
18. SUPPLEMENTARY NOTES THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DDC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY. A		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety National Dam Safety Program Visual Inspection Hydrology, Structural Stability		Fredonia Reservoir Chautauqua County Lake Erie Canadaway Creek
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 revealed conditions which if not corrected constitute a 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 by all storms exceeding approximately 34 percent of the PMF. The overtopping of the dam could cause erosion in the notched earthen section adjacent and parallel to the concrete Ogee weir resulting in possible undermining and failure of the spillway. Failure of the spillway would result in an increased hazard to the loss of life and property downstream. The spillway is, therefore, judged 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 imply the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, there appears to be a serious deficiency in the spillway capacity and if a severe storm were to occur, overtopping and possible failure of the spillway and dam could take place, thereby significantly increasing the hazard to loss of life downstream of the dam.

Structural stability analysis based on available information and the visual inspection indicates that the stability of the spillway section against overturning and sliding is inadequate for nearly all loading conditions other than those when the reservoir is at the spillway crest.

Seepage was detected adjacent to the spillway and in the downstream slope of the west embankment. A wet area was observed along the downstream slope of the east abutment-embankment contact of the east embankment. Those wet areas and seeps could seriously affect the stability of the spillway and embankment.

It is, therefore, recommended that within 3 months of notification to the owner, detailed hydrologic/ hydraulic investigation of the structure should be undertaken to better determine the site specific characteristics of the watershed and their affect upon potential overtopping of the dam. The results of these investigations will determine the appropriate remedial measures which will be required to achieve a spillway capacity adequate to discharge the outflow from at least one-half the PMF. A detailed field investigation and monitoring program should be undertaken to determine the source of seepage and the wet areas noted above. At the same time a detailed investigation should be performed to determine the structural stability of the spillway and slope stability of the downstream embankment slopes.

At this time we do not recommend the trees be removed from the embankment slopes unless provisions are made to drain and protect these slopes using a granular drainage blanket. Indiscriminate cutting of trees could result in serious sloughing of the slopes.

In the interim, a detailed emergency action plan must be developed and implemented providing around-the-clock monitoring of the structure and provisions for notification of downstream residents during periods of unusually heavy precipitation.

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Lake Erie Basin Safety Program

FREDONIA RESERVOIR

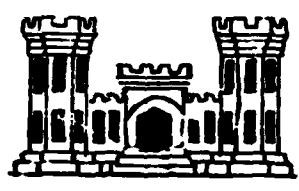
(Inventory Number NY 749)

CHAUTAUQUA COUNTY, NEW YORK

INVENTORY NO. NY 749

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

(13) E. L. Thomsen
/ Gary L. Wood



(13) DACW 51-77-C-4141

(4) 21 1/2

15152

Prepared by
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Prepared for
DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
NEW YORK, NEW YORK

SEPTEMBER 1980

APPROVED FOR PUBLIC RELEASE
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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway 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.

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
FREDONIA RESERVOIR
I. D. NO. N.Y. 749
LAKE ERIE BASIN
CHAUTAUQUA COUNTY, NEW YORK

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

NAME OF DAM: Fredonia Reservoir
Inventory No. N.Y. 749
STATE LOCATED: New York
COUNTY: Chautauqua
WATERSHED: Lake Erie
STREAM: Canadaway Creek
DATE OF INSPECTION: May 14, 15, and 22, 1980
See Vicinity Map and Topographic Map,
Appendix C

ASSESSMENT

Examination of available documents and a visual inspection of the dam revealed conditions which if not corrected constitute a 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 by all storms exceeding approximately 34 percent of the PMF. The overtopping of the dam could cause erosion in the notched earthen section adjacent and parallel to the concrete Ogee weir resulting in possible undermining and failure of the spillway. Failure of the spillway would result in an increased hazard to the loss of life and property downstream. The spillway is, therefore, judged 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 imply the same degree of emergency as would be associated with an 'unsafe' classification applied for a structural deficiency. It does mean, however, there appears to be a serious deficiency in the spillway capacity and if a severe storm were to occur, overtopping and possible failure of the spillway and dam could take place, thereby significantly increasing the hazard to loss of life downstream of the dam.

Structural stability analysis based on available information and the visual inspection indicates that the stability of the spillway section against overturning and sliding is inadequate for nearly all loading conditions other than those when the reservoir is at the spillway crest.

Seepage was detected adjacent to the spillway and in the downstream slope of the west embankment. A wet area was observed along the downstream slope of the east abutment-embankment contact of the east embankment. Those wet areas and seeps could seriously affect the stability of the spillway and embankment.

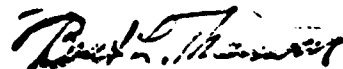
It is, therefore, recommended that within 3 months of notification to the owner, detailed hydrologic/ hydraulic investigation of the structure should be undertaken to better determine the site specific characteristics of the watershed and their affect upon potential overtopping of the dam. The results of these investigations will determine the appropriate remedial measures which will be required to achieve a spillway capacity adequate to discharge the outflow from at least one-half the PMF. A detailed field investigation and monitoring program should be undertaken to determine the source of seepage and the wet areas noted above. At the same time a detailed investigation should be performed to determine the structural stability of the spillway and slope stability of the downstream embankment slopes.

At this time we do not recommend the trees be removed from the embankment slopes unless provisions are made to drain and protect these slopes using a granular drainage blanket. Indiscriminate cutting of trees could result in serious sloughing of the slopes.

In the interim, a detailed emergency action plan must be developed and implemented providing around-the-clock monitoring of the structure and provisions for notification of downstream residents during periods of unusually heavy precipitation.

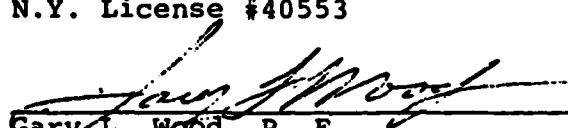
In addition, the dam has a number of deficiencies which, if left untreated, could increase the potential for hazardous conditions to develop. These deficiencies should be corrected within the first construction season following notification of the owner. The deficiencies and recommended measures are as follows:

- 1) Restore spillway retaining walls to the lines and grades of the original construction
- 2) Bench, place and compact any embankment slips or sloughs
- 3) Place and compact embankment type material along all eroded embankment-abutment contacts
- 4) Provide erosion protection along abutment-embankment contacts and the berm on the west embankment downstream slope
- 5) Place and compact embankment type material adjacent to the spillway crest where the level of existing grades is below the top of the retaining wall (see as-built drawing in Appendix G - Survey by Thomsen Associates-1980)
- 6) Place and compact embankment material where the concrete corewall is exposed and regrade west embankment crest to the elevation and dimension of the east embankment crest
- 7) Remove all debris from spillway
- 8) Patch and fill all cracks in the spillway



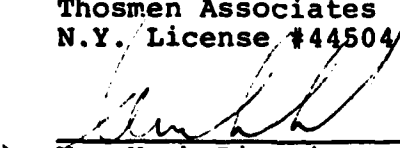
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26 SEP 1980



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APPROVED BY:



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



View of Spillway & Spillway Exit
channel from east embankment.
Note: Inward movement of Wing-
wall and erosion behind Wingwall,
log in spillway.

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NATIONAL DAM SAFETY PROGRAM
FREDONIA RESERVOIR
I.D. No. N.Y. 749
LAKE ERIE BASIN
CHAUTAUQUA COUNTY, NEW YORK

SECTION 1: PROJECT INFORMATION

1.1 GENERAL

a. Authority

This Phase I Inspection Report was authorized by the New York State Department of Environmental Conservation by Contract No. D-201458. This study was performed in accordance with the terms of the above contract and the Recommended Guidelines for Safety Inspection of Dams prepared by the Department of Army, Office of the Chief of Engineers to fulfill the requirements of the National Dam Inspection Act, Public Law 92-327.

b. Purpose of Inspection

This inspection was conducted to obtain available data concerning design and construction of the dam, to evaluate that data, to visually inspect existing conditions at the dam, to identify and evaluate deficiencies and/or hazardous conditions which, if present, may threaten life and property of the residents downstream of the dam and to recommend remedial measures to mitigate such deficiencies and hazardous conditions.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam

The Fredonia Reservoir dam consists of two separate earth embankments and a central concrete Ogee spillway. Both embankments are constructed of a "rolled" mixture of silt, sand and clay and have a crest width of 11 feet.

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I.D. No. N.Y. 749
LAKE ERIE BASIN
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SECTION 1: PROJECT INFORMATION

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1.2 DESCRIPTION OF PROJECT

a. Description of Dam

The Fredonia Reservoir dam consists of two separate earth embankments and a central concrete Ogee spillway. Both embankments are constructed of a "rolled" mixture of silt, sand and clay and have a crest width of 11 feet.

The west embankment is constructed on the downstream slope of a former embankment and has an embankment length of 270 feet with a maximum height above the original ground surface of 80 feet. The upstream slope is 1 vertical on 6 horizontal with the former embankment crest acting as a berm at elevation 1021.0. The downstream slope is 1 vertical on 2.3 horizontal with a stone lined gutter at about elevation 1011.0. The east embankment is constructed at the location of the former spillway associated with the buried embankment noted above. This embankment is 260 feet long and has a maximum height of about 50 feet. The upstream slope is 1 vertical on 5 horizontal with a downstream slope of 1 vertical on 2 horizontal.

A rockfilled section is constructed at the downstream toe of both embankments. Likewise both embankments are provided with concrete corewalls with concrete cutoff walls and steel sheet pile walls keyed into either the bedrock or "hard impervious clay".

A series of stone underdrains were constructed under the embankment from the rockfill toe towards the corewall (see "plan" in Appendix G).

The spillway is an uncontrolled concrete Ogee weir with the crest at elevation 1036.0 and a weir length of 75 feet. The approach apron is 4 feet below the crest elevation and the exit channel slopes away from the Ogee section at a 2 percent slope for a distance of 90 feet. The exit channel gradually narrows from the spillway crest to a width of 40 feet. The remainder of the spillway structure from the end of the exit apron to the tailwater elevation is constructed in a tread and riser (i.e., stepped) fashion with an average slope of 1 vertical on 1.1 horizontal.

The tailwater elevation is maintained by a masonry dam in the downstream channel which was notched (partially breached) as part of the construction in 1937. The tailwater elevation at the time of the inspections was about 967 $\pm$.

A notched earthen section parallels the concrete spillway. This notched section rises from the top of the spillway retaining walls which is at elevation 1042.0 along the spillway crest centerline to the dam crest at elevation 1044.8. A cross-section of the existing spillway profile along the spillway crest centerline is shown on a drawing in Appendix G.

The reservoir can be drained to about elevation 1016 by a 12 inch cast iron intake water pipe with a tee-section to a "blowoff" valve. The gate valve is manually operated.

b. Location

The Fredonia Reservoir Dam is located about 3.2 miles southeast of the village of Fredonia and 2 miles south of the village of Laona, New York.

c. Size Classification

The dam has a maximum height of 80 feet and an estimated total storage capacity of 1524 acre-feet at the top of the dam. Therefore, the dam is of intermediate size by virtue of its height and storage capacity.

d. Hazard Classifications

The dam is classified as a high hazard structure due to the number of homes, businesses and bridges along the downstream channel.

e. Ownership

The dam is owned by the village of Fredonia, New York. The village engineer, Mr. George Nutbrown, was contacted

as part of the Phase I inspection. Mr. Nutbrown's address is Village Hall, Temple and Church Street, Fredonia, New York and his telephone number is 716-679-4741.

f. Purpose of the Dam

The purpose of the dam is to impound and store the village of Fredonia water supply.

g. Design and Construction History

The design of the dam was performed by Fretts, Tallamy and Senior, Consulting Engineers of Williamsville, New York. The dam was constructed about 1937 by the Works Progress Administration.

Prior to construction of the present dam the site was formerly occupied by at least two other dams. The newer of these dams was of similar construction (i.e. earth embankment with concrete corewall) to the present dam but had its crest at elevation 1021.0 and was located upstream of the existing west embankment.

The 1915 Dam Report submitted to the State of New York Conservation Commission indicates another dam of masonry construction was situated upstream of the present east embankment. This dam was constructed around 1896 and was extensively repaired in 1912 when it was partially breached. The masonry dam may have been renovated to form the spillway of the earth embankment dam presently buried by the existing west embankment.

h. Normal Operations Procedures

Normal flows are discharged over the concrete spillway. The elevation of the spillway crest is 1036.0 based on the pool elevation shown on the 7 1/2 minute U.S.G.S. Dunkirk, New York quadrangle. All discharge passes through the spillway until the reservoir level exceeds elevation 1042.0. The spillway has sufficient capacity

to discharge 34 percent of the Probable Maximum Flood (PMF) without discharge occurring in the notched earthen section adjacent to the spillway. The dam, however, would be overtopped by all storms exceeding 67 percent of the PMF.

1.3

PERTINENT DATA

a. <u>Drainage Area</u> (sq. mi.)	5.55
b. <u>Discharge at Damsite</u> (cfs)	
Reservoir Drain at Spillway Crest	21
Spillway (flow only through concrete section Elev. 1042.0)	4234
Combined Spillway and Notched Earth Section at Top of Dam (Elev. 1044.8)	8292
c. <u>Elevation</u> (ft. above MSL)	
Spillway Crest and Normal Pool	1036.0
Top of Dam	1044.8
d. <u>Storage</u> (acre-feet) (as taken from Application for Construction, See Appendix E)	
Normal Pool	1024
f. <u>Flood Storage</u> (acre-feet)	
Top of Concrete Spillway Section (Elev. 1042)	320
Top of Dam (Elev. 1044.8)	497
g. <u>Reservoir Surface</u> (acres)	
Normal Pool	48
Top of Dam	65
h. <u>Dam</u> (as taken from design drawings)	
Type: The dam is an earth embankment with a concrete corewall	
Length: (ft.)	
East Embankment:	260
West Embankment:	270
Height: (ft.)	
East Embankment:	50
West Embankment:	80
Top Width: (ft.)	11

Upstream Slope: (V:H)

East Embankment: 1:5

West Embankment: 1:6

Downstream Slope: (V:H)

East Embankment: 1:2

West Embankment: 1:2:3

Cutoff: Concrete corewall with concrete cutoff trench in rock in maximum sections of dam and steel sheet piles toward abutments and below the spillway

Grout Curtain: None

i. Spillway

Type: Concrete Ogee weir with crest elevation at 1036.0. Entrance (approach) channel 4.0 feet below crest and a 90 foot concrete exit channel on a 2 percent slope.

Length of Weir: 75 feet

Minimum Width of Exit Channel: 40 feet

j. Reservoir Drain

Type: 12 inch diameter cast iron pipe

Length: 670 feet

Control: Manually operated gate valve near exit portal of tunnel to intake structure

SECTION 2: ENGINEERING DATA

2.1 GEOTECHNICAL DATA

a. General Geology

The Fredonia Reservoir and dam are located approximately three miles south of Fredonia, New York on the rim of the Allegheny Plateau.

Local bedrock consists of interbedded shales and siltstones of Upper Devonian age which have been uplifted and dissected. Although a regional dip southward at a gentle rate may be discerned, these strata are essentially flat-lying over short distances. No major or active faults are known to exist in the area.

The Village of Fredonia and Fredonia Reservoir are situated in a region classified as Zone 3 seismicity, as shown on Figure No. 1 of the Recommended Guidelines for Safety Inspection of Dams.

Pleistocene glaciation has modified the topography by means of both erosion and deposition. The continental ice sheet advanced and receded repeatedly in southwestern New York, smoothing terrain by glacial scour and mantling the uplands with stony till deposits. Glacial valleys were filled with lacustrine sediments and subsequently, by granular stratified outwash; such is the case in the Canadaway Creek Valley.

The Pleistocene geology of the immediate dam site is that of glacial lake sediments as shown on a portion of the map titled "Pleistocene Geology of Chautauqua County, New York" by E. H. Muller, New York State Museum and Science Service Bulletin 391, which is contained in Appendix G.

In Holocene (recent) times, soil profiles have developed on these glacial deposits and infilling of valleys with alluvial material eroded from the uplands has continued.

b. Subsurface Conditions

The only available data concerning the subsurface conditions at the dam site is that shown on the design engineering drawings included in Appendix G.

2.2 DESIGN RECORDS

The dam was designed by Fretts, Tallamy and Senior, Consulting Engineers of Williamsville, New York who prepared a "Report of Proposal to Increase Reservoir Capacity for Fredonia, New York" and prepared engineering drawings for the construction of the dam and appurtenant structures. Appendix E contains portions of the above report.

2.3 CONSTRUCTION RECORDS

No construction records were available, however, it is noted the actual construction of the spillway is different from what the engineering drawings indicate. The spillway centerline was surveyed as part of the Phase I inspection and the cross-section shown in Appendix G is different than the design cross-section also contained in Appendix G.

In 1966 modifications were made to the reservoir drain "blow-off" valve, intake structure and regrading along the spillway. This work was part of a large contract for construction of an addition to the Water Filtration Plant. This project was designed by Bissell, Bronkie and Associates, Consulting Civil Engineers of Williamsville, New York. Those drawings pertaining to the regrading adjacent to the spillway are included in Appendix G.

2.4 OPERATION RECORDS

The dam is designed as an uncontrolled water storage structure, therefore no operating records are maintained regarding reservoir level or spillway discharge.

2.5 EVALUATION OF DATA

The data presented in this report has been compiled from information obtained from the Village of Fredonia and the

files of the New York State Department of Environmental Conservation.

The data reviewed indicated a number of discrepancies between the design and as-built features of the dam. In addition, both the dam designers and filtration plant addition designers used a different datum for vertical control, both of which do not correspond to the U.S.G.S. datum.

In general, the data is considered adequate and reliable.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General

A visual inspection of the dam was conducted on May 14, May 15, and May 22, 1980. The weather at the time of the initial inspection was cloudy and rainy which resulted in the reinspection on May 15, 1980 during clear and warm weather to better observe any evidence of seepage. The purpose of the May 22, 1980 inspection was to operate the reservoir drain gate valve. The reservoir level during all inspections was at the crest of the spillway.

b. Embankment

The embankment sections are heavily wooded, and based on the size of some trees, the embankments have apparently been wooded at least 20 years. The only area not tree covered is the crest of the east embankment and the relatively flat cut area east of the spillway. The grouted stone gutters along the embankment-abutment contacts are badly eroded and/or missing entirely resulting in erosion and gully development. The downstream slopes of both embankments exhibit signs of surface creep as evidenced by numerous bowed tree trunks. A surface slough was detected on the downstream slope of the west embankment above the stone gutter-berm near the east abutment-embankment contact.

The west embankment crest was crown shaped and slopes away from the exposed and deteriorated top of the concrete corewall. The horizontal and vertical alignment of the east embankment was satisfactory.

Seepage was emerging from the downstream slope of the west embankment 3 to 5 feet above the rockfilled toe from near the center of the embankment to the west

embankment-abutment contact. The line of seepage occurred along the same elevation and is estimated to be less than 5 gallons per minute.

Flowing water was detected along the west embankment-abutment contact of the east embankment on the lower half of the downstream slope. The source of the water could not be determined and may represent seepage or surface run-off due to precipitation on the day preceding the inspection.

c. Spillway

During the inspection all of the spillway was exposed except the upstream face of the weir and the concrete approach apron.

Both retaining walls (wingwalls) of the spillway have undergone inward movement in the past. The east wall has experienced between 1 1/2 and 6 inches of movement at the top of the wall, whereas, the west wall movement is on the order of 1 to 2 inches. Both walls have exposed steel anchor plates which are part of some type of tie back system used to stabilize the wall movement. Details of the tie back were not available. Each wall has a total of seven anchor plates spaced approximately 9 feet apart.

In general, the concrete surfaces are in good condition. A few construction joints need repair to refill the joints and a minor crack has occurred along the construction joint at the intersection of the exit channel and lower nappe of the Ogee section near the west retaining wall.

Significant structural cracking has occurred in the retaining walls due to the wall rotation.

Erosion has occurred behind the east retaining wall 100 feet downstream of the spillway crest. A slight amount of debris was present in the exit channel.

Seepage was emerging from the embankment side of the spillway west retaining wall at approximately elevation 1012. The water flowing from this concentrated seep was clear and the quantity was estimated to be less than 5 gallons per minute. Two 1 to 1 1/2 inch diameter black plastic pipes were present at the site of the seep.

d. Notched Earth Section

A notched earth section is on both sides of the spillway. The notched section slopes upward from the top of retaining wall at elevation 1042.0 to the top of the dam at elevation 1044.8 along the spillway crest centerline. East of the spillway the notched section is grass lined, whereas west of the spillway the area is tree covered.

e. Reservoir Drain

The reservoir is drained by a 12 inch cast iron pipe attached to one of the 12 inch water intake pipes which conveys water from the intake structure to the water filtration plant. The reservoir is drained by opening a 12 inch gate valve which is connected to the water intake pipe by a 12 inch tee and then closing a similar valve on the water intake pipe. The reservoir water is discharged into the downstream channel below the partially breached masonry dam. The "blow off" gate valve is in operable condition and was operated on May 22, 1980.

f. Downstream of Toe

The area downstream of both embankments is quite flat and several inches of a rust colored water covered the surface at the time of the inspection. These areas are brush covered and occasionally heavily wooded.

g. Downstream Channel

The downstream channel is in a very steep ravine with rock outcrops along the lower quarter of the slopes. The partially breached masonry dam in the downstream channel maintains the tailwater during normal spillway

discharge near elevation 967. Downstream of the masonry dam the channel is still quite steep and bedrock forms the stream bed.

h. Reservoir Area

The area surrounding the reservoir is forested with moderate to steep slopes. No signs of instability were observed.

3.2

EVALUATION

The visual inspection of this dam revealed that the notched earthen section was not constructed with the crest elevations as originally designed. Therefore, the spillway notched earthen section and embankment was surveyed to determine the actual profile.

In addition, the following deficiencies were observed:

a. Seepage

- 1) Seepage emerging from downstream slope of west embankment
- 2) Seepage emerging from west side of spillway
- 3) Water flowing in west abutment-embankment contact on downstream slope of east embankment

b. Spillway

- 1) Rotational movement of spillway retaining walls along exit channel
- 2) Erosion behind east spillway retaining wall
- 3) Minor cracks in spillway exit channel base
- 4) Debris in spillway

c. Embankment

- 1) Surface sloughing on west embankment downstream slope
- 2) Surface creep on downstream embankment slopes
- 3) Heavily wooded embankments
- 4) Erosion gullies along embankment-abutment contacts
- 5) Deteriorated condition of exposed concrete along west embankment corewall
- 6) Horizontal alignment of west embankment crest

SECTION 4: OPERATION AND MAINTENANCE PROCEDURES

4.1 PROCEDURES

The normal reservoir level is controlled by the crest elevation of the concrete Ogee spillway. Downstream flow is limited by the flow over the spillway. The reservoir has sufficient capacity to store and discharge over the spillway 34 percent of the PMF without discharge occurring in the notched earthen section. The dam is overtopped by all storm events exceeding 67 percent of the PMF.

4.2 MAINTENANCE OF DAM

The responsibility for maintaining the dam is the Village of Fredonia. From the present condition of the dam it is obvious little or no maintenance has occurred.

4.3 WARNING SYSTEM IN EFFECT

There is no warning system or evacuation plan in effect.

4.4 EVALUATION

The operation procedure for this structure is satisfactory. A formal maintenance program is necessary and should be implemented within 3 months from the time of notification to the owner.

SECTION 5: HYDROLOGIC/HYDRAULIC

5.1 DRAINAGE AREA CHARACTERISTICS

Delineation of the watershed draining into the reservoir pool area was made using the U.S.G.S. 7.5 minute quadrangles for Dunkirk and Cassadaga, New York. The drainage area measures 5.55 square miles and consists predominantly of wooded land along with some open fields. The relief in the area consists of moderate to steep sloped hills that surround the reservoir to the east, west and south.

5.2 ANALYSIS CRITERIA

The analysis of the floodwater retarding capacity of this dam was performed using the Corps of Engineers HEC-1 computer program, Dam Safety Version. This program develops an inflow hydrograph based upon the "Snyder Synthetic Unit Hydrograph" and then uses the "Modified Puls" flood routing procedure. The spillway design flood selected for analysis was the PMF in accordance with the Recommended Guidelines of the U.S. Army Corps of Engineers.

5.3 SPILLWAY CAPACITY

The Fredonia Reservoir spillway structure consists of a 75 foot long Ogee concrete weir that is situated approximately in the center of the dam. The spillway crest elevation is at 1036 feet above mean sea level. The discharge over the spillway was computed assuming the coefficient of discharge 'C' varies with the height of head 'H' over the spillway. The discharge was also adjusted due to tailwater submergence. The spillway does not have sufficient capacity for discharging the peak outflow from the Probable Maximum Flood (PMF). For the PMF, the peak inflow is 12,811 cfs and the peak outflow is 12,760 cfs. For one-half the PMF, the peak inflow is 6,405 cfs and the peak outflow is 6,151 cfs. The computed spillway capacity for flow within the concrete spillway and the reservoir at elevation 1042.0 is 4234 cfs.

5.4 RESERVOIR CAPACITY

The flood storage capacity (above normal pool) of the reservoir at the top of dam is 497 acre-feet which is equivalent to a runoff depth of 1.68 inches of rain over the entire drainage area.

5.5 FLOODS OF RECORD

Due to the lack of reliable information, no attempt was made to estimate the discharge of the flood of record.

5.6 OVERTOPPING POTENTIAL

Analysis using the PMF indicates that the dam does not have sufficient spillway capacity. For a PMF peak outflow of 12,760 cfs, the dam would be overtopped to a computed depth of 1.18 feet. The dam would be overtopped by all storms exceeding 67 percent of the PMF and discharge would occur in the notched earthen section adjacent to the spillway for all storms exceeding 34 percent of the PMF.

5.7 EVALUATION

Using the available data, the spillway is capable of discharging approximately 34 percent of the PMF. Outflow in excess of 34 percent of the PMF would discharge through the spillway and the notched earthen section adjacent to the spillway. For discharges in excess of 67 percent of the PMF the dam would be overtopped.

The notched earthen section is not protected, therefore, the potential for erosion and possible undermining of the spillway exists.

SECTION 6: STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

The present condition of the spillway retaining walls are considered marginally stable. Portions of the retaining wall have undergone rotational movement at the top of wall between 1 and 6 inches. This magnitude of movement may well have overstressed the reinforcing steel which ties the wall to the foundation.

b. Design and Construction Data

No records concerning structural stability analyses were available for review.

A review of the engineering drawings in accordance with recommended design parameters* for earth embankments of "compacted" sand, silt and clay indicates adequate factors of safety against embankment shear failure for the upstream slope of both embankments.

The downstream embankment slopes, however, are fairly steep for homogeneous downstream earth embankment construction. As the condition of the concrete corewall and cutoff trench can not be evaluated, and the composition of the downstream embankment section is unknown, the actual stability of the downstream embankment slopes is also unknown. Therefore, it is recommended that additional investigations and analyses be performed to determine the stability of the downstream embankment slopes.

A stability analyses was performed on the concrete spillway. Cross-sections of the spillway shown in the engineering drawings in Appendix G were used to perform this analysis. The following cases with varying loading conditions were analyzed.

*"Design of Small Dams", U.S. Department of Interior, Bureau of Reclamation, 1977.

- a. Normal Pool with the reservoir at the spillway crest
- b. One half PMF, water flowing over the spillway crest at a depth of 7.5 feet
- c. PMF, water flowing over the spillway crest at a depth of 9.98 feet.

The basis of the analysis is contained in Appendix D and is summarized in the table on the following page.

The analyses indicates sliding safety factors, for the strength parameters selected, are below the recommended minimum safety factor of 3 for nearly all loading conditions without earthquake, and 1.5 when earthquake loading is included. For overturning stability, the analysis indicates the resultant of the applied forces is outside the middle third of the spillway crest section for most cases of half and full PMF as well as several conditions at normal pool elevation. The one major overturning force which can not be accurately evaluated is that of hydrostatic uplift. For this reason it is recommended that the actual distribution and magnitude of the hydrostatic uplift pressures be determined and based on these results additional structural stability analyses be performed.

c. Seismic Stability

The dam is situated in Seismic Zone 3, therefore, a seismic stability analyses was performed using the Zanger hydrodynamic pressure distribution which is similar to the Westergaard distribution recommended by the Corps of Engineers guidelines. The analysis was performed under normal pool, half PMF and full PMF. The results are tabulated on the following page and these indicate the spillway is marginally stable under all conditions except maximum ice load (10 kips) at normal pool and the PMF storm event.

FREDONIA RESERVOIR SPILLWAY
SUMMARY OF STABILITY ANALYSES

CASE	LOADING CONDITIONS				FACTOR OF SAFETY		Resultant Within Middle 1/3	Resultant Within Base
	Full Uplift	1/2 Uplift	Ice	Seismic (Zone 3)	Overturning	Sliding		
Normal		X	X		1.20	1.16	No*	Yes
	X		X		1.01	1.08	No*	Yes
	X		X	X	0.97	0.95	No	No*
		X	X	X	1.14	1.02	No	Yes
	X				2.81	13.1	Yes	
1/2 PMF		X			4.92	14.1	Yes	
	X				1.28	2.19	No*	Yes
	X			X	1.20	1.57	No	Yes
		X			2.07	2.55	Yes	
PMF		X		X	1.85	1.83	Yes	
	X				1.09	1.64	No	Yes
	X			X	1.02	1.23	No	Yes
		X			1.74	1.97	Yes	
		X		X	1.57	1.48	No	Yes

*Resultant of applied loads falls outside middle 1/3 for non-seismic loadings and outside base for seismic loadings.

SECTION 7: ASSESSMENT/RECOMMENDATIONS

7.1 ASSESSMENT

a. Safety

The Phase I inspection of the Fredonia Reservoir Dam revealed numerous conditions which, if left uncorrected, could constitute a hazard to human life and property of the downstream residents.

From the available data the spillway is capable of discharging 34 percent of the PMF without flow occurring in the notched earthen section. The spillway is, therefore, judged to be "seriously inadequate" and the dam considered to be unsafe, non-emergency.

Existing conditions observed during the visual inspection revealed problems which could jeopardize the integrity of the structure. The conditions are as follows:

- 1) Rotational inward movement of the concrete spillway retaining walls
- 2) Seepage exiting the west side of the spillway and on the downstream slope of the west embankment
- 3) Water flowing in the lower half of the downstream slope at the west abutment-embankment contact of the east embankment could constitute a serious problem if the source of this water is from seepage through the embankment or along the abutment-embankment contact

The structural stability analyses performed as part of this investigation indicates the spillway is not stable against sliding or overturning for nearly all loading conditions.

The downstream embankment slopes are, in our opinion, steeper than would presently be recommended for embankment materials composed of a silty clay, which we believe to be the case.

b. Adequacy of Information

The information which was reviewed is considered to be adequate for Phase I study purpose.

c. Need for Additional Inspection

Additional investigation, monitoring and analyses are required for this structure because of the conditions and deficiencies disclosed by this Phase I inspection. These investigations and analyses are grouped into three (3) separate study areas, all of which are interrelated. The study areas and specific tasks within each study area are as follows:

- 1) Study Area No. 1 - Perform a detailed hydrologic/hydraulic investigation and analysis of this structure
 - o Determine the site specific characteristics of the watershed and their affect upon the overtopping potential of the dam
 - o Determine appropriate remedial measures to achieve a spillway capacity capable of discharging the outflow from 1/2 the PMF
- 2) Study Area No. 2 - Perform a detailed investigation and analysis of the structural stability of the spillway
 - o Determine the magnitude and distribution of the hydrostatic uplift pressure perpendicular to the spillway
 - o Determine the source of seepage west of the spillway emerging near elevation 1021+ and the appropriate remedial measures to correct or mitigate this deficiency
 - o Determine the cause of the distress and resulting rational movement of the spillway retaining walls and provide recommendation(s) to correct this condition.
 - o Determine the soil strength parameters (C& ϕ) for those soils which affect the structural stability of the spillway

3) Study Area No. 3 - Perform a detailed investigation and analysis of the embankment downstream slope stability

- o Determine the source of seepage through the west embankment, the source of water observed to be flowing in the west abutment-embankment contact of the east embankment and provide the appropriate recommendation(s) to correct these conditions
- o Determine the location of the phreatic surface in the embankment and the soil strength parameters (C& ϕ) of the embankment and foundation materials
- o Provide the appropriate recommendations based on the slope stability analysis. These recommendations should also consider the influence of removing the existing heavy tree cover and methods of stabilizing the surface creep and surface sloughing problem which presently exists and could be further aggravated by indiscriminate tree removal

d. Urgency

The above studies and investigations should be initiated within 3 months and completed within 18 months after notification has been made to the owner.

7.2

RECOMMENDED REMEDIAL MEASURES

a. General

Develop and implement within 3 months a monitoring and warning system for the structure as well as an evacuation plan for downstream residents in the event of large spillway discharge.

b. Specific Areas

The following deficiencies should be corrected within the first construction season following notification to the owner.

1) Spillway

- o Restore spillway wingwalls to original construction
- o Patch and fill all cracks in the spillway
- o Remove debris from spillway

2) Embankments

- o Place and compact embankment type material along all eroded embankment-abutment contacts
- o Provide erosion protection along abutment-embankment contacts and the berm on the west embankment downstream slope
- o Bench, place and compact any embankment slips or sloughs
- o Place and compact embankment type material adjacent to the spillway crest where the level of existing grades is below the top of the retaining wall (see as-built drawing in Appendix G - Survey by Thomsen Associates-1980)
- o Place and compact embankment material where concrete corewall is exposed and regrade west embankment crest to the elevation and dimension of the east embankment crest

c. Future Remedial Measures

Those remedial measures recommended as a result of the additional investigations noted in Section 7.1 should be completed within the first construction season following the completion of the additional investigation.

