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NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
WANGUM LAKE DAM (CT 0. (U) CORPS OF ENGINEERS WALTHAM
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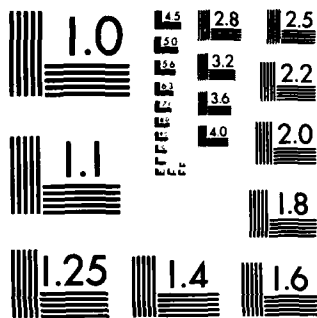
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AD-A144 725

HOUSATONIC RIVER BASIN
CANAAN, CONNECTICUT

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WANGUM LAKE DAM
CT 00516

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

MARCH 1980

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Wangum Lake Dam is a 300 foot long earth embankment with a maximum height of about 10 feet. The dam appears to be in fair condition. It has a maximum storage capacity of 714 acre-feet and a maximum height of about 10 feet. Therefore, the dam is classified in the "Small" size category. The dam is also classified in the Significant hazard dam category. The selected test flood for this structure is $\frac{1}{2}$ the PMF.		



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF
NEDED

MAY 13 1990

Honorable Ella T. Grasso
Governor of the State of Connecticut
State Capitol
Hartford, Connecticut 06115

Dear Governor Grasso:

Inclosed is a copy of the Wangum Lake Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Protection, the cooperating agency for the State of Connecticut. In addition, a copy of the report has also been furnished the owner, Litchfield County Water Company, Canaan, Connecticut 06018.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Protection for your cooperation in carrying out this program.

Sincerely,


MAX B. SCHEIDER

Incl
As stated

Colonel, Corps of Engineers
Division Engineer

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WANGUM LAKE DAM

CT 00516



HOUSATONIC RIVER BASIN
CANAAN, CONNECTICUT

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No:	CT00516
Name of Dam:	Wangum Lake Dam
Town:	Canaan
County and State:	Litchfield, Connecticut
Stream	Wangum Lake Brook
Date of Inspection:	November 19, 1979

BRIEF ASSESSMENT

Wangum Lake Dam is a 300-foot long earth embankment with a maximum height of about 10 feet. The upstream face of the dam is on a slope of about 1H:1V and the downstream face of the dam is variable, with the slope averaging about 5H:1V. The crest width averages about 35 feet. The spillway consists of a masonry weir about 5.5 feet wide with a crest elevation about one foot below the top of the dam.

A 12-inch diameter valve is located in the center of the spillway headwall. The invert of the valve is one foot below the spillway crest. The spillway discharge travels 15 feet through a stone-paved outlet channel and into a 24-inch diameter cast iron pipe. The pipe directs the discharge into a small mill pond located at the downstream toe of the dam.

The dam appears to be in fair condition. The upstream face is provided with limited riprap protection resulting in exposure of portions of the embankment to erosion. The normal pool freeboard of about one foot exposes the dam crest to wave action. The dam was overtopped by an estimated 3 inches in 1972, which indicates that the spillway discharge capacity and reservoir storage capacity above normal pool are inadequate for appreciable storm events. The continued deterioration of the headwall at the entrance to the spillway outlet conduit could lead to obstruction of the pipe entrance. No emergency low-level outlet, independent of the water supply system, exists at this site.

Wangum Lake Dam has a maximum storage capacity of 714 acre-feet and a maximum height of about 10 feet. Therefore, the dam is classified in the "Small" size category. A private dwelling is located in a swale about 150 feet downstream of the embankment. The failure analysis indicates that a breaching of the dam would result in a 3.8-foot depth of water in the swale, which would result in at least 3 feet of water in the house. This depth of water would cause excessive property damage and possible loss of life in the damage center. Therefore, the dam is classified in the "Significant" hazard category. The recommended test flood range for a "Small" size, "Significant" hazard dam is from the 100 year frequency flood to one-half of the Probable Maximum Flood (PMF). The selected test flood for this structure is one-half of the PMF.

The test flood peak inflow to Wangum Lake Dam was computed to be 1,570 cfs. The routed test flood outflow of 850 cfs overtops the embankment by 1.0-foot. The spillway system is capable of discharging 19 cfs, which is about 2 percent of the routed test flood outflow, prior to overtopping of the dam.

Within one year of receipt of this Phase I inspection report, the Owner, the Litchfield County Water Company, should retain the services of a qualified registered professional engineer for the following purposes: 1) to perform detailed hydrologic and hydraulic analyses to assess the need for increasing the project discharge capacity; 2) to study the need for providing additional freeboard; and 3) to design an emergency low-level outlet for reservoir drawdown which could be operated independently from the water supply system.

In addition, the Owner should implement the following operational and maintenance procedures: 1) provide adequate erosion protection on the upstream embankment slope; 2) repair the headwall at the entrance to the spillway outlet conduit; 3) institute a program of annual periodic technical inspection; and 4) monitor the dam during heavy precipitation.

O'BRIEN & GERE ENGINEERS, INC.

John J. Williams
John J. Williams, P.E.
Vice President
New York Registration No. 050794



Date: 14 APRIL 80

This Phase I Inspection Report on Wangum Lake Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Richard J. DiBuono

RICHARD DIBUONO, MEMBER
Water Control Branch
Engineering Division

Aramast Mahtesian

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, CHAIRMAN
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

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 continued care and inspection can there be any chance that unsafe conditions be detected.

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 aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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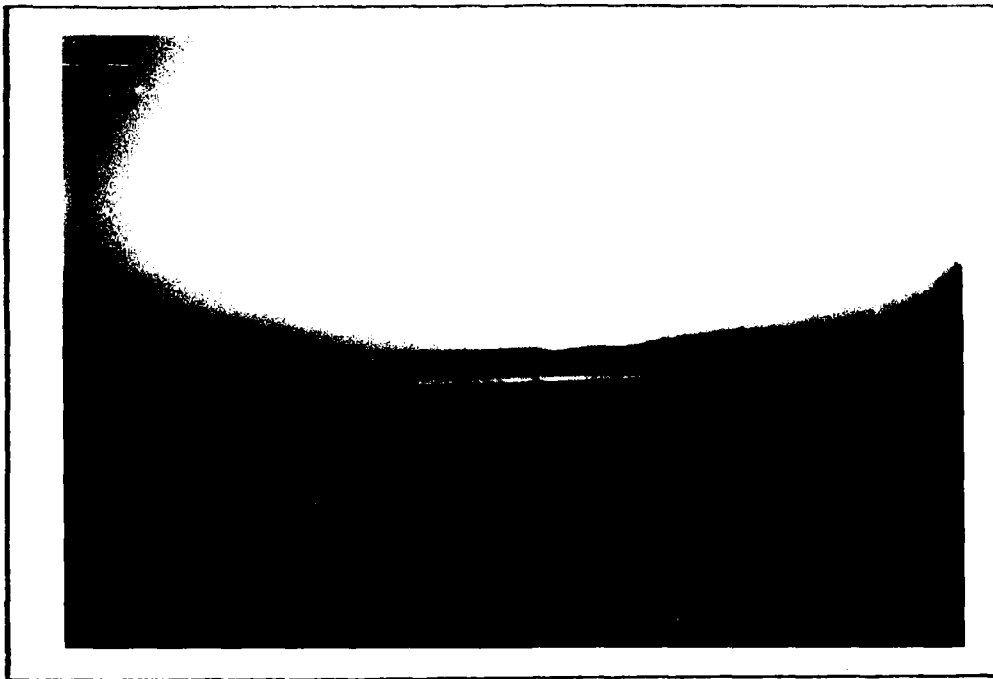
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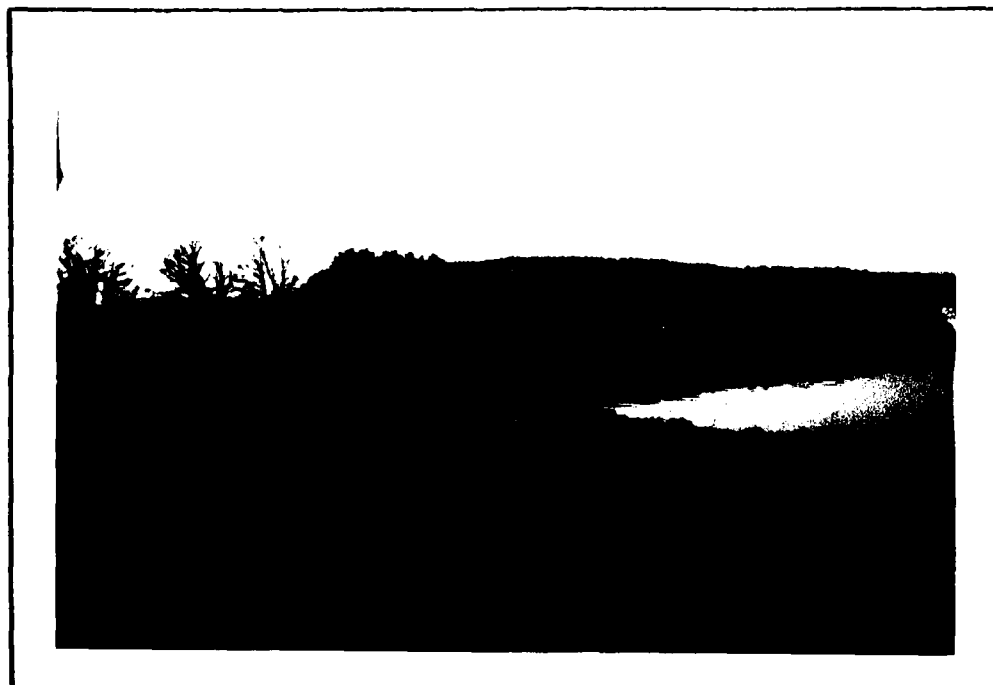
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OVERVIEW LOOKING UPSTREAM. (11/19/79)



OVERVIEW LOOKING FROM THE LEFT ABUTMENT TO THE RIGHT ABUTMENT.
(11/19/79)

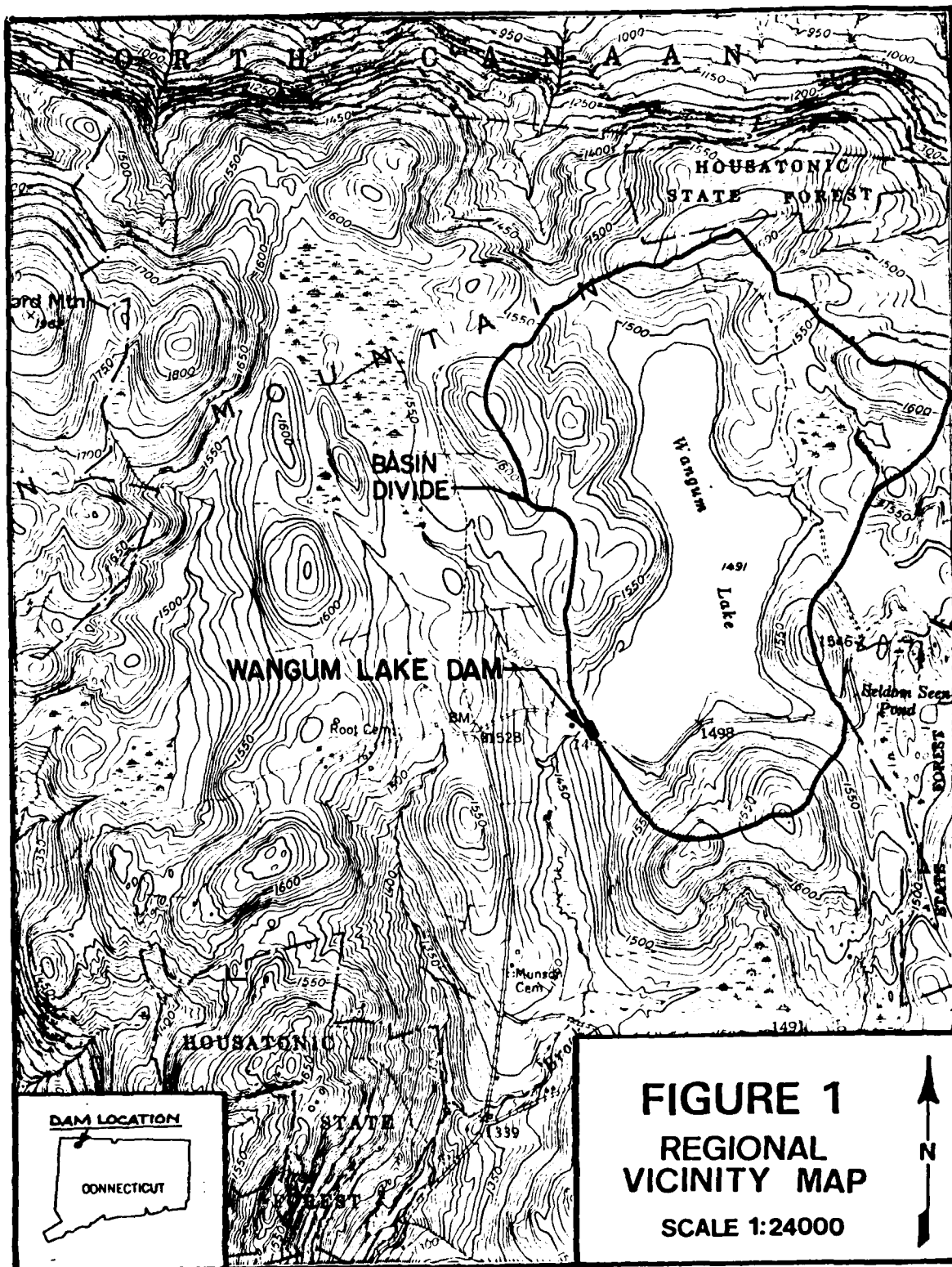


FIGURE 1
REGIONAL
VICINITY MAP
SCALE 1:24000

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
WANGUM LAKE DAM

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. The National Dam inspection Act (Public Law 92-367), passed by Congress on August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate the National Program for Inspection of Dams throughout the United States. Responsibility for supervising inspection of dams in the New England Region has been assigned to the New England Division of the Corps of Engineers. O'Brien & Gere Engineers, Inc. has been retained by the New England Division to inspect and report on selected non-federal dams in the State of Connecticut. Authorization and Notice to Proceed were issued to O'Brien & Gere by a letter dated November 6, 1979 and signed by Colonel William E. Hodgson, Jr. Contract No. DACW33-80-C-0014 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection. The purpose of performing technical inspection and evaluation of non-federal dams is to:

1. Identify conditions which threaten public safety and make the Owner aware of any deficiencies to permit him to correct them in a timely manner.
2. Encourage and prepare the states to initiate effective dam safety programs for non-federal dams as soon as possible.
3. Update, verify, and complete the National Inventory of Dams.

1.2 Description of Project. (Information with regard to this dam was obtained from Mr. Peter Bickford, Litchfield County Water Company and the State of Connecticut, Department of Environmental Protection (DEP).

a. Location. Wangum Lake Dam is located on Wangum Lake Brook in the Town of Canaan, Connecticut. Wangum Lake Brook flows into Hollenbeck River about 7 miles downstream of the dam. The Hollenbeck River flows into the Housatonic River an estimated 3 miles further downstream. A portion of the USGS Quadrangle map entitled "South Canaan, Connecticut" has been included as Figure 1 on page vi of this report to illustrate the location. USGS reference coordinates for this dam are N 41°58.0', W 73°16.4'. The flood impact area consists of one house about 150 feet downstream from the dam, approximately in line with the right abutment of the dam.

b. Description of Dam and Appurtenances. Wangum Lake Dam is an earth embankment approximately 300 feet long with an estimated maximum height of 10 feet. The upstream face of the embankment is on a slope of about 1H:1V with riprap facing of varying size stone. The crest width of the dam averages about 35 feet. The slope of the downstream face of the dam is variable, averaging about 5H:1V.

The masonry spillway, located approximately 100 feet to the right of the left abutment of the dam, is 5.5 feet wide with a 2-foot wide weir crest constructed about one foot below the top of the dam. A 12-inch diameter valve with an invert about 2 feet below the crest of the dam is located in the center of the spillway headwall. A stone-paved outlet channel with an invert approximately 2.5 feet below the weir crest at the base of the headwall directs the discharge from the spillway headwall to a road culvert. In the 15 foot distance from the spillway headwall to the road culvert, the channel invert drops about 2.5 feet. The conduit under the 14-foot wide gravel road is a 24-inch diameter cast iron pipe. (Refer to page C-1, Appendix C.)

The outlet conduit conveys discharge through the embankment and into a small pond with a surface area of about 0.2 acres located at the downstream toe of the dam. The pond is contained by an essentially vertical masonry dam about 10 feet high. The spillway for this small impoundment is a notch near the center of the dam which is 30 inches wide and 6 inches deep. This impoundment may be drawn down about 8 feet by opening a 12-inch diameter valve on a cast iron drain pipe. (Refer to Photograph #4 in Appendix C.)