APPENDIX A

PHOTOGRAPHS



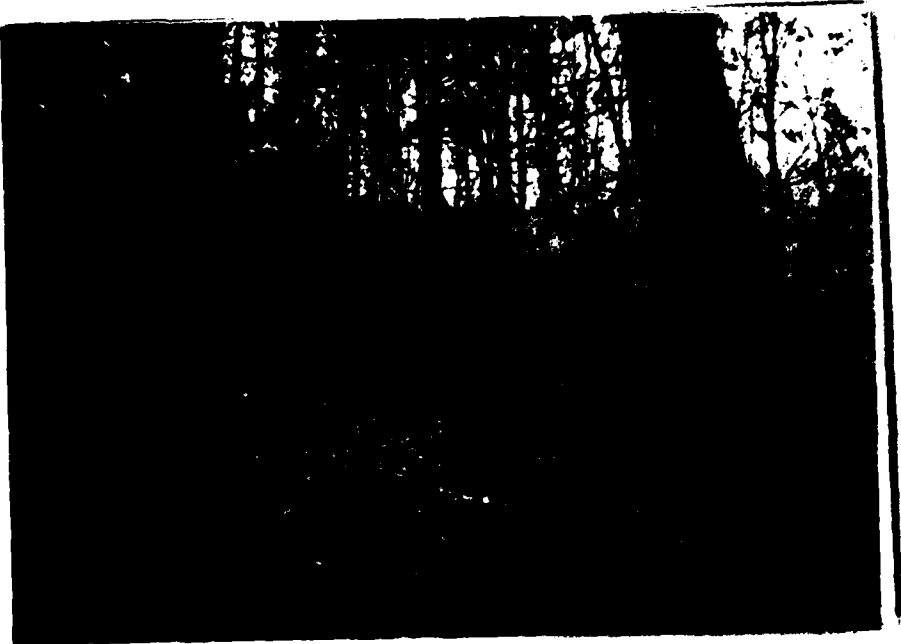
View of Upstream Slope-
East Embankment
Note: Trees on Slope



View of Crest-East Embank-
ment. Note: Upstream Slope-
Right hand side of Photo
Downstream Slope-Left hand
side of Photo



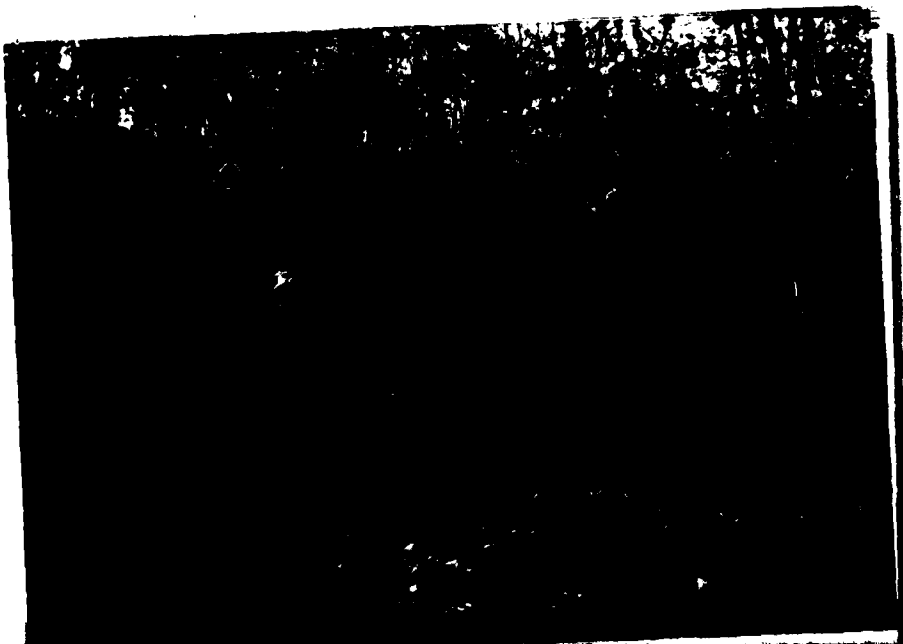
View of Downstream Slope-East
Embankment
Note: Trees on Slope



View of Downstream Slope-East
Embankment from East Embankment
Abutment Contact. Note: Bowed
tree trunk near center of photo
(Evidence of Surface Creep)



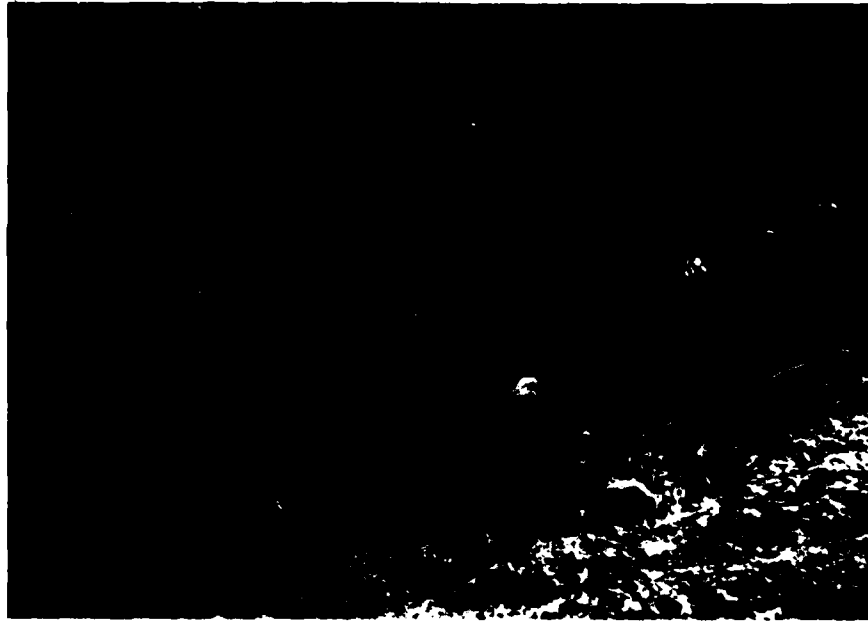
View of Downstream Slope and
Rock Fill at Toe of East Embank
ment, Note: Trees on Slope and
in Rock Fill, Rust Colored
Standing Water at Toe of Rock
Fill.



View of Downstream Slope and
Rock Fill at Toe of West Emban
ment, Note: Trees on Slope and
in Rock Fill, Rust Colored
Standing Water at Toe of Rock
Fill.



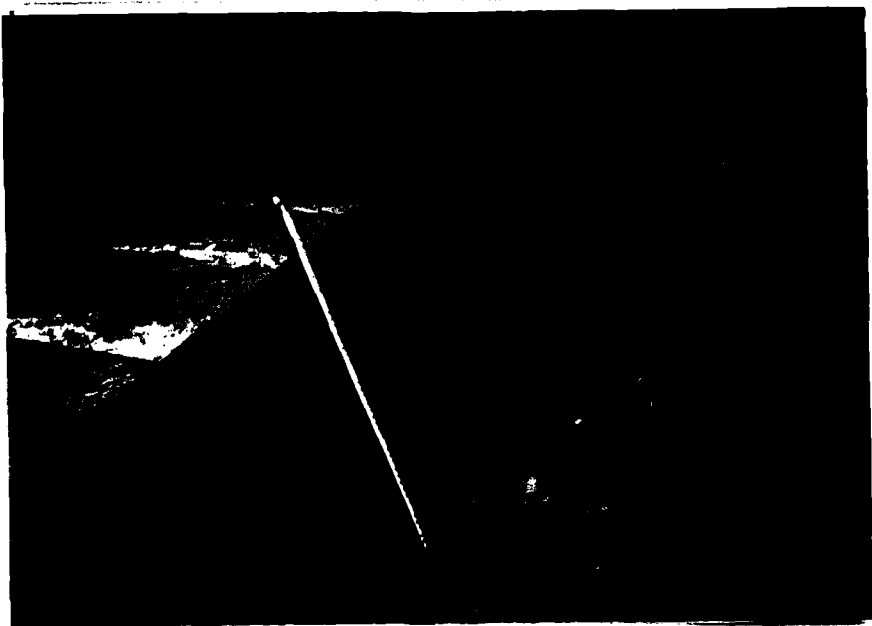
View of Spillway & Spillway Exit
channel from east embankment.
Note: Inward movement of Wing-
wall and erosion behind wingwall,
log in spillway.



View of Downstream Slope-West
Embankment. Note: Seeps emerging
from embankment upslope of the
rock filled toe.



View of Downstream Slope-West
Embankment, Evidence of Surface
Sloughing-Note: Scrap in Center
of Photo with toe of surface
slough in lower right hand corner
of photo where tree trunk bowed.



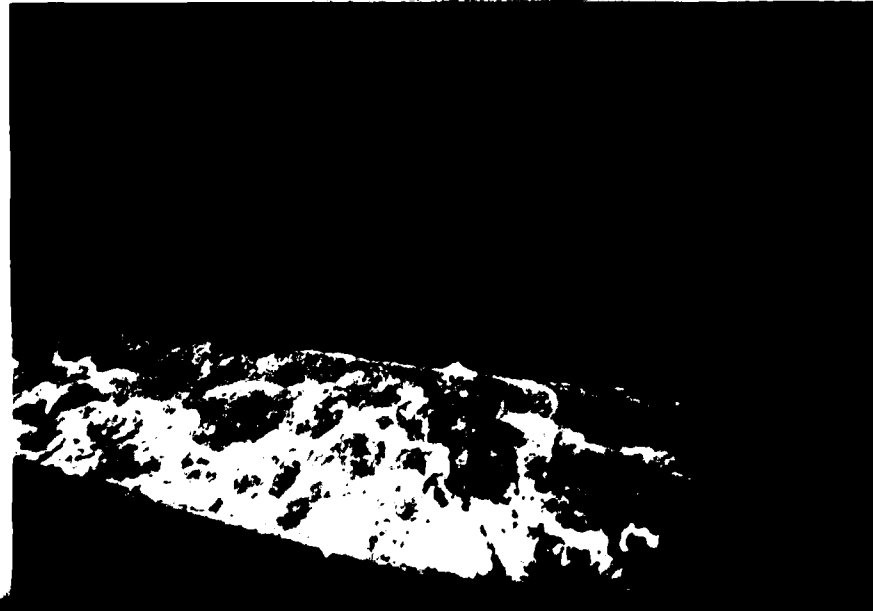
View of Erosion behind east wing
wall of Spillway exit channel
Note: Movement of Wingwall



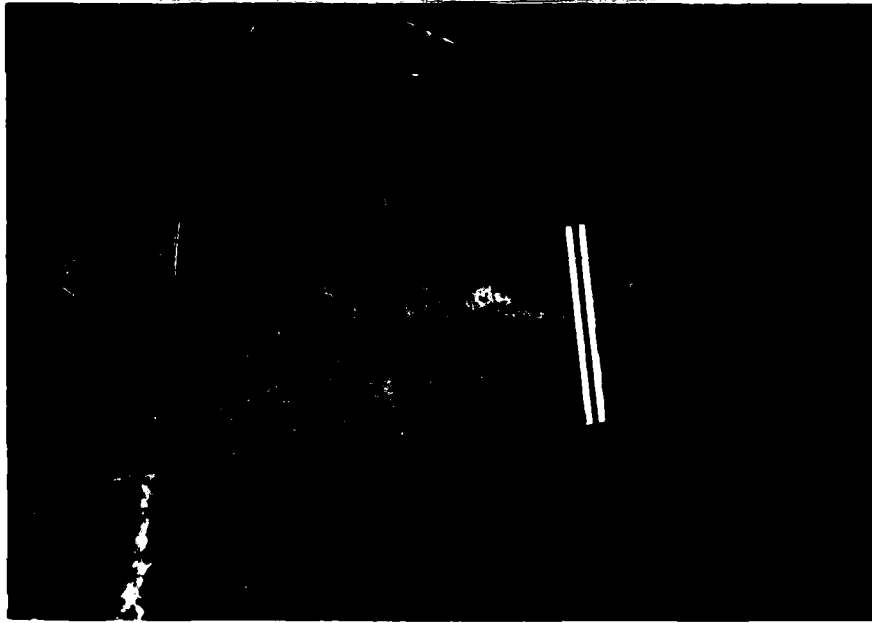
View of Erosion Behind west
wingwall of Spillway Entrance
Channel.



View of East Wingwall of Spill-
way Exit Channel Note: Bearing
Plates of Tie Back System used
to minimize wall movement.



View Looking Downstream of
Stepped Spillway Channel to
Tailwater.



View of Crack in East Spillway
Wingwall.



View of Crack in Spillway
Exit Channel.



- View of Stepped Spillway
Channel.



- View of Downstream Channel be-
low Spillway Note: Structure
in Center of Photo is abandoned
Intake Structure for Breached
Masonry Stone Dam.



- View of Downstream Portal for
Rock Tunnel under East Embank-
ment: Tunnel has Intake Pipes
to Filtration Plant and Reser-
voir Drain Pipe.



View of Downstream Face of
Breached (Notched) Masonry
Stone Dam which controls the
tailwater elevation of
Fredonia Reservoir.

APPENDIX B

VISUAL INSPECTION CHECKLIST

THOMSEN ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS & GEOLOGISTS

VISUAL INSPECTION CHECKLIST

1) Basic Data

a. General

Name of Dam Frederick Reservoir
I.D. # 33-608 DEC. Dam No. NY 747
River Basin Lake Erie
Location: Town Poultice County Chautauque
U.S.G.S. Quadrangle Dunkirk
Stream Name West Branch Sandaway Creek
Tributary of Sandaway Creek
Latitude (N) 42° 23.3' Longitude (W) 79° 13.7'
Type of Dam Earth Embankment w/ Concrete Conduit, 12 inch Dia. 21 ft. high
Hazard Category High
Date(s) of Inspection 5/14/80, 5/15/80 & 5/22/80
Weather Conditions 5/14 - Cloudy, 5/15 & 5/22 - Clear
Reservoir Level at Time of Inspection 1026.1
Tailwater Level at Time of Inspection 989.0

b. Inspection Personnel Charles T. Gaynor - Town Supervisor
Shirley E. Woldt - McFarland - Town Engineer

c. Persons Contacted (Including Address & Phone No.)
16 George Notbrown - Village of Frederick - Engineer
Village Hall, Town & Church St., Frederick, New York
716-679-4741

d. History:
Date Constructed 1937 Date(s) Reconstructed _____

Designer Frederick, Tallant & Jones, Consulting Engineers, W. Versaille, N.Y.
Constructed by W.P.A.
Owner Village of Frederick, New York

e. Seismic Zone Zone 3

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VISUAL INSPECTION CHECKLIST

2) Embankment

a. Characteristics

- 1) Embankment Material East Emb - Silty Clay, West
Emb - Silty Clay
- 2) Cutoff Type Conc. Cutoff Terrace on Rock Foundation through
Max. Sections, Steel Sheet Piles (SP-4-16") near Abutment
- 3) Impervious Core Conc. Corewall
- 4) Internal Drainage System Stone Drain Terrace
- 5) Miscellaneous

b. Crest

- 1) Vertical Alignment East - OK, West - OK
- 2) Horizontal Alignment East - OK, West - Crowned & Sloped
away from exposed Conc. Corewall
- 3) Surface Cracks None Observed
- 4) Miscellaneous

c. Upstream Slope

- 1) Slope (Estimate) (V:H) East - 1.85, West 1.86
- 2) Undesirable Growth or Debris, Animal Burrows Both Embankments
are Heavily Weeded
- 3) Sloughing, Subsidence or Depressions None Observed

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VISUAL INSPECTION CHECKLIST

4) Slope Protection NONE

5) Surface Cracks or Movement at Toe NOT OBSERVED

d. Downstream Slope

1) Slope (Estimate - V:H) East - 1:2, West - 1:2.3

2) Undesirable Growth or Debris, Animal Burrows East -

West Embankment is both heavily wooded

3) Sloughing, Subsidence or Depressions Evidence of Surface

Cracks - Potential for Down-Slope Slides both Embankments

West Embankment - Slough near East Abutment along Road

4) Surface Cracks or Movement at Toe Evidence None

Detected in Embankment Slopes

5) Seepage East - None Observed, West - Seepage emerging

above Right-of-Way line south of embankment to

West abutment

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

Graded Stone Gutters at Embankment-Abutment Contact shown on Plans,

EAST Side - Gutters badly eroded and missing along east abutment,

WEST Side - Gutters badly eroded and missing along both abutments.

7) Condition Around Outlet Structure OK - No Seepage

Along West Side of Spillway

8) Seepage Beyond Toe East - None West - Seepage

in East Abutment through natural rock outcrops

e. Abutments-Embankment Contact

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VISUAL INSPECTION CHECKLIST

- 1) Erosion at Contact East Dam - Erosion along east abutment along lower half of embankment. West Dam - Erosion along both contacts.
- 2) Seepage Along Contact East Dam - Wet areas detected in remains of June gutters along west abutment lower 1/2 of embankment. West Dam - None

3) Drainage System

- a. Description of System Internal Stone Underdrains shown on plans. Rock fill at toe of embankments. Foundation drains shown along Stillman Wingwall.
- b. Condition of System Not observable
- c. Discharge from Drainage System None Observed. Note: Rust colored staining water downstream of rock filled toe at both embankments

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

NONE

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VISUAL INSPECTION CHECKLIST

5) Reservoir

- a. Slopes Moderate to Steep Slopes - Forested
- b. Sedimentation Sedimentation has occurred, Turbidity of Reservoir Water quite high following Sept. 1979 Flood
- c. Unusual Conditions Which Affect Dam _____

6) Area Downstream of Dam

- a. Downstream Hazard (No. of Homes, Highways, etc.) None known Along Canadian Creek, Serious Erosion of Creek due to Sept. 1979 Flood
- b. Seepage, Unusual Growth Natural Seepage through Bedrock Interiors
- c. Evidence of Movement Beyond Toe of Dam None
- d. Condition of Downstream Channel Trail water signficantly controlled by Remains of Masonry Dam which was notched as part of this dam construction in 1937 ±

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

- a. General Concrete Ogee Weir
- b. Condition of Service Spillway Wingwall (Retaining Wall) east side of Spillway has moved inward ≈ 6" inches, Erosion behind wall 3' Deep by 4' wide by 8' Long, Several large cracks in Wall, Wingwall west of Spillway has moved inward 1" to 2". Tie back added to both wall along east wingwall. Total 7 tiebacks each wall, ≈ 9' centers

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VISUAL INSPECTION CHECKLIST

c. Condition of Auxiliary Spillway Noted Embankment
on either side of spillway, grass covered
on East Embankment crest, wooded on West embankment
(See Survey Data of Spillway & East Embankment)

d. Condition of Discharge Conveyance Channel Good Some
minor cracking along construction joints. Construction
joints need to be refilled. Note: Seepage
emerging from embankment along west side of spillway
at Elev. 1012 ±

8) Reservoir Drain/Outlet

Type: Pipe ☒ Conduit _____ Other _____

Material: Concrete _____ Metal ☒ Other _____

Size: _____ Length _____

Invert Elevations: Entrance 1016.2 ± Exit 976 ±

Physical Condition (Describe): _____ Unobservable ☒

Material: _____

Joints: _____ Alignment _____

Structural Integrity: _____

Hydraulic Capability: _____

Means of Control: Gate _____ Valve ☒ Uncontrolled _____

Operation: Operable ☒ Inoperable _____ Other _____

Present Condition (Describe): Operated on 5/22/80

Drain is a tee connection of intake pipe to
Filtration Plant

No Operation & Maint. Records

No Warning System or Evacuation Plans

No Records on Reservoir Level or Spillway Discharge

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9) Structural

- a. Concrete Surfaces Spillway - Good, Exposed
Top of Concrete Corewall - Badly Deteriorated
- b. Structural Cracking Several Structural Cracks in
Spillway Retaining Wall along Exit Channel
- c. Movement - Horizontal & Vertical Alignment (Settlement)
Vertical - OK
Horizontal - 6" Movement of Spillway Wingwall East Side
1" to 2" Movement of " " West Side
- d. Junctions with Abutments or Embankments Erosion at
Junction of embankment along East Wingwall of
Spillway
- e. Drains - Foundation, Joint, Face Foundation Drains along
along Wingwalls for Spillway
- f. Water Passages, Conduits, Sluices Concrete Open Weir
- g. Seepage or Leakage Seepage emerging from
outside West Spillway Wingwall along
embankment near elevation 1012.0

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- h. Joints - Construction, etc. Most good, some
Along Exit channel of Spillway, need to be
filled
- i. Foundation Primarily Rock
- j. Abutments N.A.
- k. Control Gates N.A.
- l. Approach & Outlet Channels Erosion along ^{west} contact between
Approach channel and embankment
- m. Energy Dissipators (Plunge Pool, etc.) Stress on Section
From Outlet (Exit) Channel to Tailwater
- n. Intake Structures Unobservable
- o. Stability Retaining (Wingwalls) Wall of Spillway
Questionable stability based on past movement
- p. Miscellaneous Retaining Wall repairs in Village
of Fredonia, Budget, Work to be completed in 1960

APPENDIX C

HYDROLOGIC/HYDRAULIC ENGINEERING
DATA AND COMPUTATIONS

THOMSEN ASSOCIATES

CONSULTING GEOTECHNICAL ENGINEERS & GEOLOGISTS

CHECK LIST FOR DAMS HYDROLOGIC AND HYDRAULIC ENGINEERING DATA

AREA-CAPACITY DATA:

	<u>Elevation</u> (ft.)	<u>Surface Area</u> (acres)	<u>Storage Capacity</u> (acre-ft.)
1) Top of Dam	<u>1044.8</u>	<u>65</u>	<u>1521</u>
2) Design High Water (Max. Design Pool)	<u>1042.0</u>	<u>58</u>	<u>1344</u>
3) Auxiliary Spillway Crest	<u>N.A.</u>	<u>N.A.</u>	<u>N.A.</u>
4) Pool Level with Flashboards	<u>N.A.</u>	<u>N.A.</u>	<u>N.A.</u>
5) Service Spillway Crest	<u>1036.0</u>	<u>43</u>	<u>1024</u> (Est. at time of Design)

DISCHARGES

	<u>Volume</u> (cfs)
1) Average Daily	<u>Unknown</u>
2) Spillway @ Maximum High Water (Top of Dam)	<u>8320</u>
3) Spillway @ Design High Water (Top of Conc. Wingwalls)	<u>4224</u>
4) Spillway @ Auxiliary Spillway Crest Elevation	<u>N.A.</u>
5) Low Level Outlet (Reservoir Drain)	<u> </u>
6) Total (of all facilities) @ Maximum High Water	<u> </u>
7) Maximum Known Flood	<u>Unknown</u>

THOMSEN ASSOCIATES

CONSULTING GEOTECHNICAL ENGINEERS & GEOLOGISTS

OUTLET STRUCTURES/EMERGENCY DRAWDOWN FACILITIES:

Type: Gate ☒ Sluice ☐ Conduit ☐ Penstock ☐

Shape: Circular

Size: 12"

Elevations: Entrance Invert 1016.0

Exit Invert 976.0

Tailrace Channel: Elevation

HYDROMETEROLOGICAL GAGES:

Type:

Location: Nearest Meteorological Gage at Cornell Experimental Station
Fredonia, New York

Records:

Date -

Max. Reading -

FLOOD WATER CONTROL SYSTEM:

Warning System: NONE

Method of Controlled Releases (mechanisms):

Reservoir Drains w/ Manually Operated Gate Valve
NEAR exit portal of Tunnel under east embankment

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CREST:

ELEVATION: 1044.3

Type: Earth Embankment w/ Core Cutoff Dam & Grout

Width: 110' Length: East Embankment - 220'
West Embankment - 200'

Spillover Concrete Ogee Weir

Location Between East & West Embankment

SPILLWAY:

PRINCIPAL

EMERGENCY

<u>1036.0</u>	Elevation	<u>VARIES to Elevation 1044.8'</u>
<u>Concrete Ogee Weir</u>	Type	<u>Earth Cut (Not a Weir) Next to Spillway</u>
<u>75 feet</u>	Width	<u>VARIES</u>

Type of Control

✓ Uncontrolled ✓

Controlled:

Type
(Flashboards; gate)

Number

Size/Length

Invert Material

Anticipated Length of operating service @ PMF - 7 hrs
1/2 PMF - 2.5 hrs

90 feet Chute Length 11 feet (width of weir crest)

4 feet Height Between Spillway Crest & Approach Channel Invert
(Weir Flow) VARIES

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DRAINAGE AREA: 5.5 sq miles

DRAINAGE BASIN RUNOFF CHARACTERISTICS:

Land Use - Type: Forested

Terrain - Relief: Moderate to Steep

Surface - Soil: Laminar Silt, Sand & Clay

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

No Changes Anticipated in Watershed

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

Some Sedimentation of Reservoir has occurred in the Past, Downstream Sedimentation is not a problem.

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

None

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

Location: None

Elevation: _____

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JOB 74
SHEET NO 1 OF 1
CALCULATED BY P.C. DATE 2/2/55
CHECKED BY _____ DATE _____
SCALE _____

D.A. = 0.55 sq. mile
L = 19600 ft. = 3.71 mi., L_c = 1.13 mi.
ESTIMATION OF LAG TIME

$$t_p = (t(0.955)(L \cdot L_c)^3 + .25 t_R) \\ = 1.7(0.955)(3.71 \times 1.13)^3 + .25(5) \\ = 2.62 \text{ hr.}$$

Check of Lag time

$$\text{Avg. Slope of the basin} = \frac{1450 - 1060}{13200} \times 100 = 2.95\%$$

Using Lagging, which is further down.

$$t_1 = 0.72 \left(\frac{L \cdot L_c^{.33}}{.45} \right) = 0.72 \left(\frac{3.71 \times 1.13}{\sqrt{.0295}} \right)^{.33} = 2.42 \text{ hr.}$$

For HEC-1 input, $t_p = 2.62$ hr. and $C_t = 0.43$ were used in the hydrograph.

POSSIBLE MAXIMUM PRECIPITATION

From Hydrometeorological Report # 42, for Lake Ontario
Precipitation = 2.27 inches (For 200 sample - 30 hr. duration)

Let's - Area Duration Relationship (7.1)

6 hr. = 116"
12 hr. = 127"
24 hr. = 141"

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JOB _____
SHEET NO _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____
SCALE _____

STAGE-DISCHARGE DATA

ELEVATION (Ft.)	RELEASE SURF (ACRES)	RUN-AROUND (ACRES)	INCREASING STORAGE (ACRES)	STAGE (Ft.)	REMARKS
1036	4	0.2	206	0	Just after flood, 1935
1040	55	65.5	655	206	U.S.G.C. gauge at "Dunkirk", N.Y.
1050	76			241	

STAGE-DISCHARGE COMPUTATION

Normal Pool Elevation - 1035
Elevation of top of dam - 1044.0

Length of spillway - 75'
Length of dam - 670'

Discharge channel is under the dam, 40 ft. wide with a
Note: Elevation and flow with ground datum and not U.S.C.C.
The built spillway is different than the one indicated in the
drawings. Elevation of the top of the dam was obtained from
field survey.

Assumptions:

- (1) Coefficient of discharge varies with the head on
spillway.
- (2) Spillway loss head is 2'
- (3) Tailwater elevation is computed with respect
to the calculation of discharge by channel

STAGE-DISCHARGE COMPUTATIONS (CONT.)

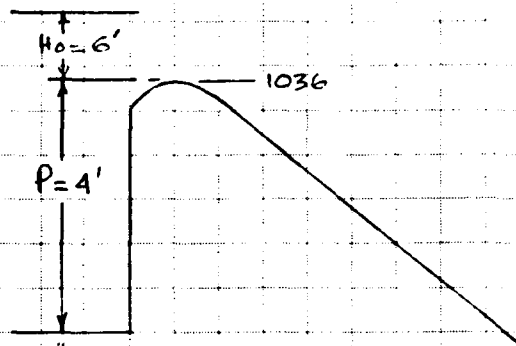
Design head = $H_0 = 6'$

Actual head = H_e

From Fig. 249, PP. 378 of "Design of Small Dams,"

$$1/H_0 = 4/6 = 0.67, C_0 = 3.84$$

From Fig. 250 of "Design of Small Dams"

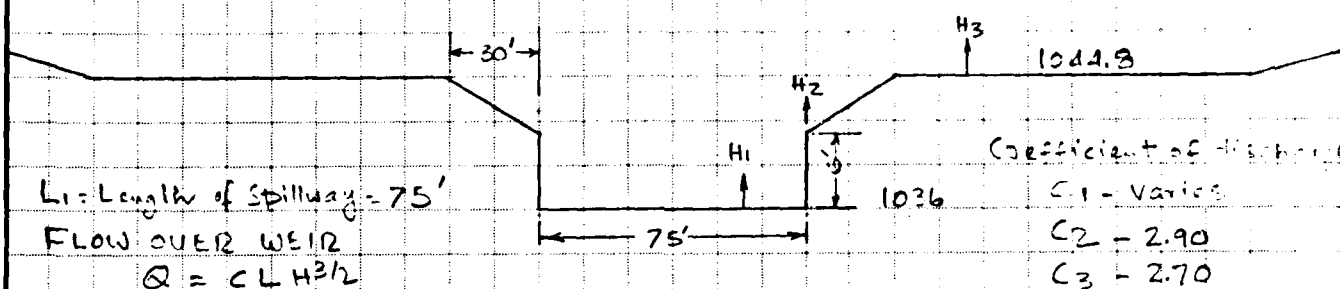


$H_e \leq 1'$	$H_e/H_0 = 1/6 = 0.17$	$C/C_0 = 0.84$	$C = 0.84 \times 3.84 = 3.23$
$H_e \leq 2'$	$H_e/H_0 = 2/6 = 0.33$	$C/C_0 = 0.885$	$C = 0.885 \times 3.84 = 3.40$
$H_e \leq 3'$	$H_e/H_0 = 3/6 = 0.50$	$C/C_0 = 0.92$	$C = 0.92 \times 3.84 = 3.53$
$H_e \leq 4'$	$H_e/H_0 = 4/6 = 0.67$	$C/C_0 = 0.95$	$C = 0.95 \times 3.84 = 3.65$
$H_e \leq 5'$	$H_e/H_0 = 5/6 = 0.83$	$C/C_0 = 0.976$	$C = 0.976 \times 3.84 = 3.75$
$H_e \leq 6'$	$H_e/H_0 = 6/6 = 1.0$	$C/C_0 = 1.0$	$C = 1.0 \times 3.84 = 3.84$
$H_e \leq 7'$	$H_e/H_0 = 7/6 = 1.17$	$C/C_0 = 1.02$	$C = 1.02 \times 3.84 = 3.92$
$H_e \leq 8'$	$H_e/H_0 = 8/6 = 1.33$	$C/C_0 = 1.04$	$C = 1.04 \times 3.84 = 3.99$
$H_e \leq 9'$	$H_e/H_0 = 9/6 = 1.5$	$C/C_0 = 1.06$	$C = 1.06 \times 3.84 = 4.07$
$H_e \leq 10'$	$H_e/H_0 = 10/6 = 1.67$	$C/C_0 = 1.07$	$C = 1.07 \times 3.84 = 4.10$
$H_e \leq 11'$	$H_e/H_0 = 11/6 = 1.83$	$C/C_0 = 1.07$	$C = 1.07 \times 3.84 = 4.10$

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SHEET NO. 1 OF 2
CALCULATED BY P.S. DATE 7/1/81
CHECKED BY _____ DATE _____
SCALE _____

STAGE-DISCHARGE COMPUTATIONS (CONT'D)



ELEV. (+ft)	H ₁ (+ft)	H ₁ ^{3/2} (+ft)	C ₁	H ₂ (+ft)	H ₂ ^{3/2} (+ft)	L ₂ (+ft)	H ₃ (+ft)	H ₃ ^{3/2} (+ft)	L ₃ (+ft)	Q ₁ (cfs)	Q ₂ (cfs)	Q ₃ (cfs)	TOTAL DISCHARGE
1036	0	0	-							0			0
1037	1	1	3.22							241			241
1038	2	2.83	3.40							722			722
1039	3	5.20	3.53							1377			1377
1040	4	8.0	3.65							2190			2190
1041	5	11.18	3.75							3144			3144
1042	6	14.7	3.84							4234			4234
1043	7	18.52	3.92	1	1	13.33				5445	39		5484
1044	8	22.62	3.99	2	2.83	26.66				6769	219		6988
1045	9	27	4.07	3	5.20	40.0	0.2	0.089	670	8242	623	162	9027
1046	10	31.62	4.10	4	8.0	60.0	1.7	1.314	670	9723	1352	2378	13453
1047	11	36.48	4.10	5	11.18	75.0	2.2	2.242	670	11218	1945	5453	17016

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JOB SPILLWAY DESIGN Draw # 1
 SHEET NO. 5 OF 5
 CALCULATED BY P.S. DATE 7/1/50
 CHECKED BY _____ DATE _____
 SCALE _____

Tailwater Computation in Spilling channel (downstream)

Since computing depth flow in the downstream channel it was assumed that the water flowing over the top of the dam will not get back to the channel immediately downstream of spillway. The channel downstream is reaching for about 40' L. with $S_o = .02$ and $n = .015$.

Using Table 7-11 of King & Cooper "Handbook of Hydraulics"

Q	K'	d/b	d	Q	K'	d/b	d
241	.0013	.014	0.56	4234	.0240	.07	3.60
722	.0041	.030	1.20	5481	.0310	.106	4.24
1377	.0078	.044	1.76	6988	.0396	.124	4.96
2190	.0124	.060	2.40	8845	.050	.145	5.90
3144	.0178	.073	2.92	11115	.063	.17	6.80
				12163	.0746	.19	7.60

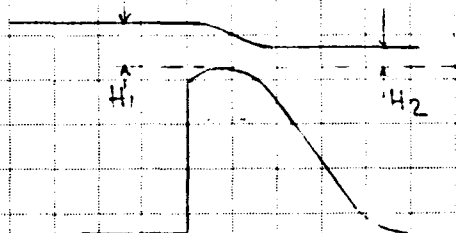
Note: The above computations indicate that the crest will be submerged from discharge of 5481 CFS. and above. Therefore the spillway discharge would be reduced due to the tailwater effect.