According to the Owner's representative, Mr. Peter Bickford, there is a 12-inch diameter valve on the water line on the east side of Wangum Lake which could be used to draw the lake down about 7 feet below normal pool.

c. Size Classification. Wangum Lake Dam has a maximum embankment height of approximately 10 feet which places it in the "Small" size category for height because it is less than 40 feet high. It also falls into the "Small" size category for storage since its maximum storage capacity of 714 acre-feet is less than the 1,000 acre-foot upper limit for "Small" size structures. Therefore, Wangum Lake Dam is classified as "Small".

d. Hazard Classification. A private residence is located about 150 feet downstream of the dam approximately in line with the right abutment. The house is situated in a swale which forms a natural course for floodwaters resulting from a dam failure. The failure analysis indicates that a breach of the dam would cause a 3.8-foot depth of water in the swale and, consequently, about 3 feet of water in the house. A flood of this magnitude would cause appreciable damage to the house and possible loss of life. No loss of human life would be expected in the stables, adjacent to the stream about 1.3 miles downstream of Wangum Lake Dam. Therefore, Wangum Lake Dam is considered to be in the "Significant" hazard category.

e. Ownership. The dam is owned by the Norfolk Division of the Litchfield County Water Company (Div. Bridgeport Hydraulic Co.), P.O. Box 294, Canaan, Connecticut, 06018; telephone (203) 824-5343.

f. Operator. Operational procedures relative to the dam are the responsibility of Peter H. Bickford, Superintendent, Norfolk Division, Litchfield County Water Company, P.O. Box 128, Norfolk, Connecticut 06058; telephone (203) 824-5860.

g. Purpose of Dam. The dam was originally constructed and is still used to provide a reservoir for water supply for the Town of Norfolk, Connecticut.

h. Design and Construction History. No information is available concerning the design and construction of Wangum Lake Dam other than that it was build in 1890 on the site of an existing natural lake.

i. Normal Operating Procedures. According to Mr. Bickford, the 12-inch diameter valve built into the spillway, with its invert an estimated 12 inches below the normal pool surface, is operated regularly during the summer to supply water to stables located about 1.3 miles downstream. Another 12-inch diameter valve on the water supply line for Norfolk, Connecticut located at the east side of Wangum Lake, could be used to lower the lake an additional 6 feet, if necessary.

1.3 Pertinent Data.

a. The area draining to Wangum Lake encompasses 1.07 square miles to the northeast of the lake in the Town of Canaan. Wangum Lake covers approximately 24 percent of the entire drainage area, while the rest of the area is almost entirely forested. No other body of water is located in the drainage area.

b. Discharge at Damsite. (Refer to discharge calculations included in Appendix D.)

1. Outlet Works. The estimated capacity of the 12-inch diameter valve located on the east side of Wangum Lake is 3 cfs.

2. Maximum Known Flood. According to the Owner's representative, no flood data exists for this site; however, the dam was last overtopped by about 3 inches in the spring of 1972.

3. Ungated Spilway Capacity at Top of Dam. The ungated spillway capacity at the top of the dam Elev. 1492.0 is 14 cfs.

4. Ungated Spilway Capacity at Test Flood Elevation. At the test flood Elevation 1493.0, the ungated spillway capacity is 43 cfs.

5. Gated Spillway Capacity at Normal Pool Elevation. The gated spillway capacity at normal pool Elevation 1491.0 is 3 cfs.

6. Gated Spillway Capacity at Test Flood Elevation. The gated spillway capacity at test flood Elevation 1493.0 is 6 cfs.

7. Total Spillway Capacity at Test Flood Elevation. At test flood Elevation 1493.0, the spillway capacity is 43 cfs.

8. Total Project Discharge at Top of Dam. The total project discharge at the top of the dam Elevation 1492.0 is 19 cfs.

9. Total Project Discharge at Test Flood Elevation. At test flood Elevation 1493.0, the total project discharge is 850 cfs.

c. Elevation. (NGVD)

1. Streambed at Toe of Dam	1482 ⁺
2. Bottom of Cutoff	Unknown
3. Maximum Tailwater	1488 ⁺
4. Normal Pool	1491.0
5. Full Flood Control Pool	NA
6. Spillway Crest (gated)	1490.0
7. Design Surcharge (Original Design)	Unknown
8. Top of Dam	1492.0
9. Test Flood Surcharge	1493.0

d. Reservoir Length. (Feet)

1. Normal Pool	5,600
2. Flood Control Pool	NA
3. Spillway Crest Pool	5,600
4. Top of Dam	5,610
5. Test Flood Pool	5,630

e. Storage. (Acre-Feet)

1. Normal Pool	543
2. Flood Control Pool	NA
3. Spillway Crest Pool	534
4. Top of Dam	714
5. Test Flood Pool	898

f. Reservoir Surface. (Acres)

1. Normal Pool	178
2. Flood Control Pool	NA
3. Spillway Crest Pool	178
4. Top of Dam	180
5. Test Flood Pool	182

g. Dam.

1. Type	Earth Embankment
2. Length	300 feet
3. Height	10 feet
4. Top Width	35 feet (average)
5. Side Slopes	Upstream 1H:1V
	Average Downstream 5H:1V
6. Zoning	Unknown
7. Impervious Core	Unknown
8. Cutoff	Unknown
9. Grout Curtain	Unknown

h. Diversion and Regulating Tunnel.

Not Applicable.

i. Spillway.

- | | |
|-----------------------|---|
| 1. Type | Broad-crested masonry weir |
| 2. Length of Weir | 5.5 feet |
| 3. Crest Elevation | 1491.0 |
| 4. Gates | 12-inch diameter, invert Elev. 1490.0 |
| 5. Upstream Channel | None |
| 6. Downstream Channel | Stone lined channel,
which outlets into a 14-foot long,
24-inch diameter pipe under the road.
The pipe outlets into a 0.2 acre pond. |
| 7. General | Refer to page B-2 of Appendix B
and Section 1.2b of this report. |

j. Regulating Outlet.

- | | |
|----------------------|--|
| 1. Invert | Unknown |
| 2. Size | (Assumed) 12-inch diameter |
| 3. Description | Valve on water line on east side of the lake |
| 4. Control Mechanism | Hand wheel |
| 5. Other | None |

SECTION 2
ENGINEERING DATA

2.1 Design

No design information with respect to the dam construction is available, according to the Owner's representative. However, a dam inspection was performed by Phillip W. Genovese & Associates, Inc., Consulting and Design Engineers, in October of 1978. A copy of the inspection report is included in Appendix B.

2.2 Construction

According to the Owner's representative, the dam was constructed in 1890 to impound a water supply reservoir. Further information is not available.

2.3 Operation

According to the Owner's representative, no operational data is available for this site.

2.4 Evaluation

a. Availability. The inspection report was obtained from the Litchfield County Water Company.

b. Adequacy. Information obtained during the field investigation and from conversations with the Owner's representative, combined with the previous inspection report, is considered adequate for a Phase I assessment.

c. Validity. The information provided by the Owner appears to be valid.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. The field inspection of Wangum Lake Dam was performed on November 19, 1979. At the time of the inspection, the reservoir water surface was about 2 inches below the spillway crest and water was discharging from the 12-inch diameter valve in the spillway. No underwater areas were inspected.

The observations and comments of the field inspection team are in the checklist which is Appendix A of this report.

b. Dam. The dam is considered to be in fair condition. The crest of the dam is capped by a 14-foot wide gravel road. The upstream face of the dam is grass covered and is protected by riprap only near the left abutment. The downstream slope is also covered with grass and appears to be in good condition. During the inspection, it was noted that the reservoir surface elevation was only about 1.2 feet below the top of dam elevation and that only one foot of freeboard is available between the spillway crest and the top of the dam.

c. Appurtenant Structures. The service spillway appears to be in good condition. The operating wheel for the 12-inch diameter gate valve in the spillway was not in place at the time of the inspection. This wheel is stored at Mr. Bickford's residence which is located about 150 feet downstream of the dam (refer to page C-1 of Appendix C). The stone masonry headwall, at the entrance to the spillway outlet conduit, is cracked in several locations and a few stone blocks have been displaced.

The stone masonry headwall at the exit from the outlet conduit appears to be in good condition. No emergency low level outlet is provided at Wangum Lake Dam other than the 12-inch diameter water supply conduit on the east side of the lake.

d. Reservoir Area. The area surrounding the pond is entirely forested with moderate to steep slopes. No indications of shoreline instability or excessive siltation were observed during the inspection.

e. Downstream Channel. The spillway outlet conduit discharges directly into a small pond (see overview on page v) located at the downstream toe. The pond is situated on the left stream valley slope and is retained by a 10-foot high stone block masonry dam. Discharge from the pond takes place through a small rectangular weir in the masonry structure (see page C-3, Appendix C). The weir discharge drops about 10 feet to the foundation stones of an old mill and continues downstream for about 200 feet where it flows into the original stream channel.

3.2 Evaluation

The dam is considered to be in fair condition. The lack of riprap protection on the upstream slope could lead to severe erosion of the embankment. The limited freeboard exposes the dam crest to wave action produced by high winds. The continued deterioration of the headwall at the entrance to the spillway outlet conduit could lead to blockage of the outlet conduit. Previous dam overtoppings indicate that the spillway discharge capacity is inadequate and that there is inadequate storage capacity above the spillway crest for large storm events.

SECTION 4

OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General. According to Mr. Peter Bickford, Superintendent, Norfolk Division, Litchfield County Water Company, no formal operating procedures have been established for Wangum Lake Dam. The water supply line remains open at all times.

b. Description of Any Warning System in Effect. According to Mr. Bickford, no flood warning system is in effect for Wangum Lake Dam.

4.2 Maintenance Procedures

a. General. According to Mr. Bickford, the grass on the embankment is cut on a regular basis during the growing season.

b. Operating Facilities. According to Mr. Bickford, the gate valve in the spillway is opened or closed as necessary to maintain stream discharge to the horse stables downstream. No formal maintenance is performed on this valve.

4.3 Evaluation

Operational facilities are limited to the gate valve located in the spillway headwall. A low-level outlet should be provided for emergency drawdown of the reservoir. Periodic inspection of the dam and appurtenant structures should be performed as recommended in Section 7.

SECTION 5

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General

Wangum Lake Dam has a drainage area of about 1.1 square miles. The watershed is entirely wooded with a state forest bordering the northern portion of the drainage area. The topography ranges from Elev. 1720 in the upper reaches to Elev. 1491 at the normal pool surface.

5.2 Design Data

Neither hydraulic nor hydrologic design data are available for Wangum Lake Dam.

5.3 Experience Data

No rainfall or reservoir level records are maintained for this site. However, according to Mr. Peter Bickford, the dam was overtopped by approximately 3 inches in the spring of 1972. During this overtopping, some material was eroded from the crest of the dam. This material was later replaced and the eroded areas were reseeded.

5.4 Test Flood Analysis

The recommended test flood range for a "Small" size, "Significant" hazard dam is from the 100-year old frequency flood to one-half of the Probable Maximum Flood (PMF). Due to the presence of a private dwelling in the flood plain 150 feet downstream of the dam and the possibility of loss of life, the selected test flood is one-half of the PMF.

Hydrologic and hydraulic calculations were performed with the assistance of the HEC-1-DB computer program. The flood hydrographs were constructed from the Snyder unit hydrograph using average coefficients, an initial infiltration of zero and a constant loss rate of 0.05 inches per hour. The Hop Brook Adjustment Factor was used to reduce the Probable Maximum Precipitation based on the drainage area. Stage vs. discharge and stage vs. storage relationships were developed for Wangum Lake Dam. These relationships were utilized by the program to route the test flood through the dam. The reservoir water surface was assumed to be at Elev. 1491 with 3 cfs of discharge through the 12-inch diameter gate valve at the beginning of the storm event.

The test flood peak inflow to Wangum Lake was computed to be 1,570 cfs. The routed test flood outflow of 850 cfs overtops the embankment by about one foot. The spillway system is capable of discharging 19 cfs, which is about 2 percent of the routed test flood outflow, prior to overtopping of the embankment.

5.5 Dam Failure Analysis

A failure of the embankment was simulated by the HEC-1-DB computer program assuming an 80-foot wide by 7-foot deep breach with vertical side slopes developing within one hour. The failure is assumed to occur with the reservoir surface at the top of dam elevation. The resulting outflow of 3840 cfs was routed to the damage center which was assumed to be the private dwelling about 150 feet downstream of the dam. Discharge would not exist at the damage center prior to breaching of the dam. The channel cross-section used in the computer program for the hazard area is shown on page D-6. It was evident from the field inspection that a dam breach would direct flood waters to the house. The depth of flood waters at this cross-section was computed to be 3.8 feet which would result in at least 3 feet of water in the house. This depth of water would cause appreciable property damage and the possible loss of lives in the damage center.

SECTION 6

STRUCTURAL STABILITY

6.1 Visual Observations

The normal pool freeboard of about one foot exposes the crest of the dam to wave action produced by high winds. The lack of adequate riprap protection on the upstream slope could lead to severe erosion of the embankment. No indications of settlement, seepage, or slope instability were observed during the inspection.

The spillway section appeared to be in good structural condition. However, cracking and some displaced stones were observed in the headwall at the entrance to the spillway outlet conduit.

6.2 Design and Construction Data

According to the Owner's representative, no information concerning the original design and construction of the dam is available.

6.3 Post Construction Changes

According to the Owner's representative, no known post construction changes have been made to the dam.

6.4 Seismic Stability

Wangum Lake Dam is located in Seismic Zone 1 on the "Seismic Zone Map of Contiguous States". A dam located in Seismic Zone 1 need not be evaluated for seismic stability, according to the Recommended Guidelines for Phase I Dam Inspections.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual observations and review of the available information indicate that Wangum Lake Dam is in fair condition. The upstream slope is provided with limited riprap protection which exposes the embankment to erosion. The normal pool freeboard of about one foot exposes the dam crest to wave action caused by high winds. The dam was overtopped and eroded in 1972, which would indicate that the spillway discharge capacity and reservoir storage capacity above normal pool are inadequate for large storm events. The continued deterioration of the upstream headwall of the spillway outlet conduit could lead to obstruction of the pipe entrance. No emergency low-level outlet exists at this site.

b. Adequacy of Information. The available information combined with the visual inspection data are considered adequate for a Phase I assessment of Wangum Lake Dam.

c. Urgency. The recommendations and remedial measures described in Sections 7.2 and 7.3 should be implemented within one year from the date of receipt of this Phase I Inspection Report.

7.2 Recommendations

It is recommended that the Owner retain and implement the results of the services of a qualified, registered professional engineer for the following purposes:

1. Perform detailed hydrologic and hydraulic analyses to assess the need for increasing the project discharge capacity.
2. Study the need for providing additional freeboard to protect the dam crest from wave action.
3. Design an emergency low-level outlet for reservoir drawdown independent of the water supply system.

7.3 Remedial Measures

a. Operation and Maintenance Procedures. The Owner should also implement the following operation and maintenance measures:

1. Provide adequate erosion protection on the upstream slope of the embankment.
2. Repair the headwall at the entrance to the spillway outlet conduit.

3. Institute a program of annual periodic technical inspections.

4. Monitor the dam during heavy precipitation.

7.4 Alternatives

No valid alternatives to the recommendations described above are considered feasible for this site.

APPENDIX A
INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST
INSPECTION TEAM ORGANIZATION

Project: Wangum Lake Dam
National I.D. #: CT 00516
Location: Town of Canaan, Connecticut
Type of Dam: Earth Fill
Inspection Date(s): Nov. 19, 1979
Weather: clear, cool 40°
Pool Elevation: ≈ 1491

Inspection Team

Leonard Beck	O'Brien & Gere	Structures
Steven Snider	O'Brien & Gere	Foundations & Materials
Alan Hanscom	O'Brien & Gere	Structures
Rodney Georges	Bryant & Associates	Hydrology/Hydraulics

*Mr. John J. Williams, Vice-President, O'Brien & Gere has visited the site but not necessarily in conjunction with the inspection team.

Owner's Representative

Mr. Peter Bickford, Superintendent, Norfolk Div.,
Litchfield County Water Co.

VISUAL INSPECTION CHECK LIST

Project: Wangurn Lake DamNational I.D. #: CT 00516Date(s): November 19, 1979

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	
Crest Elevation	≈ 1492
Current Pool Elevation	≈ 1491
Maximum Impoundment to Date	≈ 1492.3
Surface Cracks	None observed
Pavement Condition	Not applicable
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	No vertical misalignment observed
Horizontal Alignment	No horizontal misalignment observed
Condition at Abutment and at <i>masonry</i> Structures	Satisfactory, no settlement or erosion observed
Indications of Movements of Structural Items on Slopes	None observed
Trespassing on Slopes	No paths have been worn on the slopes
Vegetation on Slopes	Good cover upstream, downstream & crest
Sloughing or Erosion of Slopes or Abutments	None observed
Rock Slope Protection - Riprap Failures	Various sizes of stone riprap on upstream face - no failures observed

VISUAL INSPECTION CHECK LIST

Project: Wangurn Lake Dam

National I.D. #: CT 00516

Date(s): November 19, 1979

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT (Con't)</u>	
Unusual Movement or Cracking at or near Toes	<i>None observed</i>
Unusual Embankment or Downstream Seepage	<i>None observed</i>
Piping or Boils	<i>None observed</i>
Foundation Drainage Features	<i>None observed</i>
Toe Drains	<i>None observed</i>
Instrumentation System	<i>None observed</i>

VISUAL INSPECTION CHECK LIST

Project: Waugum Lake Dam

National I.D. #: CT 00516

Date(s): November 19, 1979

AREA EVALUATED	CONDITIONS
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
a. Approach Channel	
General Condition	<i>Good, but very limited capacity</i>
Loose Rock Overhanging Channel	<i>None observed</i>
Trees Overhanging Channel	<i>None observed</i>
Floor of Approach Channel	<i>Masonry, satisfactory condition</i>
b. Weir and Training Walls	
General Condition of <i>masonry</i>	<i>Good, but very limited capacity</i>
Rust or Staining	<i>Not applicable</i>
Spalling	<i>Not applicable</i>
Any Visible Reinforcing	<i>Not applicable</i>
Any Seepage or Efflorescence	<i>No</i>
Drain Holes	<i>Not applicable</i>
c. Discharge Channel	
General Condition	<i>Good, but very limited capacity</i>

VISUAL INSPECTION CHECK LIST

Project: Waugum Lake DamNational I.D. #: CT 00516Date(s): November 19, 1979

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS (Con't)	
Loose Rock Overhanging Channel	None observed
Trees Overhanging Channel	None observed
Floor of Channel	Masonry, satisfactory condition
Other Obstructions	24" diam. cast iron pipe which constricts discharge in already limited capacity 5.5-foot wide outlet channel. 24" diam. cast iron pipe is 17 feet downstream of overflow weir. Pipe conveys discharge under embankment and road.