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JOB: _____
SHEET NO. 6 OF 6
CALCULATED BY P.C. DATE 7/2/77
CHECKED BY _____ DATE _____
SCALE _____

REVISED STAGE-DISCHARGE DATA FOR "D" TAILWATER
Using Fig 5-5, 11-5-12 of King & Brater "Handbook of Hydraulics"

ELEV.	H ₁	H ₂	H ₂ /H ₁	(H ₂ /H ₁) ³	Q/Q ₁	Q ₁ (cfs)	OVERALLING DISCHARGE (cfs)
1043	7	0.24	.034	.006	0.995	5481	5487
1044	8	0.96	.12	.041	0.98	6988	6845
1045	9	1.8	.20	.079	0.96	8845	8491
1046	10	2.8	.28	.148	0.94	11115	10443
1047	11	3.6	.33	.197	0.92	12143	12041

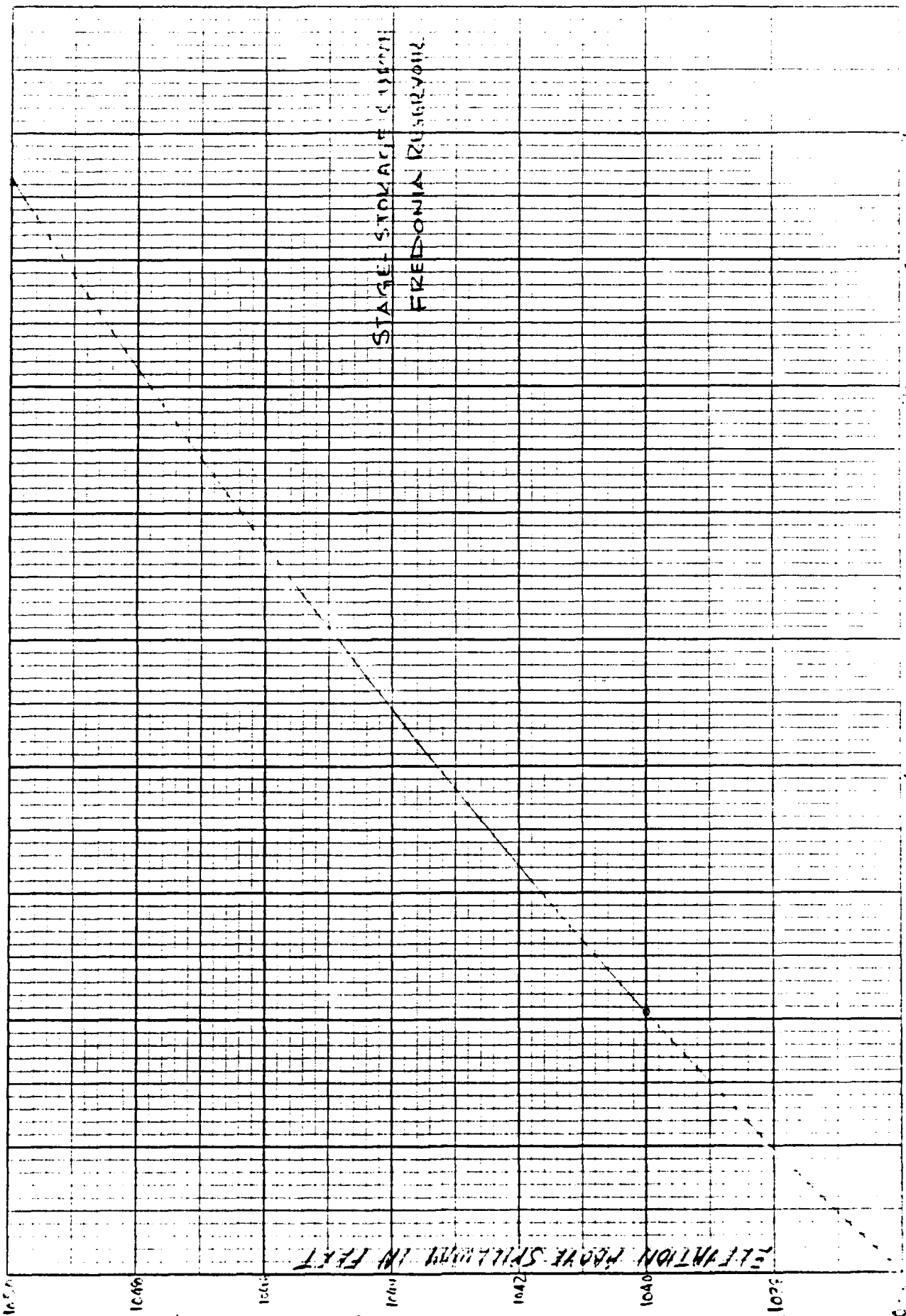


REVISED STAGE-DISCHARGE DATA

ELEV.	DISCHARGE	ELEV.	DISCHARGE	ELEV.	DISCHARGE
1036	0	1040	2190	1044	6843
1037	241	1041	3144	1045	8653
1038	722	1042	4234	1046	12824
1039	1377	1043	5457	1047	17947

K.E 10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

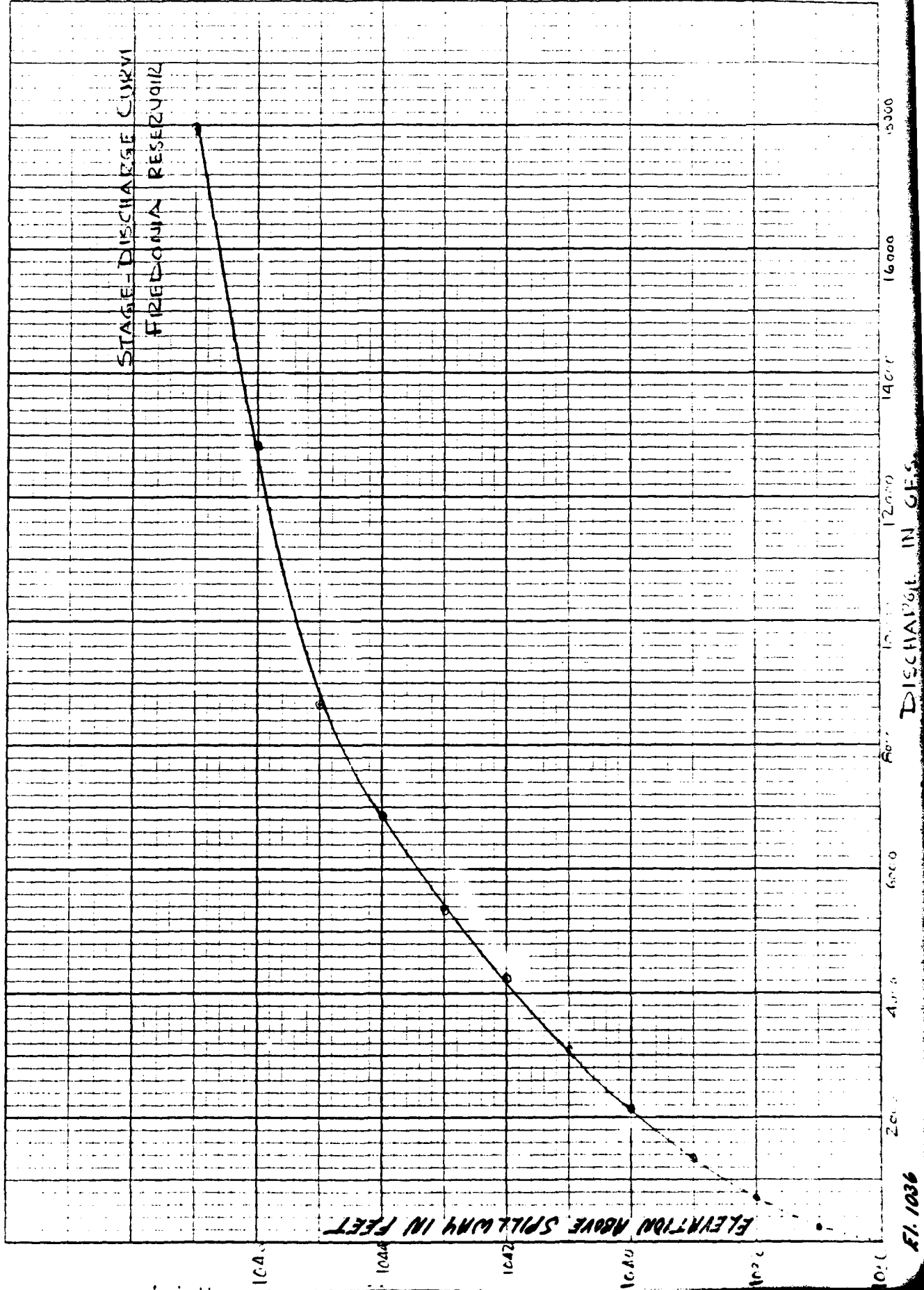
46 0782

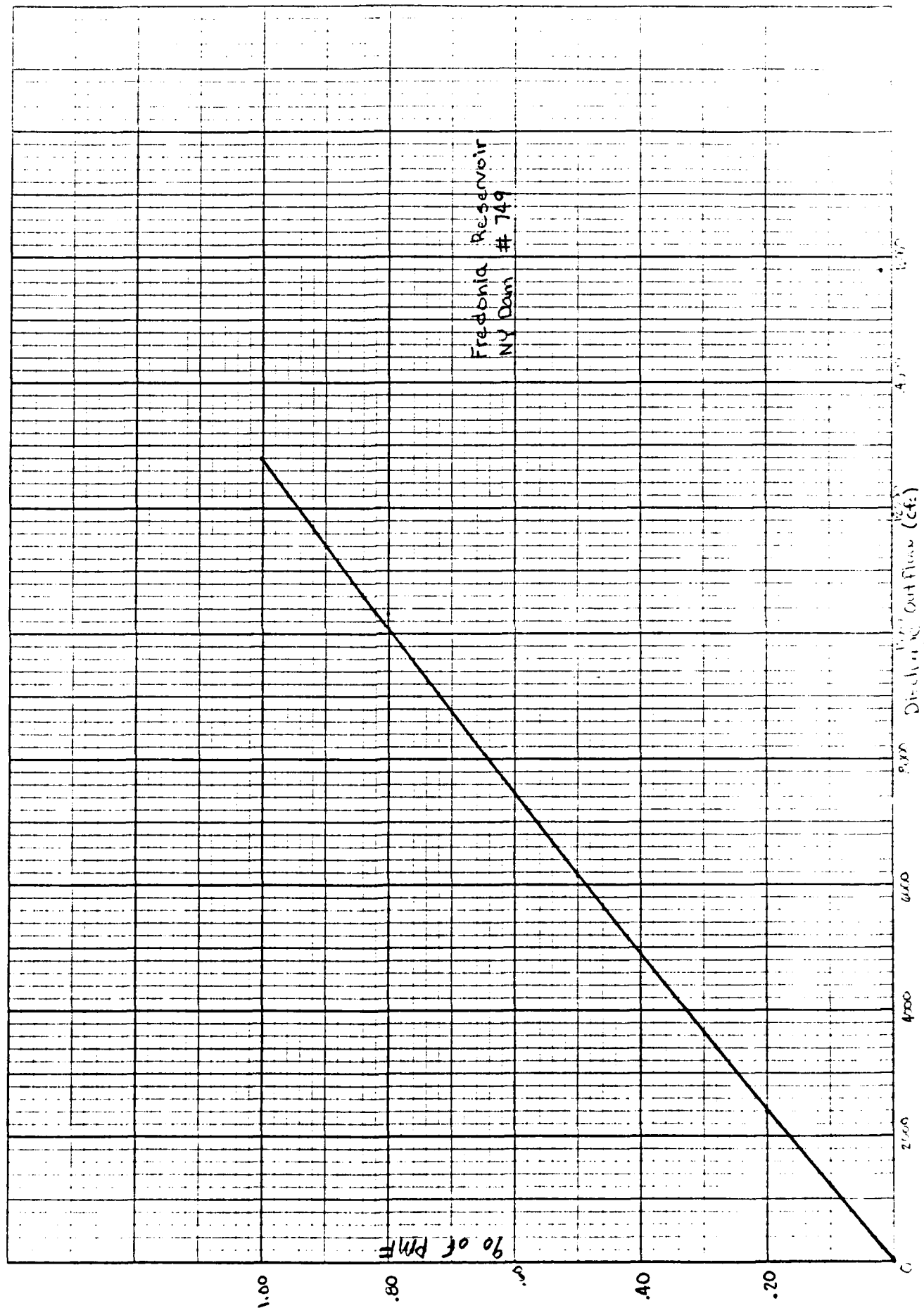


STAGE STORAGE CURVE
FREDSONIA RESERVOIR

SL 1036

STORAGE IN ACRES





 FUJIO HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1975
 LAST MODIFICATION 20 Feb 75

		ANALYSIS OF DAM OVERTOPP HYDROLOGIC-HYDRAULIC ANAL RATIOS OF PMF ROUTED TH				
1	A1					
2	A2					
3	A3					
4	B	150	0	30	0	0
5	E1	5				
6	J	1	5	1		
7	J1	.2	.35	.50	.65	.80
8	K	0	1	0	0	0
9	K1	CALCULATION OF INFLOW HYDROGRAPH				
10	A	1	1	5.55	0	5.55
11	P	0	22.7	116	127	141
12	T	0	0	0	0	0
13	W	2.52	.63			
14	X	-2	-.1	2		
15	K	1	2	0	0	0
16	K1	ROUTING OF INFLOW HYDROGRAPH				
17	Y	0	0	0	1	1
18	Y1	1	0	0	0	0
19	Y4	1036	1037	1038	1039	1040
20	Y4	1040	1047			
21	Y5	0	241	722	1377	2190
22	Y5	10455	12044			
23	SS	0	43	94	150	206
24	SS	575	643			
25	SE	1036	1037	1038	1039	1040
26	SE	1040	1047			
27	SS	1036				
28	S01044.3		2.7	1.5	670	
29	K	93				

OVERTOPPING USING RATIOS OF PMF
 LIC ANALYSIS OF SAFETY OF NY 749
 DUTED THROUGH THE RESERVOIR

0	0	0	0	0	0
.80	1				
0	0	1			
ROGRAPH					
5.55	0	0	0	0	0
141	0	0	0	0	0
0	0	1	.1	0	0
0	0	1	0	0	0
RAPH					
1					
0	0	-1036	-1		
1040	1041	1042	1043	1044	1045
2190	3144	4234	5457	6848	8491
206	262	321	381	445	510
1040	1041	1042	1043	1044	1045

 FLOOD HYDROGRAPH PACKAGE (FEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 20 FEB 79

TIME OF EXECUTION 15-JUL-80 10:02:56

ANALYSIS OF DAM OVERTOPPING
 HYDROLOGIC-HYDRAULIC ANALYSIS
 RATIOS OF PMF ROUTED IN

JOB SPECIFICATIONS
 NO. 150 PER 0 GMIN 30 IDAY 0 INR 0
 JOPEX NW1 1
 5 0

MULTI-PLAN ANALYSIS
 NPLAN= 1 NRII
 R105= 0.20 0.35 0.50 0.65

SUB-AREA RUNOFF

CALCULATION OF INFLUX HYDROGRAPH

ISTAG 1 ICOMP 0 IECN 0

HYDROGRAPH
 INYD 1 IUNG 1 TAREA 5.55 SNAP 0.00 TRSDA 5.55

PRECIP
 SPPS PMS MO R12
 0.00 22.70 116.00 127.00

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS
 LFCPI STRR DLTR R10L ERALN STRI
 0 0.00 0.00 1.00 0.00 0.0

UNIT HYDROGRAPH
 TP= 2.62 CP=

RECESSION
 STRR= -2.00 ORCSN
 APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNIDER CP AND TP

UNIT HYDROGRAPH 26 END-OF-PERIOD ORDINATE
 64. 231. 454. 673. 822.
 332. 265. 216. 174. 140.
 36. 31. 25. 20. 16.

END-JF-PE

50
OVERTOPPING USING RATIOS OF PMF
PUBLIC ANALYSIS OF SAFETY OF NY 749
ROUTED THROUGH THE RESERVOIR

JOB SPECIFICATION

INR	IMV	MEIRC	IPLT	IPRT	NSTAN
0	0	0	0	0	0
AWI	LRPT	IRACE			
0	0	0			

ANALYSES TO BE PERFORMED

1 NR10= 0 LR10= 1
0.65 0.80 1.00

REA RUNOFF COMPUTATION

HYDROGRAPH

ECUN	ITAPE	JPL1	JPRT	INAME	ISIAGE	IAUTO
0	0	0	0	1	0	0

HYDROGRAPH DATA

IRSDA	IRSPC	RATIO	ISNOW	ISAME	LOCAL
5.55	0.00	0.000	0	0	0

PRECIP DATA

R12	R24	R48	R72	R96
127.00	141.00	0.00	0.00	0.00

LOSS DATA

IN	STRKS	RTION	SIRTL	CNSTL	ALSMX	RTIMP
00	0.00	1.00	1.00	0.10	0.00	0.00

IF HYDROGRAPH DATA

52 CP=0.63 NIA= 0

RECESSION DATA

ORCSN= -0.10 RTIOR= 2.00

AND IP ARE 1C= 0.20 AND R= 4.65 INTERVALS

ORDINATES, LAG= 2.62 HOURS, CP= 0.63 VOL= 1.00

822.	805.	780.	635.	511.	412.
140.	113.	91.	73.	59.	48.
10.	13.	11.	8.		

2-JF-PERIOD FLOW

MO.DA	HR.MM	PERIOD	RAIN	WACS	LOSS	COMP	MO.DA	HR.MM
1.01	0.30	1	0.05	0.00	0.08	10.	1.02	14.00
1.01	1.00	2	0.05	0.00	0.08	10.	1.02	14.30
1.01	1.30	3	0.05	0.00	0.08	9.	1.02	15.00
1.01	2.00	4	0.05	0.00	0.08	8.	1.02	15.30
1.01	2.30	5	0.05	0.00	0.08	8.	1.02	16.00
1.01	3.00	6	0.05	0.00	0.08	7.	1.02	16.30
1.01	3.30	7	0.05	0.00	0.08	7.	1.02	17.00
1.01	4.00	8	0.05	0.00	0.08	6.	1.02	17.30
1.01	4.30	9	0.08	0.00	0.08	6.	1.02	18.00
1.01	5.00	10	0.08	0.00	0.08	6.	1.02	18.30
1.01	5.30	11	0.08	0.00	0.08	5.	1.02	19.00
1.01	6.00	12	0.08	0.01	0.08	5.	1.02	19.30
1.01	6.30	13	0.17	0.12	0.05	14.	1.02	20.00
1.01	7.00	14	0.17	0.12	0.05	42.	1.02	20.30
1.01	7.30	15	0.17	0.12	0.05	96.	1.02	21.00
1.01	8.00	16	0.17	0.12	0.05	175.	1.02	21.30
1.01	8.30	17	0.17	0.12	0.05	271.	1.02	22.00
1.01	9.00	18	0.17	0.12	0.05	371.	1.02	22.30
1.01	9.30	19	0.17	0.12	0.05	460.	1.02	23.00
1.01	10.00	20	0.17	0.12	0.05	533.	1.02	23.30
1.01	10.30	21	0.17	0.12	0.05	592.	1.03	0.00
1.01	11.00	22	0.17	0.12	0.05	639.	1.03	0.30
1.01	11.30	23	0.17	0.12	0.05	677.	1.03	1.00
1.01	12.00	24	0.17	0.12	0.05	708.	1.03	1.30
1.01	12.30	25	1.05	1.00	0.05	789.	1.03	2.00
1.01	13.00	26	1.05	1.00	0.05	1014.	1.03	2.30
1.01	13.30	27	1.25	1.21	0.05	1446.	1.03	3.00
1.01	14.00	28	1.25	1.21	0.05	2104.	1.03	3.30
1.01	14.30	29	1.55	1.53	0.05	2959.	1.03	4.00
1.01	15.00	30	1.58	1.53	0.05	3949.	1.03	4.30
1.01	15.30	31	1.92	1.87	0.05	4986.	1.03	5.00
1.01	16.00	32	5.08	6.03	0.05	6293.	1.03	5.30
1.01	16.30	33	1.47	1.42	0.05	7999.	1.03	6.00
1.01	17.00	34	1.47	1.42	0.05	9326.	1.03	6.30
1.01	17.30	35	1.15	1.11	0.05	11448.	1.03	7.00
1.01	18.00	36	1.15	1.11	0.05	12520.	1.03	7.30
1.01	18.30	37	0.13	0.08	0.05	12611.	1.03	8.00
1.01	19.00	38	0.13	0.08	0.05	12182.	1.03	8.30
1.01	19.30	39	0.13	0.08	0.05	10949.	1.03	9.00
1.01	20.00	40	0.13	0.08	0.05	9549.	1.03	9.30
1.01	20.30	41	0.13	0.08	0.05	8105.	1.03	10.00
1.01	21.00	42	0.13	0.08	0.05	6731.	1.03	10.30
1.01	21.30	43	0.13	0.08	0.05	5537.	1.03	11.00
1.01	22.00	44	0.13	0.08	0.05	4570.	1.03	11.30
1.01	22.30	45	0.13	0.08	0.05	3790.	1.03	12.00
1.01	23.00	46	0.13	0.08	0.05	3161.	1.03	12.30
1.01	23.30	47	0.13	0.08	0.05	2654.	1.03	13.00
1.02	0.00	48	0.13	0.08	0.05	2246.	1.03	13.30
1.02	0.30	49	0.00	0.00	0.00	1911.	1.03	14.00
1.02	1.00	50	0.00	0.00	0.00	1625.	1.03	14.30
1.02	1.30	51	0.00	0.00	0.00	1379.	1.03	15.00
1.02	2.00	52	0.00	0.00	0.00	1233.	1.03	15.30
1.02	2.30	53	0.00	0.00	0.00	1150.	1.03	16.00
1.02	3.00	54	0.00	0.00	0.00	1073.	1.03	16.30
1.02	3.30	55	0.00	0.00	0.00	1001.	1.03	17.00
1.02	4.00	56	0.00	0.00	0.00	934.	1.03	17.30
1.02	4.30	57	0.00	0.00	0.00	872.	1.03	18.00
1.02	5.00	58	0.00	0.00	0.00	813.	1.03	18.30
1.02	5.30	59	0.00	0.00	0.00	759.	1.03	19.00

LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
0.08	10.	1.02	14.00	76	0.00	0.00	0.00	234.
0.08	10.	1.02	14.30	77	0.00	0.00	0.00	218.
0.08	9.	1.02	15.00	78	0.00	0.00	0.00	203.
0.08	8.	1.02	15.30	79	0.00	0.00	0.00	190.
0.08	8.	1.02	16.00	80	0.00	0.00	0.00	177.
0.08	7.	1.02	16.30	81	0.00	0.00	0.00	165.
0.08	7.	1.02	17.00	82	0.00	0.00	0.00	154.
0.08	6.	1.02	17.30	83	0.00	0.00	0.00	144.
0.08	6.	1.02	18.00	84	0.00	0.00	0.00	134.
0.08	6.	1.02	18.30	85	0.00	0.00	0.00	125.
0.08	5.	1.02	19.00	86	0.00	0.00	0.00	117.
0.08	5.	1.02	19.30	87	0.00	0.00	0.00	109.
0.05	14.	1.02	20.00	88	0.00	0.00	0.00	102.
0.05	42.	1.02	20.30	89	0.00	0.00	0.00	95.
0.05	96.	1.02	21.00	90	0.00	0.00	0.00	89.
0.05	175.	1.02	21.30	91	0.00	0.00	0.00	83.
0.05	271.	1.02	22.00	92	0.00	0.00	0.00	77.
0.05	371.	1.02	22.30	93	0.00	0.00	0.00	72.
0.05	460.	1.02	23.00	94	0.00	0.00	0.00	67.
0.05	533.	1.02	23.30	95	0.00	0.00	0.00	63.
0.05	592.	1.03	0.00	96	0.00	0.00	0.00	58.
0.05	639.	1.03	0.30	97	0.00	0.00	0.00	54.
0.05	677.	1.03	1.00	98	0.00	0.00	0.00	51.
0.05	708.	1.03	1.30	99	0.00	0.00	0.00	47.
0.05	789.	1.03	2.00	100	0.00	0.00	0.00	44.
0.05	1014.	1.03	2.30	101	0.00	0.00	0.00	41.
0.05	1446.	1.03	3.00	102	0.00	0.00	0.00	39.
0.05	2104.	1.03	3.30	103	0.00	0.00	0.00	36.
0.05	2959.	1.03	4.00	104	0.00	0.00	0.00	34.
0.05	3949.	1.03	4.30	105	0.00	0.00	0.00	31.
0.05	4986.	1.03	5.00	106	0.00	0.00	0.00	29.
0.05	6293.	1.03	5.30	107	0.00	0.00	0.00	27.
0.05	7999.	1.03	6.00	108	0.00	0.00	0.00	25.
0.05	9326.	1.03	6.30	109	0.00	0.00	0.00	24.
0.05	11448.	1.03	7.00	110	0.00	0.00	0.00	22.
0.05	12520.	1.03	7.30	111	0.00	0.00	0.00	21.
0.05	12811.	1.03	8.00	112	0.00	0.00	0.00	19.
0.05	12182.	1.03	8.30	113	0.00	0.00	0.00	18.
0.05	10949.	1.03	9.00	114	0.00	0.00	0.00	17.
0.05	9549.	1.03	9.30	115	0.00	0.00	0.00	16.
0.05	8105.	1.03	10.00	116	0.00	0.00	0.00	15.
0.05	6731.	1.03	10.30	117	0.00	0.00	0.00	14.
0.05	5537.	1.03	11.00	118	0.00	0.00	0.00	13.
0.05	4570.	1.03	11.30	119	0.00	0.00	0.00	12.
0.05	3790.	1.03	12.00	120	0.00	0.00	0.00	11.
0.05	3161.	1.03	12.30	121	0.00	0.00	0.00	10.
0.05	2654.	1.03	13.00	122	0.00	0.00	0.00	10.
0.05	2246.	1.03	13.30	123	0.00	0.00	0.00	9.
0.00	1911.	1.03	14.00	124	0.00	0.00	0.00	8.
0.00	1625.	1.03	14.30	125	0.00	0.00	0.00	8.
0.00	1379.	1.03	15.00	126	0.00	0.00	0.00	7.
0.00	1233.	1.03	15.30	127	0.00	0.00	0.00	7.
0.00	1150.	1.03	16.00	128	0.00	0.00	0.00	6.
0.00	1073.	1.03	16.30	129	0.00	0.00	0.00	6.
0.00	1001.	1.03	17.00	130	0.00	0.00	0.00	6.
0.00	934.	1.03	17.30	131	0.00	0.00	0.00	5.
0.00	874.	1.03	18.00	132	0.00	0.00	0.00	5.
0.00	813.	1.03	18.30	133	0.00	0.00	0.00	4.

1.02	0.00	60	0.00	0.00	0.00	705.	1.03	19.30
1.02	0.30	61	0.00	0.00	0.00	661.	1.03	20.00
1.02	1.00	62	0.00	0.00	0.00	616.	1.03	20.30
1.02	1.30	63	0.00	0.00	0.00	575.	1.03	21.00
1.02	2.00	64	0.00	0.00	0.00	537.	1.03	21.30
1.02	2.30	65	0.00	0.00	0.00	501.	1.03	22.00
1.02	3.00	66	0.00	0.00	0.00	467.	1.03	22.30
1.02	3.30	67	0.00	0.00	0.00	435.	1.03	23.00
1.02	4.00	68	0.00	0.00	0.00	407.	1.03	23.30
1.02	4.30	69	0.00	0.00	0.00	379.	1.04	0.00
1.02	5.00	70	0.00	0.00	0.00	354.	1.04	0.30
1.02	5.30	71	0.00	0.00	0.00	330.	1.04	1.00
1.02	6.00	72	0.00	0.00	0.00	308.	1.04	1.30
1.02	6.30	73	0.00	0.00	0.00	286.	1.04	2.00
1.02	7.00	74	0.00	0.00	0.00	268.	1.04	2.30
1.02	7.30	75	0.00	0.00	0.00	250.	1.04	3.00

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOT
CFS	12511.	9473.	3501.	1219.	
CMS	303.	268.	99.	35.	
INCHES		15.88	23.47	24.52	
MM		403.29	595.14	622.90	
AC-FT		4637.	6944.	7255.	
THOUS CU YD		5794.	6505.	6949.	

HYDROGRAPH AT STA				1 FOR PLAN 1, RTIO 1		
2.	2.	4.	2.	2.	1.	1.
1.	1.	3.	0.	19.	35.	54.
116.	128.	135.	142.	158.	203.	289.
947.	1259.	1595.	1905.	2290.	2504.	2502.
1621.	1346.	1107.	914.	758.	632.	531.
270.	247.	230.	215.	200.	167.	174.
132.	123.	115.	107.	100.	93.	87.
66.	62.	58.	54.	50.	47.	44.
33.	31.	29.	27.	25.	23.	22.
17.	15.	14.	13.	13.	12.	11.
8.	6.	7.	7.	6.	6.	5.
4.	4.	4.	3.	3.	3.	3.
2.	2.	2.	2.	2.	1.	1.
1.	1.	1.	1.	1.	1.	1.
1.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOT
CFS	2502.	1895.	700.	244.	
CMS	75.	54.	20.	7.	
INCHES		3.16	4.69	4.90	
MM		80.00	119.23	124.58	
AC-FT		939.	1389.	1451.	
THOUS CU YD		1154.	1713.	1790.	

HYDROGRAPH AT STA				1 FOR PLAN 1, RTIO 2		
1.	3.	3.	3.	3.	3.	2.
2.	2.	3.	15.	34.	61.	95.

705.	1.03	19.30	135	0.00	0.00	0.00	4.
601.	1.03	20.00	136	0.00	0.00	0.00	4.
616.	1.03	20.30	137	0.00	0.00	0.00	3.
575.	1.03	21.00	138	0.00	0.00	0.00	3.
537.	1.03	21.30	139	0.00	0.00	0.00	3.
501.	1.03	22.00	140	0.00	0.00	0.00	3.
467.	1.03	22.30	141	0.00	0.00	0.00	3.
435.	1.03	23.00	142	0.00	0.00	0.00	2.
407.	1.03	23.30	143	0.00	0.00	0.00	2.
379.	1.04	0.00	144	0.00	0.00	0.00	2.
351.	1.04	0.30	145	0.00	0.00	0.00	2.
330.	1.04	1.00	146	0.00	0.00	0.00	2.
308.	1.04	1.30	147	0.00	0.00	0.00	2.
286.	1.04	2.00	148	0.00	0.00	0.00	2.
268.	1.04	2.30	149	0.00	0.00	0.00	1.
250.	1.04	3.00	150	0.00	0.00	0.00	1.

SUM 25.61 22.80 2.81 175591.
(650.)(579.)(71.)(4972.18)

5-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
9473.	3501.	1219.	175585.
268.	99.	35.	4972.
15.85	23.47	24.52	24.52
403.29	595.14	622.90	622.93
4037.	6944.	7255.	7256.
5734.	6505.	6949.	8950.

AT STA 1 FOR PLAN 1, RTIO 1

2.	1.	1.	1.	1.	1.
19.	35.	54.	74.	92.	107.
158.	203.	289.	421.	592.	790.
2290.	2504.	2502.	2436.	2190.	1910.
758.	632.	531.	449.	382.	326.
200.	167.	174.	163.	152.	142.
100.	93.	87.	81.	76.	71.
50.	47.	44.	41.	38.	35.
25.	23.	22.	20.	19.	18.
13.	12.	11.	10.	9.	9.
6.	6.	5.	5.	5.	4.
3.	3.	3.	3.	2.	2.
2.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.
0.	0.	0.	0.	0.	0.

5-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
1895.	700.	244.	35117.
54.	20.	7.	994.
3.15	4.09	4.90	4.90
80.00	119.23	124.58	124.59
939.	1369.	1451.	1451.
1154.	1713.	1790.	1790.

AT STA 1 FOR PLAN 1, RTIO 2

3.	3.	2.	2.	2.	2.
34.	61.	95.	130.	161.	187.

1745.	2202.	2500.	3439.	4007.	4382.	4484.
2537.	2350.	1958.	1599.	1320.	1100.	929.
483.	431.	403.	370.	350.	327.	305.
231.	210.	201.	188.	175.	164.	153.
110.	100.	101.	94.	80.	82.	76.
50.	54.	50.	47.	44.	41.	38.
29.	27.	25.	23.	22.	20.	19.
14.	13.	13.	12.	11.	10.	10.
7.	7.	0.	0.	5.	5.	5.
4.	3.	3.	3.	3.	3.	2.
2.	2.	2.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.
PEAK 0-HOUR 24-HOUR 72-HOUR TOTAL						
CFS	4484.	3310.	1225.	427.		
CMS	127.	94.	35.	12.		
INCHES		5.50	8.21	8.58		
MM		141.15	208.55	218.01		
AC-F1		1044.	2430.	2539.		
THOUS CU YD		2020.	2998.	3132.		

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3						
5.	5.	5.	4.	4.	4.	3.
3.	3.	7.	21.	48.	67.	135.
290.	320.	339.	354.	395.	507.	723.
2493.	3140.	4000.	4913.	5724.	6200.	6405.
4003.	3305.	2709.	2205.	1895.	1580.	1327.
090.	010.	070.	037.	501.	407.	436.
330.	308.	280.	200.	250.	234.	218.
105.	154.	144.	134.	125.	117.	109.
83.	77.	72.	67.	63.	58.	54.
41.	39.	30.	34.	31.	29.	27.
21.	19.	18.	17.	16.	15.	14.
10.	10.	9.	6.	8.	7.	7.
5.	5.	4.	4.	4.	4.	3.
3.	2.	2.	2.	2.	2.	2.
1.	1.	1.	1.	1.	1.	1.
PEAK 0-HOUR 24-HOUR 72-HOUR TOTAL						
CFS	6405.	4730.	1750.	610.		
CMS	181.	134.	50.	17.		
INCHES		7.94	11.74	12.26		
MM		201.64	298.07	311.45		
AC-F1		2349.	3472.	3628.		
THOUS CU YD		2697.	4262.	4475.		

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4						
7.	0.	0.	0.	0.	0.	4.
3.	3.	9.	27.	62.	114.	170.
305.	415.	440.	460.	513.	659.	940.
3241.	4090.	5199.	6367.	7441.	8138.	8327.
5208.	4375.	3599.	2970.	2463.	2055.	1725.
097.	001.	740.	096.	651.	607.	567.
429.	471.	374.	349.	325.	304.	283.
215.	200.	167.	174.	163.	152.	142.
107.	100.	83.	67.	81.	70.	71.
54.	50.	47.	44.	41.	36.	35.

4007.	4382.	4484.	4204.	3832.	3342.
1320.	1100.	929.	786.	669.	570.
350.	327.	305.	285.	206.	248.
175.	154.	153.	142.	133.	124.
30.	82.	76.	71.	66.	62.
44.	41.	38.	36.	33.	31.
22.	20.	19.	18.	17.	15.
11.	10.	10.	9.	8.	8.
5.	5.	5.	4.	4.	4.
3.	3.	2.	2.	2.	2.
1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	0.

-HOOR	24-HOOR	72-HOOR	TOTAL VOLUME
3310.	1225.	427.	61455.
94.	35.	12.	1740.
5.50	8.21	8.58	8.58
41.15	208.55	218.01	218.02
1644.	2430.	2539.	2539.
2020.	2998.	3132.	3132.

AT STA 1 FOR PLAN 1, RTIO 3

4.	4.	3.	3.	3.	3.
48.	87.	135.	185.	230.	267.
395.	507.	723.	1052.	1480.	1975.
5724.	6200.	6405.	6091.	5475.	4775.
1895.	1580.	1327.	1123.	956.	814.
501.	407.	436.	407.	379.	354.
250.	234.	218.	203.	190.	177.
125.	117.	109.	102.	95.	89.
63.	58.	54.	51.	47.	44.
31.	29.	27.	25.	24.	22.
10.	15.	14.	13.	12.	11.
8.	7.	7.	6.	6.	6.
4.	4.	3.	3.	3.	3.
2.	2.	2.	2.	1.	1.
1.	1.	1.	1.	1.	1.

-HOOR	24-HOOR	72-HOOR	TOTAL VOLUME
4730.	1750.	610.	87792.
134.	50.	17.	2486.
7.94	11.74	12.26	12.26
01.04	298.07	311.45	311.46
2349.	3472.	3628.	3628.
2897.	4282.	4475.	4475.

STA 1 FOR PLAN 1, RTIO 4

5.	5.	4.	4.	4.	4.
62.	114.	176.	241.	299.	347.
513.	659.	940.	1307.	1923.	2567.
7441.	8138.	6327.	7918.	7117.	6207.
2463.	2055.	1725.	1460.	1242.	1058.
651.	607.	507.	529.	493.	460.
325.	304.	283.	264.	247.	230.
103.	152.	142.	132.	123.	115.
81.	70.	71.	66.	62.	58.

27.	25.	23.	22.	20.	19.	18.
13.	13.	12.	11.	10.	9.	9.
7.	6.	6.	5.	5.	5.	4.
3.	3.	3.	3.	3.	2.	2.
2.	2.	1.	1.	1.	1.	1.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL
CFS	6327.	6157.	2275.	793.	
CMS	236.	174.	64.	22.	
INCHES		10.32	15.26	15.94	
MM		262.14	387.49	404.88	
AC-FT		3053.	4513.	4710.	
THOUS CU M		3766.	5567.	5817.	

HIDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

6.	6.	7.	7.	6.	6.	5.
4.	4.	11.	33.	77.	140.	217.
473.	511.	542.	566.	631.	611.	1157.
3989.	5034.	5399.	7661.	9158.	10016.	10249.
6464.	5365.	4430.	3656.	3032.	2529.	2123.
1103.	986.	920.	859.	801.	747.	697.
529.	493.	460.	429.	401.	374.	349.
264.	247.	230.	215.	200.	187.	174.
132.	123.	115.	107.	100.	93.	87.
66.	62.	56.	54.	50.	47.	44.
33.	31.	24.	27.	25.	23.	22.
17.	15.	14.	13.	13.	12.	11.
8.	6.	7.	7.	6.	6.	5.
4.	4.	4.	3.	3.	3.	3.
2.	2.	2.	2.	2.	1.	1.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL
CFS	10249.	7578.	2801.	975.	
CMS	240.	215.	79.	28.	
INCHES		12.70	18.78	19.62	
MM		322.63	470.91	498.32	
AC-FT		3753.	5555.	5804.	
THOUS CU M		4635.	6652.	7159.	

HIDROGRAPH AT STA 1 FOR PLAN 1, RTIO 6

10.	10.	9.	6.	8.	7.	7.
5.	5.	14.	42.	96.	175.	271.
592.	639.	677.	706.	789.	1014.	1446.
4966.	6293.	7399.	9826.	11448.	12520.	12811.
6105.	6731.	5337.	4570.	3790.	3161.	2654.
1379.	1233.	1150.	1073.	1001.	934.	872.
661.	616.	575.	537.	501.	467.	436.
330.	308.	286.	266.	250.	234.	218.
165.	154.	144.	134.	125.	117.	109.
83.	77.	72.	67.	63.	58.	54.
41.	39.	36.	34.	31.	29.	27.
21.	19.	16.	17.	16.	15.	14.
10.	10.	9.	8.	8.	7.	7.
5.	5.	4.	4.	4.	4.	3.
3.	2.	2.	2.	2.	2.	2.

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL
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2.	20.	19.	18.	17.	15.	14.
1.	19.	9.	9.	8.	8.	7.
5.	5.	5.	4.	4.	4.	4.
3.	3.	2.	2.	2.	2.	2.
1.	1.	1.	1.	1.	1.	1.

6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
6157.	2275.	793.	114130.
174.	64.	22.	3232.
10.32	15.26	15.94	15.94
262.14	387.49	404.88	404.90
3053.	4513.	4716.	4716.
3766.	5567.	5817.	5817.

AT STA 1 FOR PLAN 1, RTIO 5

7.	6.	6.	5.	5.	5.	4.
3.	77.	140.	217.	296.	368.	426.
6.	631.	611.	1157.	1683.	2367.	3159.
1.	9158.	10010.	10249.	9745.	8759.	7640.
6.	3032.	2529.	2123.	1796.	1529.	1303.
9.	501.	747.	697.	651.	607.	566.
9.	401.	374.	349.	325.	304.	283.
5.	200.	187.	174.	163.	152.	142.
7.	100.	93.	87.	81.	76.	71.
4.	50.	47.	44.	41.	38.	35.
7.	25.	23.	22.	20.	19.	18.
3.	13.	12.	11.	10.	9.	9.
7.	6.	6.	5.	5.	5.	4.
9.	3.	3.	3.	3.	2.	2.
2.	2.	1.	1.	1.	1.	1.

6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
7578.	2801.	975.	140468.
215.	79.	28.	3976.
12.70	18.78	19.62	19.62
322.63	476.91	493.32	496.34
3753.	5555.	5804.	5804.
4035.	6652.	7159.	7160.

AT STA 1 FOR PLAN 1, RTIO 6

6.	7.	7.	6.	6.	6.
96.	175.	271.	371.	460.	533.
789.	1014.	1446.	2104.	2959.	3949.
11448.	12520.	12811.	12182.	10949.	9549.
3790.	3161.	2654.	2246.	1911.	1628.
1001.	934.	872.	813.	759.	708.
501.	467.	436.	407.	379.	354.
250.	234.	218.	203.	190.	177.
125.	117.	109.	102.	95.	89.
63.	56.	54.	51.	47.	44.
31.	29.	27.	25.	24.	22.
16.	15.	14.	13.	12.	11.
8.	7.	7.	6.	6.	6.
4.	4.	3.	3.	3.	3.
2.	2.	2.	2.	1.	1.

9473.	3501.	1219.	175585.
200.	99.	35.	4972.
15.00	23.47	24.52	24.52
03.29	596.14	022.90	022.93
4697.	6944.	7255.	7250.
5794.	6500.	8949.	8950.

HYDROGRAPH ROUTING

GRAPH

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

ROUTING DATA

IRIS	ISAME	IOPI	IPMP	LSTR
1	1	0	0	0

LAG	AMSKA	X	TSK	STORA	ISPRAT
0	0.000	0.000	0.000	-1030.	-1

1039.00	1040.00	1041.00	1042.00	1043.00	1044.00	1045.00
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1377.00	2190.00	3144.00	4234.00	5457.00	6848.00	8491.00
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150.	200.	202.	321.	381.	445.	510.
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1039.	1040.	1041.	1042.	1043.	1044.	1045.
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W	EXP4	ELEV	COUL	CAREA	EXPD
0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COGD	EXPD	DAMWID
044.8	2.7	1.5	670.

TATION 2, PLAN 1, RATIO 1

D-D-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

1.	1.	1.	1.	1.	1.
4.	9.	15.	25.	30.	48.
104.	118.	142.	182.	245.	393.
1701.	2022.	2207.	2388.	2549.	2193.
1103.	935.	789.	677.	590.	512.
207.	243.	231.	219.	208.	196.
145.	130.	127.	119.	112.	104.
75.	70.	65.	61.	57.	53.
39.	35.	33.	31.	28.	27.
19.	18.	16.	15.	14.	13.

5.	5.	5.	5.	5.	4.	4.
3.	3.	3.	3.	2.	2.	2.
2.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.

STORAGE

0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	1.	2.	3.
12.	11.	17.	19.	21.	24.	28.
81.	101.	123.	147.	172.	194.	210.
193.	170.	157.	143.	120.	115.	103.
09.	03.	50.	54.	51.	40.	46.
37.	35.	33.	31.	29.	27.	25.
14.	10.	17.	10.	15.	14.	13.
10.	9.	9.	8.	7.	7.	7.
5.	5.	4.	4.	4.	3.	3.
4.	4.	2.	2.	2.	2.	2.
1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.

STAGE

1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.1
1036.2	1036.3	1036.3	1036.4	1036.4	1036.5	1036.6
1037.7	1036.0	1039.5	1038.9	1039.4	1039.8	1040.1
1039.8	1039.5	1039.2	1038.9	1038.6	1038.3	1038.1
1037.4	1037.3	1037.2	1037.1	1037.1	1037.0	1037.0
1036.8	1036.7	1036.7	1036.6	1036.6	1036.5	1036.5
1036.4	1036.4	1036.4	1036.3	1036.3	1036.3	1036.3
1036.2	1036.2	1036.2	1036.2	1036.2	1036.1	1036.1
1036.1	1036.1	1036.1	1036.1	1036.1	1036.1	1036.1
1036.1	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0

PEAK OUTFLOW IS 2368. AT TIME 19.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL
CFS	2368.	1824.	690.	244.	
CMS	66.	52.	20.	7.	
INCHES		3.05	4.66	4.91	
MM		77.66	118.44	124.60	
AC-FT		904.	1360.	1451.	
THOUS CU M		1116.	1702.	1790.	

STATION 2, PLAN 1, RA110 2

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

1.	1.	2.	2.	2.	2.	2.
2.	2.	2.	4.	8.	15.	27.
104.	125.	145.	163.	182.	207.	255.
1101.	1474.	1947.	2520.	3150.	3727.	4117.

5.	5.	4.	4.	4.	4.	3.
3.	2.	2.	2.	2.	2.	2.
1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	0.	0.

STORAGE

0.	0.	0.	0.	0.	0.	0.
0.	1.	2.	3.	5.	7.	9.
9.	21.	24.	28.	36.	48.	64.
7.	172.	194.	210.	218.	215.	206.
3.	126.	115.	103.	93.	84.	76.
1.	51.	46.	46.	44.	41.	39.
1.	29.	27.	25.	24.	22.	21.
6.	15.	14.	13.	12.	11.	11.
6.	7.	7.	7.	6.	6.	5.
4.	4.	3.	3.	3.	3.	3.
2.	2.	2.	2.	2.	1.	1.
1.	1.	1.	1.	1.	1.	1.
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.

STAGE

0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
0	1036.0	1036.0	1036.1	1036.1	1036.1	1036.2
4	1036.4	1036.5	1036.6	1036.8	1037.0	1037.3
9	1039.4	1039.8	1040.1	1040.2	1040.2	1040.0
9	1038.6	1038.3	1038.1	1037.9	1037.7	1037.6
1	1037.1	1037.0	1037.0	1036.9	1036.9	1036.8
6	1036.6	1036.6	1036.5	1036.5	1036.5	1036.4
3	1036.3	1036.3	1036.3	1036.3	1036.2	1036.2
2	1036.2	1036.1	1036.1	1036.1	1036.1	1036.1
1	1036.1	1036.1	1036.1	1036.1	1036.1	1036.1
0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0

6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
1824.	696.	244.	35123.
52.	20.	7.	995.
3.06	4.66	4.91	4.91
77.66	118.44	124.60	124.61
904.	1380.	1451.	1451.
1116.	1702.	1790.	1790.

STATION 2, PLAN 1, RA110 2

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

2.	2.	2.	2.	2.	2.
8.	15.	27.	43.	62.	83.
182.	207.	255.	376.	505.	776.

3423.	2977.	2545.	2146.	1631.	1547.	1311.
703.	621.	554.	499.	454.	416.	363.
263.	253.	245.	234.	224.	214.	204.
163.	153.	144.	135.	127.	119.	112.
80.	60.	75.	70.	65.	61.	57.
43.	40.	35.	35.	33.	31.	29.
24.	20.	19.	18.	16.	15.	14.
11.	10.	9.	9.	8.	8.	7.
5.	5.	5.	4.	4.	4.	4.
3.	3.	2.	2.	2.	2.	2.
1.	1.	1.	1.	1.	1.	1.

STORAGE

0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	1.	1.	3.	5.
21.	25.	29.	33.	36.	41.	49.
126.	157.	189.	220.	262.	294.	315.
277.	252.	227.	203.	161.	152.	145.
90.	66.	61.	75.	70.	66.	63.
54.	50.	48.	47.	45.	43.	41.
32.	31.	29.	27.	25.	24.	22.
17.	16.	15.	14.	13.	12.	11.
9.	6.	6.	7.	7.	6.	6.
4.	4.	4.	4.	3.	3.	3.
2.	2.	2.	2.	2.	2.	1.
1.	1.	1.	1.	1.	1.	1.
1.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.

STAGE

1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.1	1036.1
1036.4	1036.5	1036.6	1036.7	1036.8	1036.9	1037.0
1036.5	1039.1	1039.7	1040.4	1041.0	1041.5	1041.9
1041.3	1040.6	1040.4	1039.9	1039.6	1039.2	1038.9
1036.0	1037.6	1037.7	1037.5	1037.4	1037.4	1037.3
1037.1	1037.0	1037.0	1037.0	1036.9	1036.9	1036.8
1036.7	1036.6	1036.6	1036.6	1036.5	1036.5	1036.5
1036.4	1036.3	1036.3	1036.3	1036.3	1036.3	1036.2
1036.2	1036.2	1036.2	1036.1	1036.1	1036.1	1036.1
1036.1	1036.1	1036.1	1036.1	1036.1	1036.1	1036.1
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0

PEAK OUTPUT IS 4261. AT TIME 19.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL
CPS	4261.	3226.	1218.	427.	
CMS	121.	91.	34.	12.	
INCHES		5.41	8.16	8.58	
MA		137.43	207.37	218.03	
AC-F1		1691.	2415.	2540.	
THOUS CUB A		1974.	2979.	3132.	

STATION 2, PLAN 1, RATIO 3

2140.	1431.	1547.	1311.	1123.	900.	819.
499.	454.	410.	303.	354.	328.	304.
234.	224.	214.	204.	193.	183.	173.
135.	127.	119.	112.	104.	98.	91.
70.	65.	61.	57.	53.	50.	46.
35.	33.	31.	29.	27.	25.	23.
18.	16.	15.	14.	13.	12.	12.
9.	8.	8.	7.	7.	6.	6.
4.	4.	4.	4.	3.	3.	3.
2.	2.	2.	2.	2.	2.	1.
1.	1.	1.	1.	1.	1.	1.

STORAGE

0.	0.	0.	0.	0.	0.	0.
1.	1.	3.	5.	9.	12.	17.
33.	35.	41.	49.	62.	80.	102.
220.	202.	294.	315.	322.	316.	299.
203.	161.	152.	145.	130.	117.	106.
15.	70.	60.	63.	60.	57.	55.
47.	45.	43.	41.	38.	36.	34.
27.	25.	24.	22.	21.	19.	18.
14.	13.	12.	11.	11.	10.	9.
7.	7.	6.	6.	5.	5.	5.
4.	3.	3.	3.	3.	2.	2.
2.	2.	2.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.
0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.

STAGE

036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
036.0	1036.0	1036.1	1036.1	1036.2	1036.3	1036.3
036.7	1036.8	1036.9	1037.0	1037.3	1037.6	1038.1
040.4	1041.0	1041.5	1041.9	1042.0	1041.9	1041.6
039.9	1039.6	1039.2	1038.9	1038.6	1038.4	1038.1
037.5	1037.4	1037.4	1037.3	1037.2	1037.2	1037.1
037.0	1036.9	1036.9	1036.8	1036.8	1036.8	1036.7
036.6	1036.5	1036.5	1036.5	1036.4	1036.4	1036.4
036.3	1036.3	1036.3	1036.2	1036.2	1036.2	1036.2
036.1	1036.1	1036.1	1036.1	1036.1	1036.1	1036.1
036.1	1036.1	1036.1	1036.1	1036.1	1036.1	1036.0
036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0

72-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
1.440.	1215.	427.	61461.
01.	30.	12.	1740.
0.01	0.10	0.58	8.58
0.00	0.00	210.03	218.03
	0.00.	2540.	2540.
	0.00.	3132.	3133.

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

1.	2.	3.	4.	5.	6.	7.
3.	3.	3.	5.	11.	21.	38.
149.	179.	217.	235.	274.	333.	420.
1050.	2193.	2912.	3751.	4645.	5443.	5994.
4827.	4159.	3550.	2996.	2525.	2124.	1814.
979.	842.	742.	670.	624.	578.	536.
402.	374.	349.	325.	304.	283.	264.
215.	205.	194.	184.	174.	164.	155.
120.	113.	105.	99.	92.	86.	81.
62.	58.	54.	50.	47.	44.	41.
31.	29.	27.	25.	24.	22.	20.
16.	14.	14.	13.	12.	11.	10.
8.	7.	7.	6.	6.	6.	5.
4.	4.	3.	3.	3.	3.	3.
2.	2.	2.	2.	1.	1.	1.

STORAGE

0.	0.	0.	1.	1.	1.	1.
1.	1.	1.	1.	2.	4.	8.
30.	30.	41.	46.	51.	58.	67.
109.	206.	248.	295.	341.	380.	406.
350.	317.	285.	253.	226.	201.	180.
116.	108.	100.	93.	88.	83.	79.
65.	62.	59.	57.	55.	52.	50.
43.	41.	39.	37.	35.	33.	31.
24.	22.	21.	20.	18.	17.	16.
12.	11.	11.	10.	9.	9.	8.
6.	5.	5.	5.	5.	4.	4.
3.	3.	3.	3.	2.	2.	2.
2.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.
0.	0.	0.	0.	0.	0.	0.

STAGE

1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.1	1036.2	1036.2
1036.6	1036.7	1036.9	1037.0	1037.1	1037.2	1037.4	1037.4
1039.3	1040.0	1040.6	1041.6	1042.3	1043.0	1043.4	1043.4
1042.5	1041.9	1041.4	1040.8	1040.4	1039.9	1039.5	1039.5
1036.4	1038.2	1036.0	1037.9	1037.6	1037.7	1037.6	1037.6
1037.3	1037.3	1037.2	1037.2	1037.1	1037.1	1037.0	1037.0
1036.9	1036.8	1036.8	1036.8	1036.7	1036.7	1036.6	1036.6
1036.5	1036.5	1036.4	1036.4	1036.4	1036.4	1036.3	1036.3
1036.3	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2
1036.1	1036.1	1036.1	1036.1	1036.1	1036.1	1036.1	1036.1
1036.1	1036.1	1036.1	1036.1	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0

PEAK OUTFLOW IS 5151. AT TIME 19.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL
CFS	5151.	4534.	1741.	610.	
CMS	174.	151.	49.	17.	
ACRES		7.77	11.57	12.26	
MM		197.29	296.51	311.47	

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

3.	3.	3.	3.	3.	3.	3.
5.	11.	21.	38.	61.	89.	119.
235.	274.	333.	420.	579.	828.	1199.
3751.	4045.	5443.	5994.	6151.	5923.	5429.
2998.	2525.	2124.	1814.	1542.	1317.	1139.
670.	624.	570.	536.	498.	463.	431.
525.	304.	283.	264.	246.	235.	225.
104.	174.	104.	155.	145.	137.	128.
99.	92.	86.	81.	70.	71.	66.
50.	47.	44.	41.	38.	36.	33.
25.	24.	22.	20.	19.	18.	17.
13.	12.	11.	10.	10.	9.	8.
6.	0.	0.	5.	5.	4.	4.
3.	3.	3.	3.	2.	2.	2.
2.	1.	1.	1.	1.	1.	1.

STORAGE

1.	1.	1.	1.	1.	1.	1.
1.	2.	4.	8.	12.	18.	24.
40.	51.	58.	67.	83.	106.	136.
295.	341.	380.	406.	413.	402.	380.
253.	226.	201.	180.	161.	145.	131.
93.	88.	83.	79.	75.	71.	68.
57.	55.	52.	50.	49.	47.	45.
37.	35.	33.	31.	29.	27.	26.
20.	18.	17.	16.	15.	14.	13.
10.	9.	9.	8.	8.	7.	7.
5.	5.	4.	4.	4.	4.	3.
3.	2.	2.	2.	2.	2.	2.
1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.

STAGE

1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.1	1036.2	1036.3	1036.4	1036.5
1037.0	1037.1	1037.2	1037.4	1037.7	1038.2	1038.7
1041.0	1042.3	1043.0	1043.4	1043.5	1043.3	1043.0
1040.8	1040.4	1039.9	1039.5	1039.2	1038.9	1038.6
1037.9	1037.6	1037.7	1037.6	1037.5	1037.5	1037.4
1037.2	1037.1	1037.1	1037.0	1037.0	1037.0	1036.9
1036.2	1036.7	1036.7	1036.6	1036.6	1036.6	1036.5
1036.4	1036.4	1036.4	1036.3	1036.3	1036.3	1036.3
1036.2	1036.2	1036.2	1036.2	1036.2	1036.1	1036.1
1036.1	1036.1	1036.1	1036.1	1036.1	1036.1	1036.1
1036.1	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0

URS

6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
4534.	1741.	610.	87799.
131.	49.	17.	2480.
	11.67	12.26	12.26

AC-FT
18000 CFS

2298. 3454. 3628.
2834. 4260. 4475.

STATION 2, PLAN 1, RATIO 4

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

1.	2.	3.	3.	4.	4.	4.
4.	4.	4.	7.	14.	28.	50.
194.	233.	291.	344.	391.	456.	570.
2214.	2970.	3635.	4990.	6161.	7205.	7910.
6193.	5350.	4542.	3827.	3213.	2712.	2284.
1239.	1076.	953.	858.	782.	720.	676.
516.	434.	402.	422.	394.	368.	343.
260.	243.	233.	223.	213.	203.	192.
153.	145.	135.	126.	119.	111.	104.
80.	74.	70.	65.	61.	57.	53.
40.	38.	35.	33.	31.	28.	27.
20.	19.	18.	16.	15.	14.	13.
10.	9.	9.	8.	8.	7.	7.
5.	5.	4.	4.	4.	4.	3.
3.	2.	2.	2.	2.	2.	2.

STORAGE

0.	0.	1.	1.	1.	1.	1.
1.	1.	1.	1.	3.	6.	10.
33.	45.	55.	59.	64.	70.	82.
207.	252.	302.	350.	413.	459.	487.
415.	376.	330.	299.	260.	237.	212.
139.	126.	115.	109.	103.	98.	93.
77.	73.	70.	67.	64.	61.	59.
50.	48.	46.	44.	42.	40.	38.
30.	29.	27.	25.	24.	22.	21.
10.	15.	14.	13.	12.	11.	11.
4.	7.	7.	7.	6.	6.	5.
1.	1.	3.	3.	3.	3.	3.
2.	2.	2.	2.	2.	1.	1.
1.	1.	1.	1.	1.	1.	1.
0.	0.	0.	0.	0.	0.	0.

STAGE

1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	10
1036.0	1036.0	1036.0	1036.0	1036.1	1036.1	1036.2	10
1036.5	1037.0	1037.1	1037.2	1037.3	1037.4	1037.7	10
1040.0	1040.6	1041.7	1042.5	1043.5	1044.2	1044.6	10
1043.5	1042.9	1042.3	1041.5	1041.1	1040.5	1040.1	10
1038.6	1038.5	1038.4	1038.2	1038.1	1038.0	1037.9	10
1037.0	1037.5	1037.4	1037.4	1037.3	1037.3	1037.2	10
1037.0	1037.0	1037.0	1036.9	1036.9	1036.6	1036.8	10
1036.5	1036.0	1036.0	1036.5	1036.5	1036.5	1036.4	10
1036.3	1036.5	1036.5	1036.3	1036.3	1036.2	1036.2	10
1036.2	1036.2	1036.1	1036.1	1036.1	1036.1	1036.1	10
1036.1	1036.1	1036.1	1036.1	1036.1	1036.1	1036.1	10
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	10
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	10
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	10

PEAK OUTFLOW IS 6050. AT TIME 19.00 HOURS

2294.	3454.	3628.	3628.
2534.	4260.	4475.	4475.

STATION 2, PLAN 1, RATIO 4

END-OF-PERIOD HYDROGRAPH ORDINATES

001FL00

3.	4.	4.	4.	4.	4.	4.
7.	14.	28.	56.	80.	115.	154.
344.	391.	456.	570.	773.	1134.	1618.
4990.	6161.	7205.	7910.	8050.	7686.	6984.
3627.	3213.	2712.	2284.	1954.	1676.	1433.
658.	762.	720.	676.	633.	593.	554.
422.	394.	368.	343.	320.	299.	279.
223.	213.	203.	192.	182.	172.	162.
126.	119.	111.	104.	97.	91.	85.
65.	61.	57.	53.	49.	46.	43.
33.	31.	28.	27.	25.	23.	22.
16.	15.	14.	13.	12.	12.	11.
8.	8.	7.	7.	6.	6.	5.
4.	4.	4.	3.	3.	3.	3.
2.	2.	2.	2.	2.	1.	1.

STORAGE

1.	1.	1.	1.	1.	1.	1.
1.	3.	6.	10.	16.	23.	31.
59.	64.	70.	82.	102.	131.	167.
350.	413.	459.	487.	493.	478.	450.
299.	260.	237.	212.	190.	171.	154.
109.	103.	98.	93.	89.	85.	81.
67.	64.	61.	59.	56.	54.	52.
44.	42.	40.	38.	36.	34.	32.
25.	24.	24.	21.	19.	18.	17.
13.	12.	11.	11.	10.	9.	9.
7.	6.	6.	5.	5.	5.	4.
3.	3.	3.	3.	2.	2.	2.
2.	2.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.
0.	0.	0.	0.	0.	0.	0.

STAGE

[illegible]

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOL
CFS	6936.	6038.	2266.	793.	114
CFS	226.	171.	64.	22.	3
INCHES		10.12	15.19	15.94	1
IN		257.06	385.91	404.90	40
AC-FT		2994.	4495.	4716.	4
THOUS CU FT		3693.	5544.	5817.	5

STATION 2, PLAN 1, RATIO 5

• END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW						
2.	3.	4.	4.	5.	5.	5.
5.	5.	5.	8.	17.	34.	61.
239.	321.	369.	444.	495.	570.	707.
2822.	3736.	4874.	6246.	7735.	9356.	10219.
7421.	8441.	5492.	4631.	3893.	3278.	2775.
1491.	1295.	1154.	1045.	956.	881.	616.
629.	569.	552.	516.	483.	451.	421.
320.	295.	279.	260.	243.	233.	223.
162.	172.	162.	152.	143.	135.	126.
97.	91.	85.	80.	74.	70.	65.
49.	46.	43.	40.	38.	35.	33.
25.	23.	22.	20.	19.	18.	16.
12.	12.	11.	10.	9.	9.	8.
6.	6.	5.	5.	5.	4.	4.
3.	3.	3.	3.	2.	2.	2.

STORAGE						
0.	1.	1.	1.	1.	1.	1.
1.	1.	1.	2.	3.	7.	12.
48.	56.	63.	69.	74.	82.	96.
243.	294.	352.	417.	480.	523.	537.
468.	426.	363.	340.	303.	269.	240.
158.	143.	132.	124.	117.	111.	105.
86.	84.	80.	77.	73.	70.	67.
56.	54.	52.	50.	48.	46.	44.
36.	34.	32.	30.	29.	27.	25.
19.	18.	17.	16.	15.	14.	13.
10.	9.	9.	8.	7.	7.	7.
5.	5.	4.	4.	4.	3.	3.
2.	2.	2.	2.	2.	2.	2.
1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	0.	0.	0.	0.

STAGE						
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.1	1036.1	1036.3
1037.0	1037.2	1037.3	1037.4	1037.5	1037.7	1038.0
1040.7	1041.5	1042.5	1043.6	1044.5	1045.2	1045.4
1044.3	1045.7	1046.0	1046.3	1046.7	1046.1	1046.6
1039.1	1038.9	1038.7	1038.5	1038.4	1038.2	1038.1
1037.6	1037.7	1037.6	1037.6	1037.5	1037.4	1037.4
1037.2	1037.1	1037.1	1037.0	1037.0	1037.0	1036.9
1036.5	1036.7	1036.7	1036.6	1036.6	1036.6	1036.5

6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
5038.	2266.	193.	114138.
171.	64.	22.	3232.
10.12	15.19	15.94	15.94
257.00	365.91	404.90	404.93
2994.	4495.	4716.	4716.
3093.	5544.	5817.	5818.

STATION 2, PLAN 1, RATIO 5

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

4.	5.	5.	5.	5.	5.
5.	17.	34.	61.	98.	142.
4.	495.	570.	707.	998.	1428.
6.	7735.	9356.	10219.	9970.	9182.
1.	3493.	3278.	2775.	2350.	2015.
5.	956.	881.	816.	757.	706.
6.	483.	451.	421.	393.	367.
0.	243.	233.	223.	213.	203.
2.	143.	135.	126.	118.	111.
0.	74.	70.	65.	61.	57.
0.	38.	35.	33.	31.	28.
0.	19.	18.	16.	15.	14.
0.	9.	9.	8.	8.	7.
5.	5.	4.	4.	4.	4.
3.	2.	2.	2.	2.	2.

STORAGE

1.	1.	1.	1.	1.	1.
2.	3.	7.	12.	20.	28.
9.	74.	82.	96.	120.	153.
7.	480.	523.	537.	533.	520.
0.	303.	269.	240.	215.	194.
4.	117.	111.	105.	101.	97.
7.	73.	70.	67.	64.	61.
0.	48.	46.	44.	42.	40.
0.	29.	27.	25.	24.	22.
6.	15.	14.	13.	12.	11.
8.	7.	7.	7.	6.	6.
4.	4.	3.	3.	3.	3.
2.	2.	2.	2.	2.	1.
1.	1.	1.	1.	1.	1.
0.	0.	0.	0.	0.	0.

STAGE

0	1036.0	1036.0	1036.0	1036.0	1036.0
0	1036.1	1036.1	1036.3	1036.4	1036.6
4	1037.5	1037.7	1038.0	1038.4	1039.1
6	1044.5	1045.2	1045.4	1045.4	1045.2
3	1041.7	1041.1	1040.6	1040.2	1039.8
5	1038.4	1038.2	1038.1	1038.1	1038.0
6	1037.5	1037.4	1037.4	1037.3	1037.3
0	1037.0	1037.0	1036.9	1036.9	1036.8
6	1036.6	1036.6	1036.5	1036.5	1036.5
3	1036.3	1036.3	1036.3	1036.3	1036.2

1036.2	1036.2	1036.2	1036.2	1036.2	1036.1	1036.1
1036.1	1036.1	1036.1	1036.1	1036.1	1036.1	1036.1
1036.1	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0

PEAK OUTFLOW IS 10219. AT TIME 18.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL
CFS	10219.	7446.	2791.	975.	
CMS	269.	211.	79.	28.	
INCHES		12.46	18.71	19.62	
MM		316.98	475.33	498.34	
AC-FT		3692.	5536.	5804.	
THOUS CU Y		4554.	6829.	7160.	

STATION 2, PLAN 1, RATIO

END-OF-PERIOD HYDROGRAPH ORDINATE

OUTFLOW

2.	3.	5.	5.	6.	6.	6.
6.	6.	7.	11.	21.	43.	77.
343.	433.	508.	569.	629.	719.	929.
3618.	4771.	6212.	7997.	10670.	12226.	12760.
6726.	7699.	8647.	9659.	4773.	4020.	3405.
1633.	1590.	1406.	1281.	1181.	1093.	1014.
763.	714.	675.	635.	597.	559.	524.
399.	373.	346.	325.	303.	283.	264.
215.	205.	194.	184.	174.	164.	154.
120.	113.	105.	99.	92.	86.	81.
62.	57.	54.	50.	47.	44.	41.
31.	29.	27.	25.	23.	22.	20.
16.	14.	14.	13.	12.	11.	10.
8.	7.	7.	6.	6.	6.	5.
4.	4.	3.	3.	3.	3.	3.

STORAGE

0.	1.	1.	1.	1.	1.	1.
1.	1.	1.	2.	4.	9.	15.
59.	65.	75.	82.	85.	98.	114.
285.	347.	416.	490.	544.	566.	574.
511.	479.	436.	390.	347.	309.	276.
181.	165.	152.	142.	134.	127.	121.
101.	97.	93.	89.	85.	81.	77.
64.	62.	59.	57.	54.	52.	50.
43.	41.	39.	37.	35.	33.	31.
24.	22.	21.	20.	18.	17.	16.
12.	11.	11.	10.	9.	9.	8.
6.	6.	5.	5.	5.	4.	4.
3.	3.	3.	3.	2.	2.	2.
2.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.

STAGE

1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.1	1036.2	1036.2
1037.2	1037.2	1037.6	1037.7	1037.8	1038.0	1038.0

1036.2	1036.2	1036.1	1036.1	1036.1	1036.1	1036.1
1036.1	1036.1	1036.1	1036.1	1036.1	1036.1	1036.1
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0

DURS

AK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
9.	7446.	2791.	975.	140477.
9.	211.	79.	28.	3978.
	12.46	18.71	19.62	19.62
	316.96	475.33	498.34	498.37
	3692.	5536.	5804.	5805.
.	4554.	6829.	7160.	7160.

STATION 2, PLAN 1, RATIO 6

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

5.	6.	6.	6.	6.	6.	6.
11.	21.	43.	77.	123.	178.	238.
569.	629.	719.	929.	1278.	1845.	2639.
7997.	10670.	12226.	12760.	12439.	11391.	10069.
5659.	4773.	4020.	3405.	2893.	2469.	2114.
1281.	1181.	1093.	1014.	944.	879.	819.
635.	597.	559.	524.	490.	456.	428.
325.	303.	283.	264.	246.	235.	225.
184.	174.	164.	154.	145.	137.	128.
99.	92.	86.	81.	75.	71.	66.
50.	47.	44.	41.	38.	36.	33.
25.	23.	22.	20.	19.	18.	17.
13.	12.	11.	10.	10.	9.	8.
6.	6.	6.	5.	5.	4.	4.
3.	3.	3.	3.	2.	2.	2.