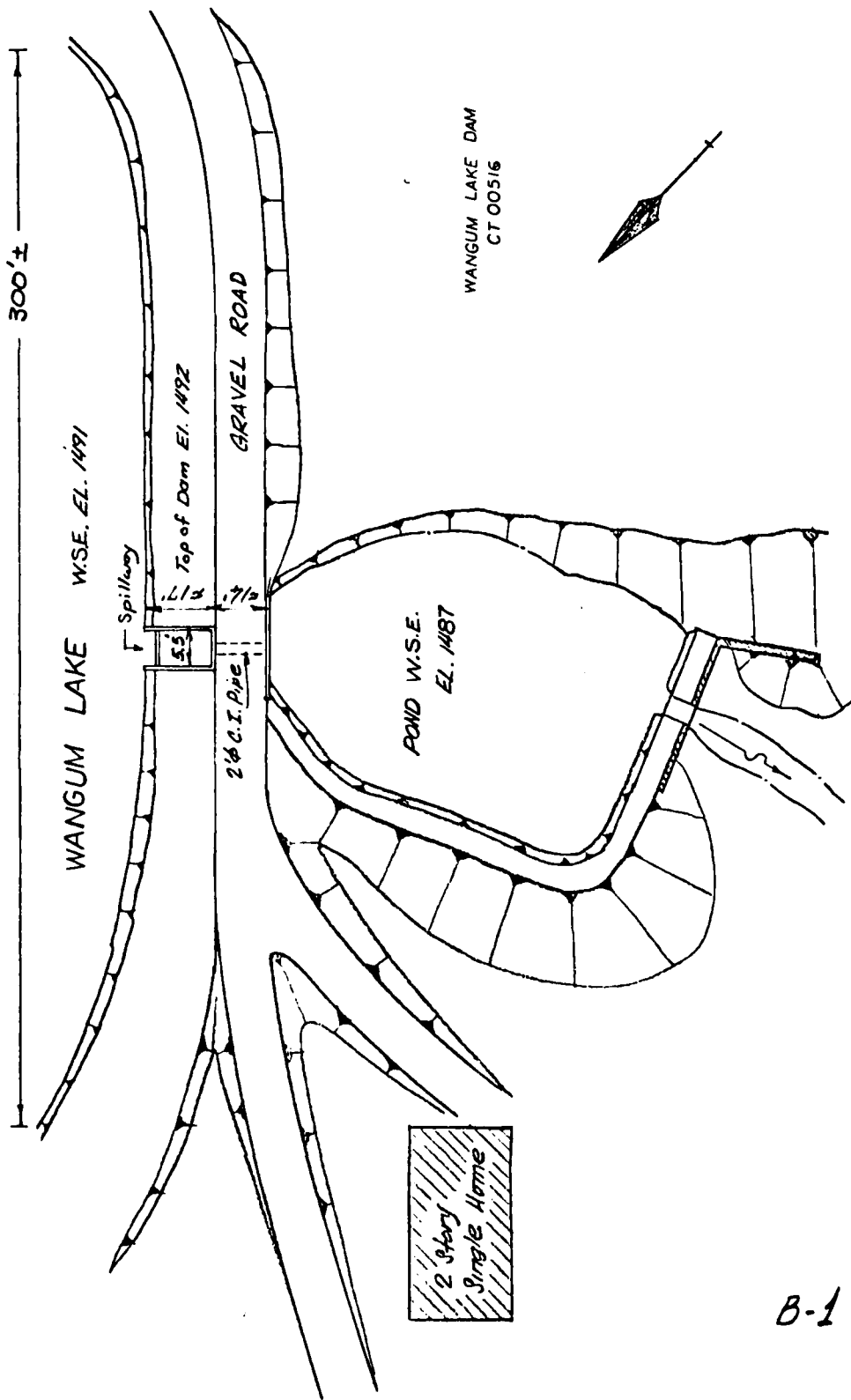
APPENDIX B

ENGINEERING DATA

SUBJECT	WANGUM LAKE DAM	SHEET	BY	DATE	JOB NO
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APPENDIX B
ENGINEERING DATA
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SECTION THROUGH SPILLWAY	B-2
SECTION THROUGH DAM EMBANKMENT	B-2
P. W. GENOVESE & ASSOC., INC. DAM INSPECTION REPORT	B-3 to B-13

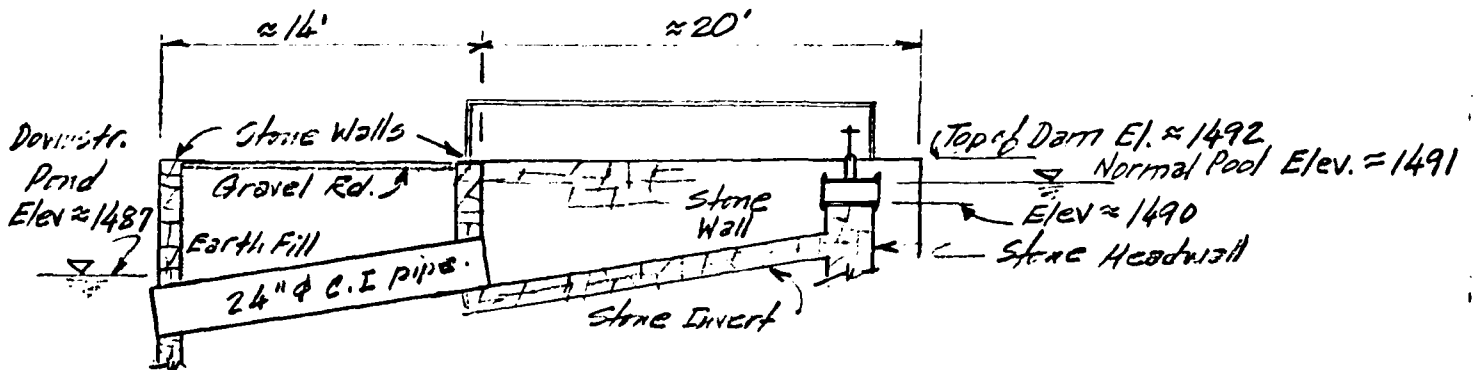


WANGUM LAKE DAM SITE PLAN

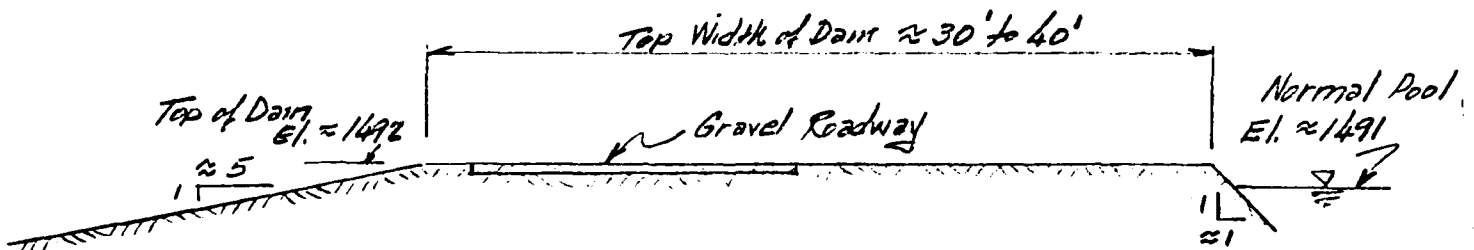
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B-1

SUBJECT	Wangum Lake Dam	SHEET	B-2	BY	JB	DATE	3/11/80	JOB NO.	2060-001
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SECTION THROUGH SPILLWAY



TYPICAL SECTION THROUGH DAM EMBANKMENT

DAM INSPECTION

Bridgeport Hydraulic Company Dams

Name of Dam: Wangum Lake

I. PROJECT INFORMATION:

A. AUTHORITY:

This inspection was authorized by a letter from Bridgeport Hydraulic Company dated October, 13, 1978 to Philip W. Genovese & Associates, Inc. Said letter was signed by Edward Stangl, whose title is Manager - Project Engineering. The letter was also signed by Robert Reinert, Vice President of Engineering and Planning.