STORAGE

1.	1.	1.	1.	1.	1.	1.
2.	4.	9.	15.	24.	35.	47.
82.	85.	98.	114.	142.	182.	232.
490.	544.	566.	574.	569.	555.	535.
330.	347.	309.	276.	247.	222.	201.
142.	134.	127.	121.	116.	110.	106.
89.	65.	81.	77.	74.	71.	67.
57.	54.	52.	50.	49.	47.	45.
37.	35.	33.	31.	29.	27.	26.
20.	18.	17.	16.	15.	14.	13.
10.	9.	9.	8.	8.	7.	7.
5.	5.	4.	4.	4.	4.	3.
3.	2.	2.	2.	2.	2.	2.
1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	0.	0.	0.

SLAGE

1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.1	1036.2	1036.3	1036.5	1036.7	1037.0
1037.7	1037.8	1038.0	1038.3	1038.8	1039.6	1040.5

1042.0	1042.1	1043.0	1044.7	1045.5	1045.9	1046.0
1043.7	1044.0	1045.3	1045.1	1045.4	1046.0	1046.2
1045.0	1045.3	1045.0	1045.4	1045.7	1045.0	1045.4
1045.4	1045.2	1045.2	1045.4	1045.7	1045.7	1045.0
1047.3	1047.3	1047.2	1047.2	1047.1	1047.1	1047.0
1048.2	1048.3	1048.1	1048.3	1048.7	1048.7	1048.0
1048.5	1048.5	1048.4	1048.4	1048.4	1048.4	1048.3
1048.3	1048.2	1048.2	1048.2	1048.2	1048.2	1048.2
1048.1	1048.1	1048.1	1048.1	1048.1	1048.1	1048.1
1048.1	1048.1	1048.1	1048.1	1048.0	1048.0	1048.0
1048.0	1048.0	1048.0	1048.0	1048.0	1048.0	1048.0
1048.0	1048.0	1048.0	1048.0	1048.0	1048.0	1048.0

PEAK OUTPUT IS 12700. AT 1100 10.50 HOURS

	PEAK	7-HOUR	24-HOUR	72-HOUR	PCT
CRS	12700.	9338.	3491.	1219.	
CRS	301.	204.	99.	35.	
1-CH20		15.00	23.40	24.52	
AC-PI		397.53	594.45	622.91	
14015 CR		4030.	5924.	7255.	
		5711.	5540.	5949.	

1044.7	1045.5	1045.9	1045.0	1045.9	1045.7	1045.4
1043.1	1042.4	1041.6	1041.2	1040.7	1040.3	1039.9
1038.7	1038.7	1038.6	1038.4	1038.3	1038.2	1038.1
1037.6	1037.7	1037.7	1037.6	1037.5	1037.5	1037.4
1037.2	1037.1	1037.1	1037.0	1037.0	1037.0	1036.9
1036.5	1036.7	1036.7	1036.6	1036.6	1036.6	1036.5
1036.4	1036.4	1036.4	1036.3	1036.3	1036.3	1036.3
1036.2	1036.2	1036.2	1036.2	1036.2	1036.1	1036.1
1036.1	1036.1	1036.1	1036.1	1036.1	1036.1	1036.1
1036.1	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0
1036.0	1036.0	1036.0	1036.0	1036.0	1036.0	1036.0

7-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
9338.	5491.	1219.	175593.
204.	49.	35.	4972.
15.65	23.40	24.52	24.53
337.53	594.45	622.91	622.96
1030.	5924.	7255.	7256.
5711.	5540.	5949.	8950.

PEAK FLOOD AND STORM (END OF PERIOD) SUMMARY FOR MULTIPLE PLAS
 FLOOD IN CUBIC FEET PER SECOND (CUBIC FEET)
 AREA IN SQUARE MILES (SQUARE MILES)

OPERATION	STATION	AREA	PEAK	RATIOS APPLIED			
				RATIO 1	RATIO 2	RATIO 3	RATIO 4
				0.20	0.35	0.50	0
HYDROGRAPH A1	1	5.55	1	2552.	4484.	6405.	83
	(	14.57)	(	12.55)(	120.97)(	181.38)(	235.
ROUTED TO	2	5.55	1	2552.	4261.	6151.	80
	(	14.57)	(	07.01)(	120.05)(	174.19)(	226.

SUMMARY FOR MULTIPLE PLANT-RATIO ECONOMIC COMPUTATIONS
 FEET PER SECOND (CUBIC FEET PER SECOND)
 SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS					
1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6
20	0.35	0.50	0.65	0.80	1.00
2.	4484.	6405.	8327.	10249.	12811.
5)(	120.97)(	181.38)(	235.80)(	290.21)(	362.76)(
8.	4261.	6151.	8056.	10219.	12760.
1)(	120.65)(	174.19)(	228.11)(	289.37)(	361.32)(

SUMMARY OF DAM SAFETY ANALY

PLAN 1

ELEVATION	INITIAL VALUE	SPILLWAY CREST
STORAGE	1036.00	1036.00
OUTFLOW	0.	0.
	0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR ELEV.	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DI U' I
0.20	1040.21	0.00	218.	2368.	
0.35	1042.02	0.00	322.	4261.	
0.50	1043.50	0.00	413.	6151.	
0.65	1044.74	0.00	493.	8056.	
0.80	1045.42	0.62	537.	10219.	
1.00	1045.93	1.16	574.	12700.	

AD-A090 940

NATIONAL DAM SAFETY PROGRAM, FREDONIA RESERVOIR (INVENTORY NUMB--ETC(U)
SEP 80 B L THOMSEN, G L WOOD

F/G 13/13

DACW51-79-C-0001

NL

UNCLASSIFIED

2 x 2

000000

■

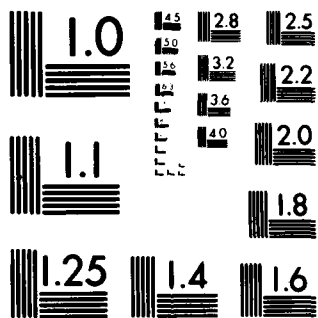
END

DATE

FILED

12-80

DTIC



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

SUMMARY OF DAM SAFETY ANALYSIS

IAL VALUE	SPILLWAY CREST	TOP OF DAM
030.00	1036.00	1044.80
0.	0.	497.
0.	0.	8162.

MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
218.	2388.	0.00	19.00	0.00
322.	4261.	0.00	19.00	0.00
413.	6151.	0.00	19.00	0.00
493.	8058.	0.00	19.00	0.00
537.	10219.	2.50	18.50	0.00
574.	12700.	3.50	18.50	0.00

APPENDIX D

STRUCTURAL STABILITY ANALYSIS

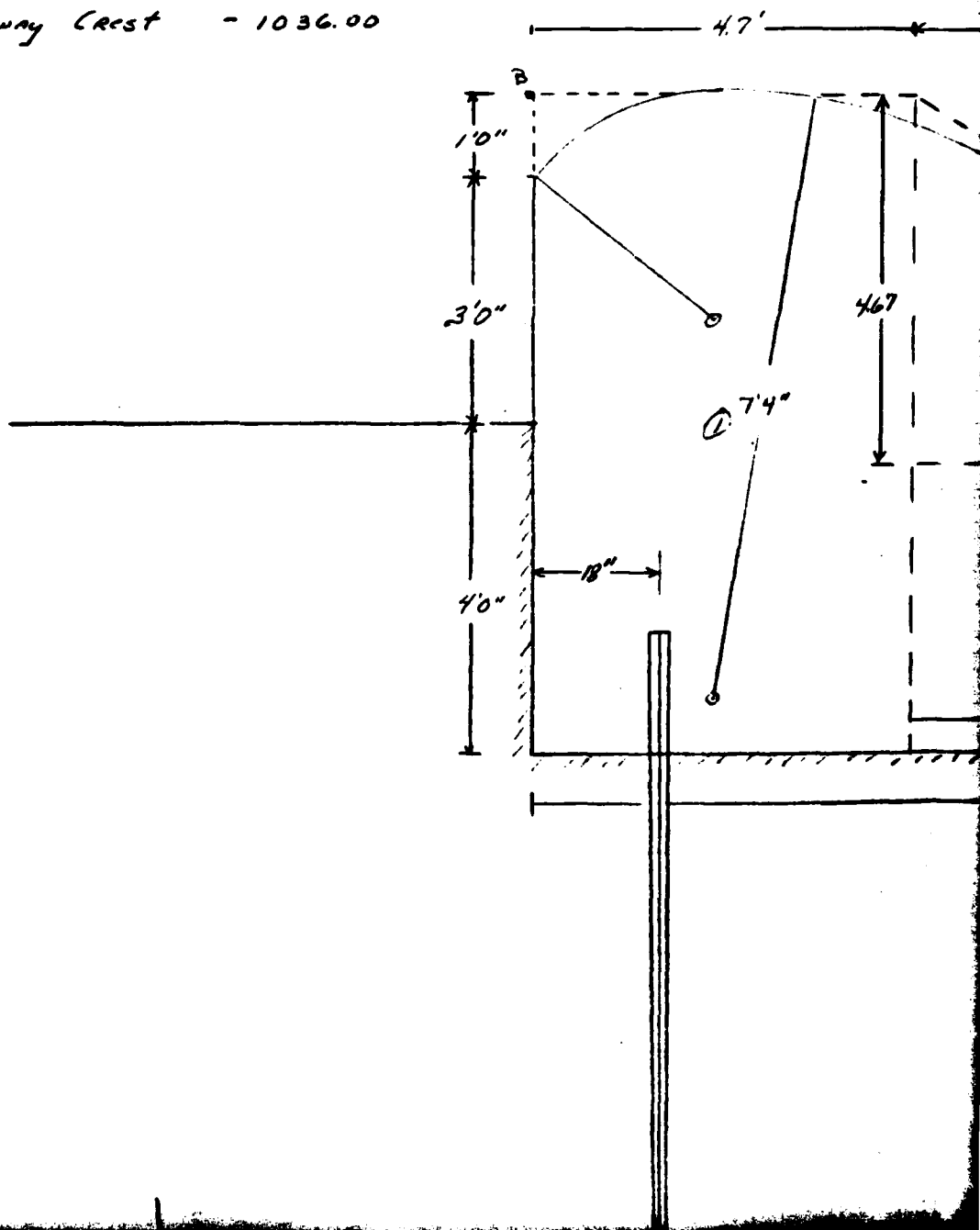
BY C76 DATE 7/23/80
CHKD. BY _____ DATE _____

SUBJECT FREDONA RESERVOIR
Spillway Stability

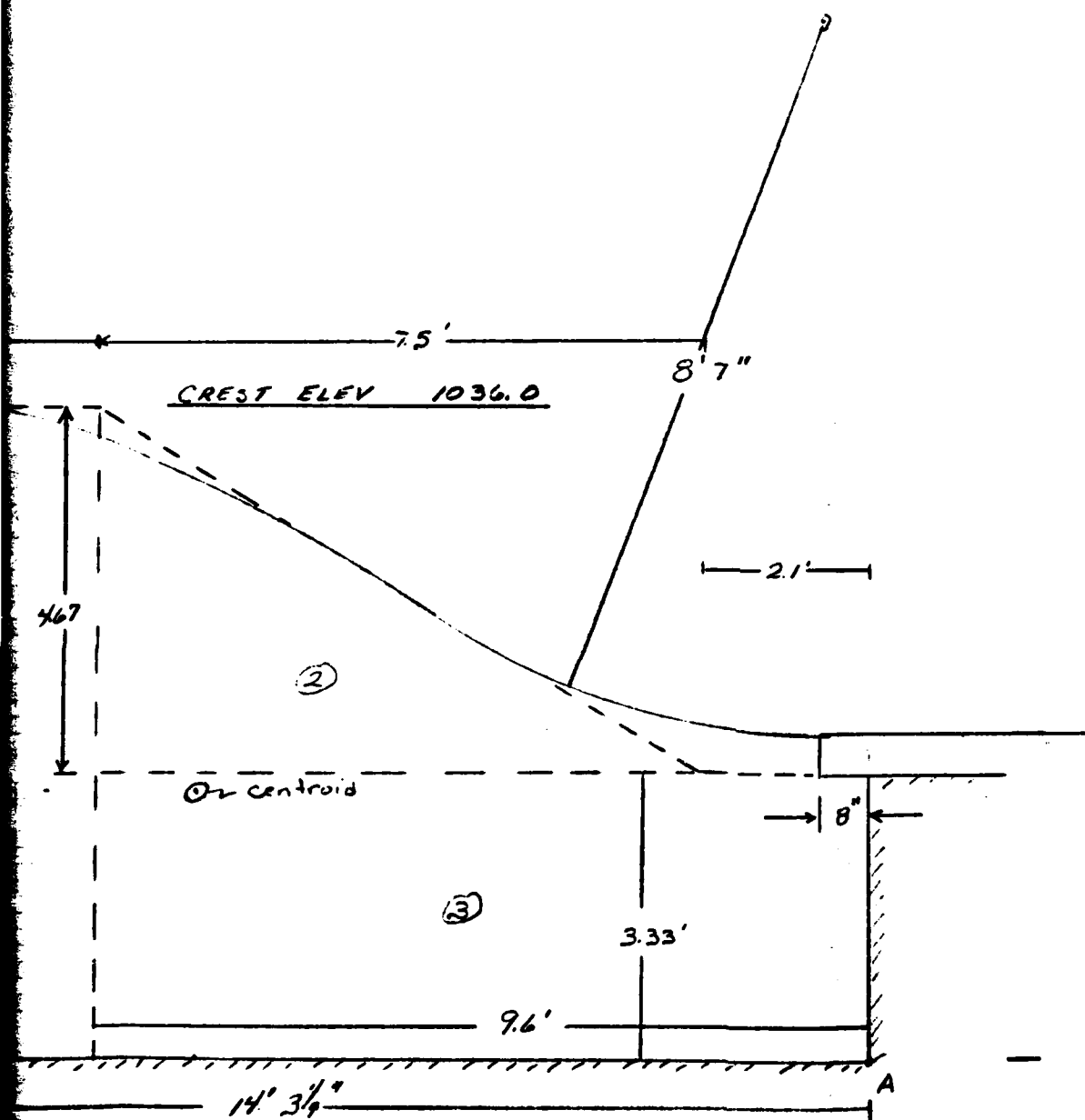
SHEET NO. 1 OF 6
JOB NO. E-80-1

Elevations

TOP OF DAM - 1044.80
Reservoir @ 1/2 PMF - 1043.50
Reservoir @ PMF - 1045.98
Spillway Crest - 1036.00



OF 6
2-1



FREDONIA RESERVOIR DAM

① Determine Centroid (Moment about Toe)

Area No.	Area	Arm	Moment
1.	80×4.7 (37.6)	$9.6 + \frac{4.7}{2}$ (11.95)	(449.32)
2.	$\frac{1}{2} \times 4.6 \times 7.5$ (17.5)	$2.1 + \frac{2}{3}(7.5)$ (7.1)	(124.34)
3.	3.33×9.6 (31.97)	$\frac{9.6}{2}$ (4.8)	(153.45)
$\Sigma A = 87.08$		$\Sigma M = 727.11$	

$$\bar{y} = \frac{\Sigma M}{\Sigma A} = \frac{727.11}{87.08} = 8.35$$

Area No	Area	Arm	Moment about B
1.	37.6	4.0	150.40
2.	17.51	$\frac{2}{3}(4.67)$	54.51
3.	31.97	$4.67 + \frac{3.33}{2}$	202.53
$\Sigma A = 87.08$		$\Sigma M = 407.44$	

$$\bar{x} = \frac{\Sigma M}{\Sigma A} = \frac{407.44}{87.08} = 4.68$$

- ② Weight of Concrete (W_c)
(from centroid computations)

$$\text{Volume} = (87.08)(1)$$

$$\text{Weight} = \frac{(87.08)(1)(150 \text{ pcf})}{1000} = 13.06 \text{ Kips/lin. ft.}$$

- ③ Determine Active Earth Pressure (P_A)

$$K_a = \tan^2(45^\circ - \phi/2)$$

$$\text{Assume: } \phi = 27^\circ$$

$$\delta = 0^\circ \text{ (wall friction)}$$

$$\gamma_{\text{sat}} = 125$$

$$\gamma' = 60 \text{ pcf}$$

$$\sigma_{A_{\text{max}}} = (60)(0.38)(4) = 91.20 \text{ psf}$$

$$P_A = \frac{(\sigma_{A_{\text{max}}})(1/2)(4)}{1000} = 0.18 \text{ Kips/lin. ft.}$$

- ④ Determine Passive Earth Pressure (P_P)

$$K_p = \tan^2(45^\circ + \phi/2)$$

$$K_p = 2.7$$

$$\sigma_{P_{\text{max}}} = (60)(2.7)(4) = 648 \text{ psf}$$

$$P_P = (1/2)(648)(4) = 1.28 \text{ Kips/lin. ft.}$$

- ⑤ Determine Water Pressure @ (P_w)

$$\text{Normal Pool} \quad 1036.0$$

$$1/2 \text{ PMF} \quad 1043.50$$

$$\text{PMF} \quad 1045.98$$

Sheet 4 of 6

1) Normal Pool (P_{WN})

$$\bar{G}_{HN} = (62.4 \text{ pc}) (1036 - 1028) = 49.2 \text{ psf}$$

$$P_{WN} = \frac{1}{2} (\bar{G}_{HN}) (H_N) = \frac{(1/2)(49.2)(8)}{1000} = 2.0 \text{ kips/lin ft}$$

Resultant acts 2.67' above BASE

2) $1/2$ PMF $P_{W1/2}$

$$P_{W1/2} = (h_{1/2} - h_N)(h_N)(\gamma_w) + P_{WN}$$

$$= \frac{(1043.5 - 1036.0)(8.0)(62.4)}{1000} + 2.0 = 5.74 \text{ kip/lin.ft.}$$

Resultant act 3.54' above BASE

3) PMF P_{WPMF}

$$P_{WPMF} = (h_{PMF} - h_N)(h_N)(\gamma_w) + P_{WN}$$

$$= \frac{(1045.98 - 1036.0)(8.0)(62.4)}{1000} + 2.0 = 6.98 \text{ kips}$$

Resultant acts 3.62' above BASE

⑥ Determine $1/2$ Uplift and Uplift for Normal Conditions,
 $1/2$ PMF and PMF

1.) Normal Pool

a) Full Uplift

$$P_{uN} = \frac{(49.2 \text{ psf})(1/2)(14.27)}{1000} = 3.56 \text{ kips/lin.ft.}$$

b) $1/2$ Uplift

$$P_{uN1/2} = 1.78 \text{ kips/lin.ft.}$$

2.) $1/2$ PMF

a) Full Uplift

$$P_{u1/2} = \frac{(967 \text{ psf})(1/2)(14.27)}{1000} = 6.90 \text{ kips/lin.ft.}$$

b) $1/2$ Uplift

$$P_{u1/21/2} = 3.45 \text{ kips/lin.ft.}$$

3) PMF

a) Full Uplift

$$P_{u, PMF} = \frac{(1121.95)(1/2)(14.27)}{1000} = 8.01 \text{ Kips/lin.ft}$$

b) 1/2 Uplift

$$P_{u, PMF/2} = 4.00 \text{ Kips/lin.ft.}$$

⑦ Ice Load (P_I)

$$P_{I, MAX} = 10,000 \text{ lbs/lin.ft} = 10 \text{ Kips/lin.ft.}$$

$$P_{I, MIN} = 5 \text{ Kips/lin.ft.}$$

⑧ Earthquake - Inertia Force within Dam (P_e)

$$P_e = \lambda W_c = (0.1)(13.06) = 1.31 \text{ Kips/lin.ft.}$$

⑨ Earthquake - Hydrodynamic Force at Normal Pool,
1/2 PMF and PMF

1.) Normal

$$P_{e_n} = C \lambda \gamma_w h = \frac{(0.73)(0.1)(62.4)(8)}{1000} = 0.0364 \text{ Ksf}$$

$$C = 0.73$$

$$\lambda = 0.1$$

$$\gamma_w = 62.4$$

$$h = 1036 - 1028 = 8$$

$$V_{e_n} = 0.726 P_{e_n} h = (0.726)(0.0364)(8) = 0.21 \text{ Kips/lin.ft}$$

$$M_{e_n} = 0.299 P_{e_n} h^2 = (0.299)(0.0364)(8)^2 = 0.696 \text{ K-ft/lin.ft.}$$

2) LANE

$$P_{e_{max}} = \frac{(0.73)(0.1)(62.4)(1043.5 - 1028.2)}{1000} = 0.0102 \text{ Ksf}$$

$$P_{e_{spillway crest}} = \frac{(0.73)(0.1)(62.4)\sqrt{(7.5)(15.5)}}{1000} = 0.049 \text{ Ksf}$$

$$V_{e_{1/2}} = 0.726 [(0.0706)(15.5) - (0.049)(7.5)]$$

$$= .794 - .267 = 527 \text{ Kips / lin ft}$$

$$M_{e_{1/2}} = 0.299(0.0706)(15.5)^2 - \left(\frac{299}{726}(7.5 + 3)\right)(0.267)$$

$$= 5.072 - 2.961 = 2.11 \text{ K-ft / ft}$$

Resultant acts 4.0' above BASE

3) PMF

$$P_{e_{max}} = \frac{(0.73)(0.1)(62.4)(1045.98 - 1028.0)}{1000} = 0.0319 \text{ Ksf}$$

$$P_{e_{spillway crest}} = \frac{(0.73)(0.1)(62.4)\sqrt{(9.98)(17.98)}}{1000} = 0.061 \text{ Ksf}$$

$$V_{e_{PMF}} = 0.726 [(0.0319)(17.98) - (0.061)(9.98)]$$

$$= 1.069 - .442 = 0.627 \text{ Kips / lin ft}$$

$$M_{e_{PMF}} = 0.299(0.0319)(17.98)^2 - \left(\frac{299}{726}(9.98 + 8)\right)(0.442)$$

$$= 7.92 - 5.35 = 2.57 \text{ Kips / lin ft}$$

Resultant acts 4.10' above BASE

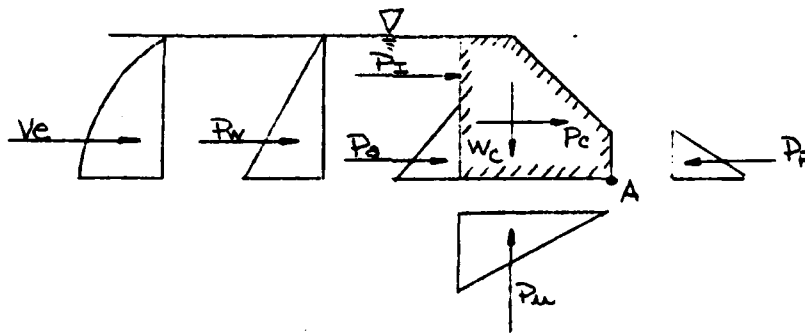
Example Computations:

Normal Pool: with the following loading conditions

A. Full Hydrostatic Uplift Force

B. Maximum Ice Load

C. Earthquake



A. Overturning Stability

1) Overturning Moments

Force	Magnitude (kips)	Moment Arm (ft)	Moment (kip-ft)
P_v	2.00	2.7	5.34
P_u	3.56	9.5	33.86
P_a	0.18	1.3	0.24
P_i	10.0	7.0	70.00
P_c	1.31	3.3	4.35
V_e	0.21	3.3	0.70

$$\sum M_o = 114.49$$

2) Resisting Moments

W_c	13.06	8.4	109.05
P_p	1.28	1.3	1.69

$$\sum M_R = 110.71$$

$$SF = \frac{\sum M_R}{\sum M_o} = \frac{110.71}{114.49} = 0.97$$

Sheet 2 of 2

$$\bar{x} = \frac{\sum M_R - \sum M_O}{\sum F_V} = \frac{110.71 - 114.47}{13.06 - 3.56} = -0.34$$

$$e = B/2 - \bar{x} = \frac{14.27}{2} - (-0.34) = 7.53$$

$$\boxed{B/6 = \frac{14.27}{6} = 2.38 < 7.53}$$

Resultant is Outside the base ∴ NOT STABLE

B. Sliding Stability

$$SF_{S-F} = \frac{cA + (Wc - P_u) \tan \phi}{\sum F_H}$$

Assume $c = 500$ psf $A = 14.27$ ft² $\phi = 26^\circ$

$$SF = \frac{\frac{(500)(14.27)}{100} + 13.06 - 3.56(0.49)}{2.0 + 0.18 + 10.0 + 1.31 + 0.21 - 1.30} = \boxed{0.95}$$

Safety Factor is less than 1.5 - the minimum sliding friction safety factor recommended by the Guidelines For Safety Inspection of Dams

STABILITY PROGRAM (HP-97)

CALCULATOR PRINT OUT

	RESERVOIR ELEVATION	935.00	***
	Water Pressure	7.50	***
	Moment Arm	5.2	***
	Hydrostatic Uplift Pressures	5.37	***
	Moment Arm	14.9	***
	Active Earth Pressure	0.75	***
	Moment Arm	2.9	***
<u>OVERTURNING MOMENTS</u>	Silt Load	0.00	***
	Moment Arm	0.0	***
	Ice Load	10.00	***
	Moment Arm	14.5	***
	Seismic-Inertial Force	3.14	***
	Moment Arm	5.1	***
	Seismic-Hydrodynamic Force	0.73	***
	Moment Arm	5.4	***
<u>RESISTING MOMENTS</u>	Weight of Concrete	71.44	***
	Moment	14.6	***
	Passive Earth Pressure	1.30	***
	Moment Arm	1.1	***
	Sum of Resisting Moments	459.30	***
	Sum of Overturning Moments	289.52	***
	Safety Factor-Overturning	1.59	***
	Eccentricity	4.60	***
	Safety Factor-Sliding	17.73	***

NORMAL POOL

1/2 Uplift

1036.00

2.00

2.7

1.78

9.5

0.18

1.3

0.00

0.0

0.00

7.0

0.00

3.3

0.00

3.3

13.06

8.3

1.26

1.3

110.77

22.51

4.92

-0.69

14.06

NORMAL POOL

1/2 Uplift & Ice

1036.00

2.00

2.7

1.78

9.5

0.18

1.3

0.00

0.0

10.00

7.0

0.00

3.3

0.00

3.3

13.06

8.3

1.26

1.3

110.77

22.51

1.20

5.52

1.16

NY 749

NORMAL POOL
1/2 Uplift, Ice
and Earthquake

NORMAL POOL
Full Uplift

1036.00

1036.00

2.00

2.00

2.7

2.7

1.78

3.56

9.5

9.5

0.18

0.18

1.3

1.3

0.00

0.00

0.0

0.0

10.00

0.00

7.0

7.0

1.31

0.00

3.3

3.3

0.21

0.00

3.3

3.3

13.06

13.06

8.3

8.3

1.28

1.28

1.3

1.3

110.77

110.77

97.55

39.45

1.14

2.81

5.96

-0.37

1.02

13.09

NORMAL POOL
Full Uplift & Ice

1036.00

2.00
2.7

3.56
9.5

0.18
1.3

0.00
0.0

10.00
7.0

0.00
3.3

0.00
3.3

13.06
8.3

1.28
1.3

110.77
109.45

1.01

7.00

1.08

NORMAL POOL
Full Uplift, Ice
and Earthquake

1036.00

2.00
2.7

3.56
9.5

0.18
1.3

0.00
0.0

10.00
7.0

1.31
3.3

0.21
3.3

13.06
8.3

1.28
1.3

110.77
114.49

0.97

7.53

0.95

1/2 PMF
1/2 Uplift

1043.50

5.74
3.54

3.45
9.5

0.18
1.3

0.00
0.0

0.00
7.0

0.00
3.3

0.00
6.4

13.06
8.3

1.28
1.3

110.77
53.37

2.07

1.17

2.55

1/2 PMF
1/2 Uplift and
Earthquake

1043.50

5.74
3.54

3.45
9.5

0.18
1.3

0.00
0.0

0.00
7.0

1.31
3.3

0.53
4.0

13.06
8.3

1.28
1.3

110.77
59.83

1.85

1.84

1.83

1/2 PMF
Full Uplift

1/2 PMF
Full Uplift and
Earthquake

1043.50

1042.50

5.74

5.74

3.54

3.54

6.90

6.90

9.5

9.5

0.18

0.18

1.3

1.3

0.00

0.00

0.0

0.0

0.00

0.00

7.0

7.0

0.00

1.31

3.3

3.3

0.00

0.53

6.4

4.0

13.06

13.06

8.3

8.3

1.28

1.28

1.3

1.3

110.77

110.77

86.18

92.64

1.28

1.20

3.15

4.20

2.19

1.57

PMF
1/2 Uplift

PMF
1/2 Uplift
and Earthquake

1045.98

1045.98

6.98
3.62

6.98
3.62

4.00
9.5

4.00
9.5

0.18
1.3

0.18
1.3

0.00
0.0

0.00
0.0

0.00
7.0

0.00
7.0

0.00
3.3

1.31
3.3

0.00
7.4

0.63
4.1

13.06
8.3

13.06
8.3

1.28
1.3

1.28
1.3

110.77
63.55

110.77
70.47

1.74

1.57

1.93

2.70

1.97

1.48

NY 749

PMF
Full Uplift

1045.98

6.98
3.62

8.01
9.5

0.18
1.3

0.00
0.0

0.00
7.0

0.00
3.3

0.00
7.4

13.06
8.3

1.28
1.3

110.77
101.69

1.09

5.35

1.64

PMF
Full Uplift
& Earthquake

1045.98

6.98
3.62

8.01
9.5

0.18
1.3

0.00
0.0

0.00
7.0

1.31
3.3

0.63
4.1

13.06
8.3

1.28
1.3

110.77
108.61

1.02

6.72

1.23

APPENDIX E

Available Documents

(NOTICE: After filling out one of these forms as completely as possible for each dam in your district, return it at once to the Conservation Commission, Albany.)

STATE OF NEW YORK
CONSERVATION COMMISSION
ALBANY

DAM REPORT

Map 3-D.

608 Erie

June 21, 1915
(Date)

CONSERVATION COMMISSION,

DIVISION OF INLAND WATERS.

GENTLEMEN:

I have the honor to make the following report in relation to the structure known as the Fredonia Upper Reservoir Dam.

This dam is situated upon the Reservoir Pond
(Give name of stream)
in the Town of Pomfret, Chautauqua County,
about 3 1/2 miles from the Village or City of Fredonia.
(State distance)

The distance down stream from the dam, to the Canadaway Creek,
(Up or down) (Give name of nearest important stream or of a bridge)
is about 1/2 mile.
(State distance)

The dam is now owned by Village of Fredonia
(Give name in full)
and was built in or about the year 1896, and was extensively repaired or reconstructed during the year 1912.

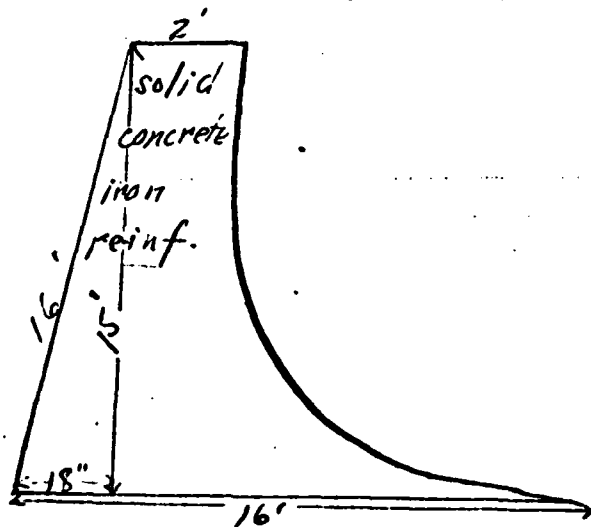
As it now stands, the spillway portion of this dam is built of concrete
(State whether of masonry, concrete or timber)
and the other portions are built of earth, masonry and concrete.
(State whether of masonry, concrete, earth or timber with or without rock fill)

As nearly as I can learn, the character of the foundation bed under the spillway portion of the dam is solid rock and under the remaining portions such foundation bed is earth and rock.

Most has been reconstructed
10/17

(In the space below, make one sketch showing the form and dimensions of a cross section through the spillway or waste-weir of this dam, and a second sketch showing the same information for a cross section through the other portion of the dam. Show particularly the greatest height of the dam above the stream bed, its thickness at the top, and thickness at the bottom, as nearly as you can learn.)

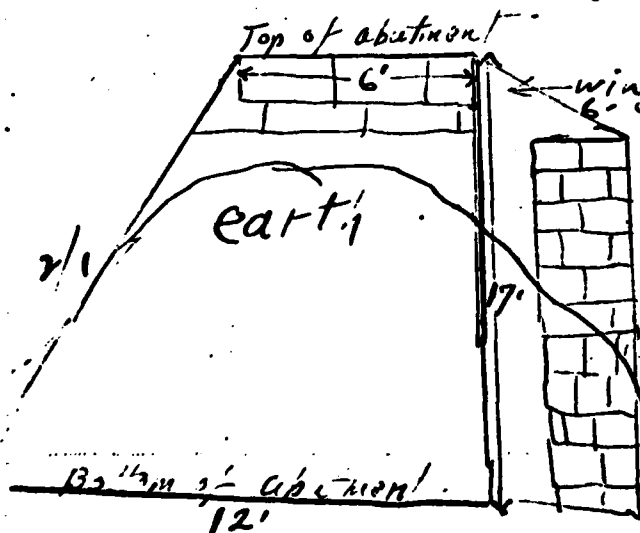
Cross-section of Spillway.



Cross of Dam below

(In the space below, make a third sketch showing the general plan of the dam, and its approximate position in relation to buildings or other conspicuous objects in the vicinity.)