B. PURPOSE:

The purpose of the study is to perform inspection and evaluation of various Bridgeport Hydraulic Dams in terms of their safety.

C. DESCRIPTION:

The reservoir and dam at Wangum Lake are located in the Town of Canaan, Connecticut. The reservoir impounds Wangum Lake Brook, which flows into the Hollenbeck River and eventually into the Housatonic. The dam appears to be entirely earthen and probably formed in part by glaciation.

The outlet works include a cement rubble masonry spillway; a concrete sill supporting ^{12"}~~44~~-inch gate valve; a ^{24"}~~30~~-inch cast iron pipe which acts as a culvert under the road; a pond down stream from the ^{24"}~~30~~-inch cast iron pipe which outlets through a 12-inch cast iron pipe.

Dam: Wangum Lake

D. PERTINENT DATA:

1. Drainage Area: 1.06 square miles - 678 acres
2. Discharge at Dam: Does not apply.
3. Elevation: 1,491 ft MSL/USGS Quad Sheet
4. Reservoir: Length of maximum pool = 5,600 ft $\pm$
5. Storage: Does not apply.
6. Reservoir Surface: Does not apply.
7. Dam:
 - Type: Earthen (natural)
 - Length: 300 ft $\pm$
 - Height: 10 ft $\pm$
 - Top Width: variable
 - Side Slopes: Up Stream Appears to be
Down Stream Steep (underwater)
Steep - Variable
8. Diversion and Regulating Controls: Does not apply.
9. Spillway: See Attached Sketch
 - Type: Cement rubble masonry w/concrete weir and valve
 - Length of Weir: See Attached Sketch
 - Gates: 12¹/₂-inch gate valve
 - Up Stream Channel: See Attached Sketch
 - Down Stream Channel: See Attached Sketch

Dam: Wangum Lake

II. ENGINEERING DATA (Existing):

None Available.

III. VISUAL INSPECTION:

A. FINDINGS:

The embankment and outlet works appear to be in good condition. The outlet works are very limited in capacity and the top of the embankment is the spillway. The up stream side of the embankment is protected with rip-rap and the down stream side is protected with vegetation.

B. EVALUATION:

The dam appears to be in good condition.

Dam: Wangum Lake

IV. OPERATIONAL PROCEDURES:

Does not apply

V. HYDROLOGY AND HYDRAULIC ANALYSES:

The results of the analysis of the hydrology and hydraulics of the dam indicate that the embankment including the 30-inch pipe discharge will pass a flow of 368 cfs (100 year frequency) with a head of 1.05 ft $\pm$ above the top of the embankment. The outlet works will accommodate a flow of 55 cfs. Hydraulic control for this structure is:

<u>Control</u>	<u>Flow (cfs)</u>	<u>Frequency (years)</u>
Top of Dam	55	10
---	366 *	100

* at this flow, the embankment is overtopped by 1.05 ft.

VI. STRUCTURAL STABILITY:

A. VISUAL OBSERVATION:

1. Embankment: Visual examination of the embankment indicates no serious structural problems.

2. Appurtenant Structures: Visual inspection indicates no significant structural problem.

Dam: Wangum Lake

B. DESIGN AND CONSTRUCTION DATA:

Does not apply

C. OPERATING RECORDS:

Does not apply

D. POST CONSTRUCTION CHANGES:

Does not apply

E. SEISMIC STABILITY:

The dam is located in seismic zone #1

VII. DAM ASSESSMENT:

Visual inspection of the dam indicates generally good condition. This condition designation means the facility requires action within 2 to 3 years by the owner for the specific areas described.

One item that requires action is the raising of the dam or construction of a spillway.

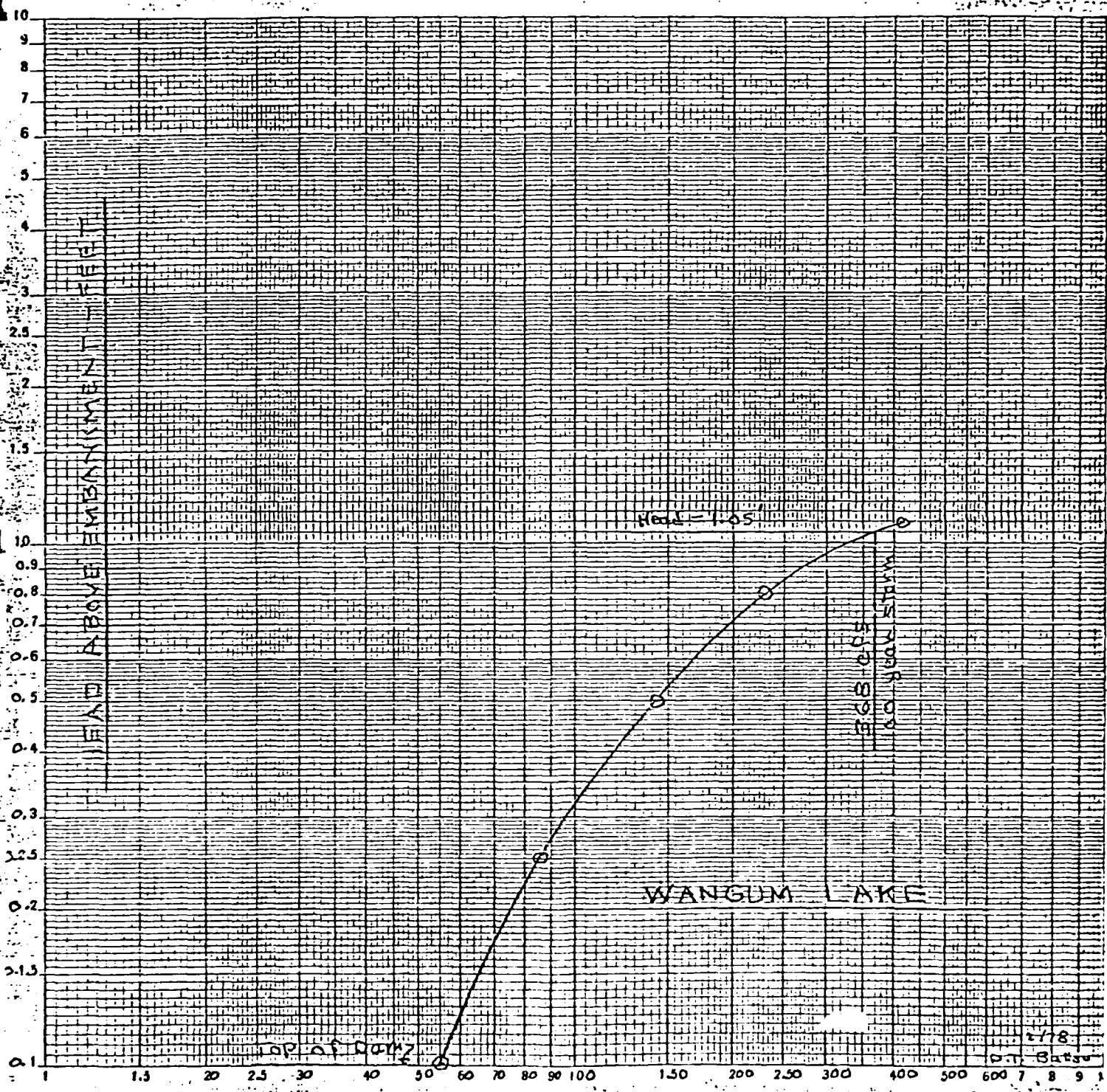
The dam should be raised or an adequate spillway constructed to prevent overtopping at a frequency less than the existing condition which indicates the dam would be overtopped at a return period of 10 years.

Prepared by: Robert L. Jones, P.E.