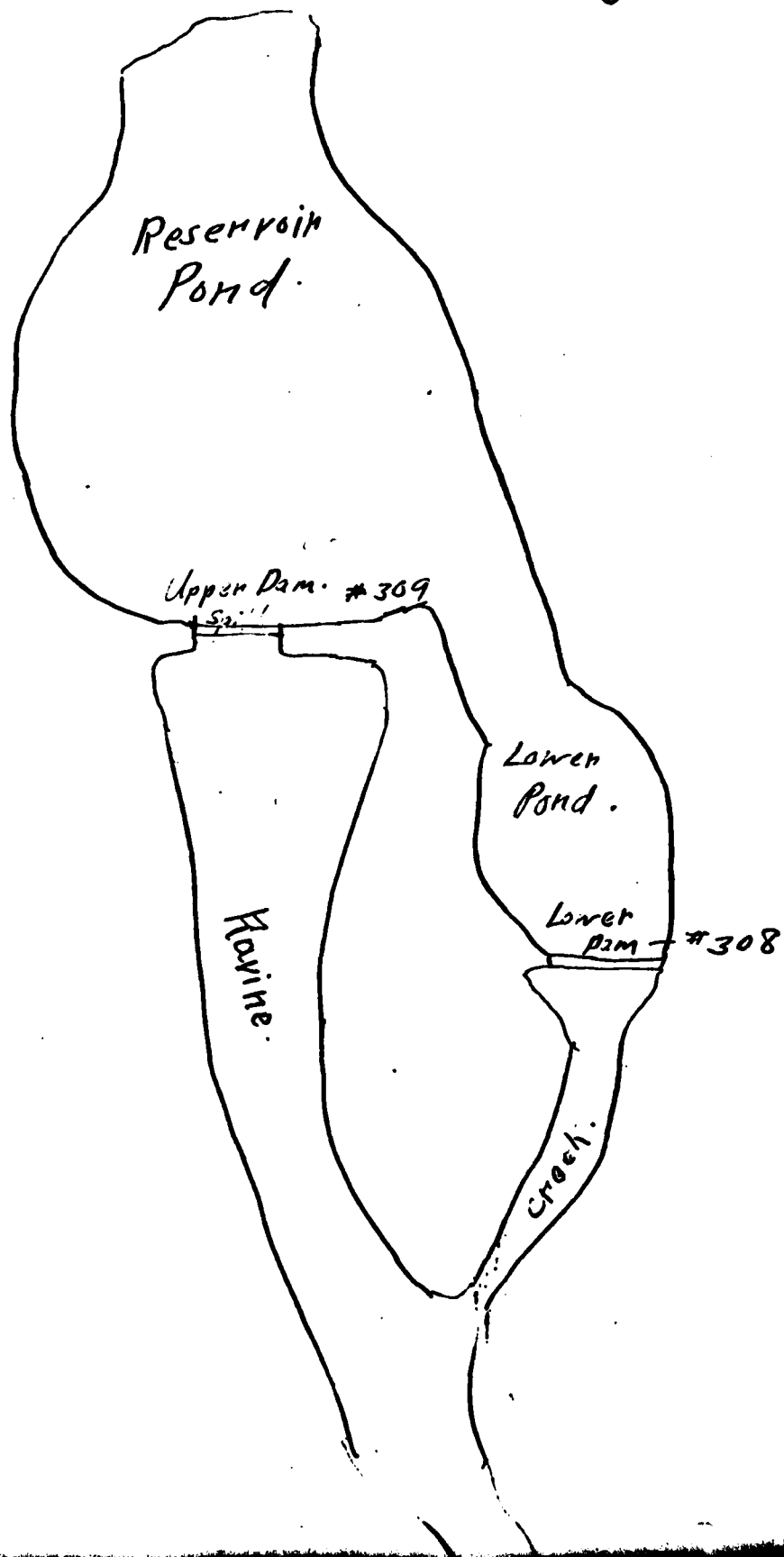
II. Cross of Dam.



wing of abutment - extends inland at 45°
is 6' long - 2 1/2' thick of
Masonry with 12" concrete
top. Is same height as
abutment or 17'

General Plan of Dam inside

115
General Plan of Dam
and Surroundings.



The total length of this dam is 90 feet. The spillway or waste-weir portion, is about 30 feet long, and the crest of the spillway is about 2 feet below the top of the dam.

The number, size and location of discharge pipes, waste pipes or gates which may be used for drawing off the water from behind the dam, are as follows: one discharge pipe - 16" diameter

State briefly, in the space below, whether, in your judgment, this dam is in good condition, or bad condition, describing particularly any leaks or cracks which you may have observed.)

This dam is in very good condition. A part of it went out, - one of the abutments, - two years ago, but has since been replaced and is strong.

The ravine, noted in Drawing III, was dug to take care of the overflow of the pond which would pour over the crest. The pond is fed by springs. and a small creek and covers an approximate area of twenty acres, with an average depth of 12 ft. The creek leading from the lower dam, leads into the Canadaway Creek. Should either of these dams give way it would cause serious damage to the homes and farms along Canadaway Creek especially in the village of Lona which is a hamlet about 2 miles below the dam. Reported by Carl B. Cooper

(Signature)

Box 697

(Address—Street and number, P. O. Box or R. F. D. route)

Hamers N.Y.

(Name of place)

(SEE OTHER SIDE)

REPORT OF
PROPOSAL TO INCREASE
RESERVOIR CAPACITY
FOR
FREDONIA, NEW YORK

on an increased population of 880 persons with the increase in consumption proportioned on the basis of the present consumption. Table IV of the appendix adds these increases to 1934 consumption and shows the estimated total consumption by months for 1956.

Table V of the appendix summarizes the consumption, percolation and evaporation as estimated for the year 1956 and totals each by months. This shows that the consumption varies from a low of 32,830,000 gallons for the month of November to a high of 45,950,000 for the month of July, with a total yearly consumption of approximately 475,330,000 gallons.

GENERAL DESCRIPTION OF THE PROPOSED WORK

It is recommended that the Village of Fredonia increase their reservoir capacity. To accomplish this purpose the writers have investigated several possible locations for a dam on the West Branch of the Canadaway Creek but after study it was considered most feasible and economical to increase the storage of the 90,000,000 gallon reservoir. The writers recommend that this be accomplished by raising the existing earth dam by constructing a smaller and new earthen dam in the present spillway location, and by constructing a new concrete spillway between these two dams and discharging same through a concrete spillway channel into the lower reservoir.

It is not considered advisable to raise the existing dam by adding to the height of the present corewall and placing more fill on the present dam because it is an old structure and it is not known how well the corewall is sealed to rock or other impervious stratum. Therefore, it is recommended that a new corewall be constructed at the downstream toe of the present dam and placing a new fill around this. Then the old dam will be used as a part of the upstream fill of the new dam as shown on the plans which are attached to the petition to the Water Power and Control Commission.

By raising the elevation of the water level in this reservoir twenty feet, 245,000,000 gallons of storage will be created over and above the 90,000,000 gallons stored at present, thus increasing storage capacity by 2-7/10 times the amount now stored. The lake created by the raising of these dams will have an area of approximately fifty acres.

THE CHARACTER OF WATERSHED AREA TRIBUTARY TO THE POINT OF

DIVERSION

The tributary watershed area at the point of diversion is

approximately five square miles. The terrain is of a steep hilly nature, fairly well wooded and only sparsely inhabited. There is no danger of excessive contamination of the raw water and the modern filtration plant which the Village now maintains and operates will unquestionably eliminate any objectionable bacteria before the water is turned into the distribution system.

ESTIMATED YIELD OF WATERSHED

Table VI of the appendix shows the estimates of watershed yield as based on the 1930 rainfall. Use of rainfall data for that year gave a minimum figure for the summer and fall months. The percentage run off was estimated from watersheds having similar characteristics and from these factors the yield was computed in millions of gallons per month and totals 980 million gallons per year.

Table VII of the appendix was compiled in order to compare by months the yield of the watershed and the present consumption. The table indicates conclusively the previous statement that the Village of Fredonia is in need of additional storage. It is interesting to note that the table shows the deficiency occurs in the months of June to October inclusive. This is a fact and is borne out by actual records proving the accuracy of factors used.

Table VIII of the appendix shows the theoretical amount of storage required for the year 1956. It shows a deficiency of approximately 172 million gallons. Consumption by months was taken from Table V and the yield from Table VI.

Thus it is indicated by increasing the reservoir capacities to 345 million gallons, the Village will have an adequate safety factor in raw water storage. In other words, twice as much storage will be available as is theoretically required for a year of maximum demand and minimum rainfall.

OTHER POSSIBLE SOURCES OF ADDITIONAL SUPPLY

Two other possible locations for the construction of a new dam and reservoir were given a preliminary study. The lower location investigated lies within the upper end of the present large reservoir and would for this reason cause considerable difficulty in construction of a dam. It would result in increased cost and would render it very difficult to maintain an adequate water supply for the Village during the preliminary stages of construction.

The other location is on the upper end of the watershed area. This site is fairly well adapted for a dam, however,

material, equipment and other costs. Table IX of the appendix summarizes the estimated cost while Table X of the appendix summarizes the cost by items of work.

SPILLWAY

The length of the existing spillway of the Fredonia Dam is 60 feet. No records have been kept of the maximum depth of overflow during flood seasons. However, the Superintendent of Water for the Village states that he has observed the flow for the past ten years or so and does not believe that it has acceded 2 feet.

In computing the maximum ten year flood the writers assumed a 3 foot overflow in order to obtain a maximum figure. This represents 1,230 sec. feet.

The proposed spillway is 75 feet long and is capable of discharging 3,320 sec. feet with a 5 foot overflow. This is well over a five hundred year probable flood.

In addition to this there is a further safety factor on either side of the spillway. Before flood water could overtop either of the dams an 8 foot depth of water would be going over the spillway with a discharge of 6,700 sec. feet, besides the enlargement of the spillway opening which would be cut on either side of the spillway by the flood water. This would be accomplished without effecting or overtopping of the dams proper.

Respectfully submitted,

FRETTS, TALLAMY & SENIOR
Consulting Engineers

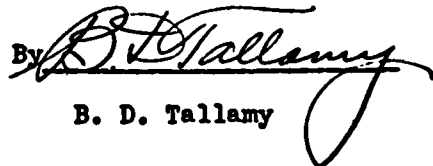
By 
B. D. Tallamy

TABLE IX
SUMMARY OF ESTIMATED COSTS

Item of Cost	Federal Funds	Sponsor's Contribution	Total
a. Labor:			
1. Unskilled	60,720.00		60,720.00
2. Intermediate	3,949.20		3,949.20
3. Skilled	9,038.50		9,038.50
4. Professional & Technical	0.00		0.00
b. Superintendence	1,992.00	1,500.00	3,492.00
c. Material, Equipment and other Costs:			
1. Material and Supplies	17,239.00	11,860.00	29,099.00
2. Equipment Rentals		37,800.00	37,800.00
3. Other direct Costs		13,000.00	13,000.00
TOTAL COST OF PROJECT	\$92,938.70	\$64,160.00	\$157,098.70

TABLE X
ESTIMATE OF COST BY ITEMS OF WORK

Quantity	Unit	Description of Operation or Feature of Work	Unit Price	Total
88,000	C.Y.	Earth Fill	0.80	\$70,400.00
2,400	C.Y.	Reinforced Concrete	16.00	38,400.00
2,430	C.Y.	Rock Excavation 4'±	8.00	19,440.00
670	C.Y.	Trench Excavation 4'±	2.00	1,340.00
110	Tons	Steel Sheet Piling	81.00	8,910.00
540	Ft.	10" C.I.P. Connections main- taining present Village supply	4.00	2,160.00
1,120	Ft.	Masonry Gutters	2.40	2,688.00
1,360	Ft.	Stone Underdrains	1.50	2,040.00
35	Acres	Cutting trees, brush, clearing Site	150.00	5,250.00
Lump -		Protecting pipe in existing Tunnel	Bid	505.70
Lump -		Sealing existing tunnels & care- fully backfilling as far as New Corewall and sealing again	Bid	2,500.00
Lump -		Contingencies & Cleanup		3,465.00
TOTAL				\$157,098.00

STATE OF NEW YORK



DEPARTMENT OF PUBLIC WORKS
DIVISION OF ENGINEERING
ALBANY

Received Nov. 21, 1936
Disposition App Nov. 21, 1936
Foundation inspected _____
Structure inspected _____

Dam No. 3-1102
Watershed Lake Erie

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 Dam and Reservoir No. 2
Fredonia, New York

herewith submitted for the ~~reconstruction~~ ^{construction} 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 June 1937
(Date)

1. The dam will be on West Branch Genesee Cr. flowing into Genesee Creek in the town of Pomfret, County of Cheautauque and 3 miles south east of Fredonia
(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 Dunkirk quadrangle of the United States Geological Survey.

3. The name of the owner is Village of Fredonia

4. The address of the owner is Village Hall, Fredonia, N. Y.

5. The dam will be used for Water supply storage

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 5 square miles.

8. The proposed dam will create a pond area at the spillcrest elevation of 50 acres and will impound 44,600,000 cubic feet of water.

9. The maximum height of the proposed dam above the bed of the stream is 80 feet _____ inches.
10. The lowest part of the natural shore of the pond is 30 feet vertically above the spillcrest, and everywhere else the shore will be at least over 30 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. none apparant
12. The natural material of the bed on which the proposed dam will rest is (clay, sand, gravel, boulders, granite, shale, slate, limestone, etc.) limestone, sand, clay
13. Facing down stream, what is the nature of material composing the right bank? _____
Big dam - shale, limestone = Smaller dam - clay
14. Facing down stream, what is the nature of the material composing the left bank? _____
Big dam - limestone, clay = Smaller dam - clay
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. both dams have hard limestone beds - banks are shale and clay and are impervious - bottoms very durable - sides also very hard for type of material and have stood up on steep slopes over long periods of exposure.
16. Are there any porous seams or fissures beneath the foundation of the proposed dam? _____
may be seams below rock surface but given no trouble in old dams.
17. WASTES. The spillway of the above proposed dam will be 75 feet long in the clear; the waters will be held at the right end by a concrete wall the top of which will be 5 feet above the spillcrest, and have a top width of one foot; and at the left end by a concrete wall the top of which will be 5 feet above the spillcrest, and have a top width of one foot.
18. The spillway is designed to safely discharge 3320 cubic feet per second.
19. Pipes, sluice gates, etc., for flood discharge will be provided through the dam as follows:
No piping for flood discharge goes through dams.
Flood piping goes through tunnel in rock below dam
but is open only on down stream side of core wall.
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 no apron
feet long across the stream, _____ feet wide and _____ feet thick.
22. Does this dam constitute any part of a public water supply? Yes

APPENDIX F

Previous Inspection Reports

October 19, 1977

October 4, 1979

177)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DAM INSPECTION REPORT
(By Visual Inspection)

Dam Number	River Basin	Town	County	Hazard Class	Date & Inspector
608	Erie	Fredonia	Chautauque	R-C	10/19/77

Stream =

Owner =

Vil. Fredonia

Type of ConstructionUse

- ☒ Earth w/Concrete Spillway
☐ Earth w/Drop Inlet Pipe
☐ Earth w/Stone or Riprap Spillway
☐ Concrete
☐ Stone
☐ Timber
☐ Other _____

- ☒ Water Supply
☐ Power
☐ Recreation - ☐ High Density
☐ Fish and Wildlife
☐ Farm Pond
☐ No Apparent Use-Abandoned
☐ Flood Control
☐ Other _____

Estimated Impoundment Size 45 Acres ## Estimated Height of Dam above Streambed 30 Ft.

Condition of Spillway

- ☒ Service satisfactory ☐ Auxiliary satisfactory
☐ In need of repair or maintenance ☐ In need of repair or maintenance

Explain: _____

Condition of Non-Overflow Section

- ☒ Satisfactory ☐ In need of repair or maintenance

Explain: _____

Condition of Mechanical Equipment

- ☒ Satisfactory ☐ In need of repair or maintenance

Explain: _____

Siltation☐ High☒ LowExplain: ?? no siltation from recent storm 9/14/79Remarks: Re-inspected 10/4/79 'C' Haz. home lost bldg. damaged during storm

7:45 PM 9/19/79 Heavy erosion in bottom channel - Spillway rd. retaining wall
 needed & moved 6" wide channel at top similar problem on the east side of wall
 in past (they used earth anchor tiebacks to support walls)

Trees need to be removed on embankment (W.D.) several have been uprooted

Evaluation (From Visual Inspection)

- ☐ Repairs req'd. beyond normal maint. ☒ No defects observed beyond normal maint.

check file 38-1102

3B-608

Fredonia Reservoir

NY 749

DATE INSPECTED 10-19-77

BY KDH

Reinspected 10/4/79 K. Thorne
P. McGoldy
Sp. Army unit (E.I.) moved G
Remore trees, heavy stone damage
in downstream channel & banks
& bluffs undermined

1

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233
Room 422



Robert F. Flacke,
Commissioner

October 15, 1979

Ms. Wanda Gustafson, Director
Chautauqua County Office of Civil
Defense
County Office Building
P.O. Box 183
Mayville, New York 14757

Re: Safety Inspection of
Chautauqua County Dams

Dear Wanda:

During the first week of October 1979, inspections of various dams were conducted at your request by Messrs. Kenneth Harmer and Robert McCarty of the DEC Dam Safety Section, and Mr. Charles Hagstrom your Deputy Director. A summary of the observations made during the inspections are as follows:

October 3, 1979

#4C-278 - Alleghany River Basin - Panama Dam - Reputed Owner: Gerry A. Green

The dam was reported to be overtopped during the September 14, 1979 storm; causing severe erosion of N.Y. Route #74, a section of the west embankment, and portions of the downstream channel. Modifications by NYS DOT in the alignment of Route #74 are blamed for the erosion. Ownership and liability will require further investigation. Future storms may initiate further erosion. We suggest this dam be monitored closely. This dam will receive a Phase I inspection this fall.

#2D-2691 - Alleghany River Basin - Jaquin's Pond Dam - Owner: Chautauqua County Federation of Sportsmen's Clubs, Inc.

The gates of this dam are open and no water is being impounded by the dam.

#2C-339 - Alleghany River Basin - Clymer Dam - Owner: Village of Clymer

The dam is in good condition.

#2C-859 - Lake Erie Basin - Findley Lake Dam - Owner: Village of Findley Lake

Concrete deterioration of the outlet structure was reported, but not observed. This structure will get a Phase I inspection this fall.

October 15, 1979

#3B-608 - Lake Erie Basin - Fredonia Reservoir Dam - Owner: Village of Fredonia

The right spillway wall is eroded and has moved inward approximately 6 inches. The embankment is heavily vegetated and these trees must be cut. Severe erosion of the downstream channel was observed as a result of the September 14, 1979 storm. This dam will receive a Phase I inspection this fall.

#6D-516 - Lake Erie Basin - Smith Mills Reservoir Dam - Owner: Village of Silver Creek

Excessive erosion of the concrete apron and underlying bedrock resulted from the September 14, 1979 storm. The sliding resistance and stability of the dam are in question. In depth engineering studies will be required to assess the dam's safety. This dam will receive a Phase I inspection this fall.

#7B-3979 - Alleghany River Basin - Conewango Creek Site 9A Dam - Owner: Conewango Creek Watershed Commission

This dam could not be located. Later it was discovered that the location map was incorrect. This dam will be reinspected later this fall.

#7C-3743 - Alleghany River Basin - Conewango Creek Site 3 Dam - Owner: Same as above

This dam is in excellent condition. Evidence of flow was noted in the auxiliary spillway adjacent to the dam. This condition is necessary for any storm in excess of the 100-year frequency. The adjacent landowner should not be permitted access to the auxiliary spillway, because extensive erosion will and has resulted. The owner is aware of this condition and will initiate the appropriate repairs.

October 5, 1979

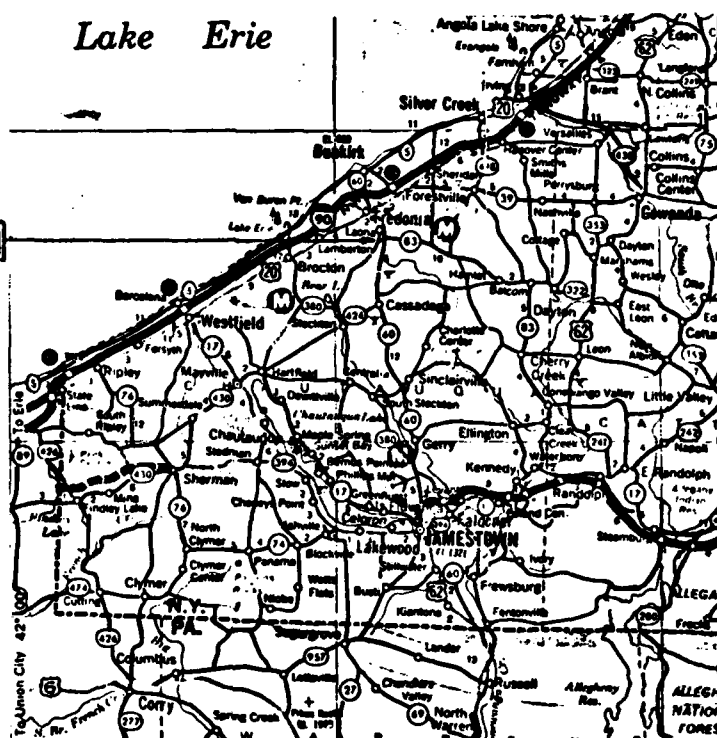
#4A-2776 - Alleghany River Basin - Hall Dam - Owner: Helen M. Hall

Serious erosion of the soil downstream of the auxiliary spillway was observed due to the September 14, 1979 storm, and it appears that the dam was nearly overtopped. Stoplogs should be removed immediately and be maintained that way until the auxiliary spillway is repaired and additional spillway capacity is achieved. This may be accomplished at the left abutment in the level area adjacent to the dam. This auxiliary spillway could be constructed with the use of a bulldozer and further erosion problems may be avoided.

APPENDIX G

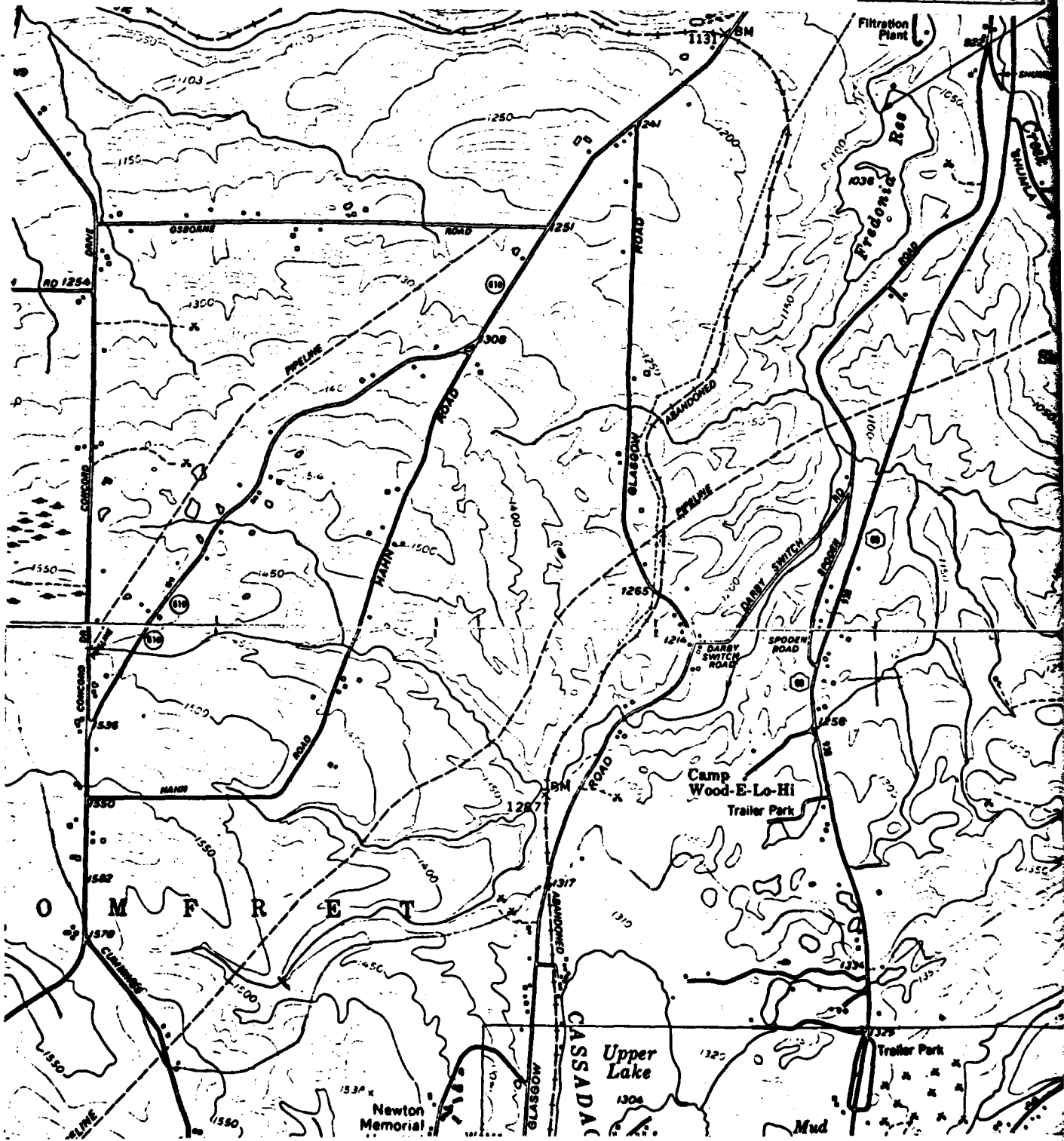
DRAWINGS

DAM LOCATION

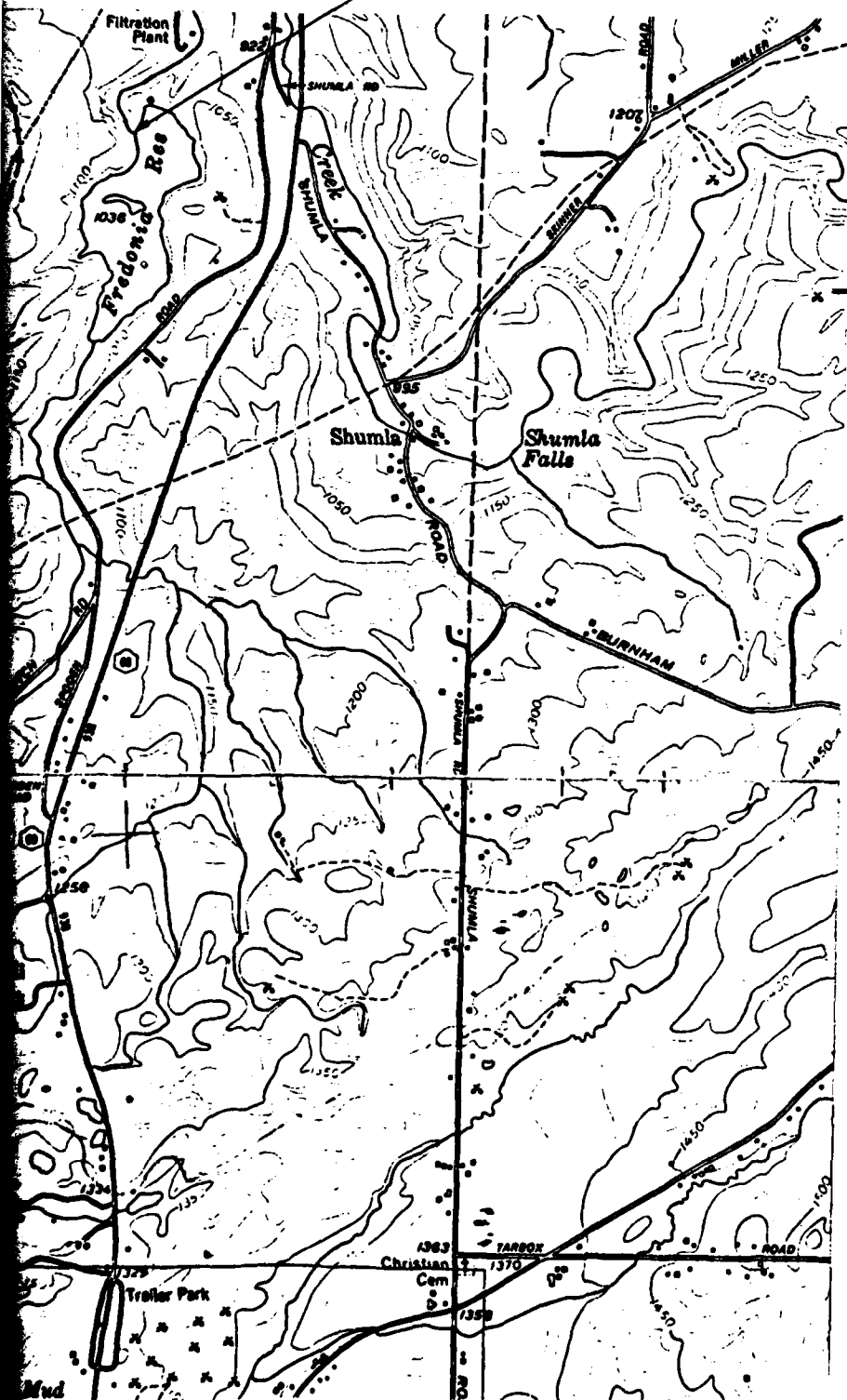


VICINITY MAP
FREDONIA RESERVOIR
I.D. NO. N.Y. 749

DAM LOCATION



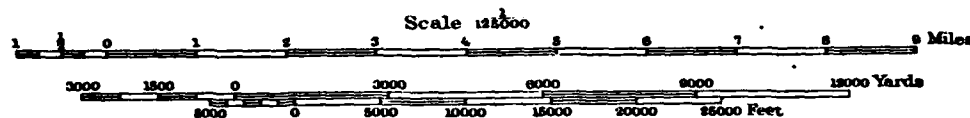
DAM LOCATION



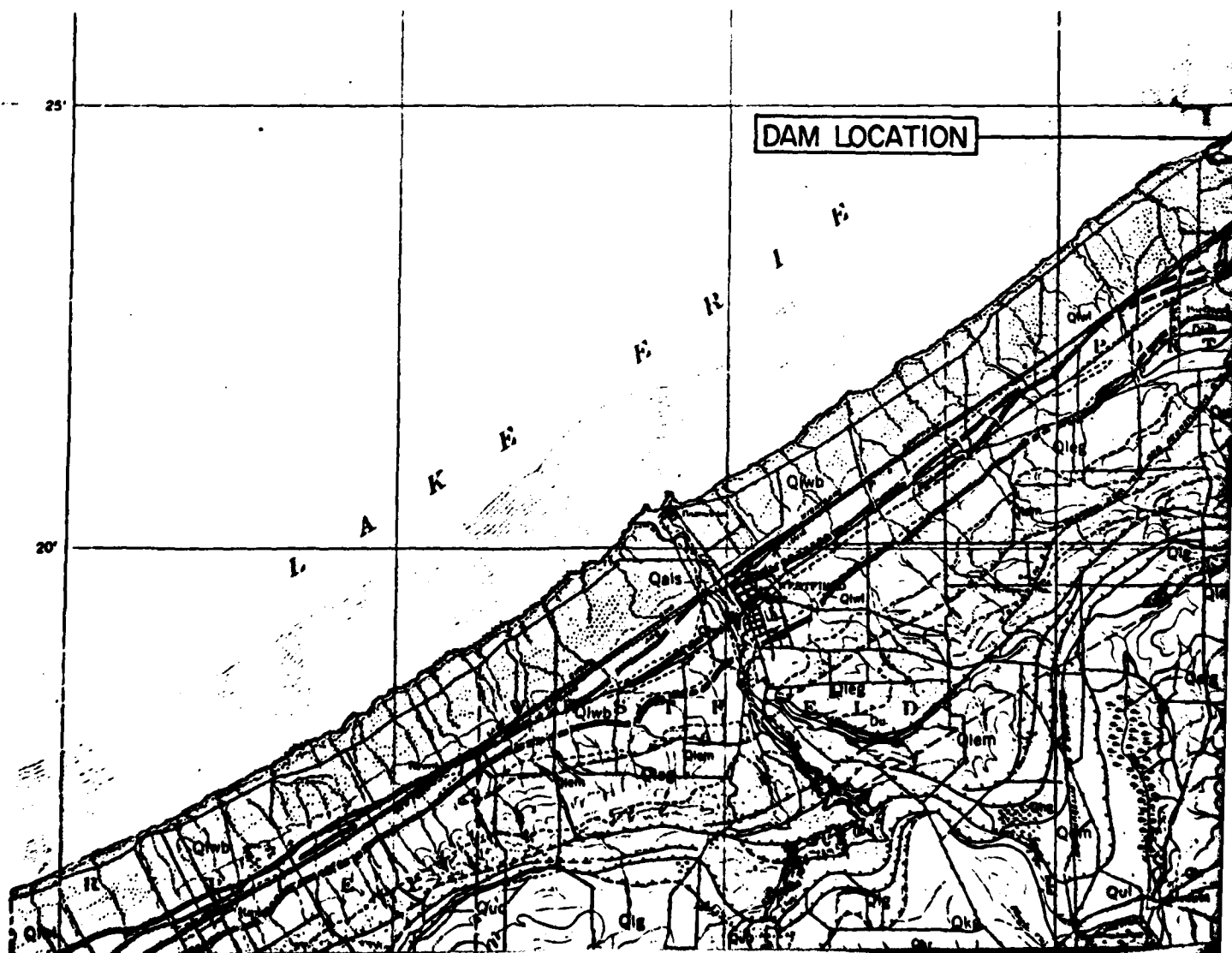
**TOPOGRAPHIC MAP
FREDONIA RESERVOIR
I.D. NO. N.Y. 749**

PLEISTOCENE GEOLOGY OF CHAUTAUQUA COUNTY, NEW YORK

By
E. H. MULLER

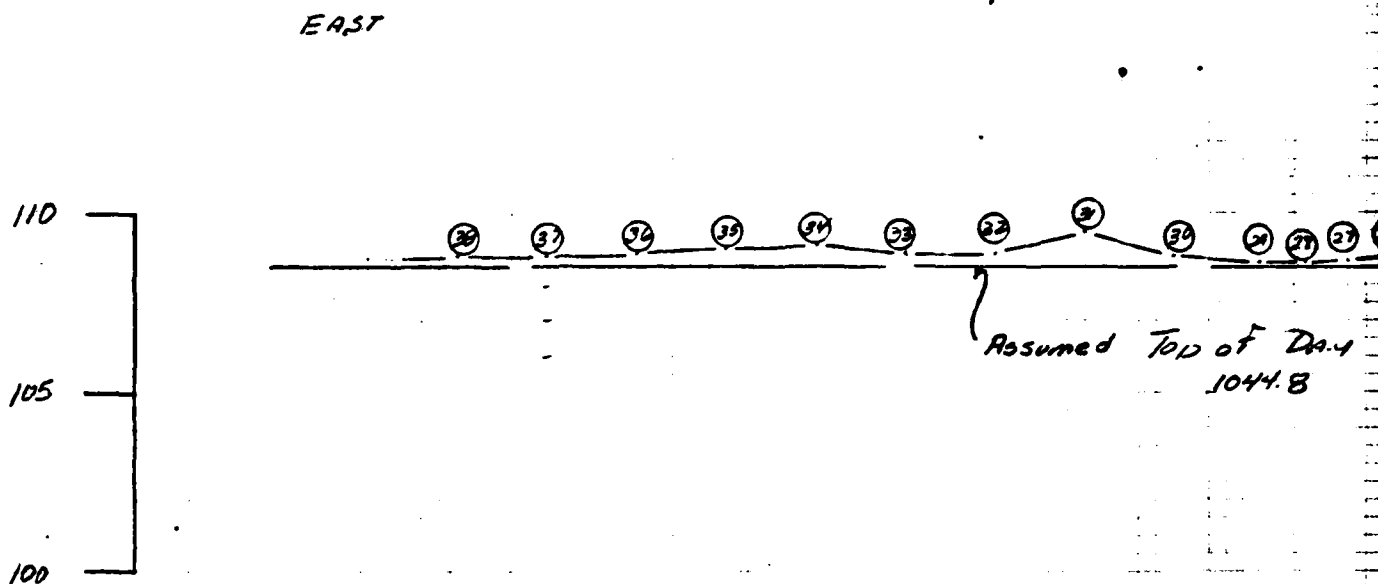


1964



BY STG DATE 6/27/82 SUBJECT Exhibit 2500.012 1st-4 SHEET NO. 1 OF 1
 CHKD. BY DATE VIEW looking Upstream JOB NO. E-80-1

Survey of Spillway Crest & East Embankment
 6/26/80 by Thomson Associates



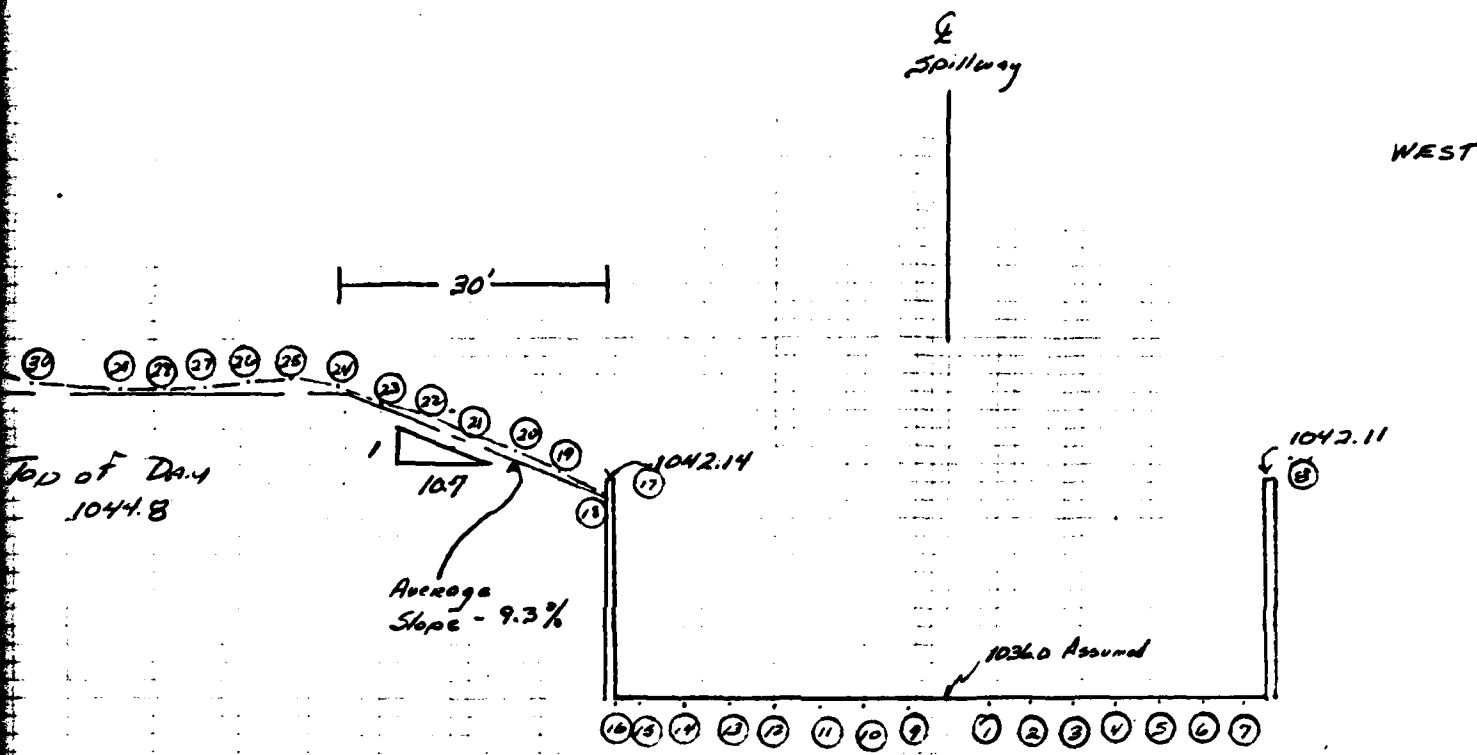
○ — Level Loop Shot No.