Project Engineer

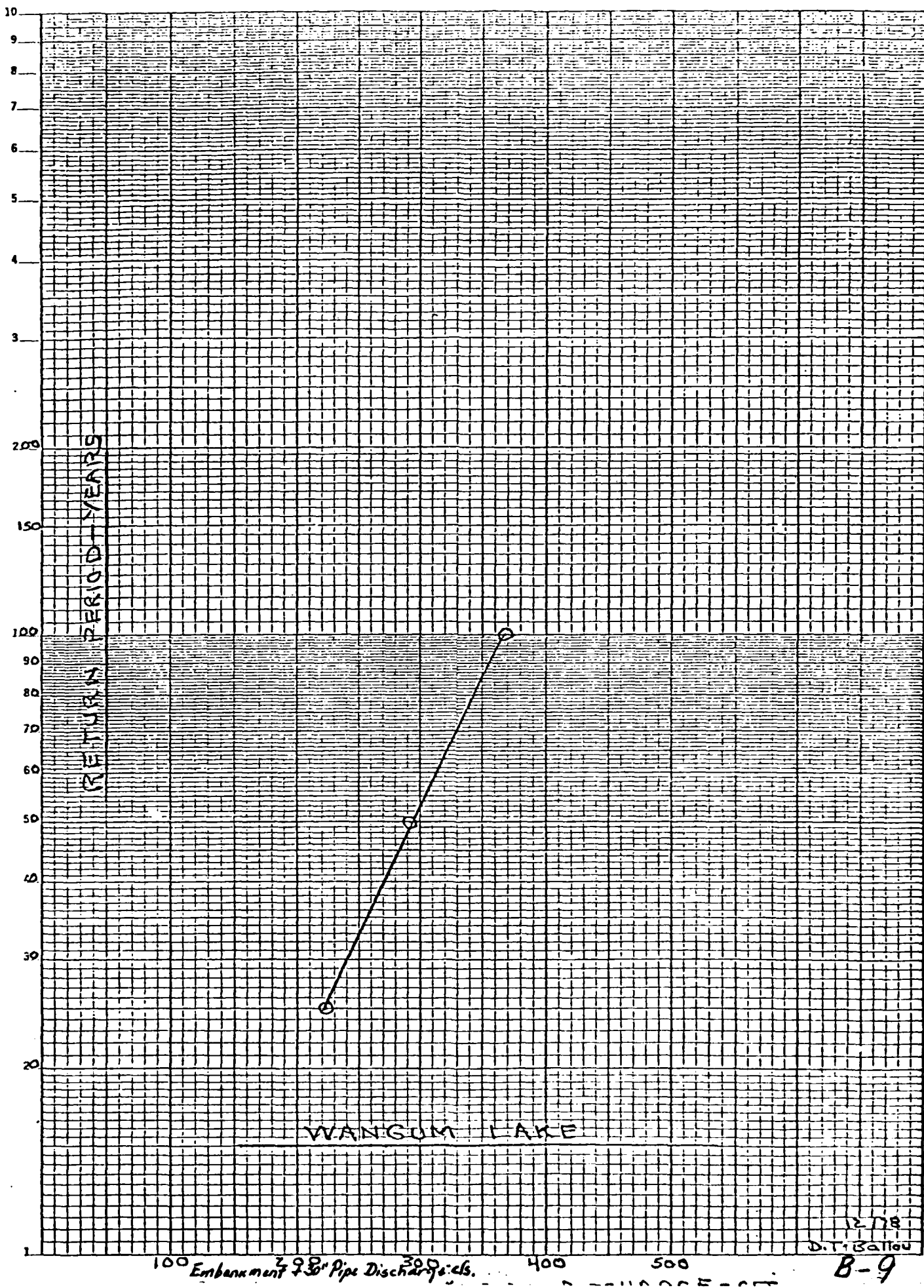
B-7

W. L. KUEFFEL & SONS CO. MAPLETON, ILL.
3 1/2" x 5 1/2" CYCLES



EMBANKMENT + 30" PIPE DISCHARGE - CFS

HOE SEMI-LOGARITHMIC 46 4870
M. J. C. 2nd EDITION
NEW YORK - R. CO.



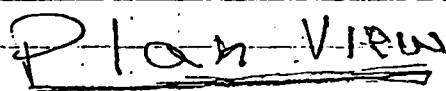
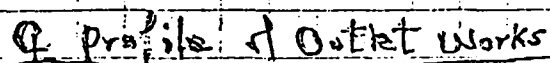
100 Embankment 28" Pipe Discharge cfs.

400

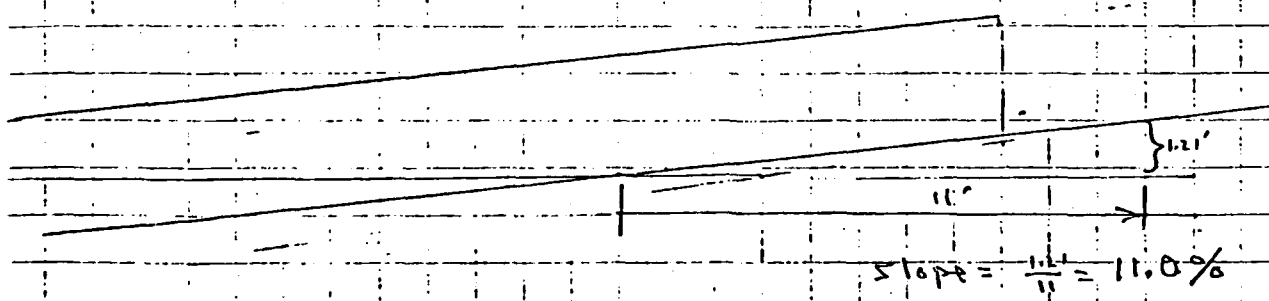
500

12.78
D.T. Ballou
B-9

Wangom Res



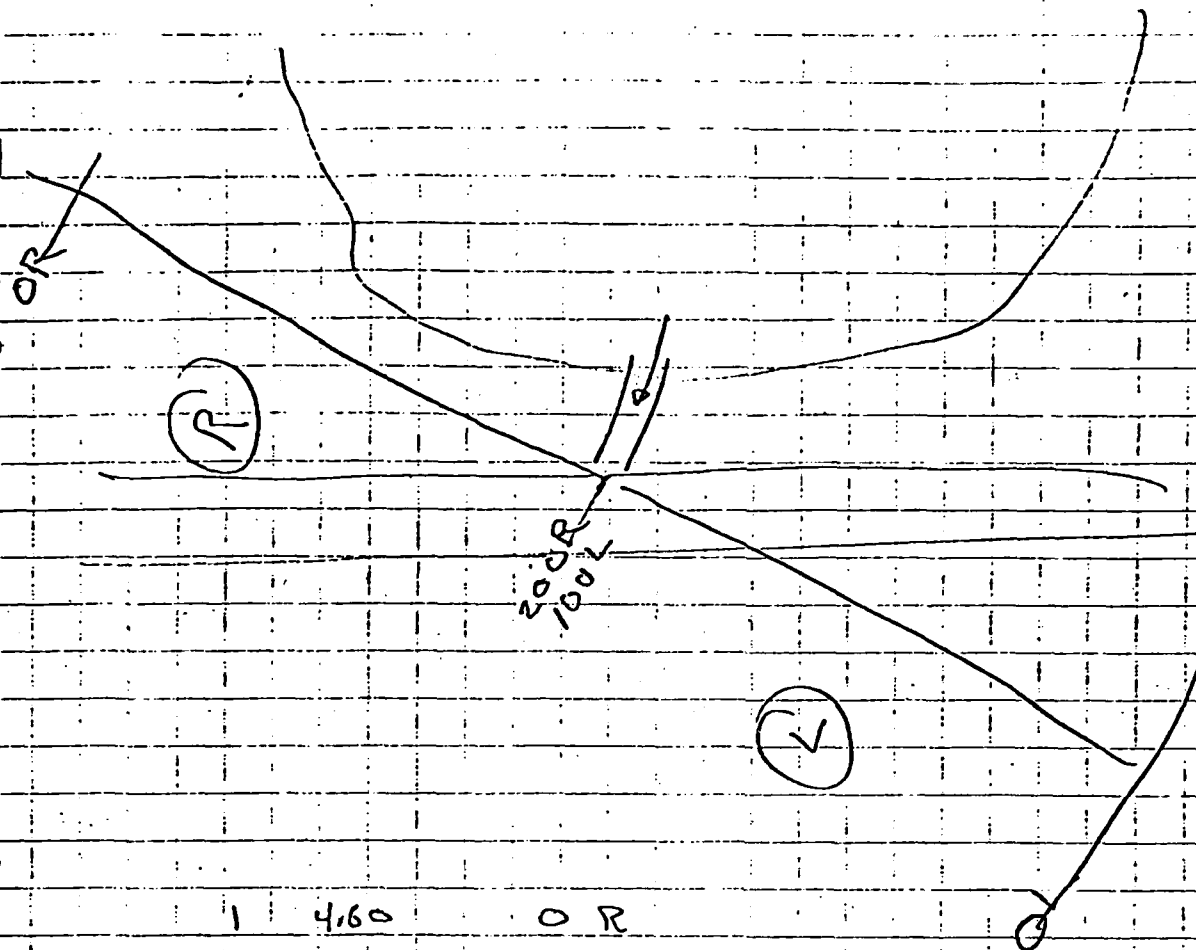
①	6.45	Top of conc sill
②	9.61	chan. Fw. e face of bridge
③	5.09	E Dirt Road
④	10.55	Top of 12" ϕ CI Pipe
⑤	10.82	Water level in lower pond
⑥	9.88	Lawn near lower pond
⑦	7.85	Remnant level in lake