Shot No.	Elevation	Shot No.	Elevation
1	1036.03	21	1043.39
2	1036.05	22	1043.90
3	1036.07	23	1044.22
4	1036.06	24	1044.70
5	1036.04	25	1044.87
6	1036.06	26	1044.79
7	1036.05	27	1044.66
8	1042.11	28	1044.58
9	1036.05	29	1044.81
10	1036.07	30	1045.51
11	1036.09	31	1044.91
12	1036.07	32	1044.94
13	1036.05	33	1045.08
14	1036.04	34	1045.01
15	1036.04	35	1044.87
16	1036.04	36	1044.78
17	1042.14	37	1044.82
18	1041.70	38	1044.75
19	1042.40		

Average
 Assumed

OF /
 /
 /

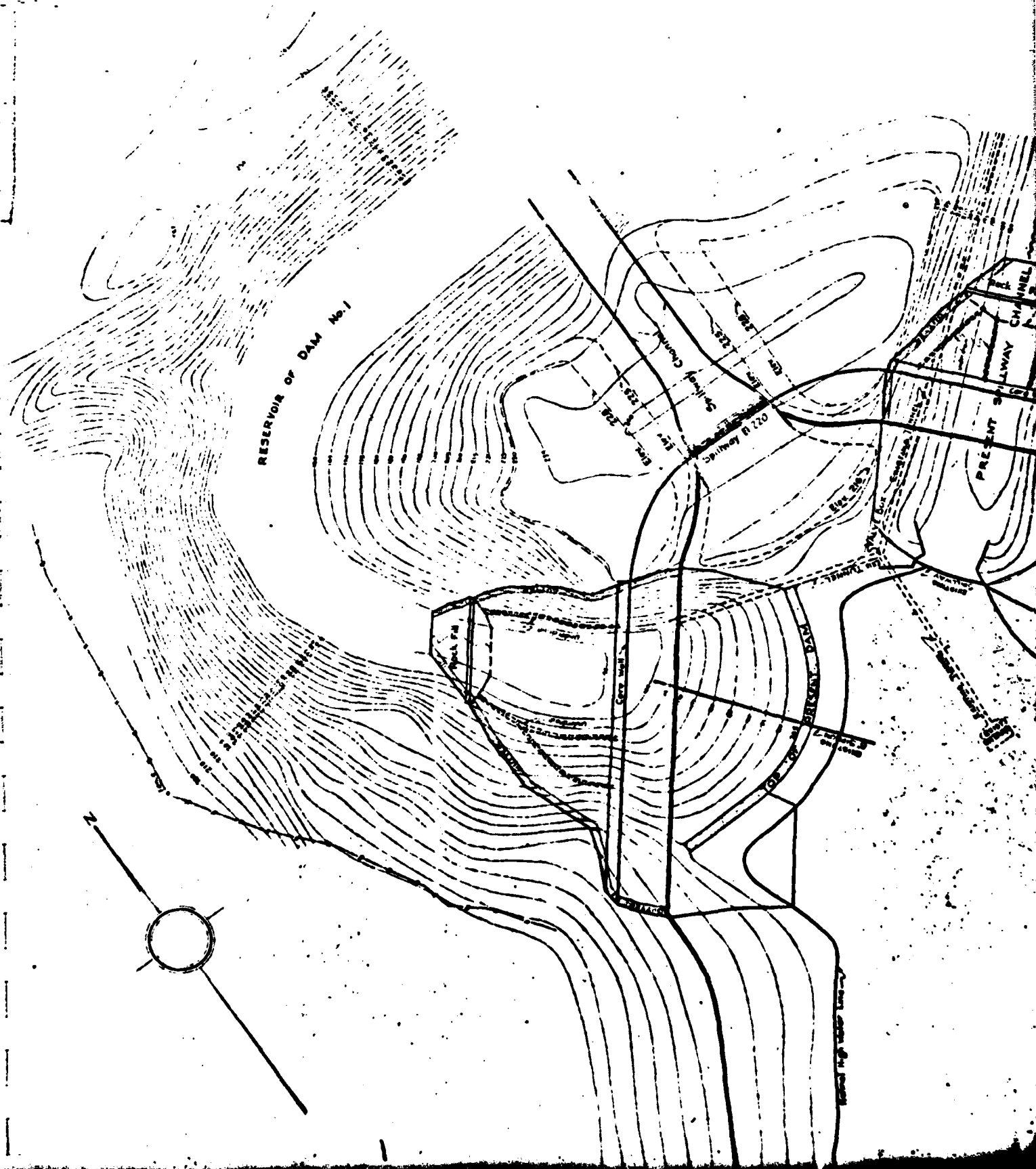
st Embankment Crest
 Associates

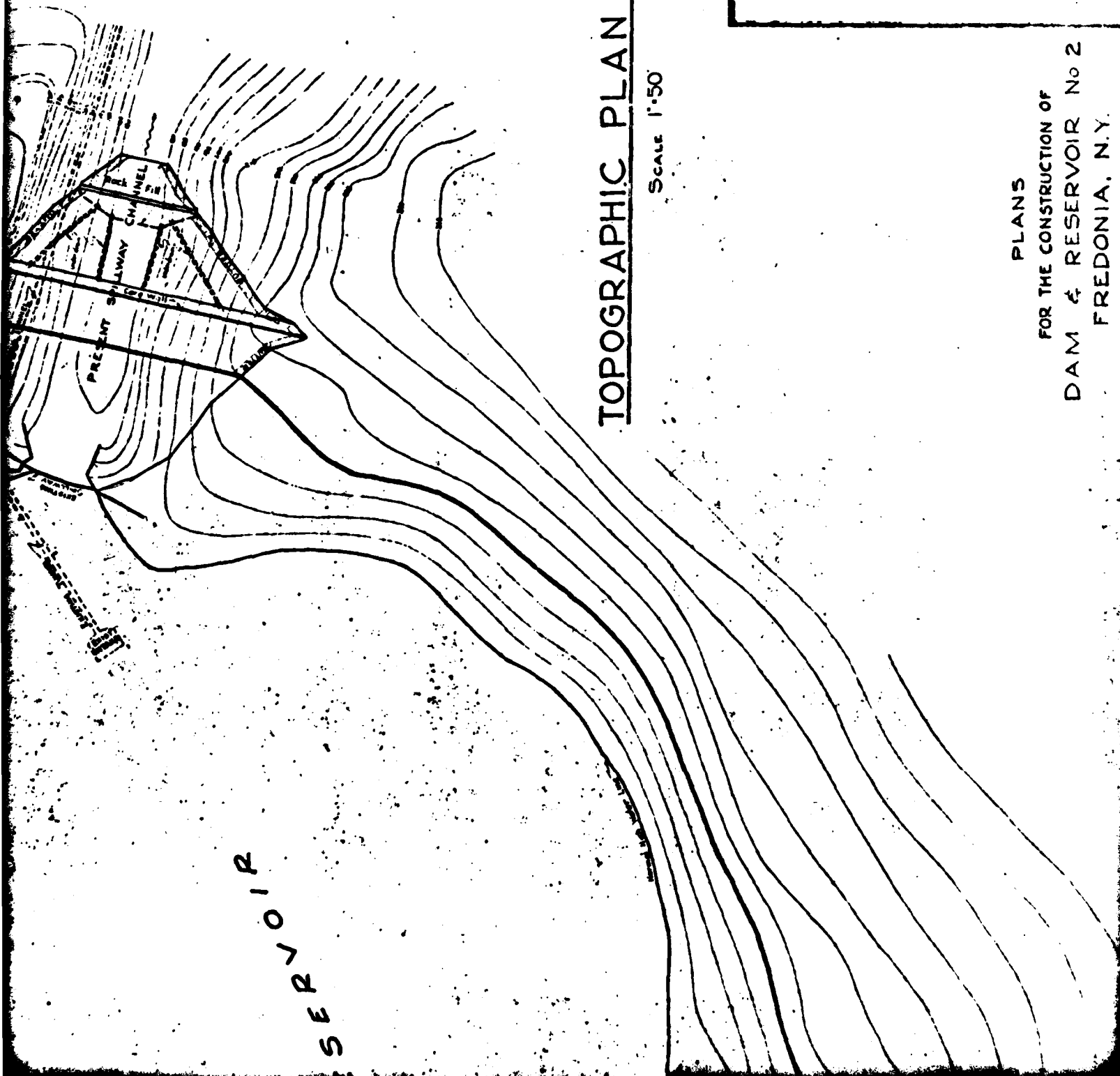


- 3.39
- 3.40
- 4.22
- 4.70
- 4.87
- 4.79
- 4.66
- 4.58
- 4.81
- 5.51
- 4.91
- 4.94
- 3.88
- 3.01
- 2.87
- 1.78
- 1.82
- 1.75

Average 1044.87
 Assumed TOP OF DAM
 - 1044.80

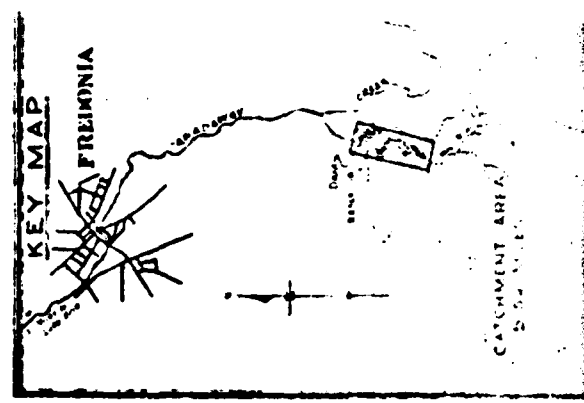
Vertical Scale: 1" = 5.0'
 Horizontal Scale: 1" = 20.0'
 Datum: E Spillway Crest
 Assumed Elevation = 1036.0



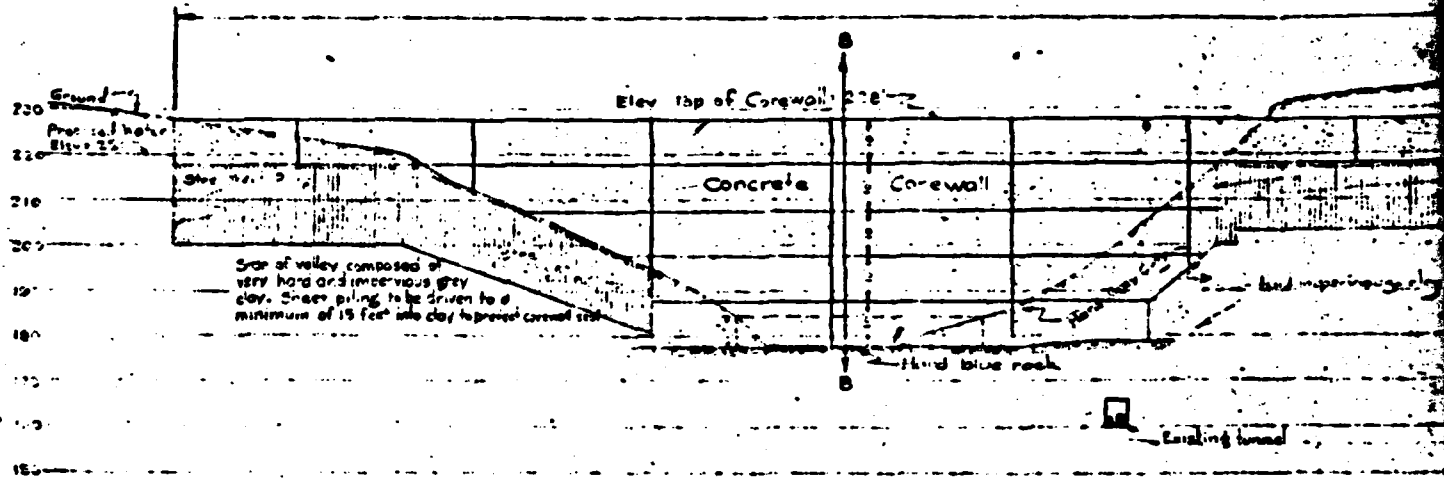


TOPOGRAPHIC PLAN OF DAM

Scale 1"=50'



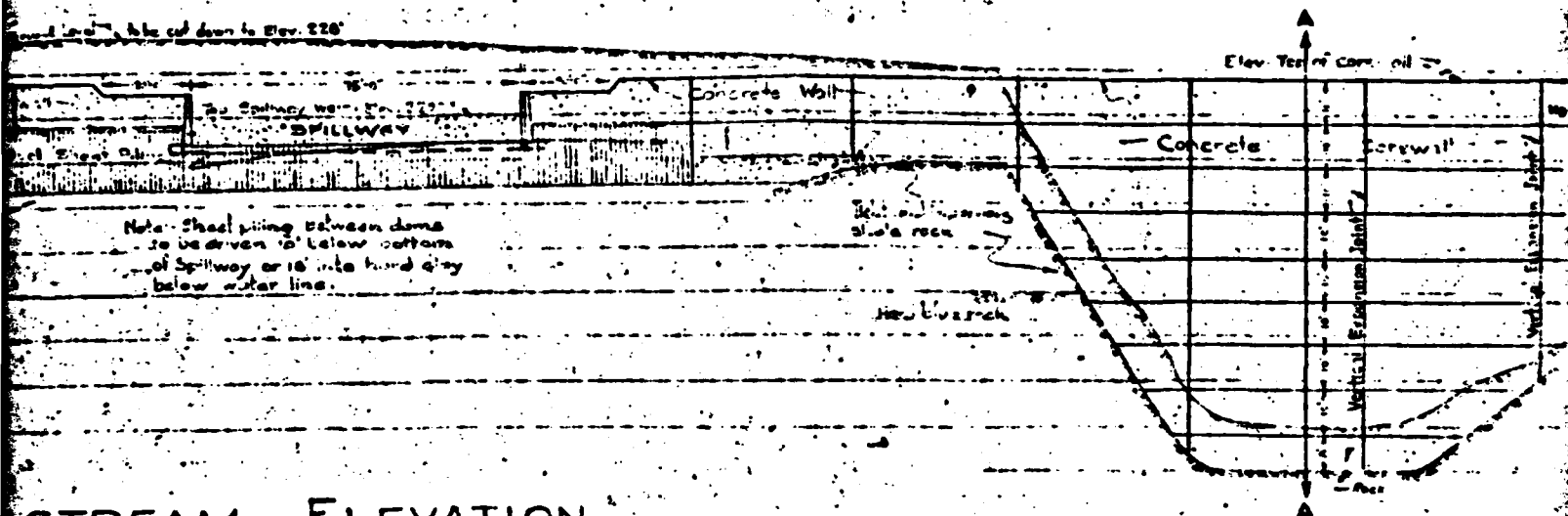
PLANS
FOR THE CONSTRUCTION OF
DAM & RESERVOIR No 2
FREDONIA, N.Y.



Do

805' 1

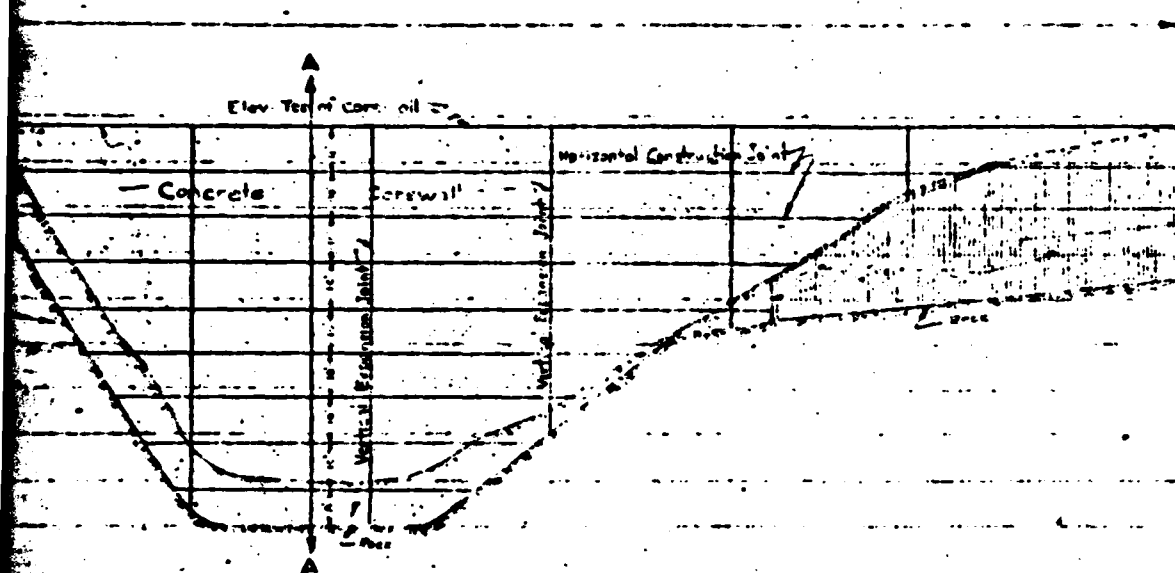
and level, hole cut down to Elev. 220'



STREAM ELEVATION

SCALE 1"=20'

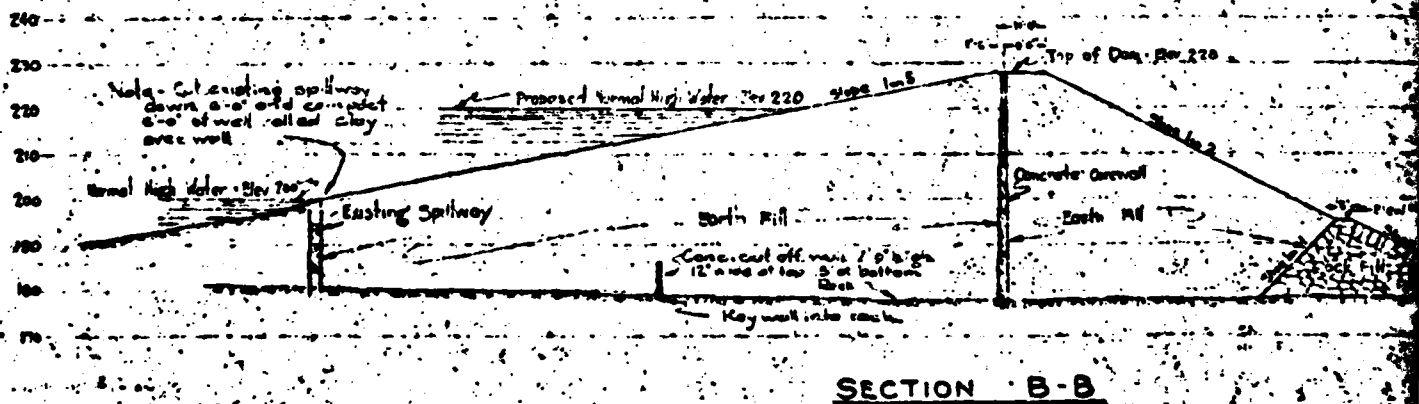
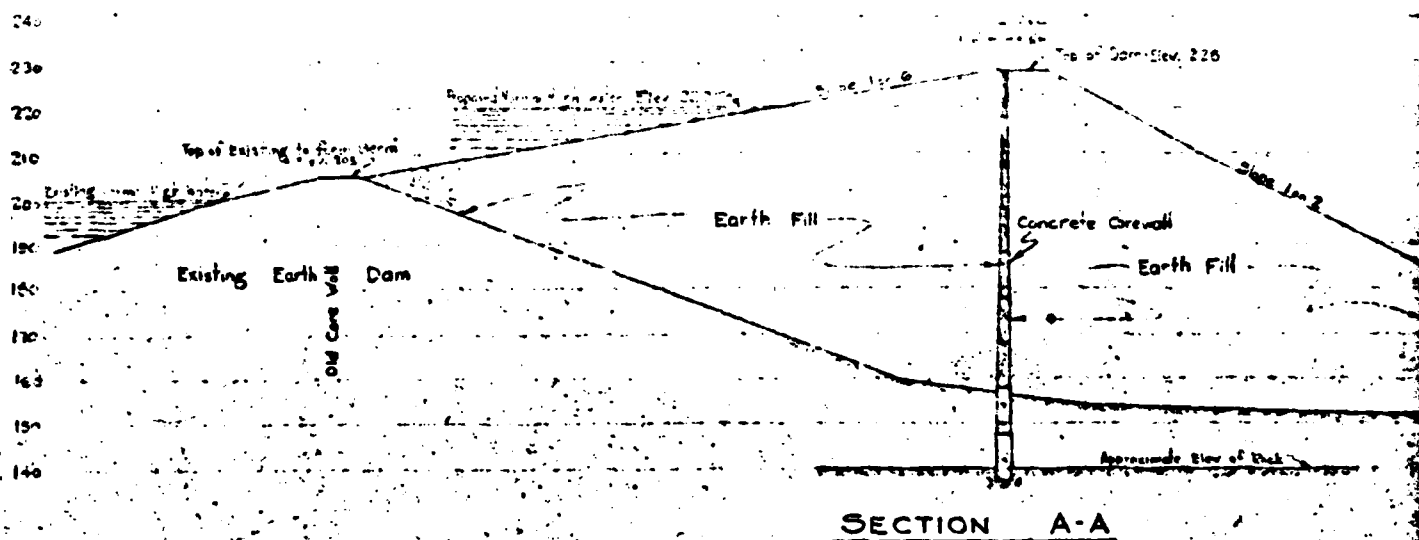
DA



PLANS
FOR THE CONSTRUCTION OF
DAM AND RESERVOIR No 2
FREDONIA, N. Y.

—E—
FRETTS, TALLAMY & SENIOR
CONSULTING ENGINEERS
WILLIAMSVILLE, N. Y.

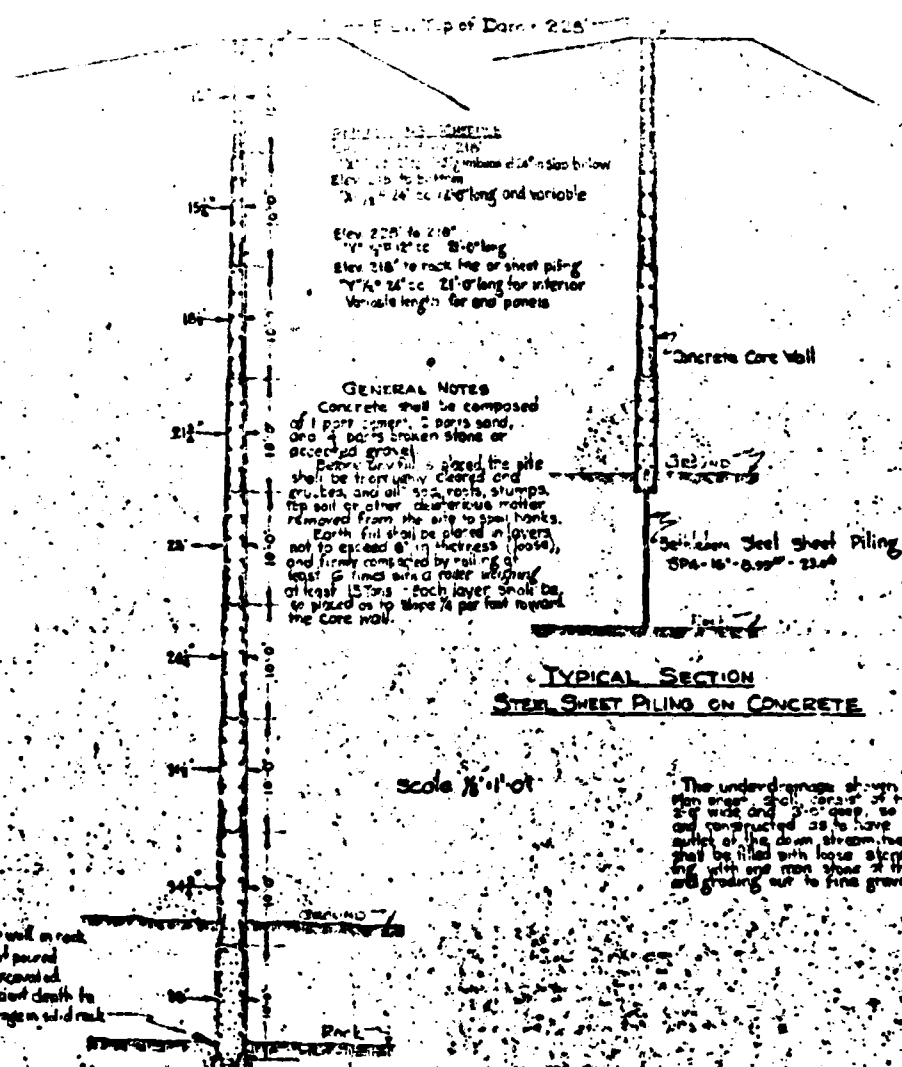
OCTOBER 1933





- At points where it is impossible to roll, the fill shall be well tamped with heavy tampers to the same density as if rolled.
- On string ground successive layers shall be placed in a grid pattern.
- Before fresh fill is placed on any compacted layer, the surface of the latter shall be sufficiently rolled to bind the two layers into one homogeneous mass.

Note: Portion of core wall in rock not to be formed but poured in rock trench as excavated. Trench to be of sufficient depth to ensure good anchorage and rock.



Concrete Core Wall

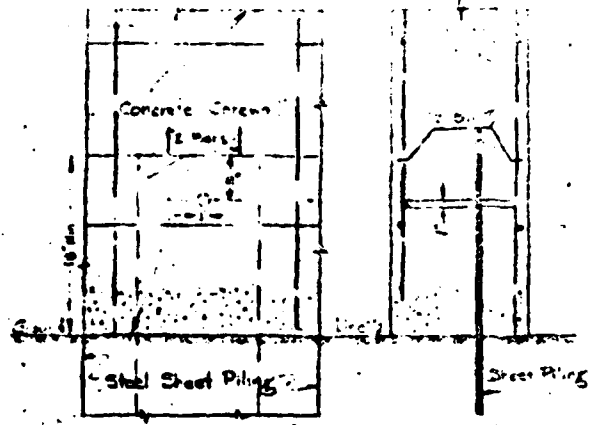
Section
Elev. 100.00

Section Steel Sheet Piling
Elev. 100.00 - 100.00 - 100.00

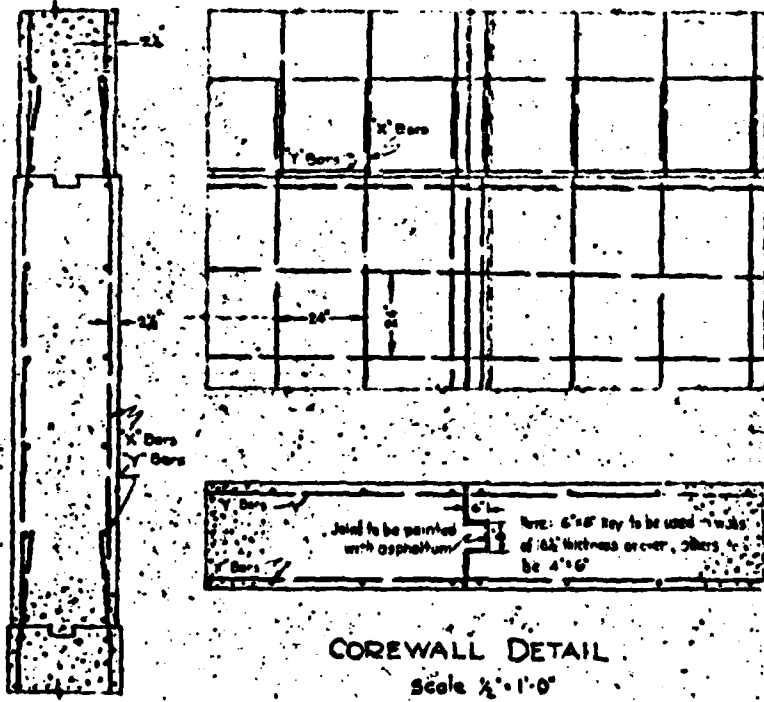
SECTION
END ON CONCRETE

The underdrains shown on the plan are to be installed in trenches 2' wide and 2' deep, so located and constructed as to have a free outlet at the down stream toe. Trenches shall be filled with loose stone, starting with one man stone 2' from bottom and grading out to fine gravel at the top.

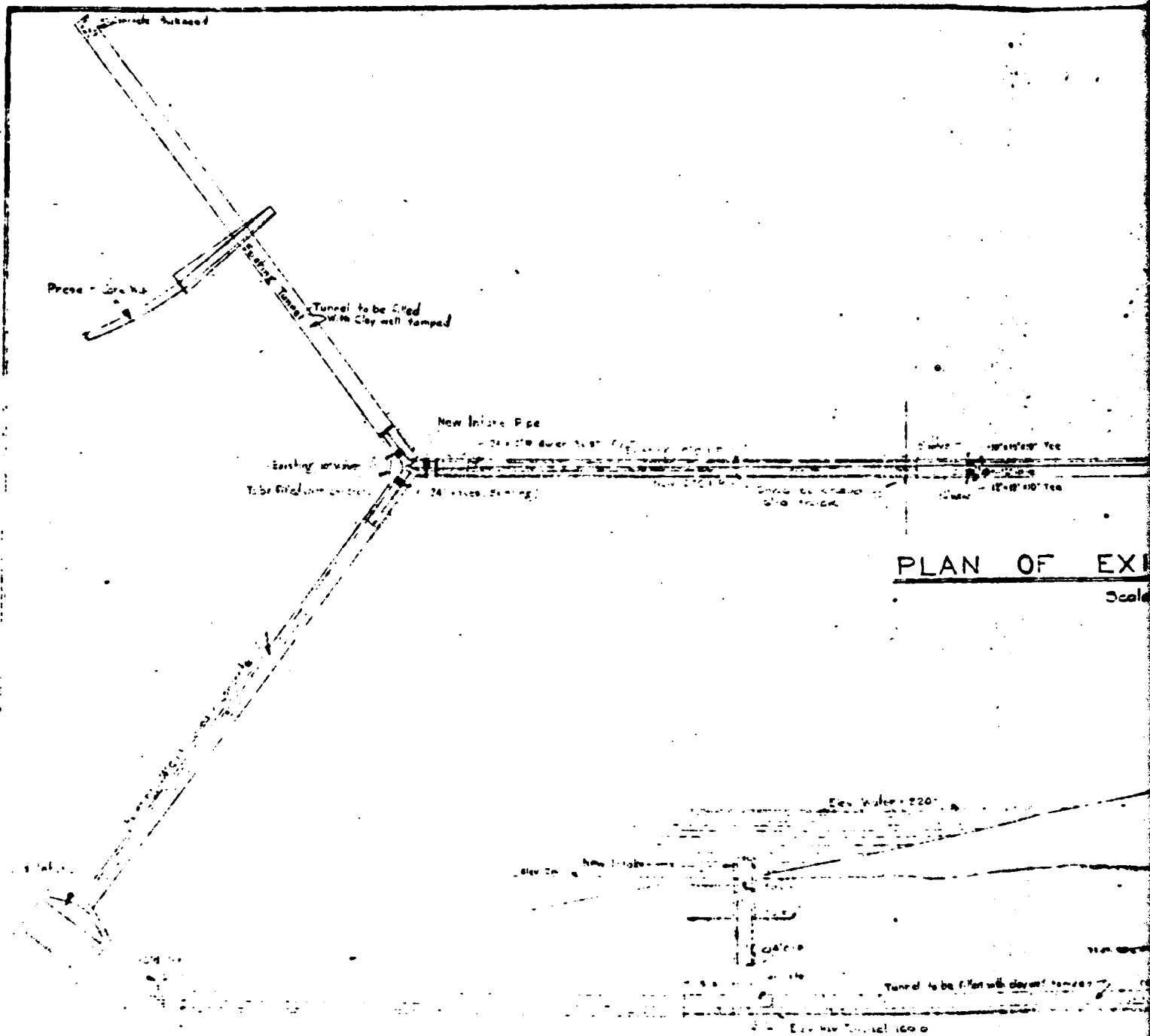
Section of drain shown
found as shown on the
plan. Outlet to be
to 6" x 6" or larger, say a 6"
and firmly grouted with 1:2 cement grout



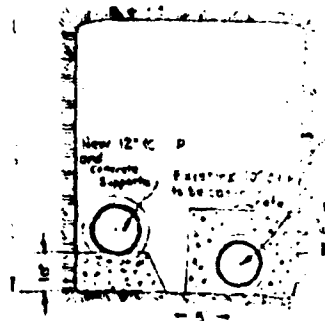
DETAIL OF CORE WALL
FOOTING ON STEEL SHEET PILING
Scale 1" = 12"



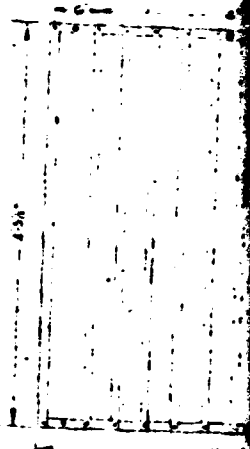
COREWALL DETAIL
Scale 1/2" = 1'-0"



SECTION THROUGH TUNNEL



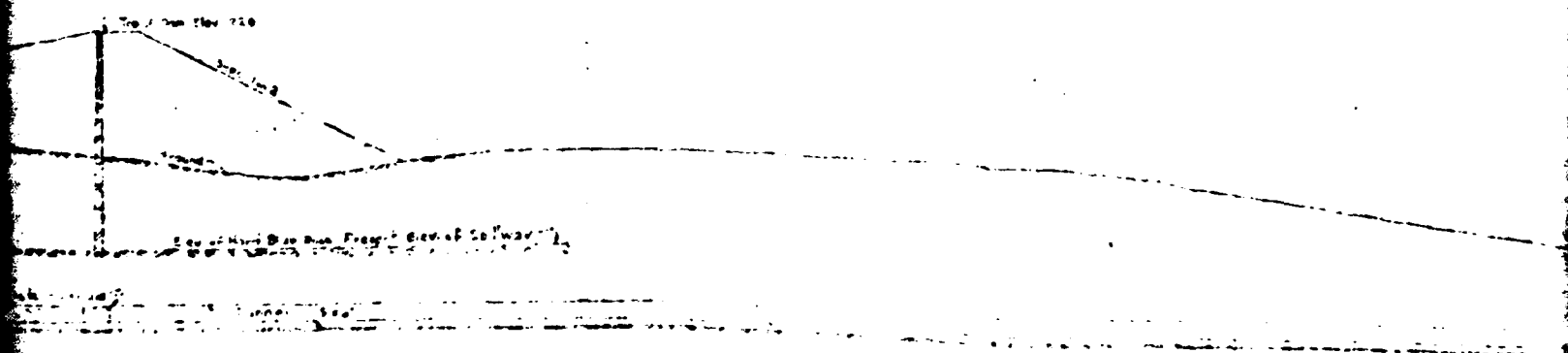
SECTION THRU TUNNEL
Scale 1/2" = 1' 0"



BRONZE SCREEN
Scale 1/2" = 1' 0"

STING TUNNEL

1/2"



UGH EXISTING TUNNEL

Scale 1/2" = 1' 0"

Elev. Road to Mill Pond 224.0

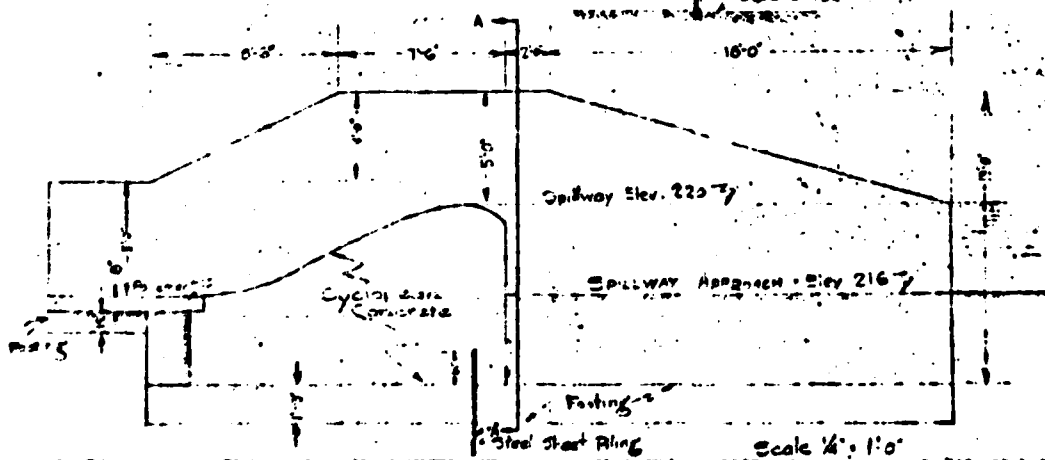
Elev. Mill Pond 222.00

Elev. Low Spillway 220.0

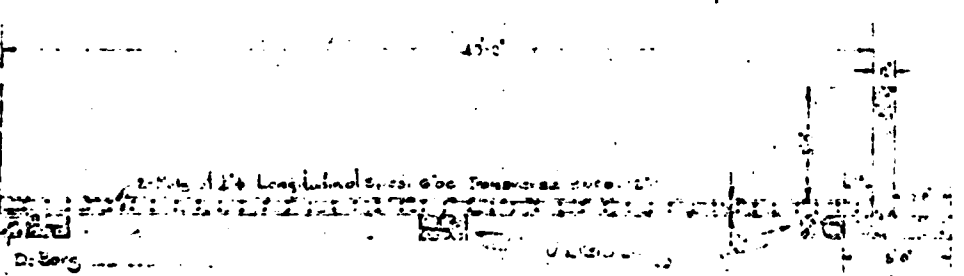
- A: Bore 14 Nov 54
- B: Bore 15 Nov 54
- C: Bore 16 Nov 54
- D: Bore 17 Nov 54

SECTION THRU SPILLWAY
Scale 1/4" = 1'-0"

Steel Sheet Piling
Driven to Rock
Maximum 2' to 3' into
hard undisturbed clay.



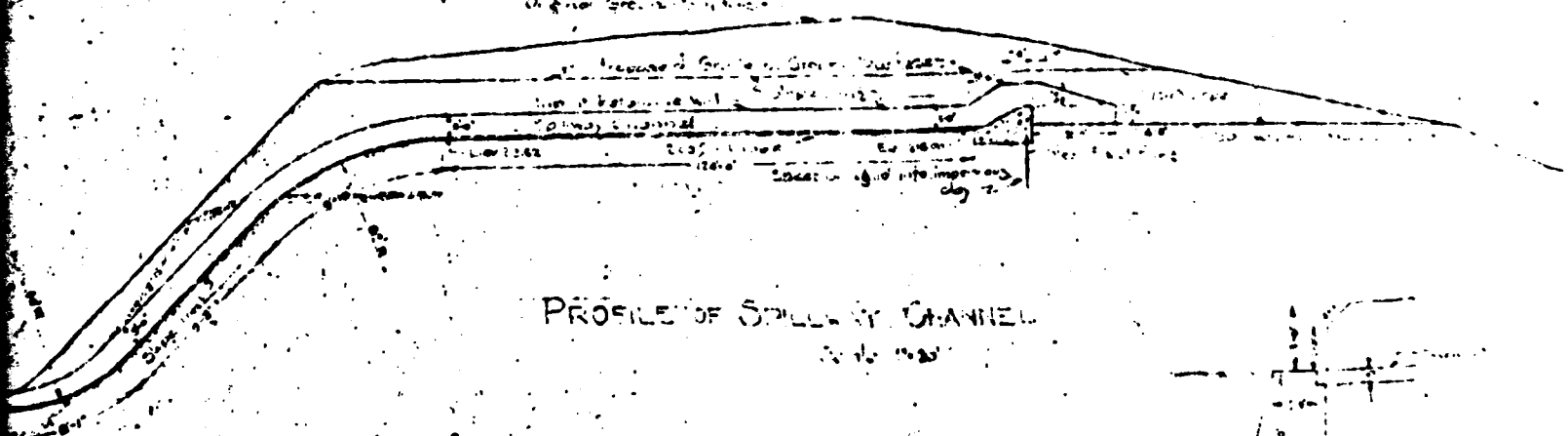
100 ft. from 500 ft. 5
 100 ft. from 500 ft. 4
 100 ft. from 500 ft. 3
 100 ft. from 500 ft. 2
 100 ft. from 500 ft. 1



SECTION THRU SPILLWAY CHANNEL

Scale 1" = 100'

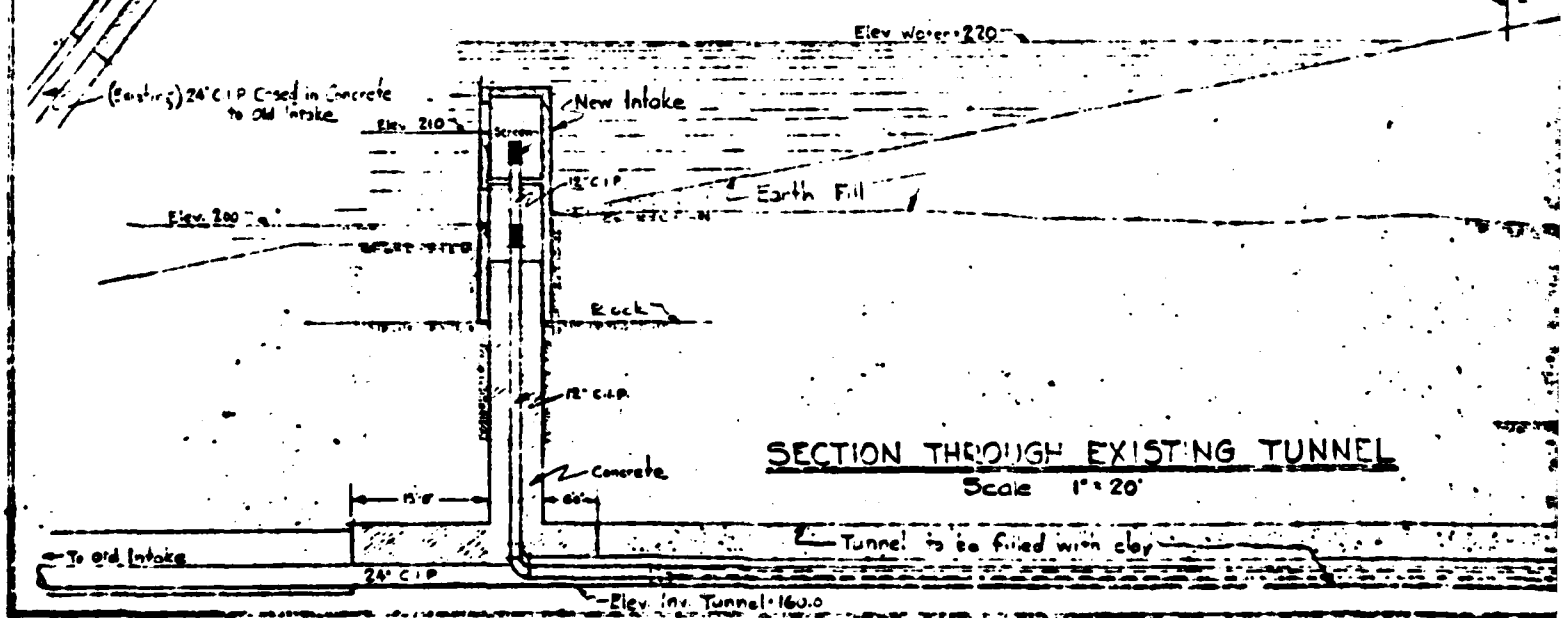
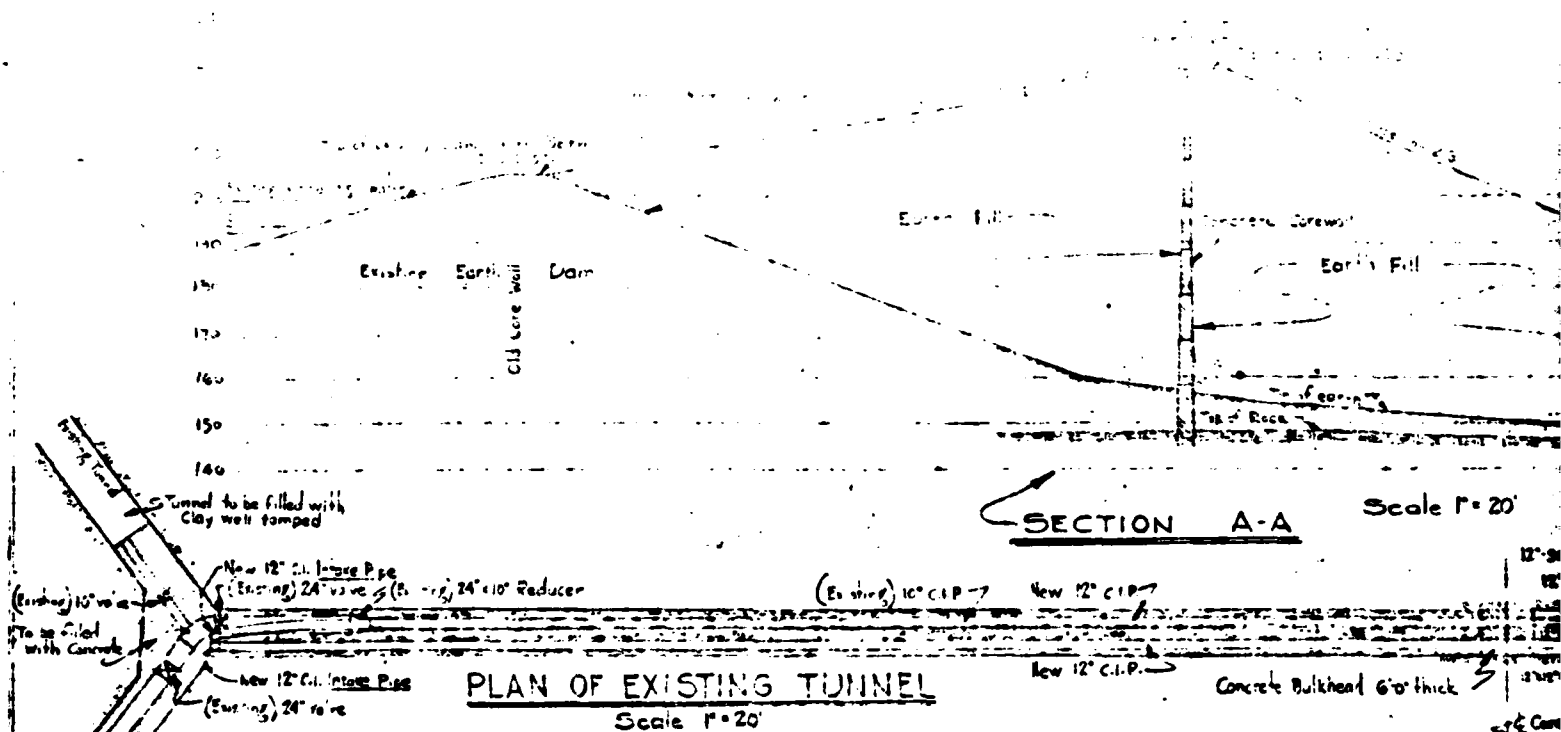
Original Ground Surface



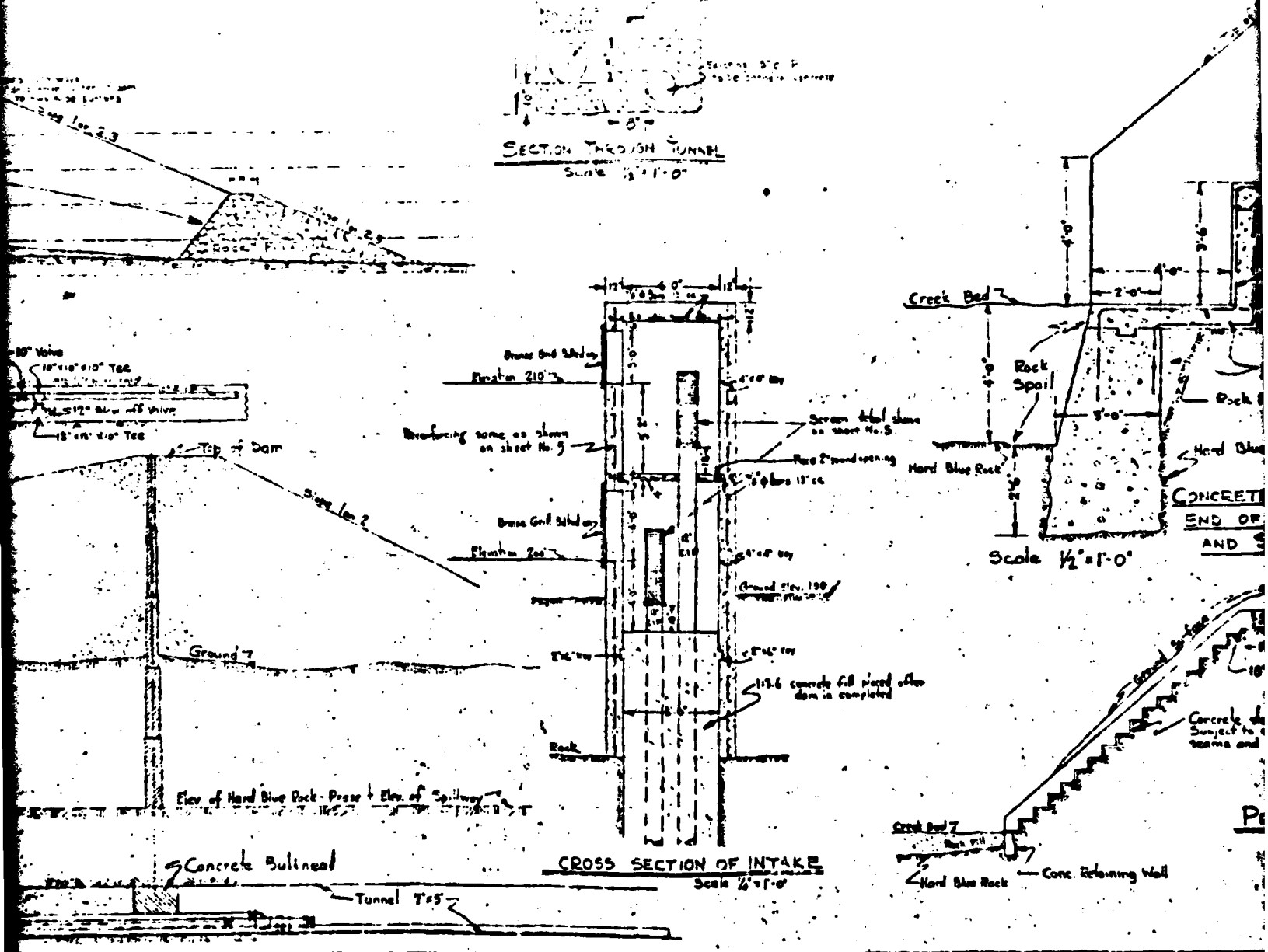
PROFILE OF SPILLWAY CHANNEL

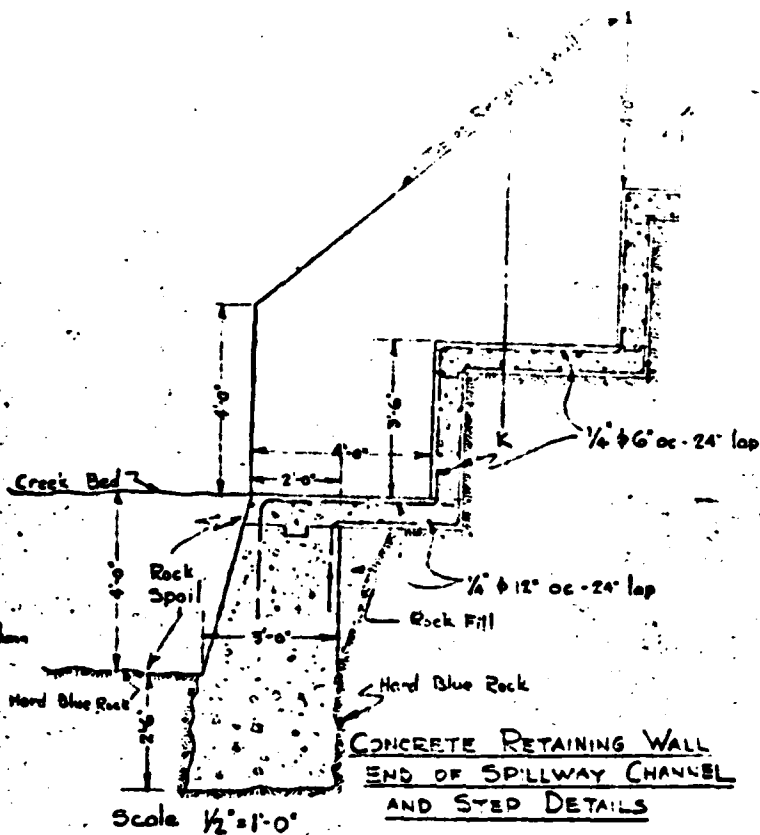
Scale 1" = 100'

CONCRETE RETAINING WALL
 100 ft. from 500 ft. 1
 100 ft. from 500 ft. 2



SECTION THROUGH TUNNEL
Scale 1/2" = 1'-0"





Not to be used for
in section shown in
Sheet No. 2

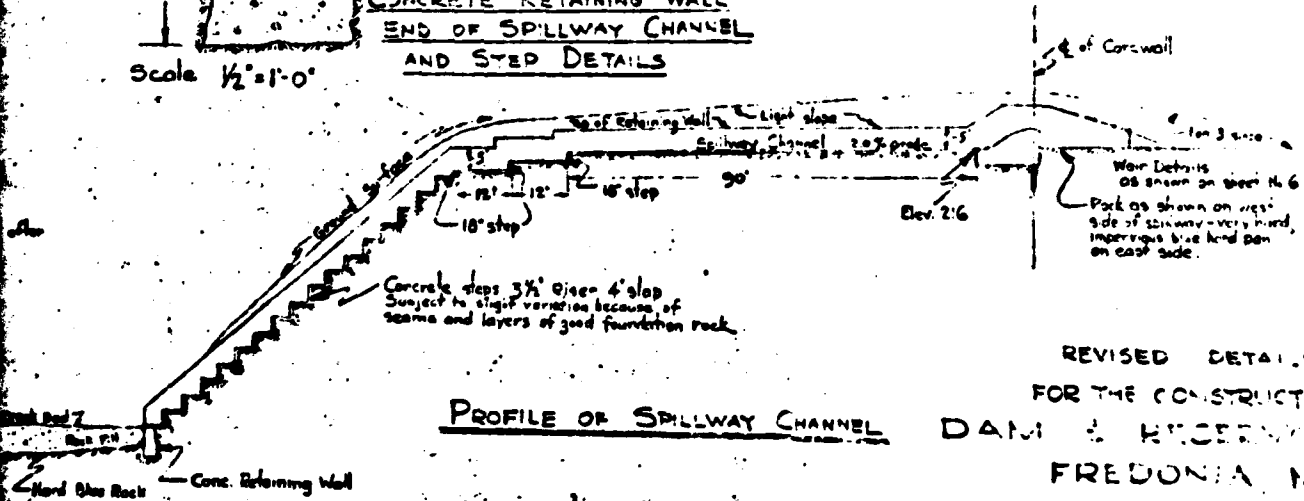
Earth Backfill
6' above footer

Rock Backfill
for drainage
2'-0"

Rock

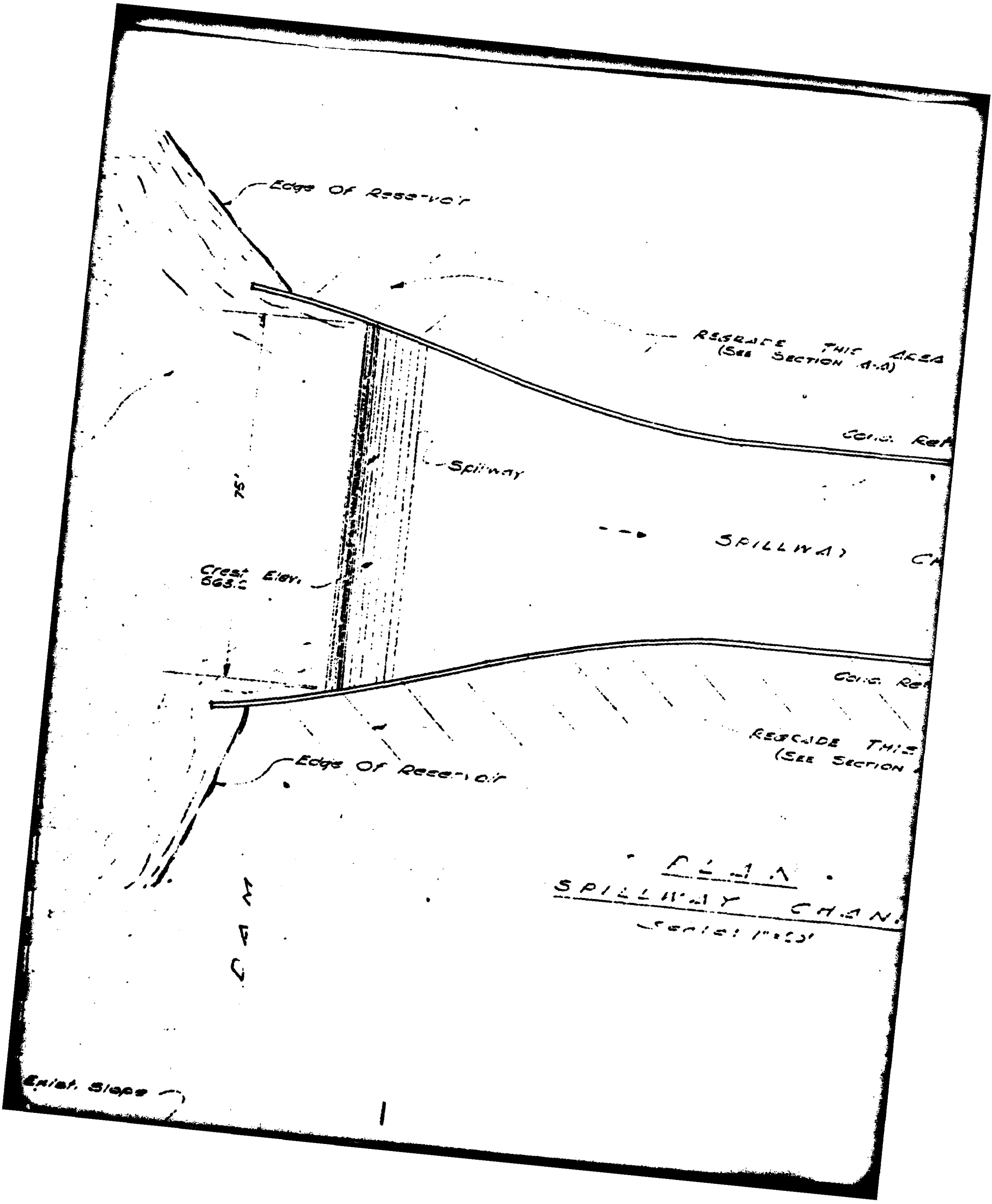
SECTION K-K
Scale $\frac{1}{2}" = 1'-0"$

Sub Foundation



REVISED DETAILS
FOR THE CONSTRUCTION OF
DAM & RECEIVING NO. 2
FREDONIA, N.Y.

FRETTS, TALLANTY & SONS
CONSULTING ENGINEERS
WILLIAMSVILLE, N.Y.
NOVEMBER 1937



Edge Of Reservoir

RESRADE THIS AREA
(SEE SECTION A-A)

CONG. RET.

Spillway

75'

Crest Elev.
563.2

SPILLWAY

CONG. RET.

RESRADE THIS
(SEE SECTION A-A)

Edge Of Reservoir

DAM

PLAN
SPILLWAY CHAN.

SERIES 11-53

Exist. Slope



THIS AREA
SECTION A-A)

Cont. Retaining Wall

WATER CHANNEL

40'

Cont. Retaining Wall

ESCAPE THIS AREA
(SEE SECTION A-A)

CHANNEL

VILLAGE OF FREDONIA

CHAUTAUQUA CO., N.Y.

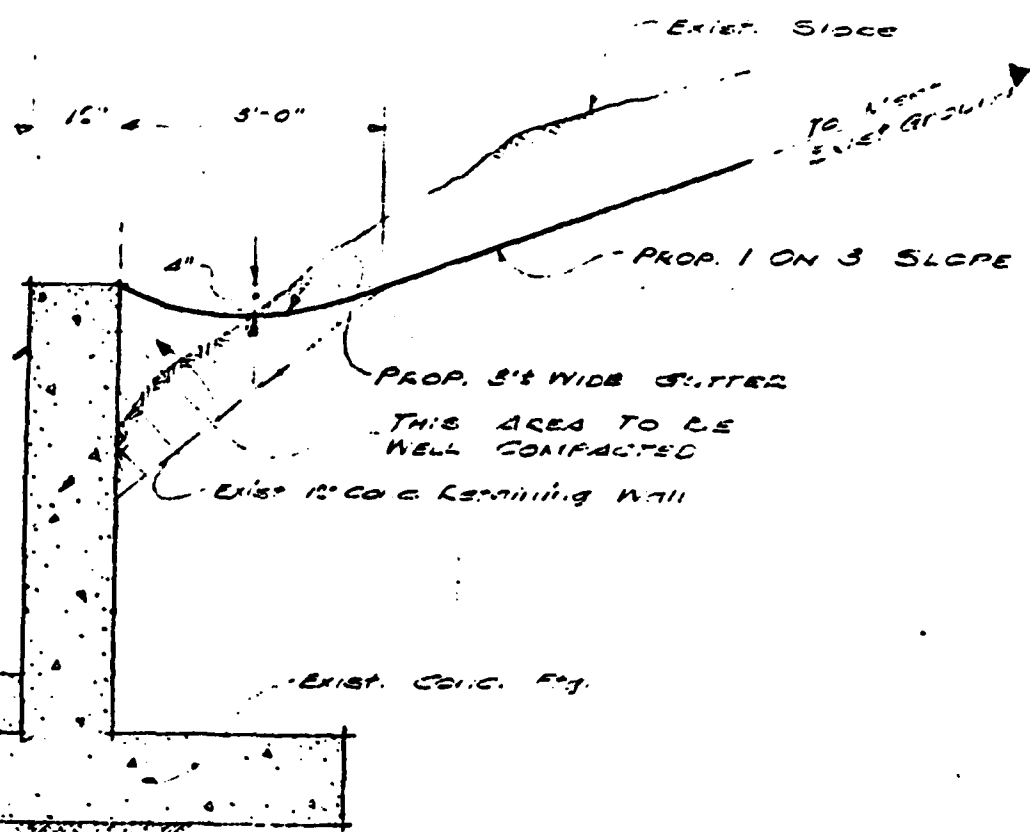
WATER TREATMENT PLANT EXPANSION
RE-GRADING PLAN FOR EXIST. SPILLWAY
REVISIONS TO EXISTING INTAKE

PREPARED BY:

BISSÉL, BRONKIE & ASSOCIATES ENGINEERS
WILLIAMSVILLE 21, N.Y.

REVISED	BY	DATE	NOV 1985	TOWN JOB NO	
		DESIGNED BY	W.H.M.	S.B.S. JOB NO	208
		TRACED BY	G.B.B.	SHEET NO	209

40'-0"



SPILLWAY CHANNEL

INTAKE FLOOR

EXIST. CONC. FLOOR

SECTION A-A

VILLAGE OF FREDONIA

CHAUTAUQUA CO., N.Y.

**WATER TREATMENT PLANT EXPANSION
RE-GRADING PLAN FOR EXIST. SPILLWAY
REVISIONS TO EXISTING INTAKE**

PREPARED BY
BISSELL, BRONKIE & ASSOCIATES ENGINEERS
WILLIAMSVILLE 21, N.Y.

REVISED	BY	DATE	NOV 1965	TOWN JOB NO	
		DESIGNED BY	W.H.M.	S.B&B JOB NO	20625
		TRACED BY	G.B.P.	SHEET NO	20 OF 24