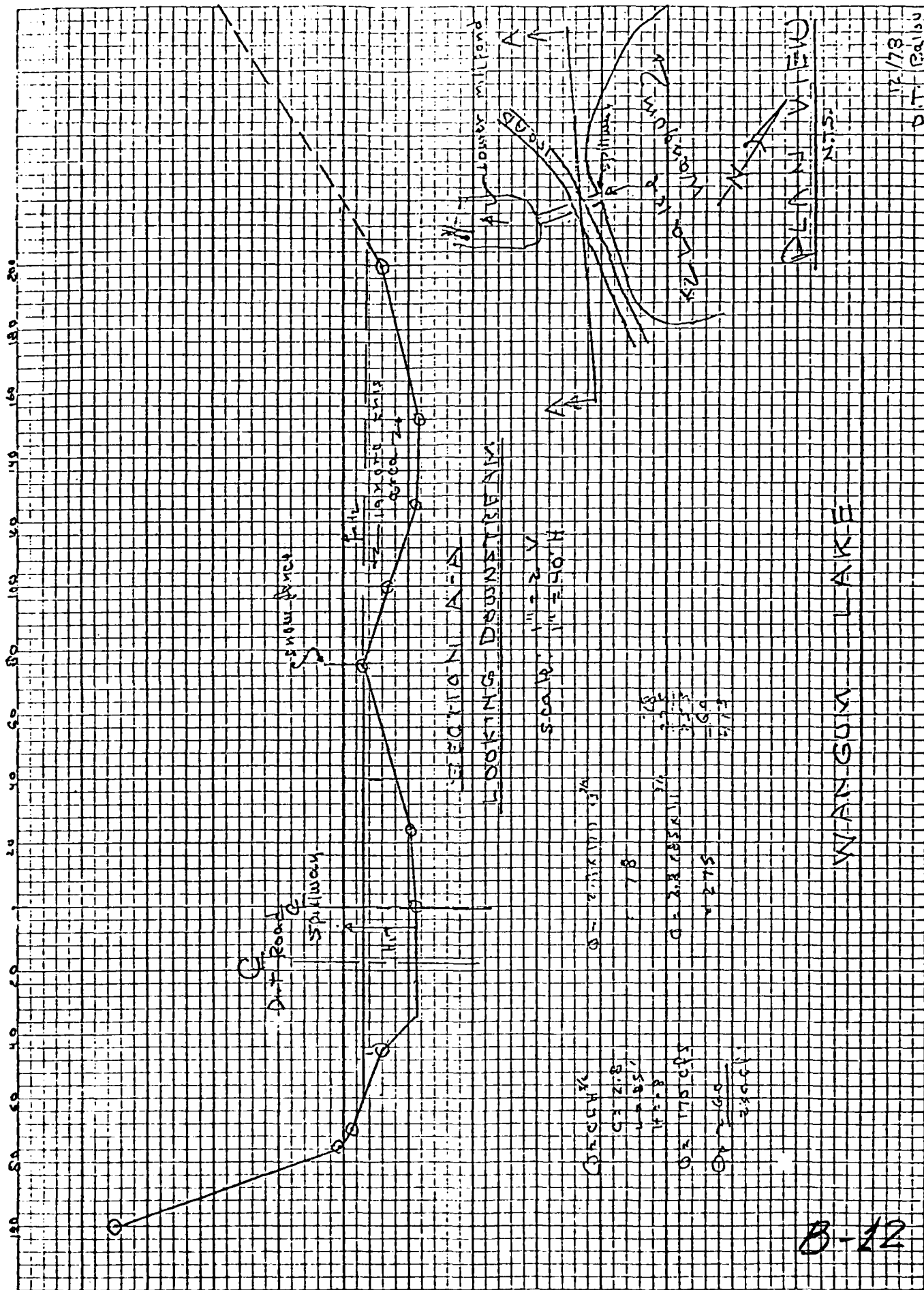
B-10

Wangum Res - Continued

11/9/78

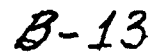


1	4.60	0 R	
2	5.20	50 R	
3	5.11	75 R	
4	4.70	100 R	
5	4.31	125 R	End of snow fence
6	5.07	175 R	
7	5.10	200 R	edge of Road
8	0.50	0 L	
9	3.91	25 L	
10	4.12	30 L	
11	4.60	50 L	edge of Road



B-12

6368 II SW
(SOUTH SANDSFIELD)

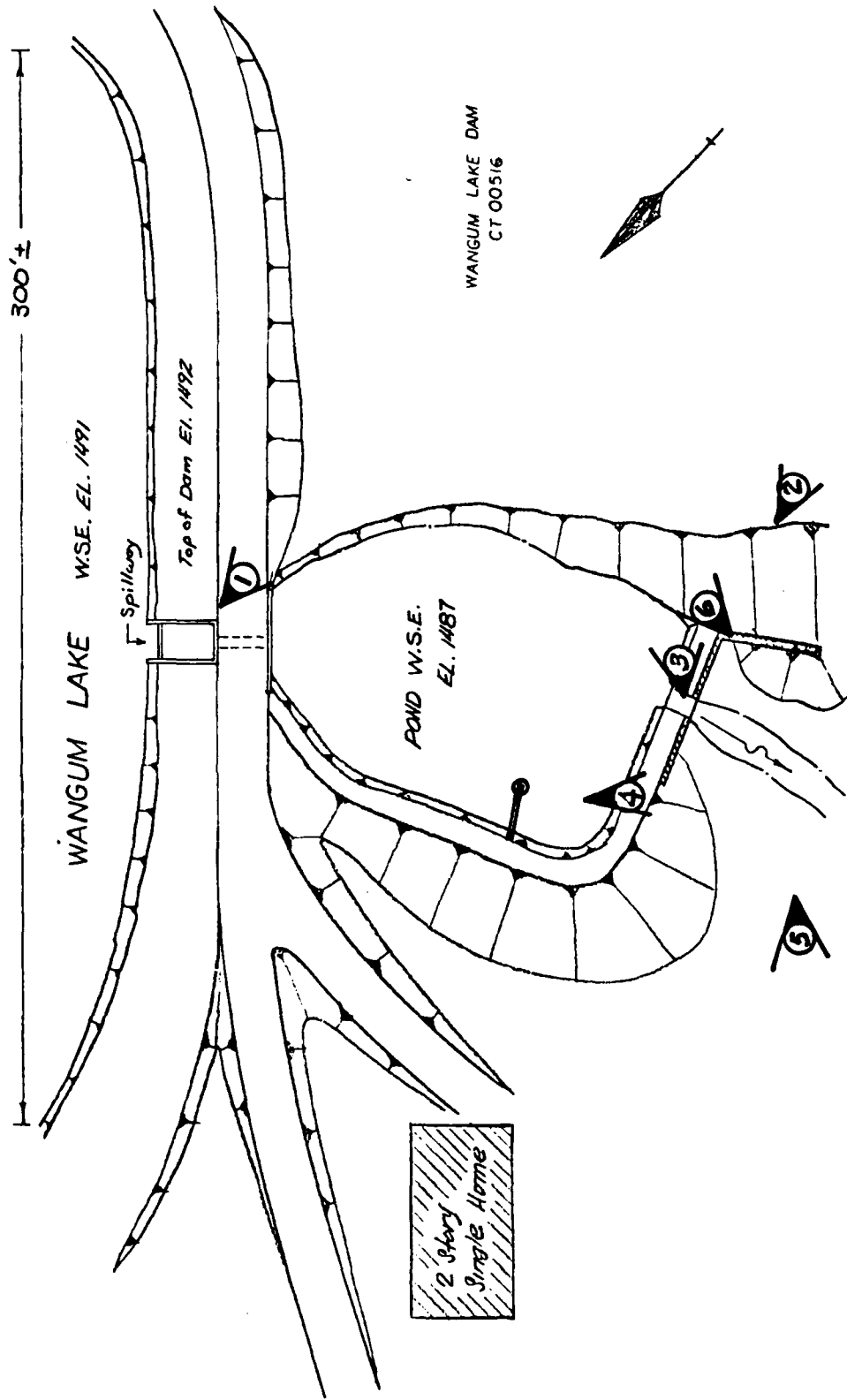


APPENDIX C

PHOTOGRAPHS

APPENDIX C
SELECTED PHOTOGRAPHS OF PROJECT

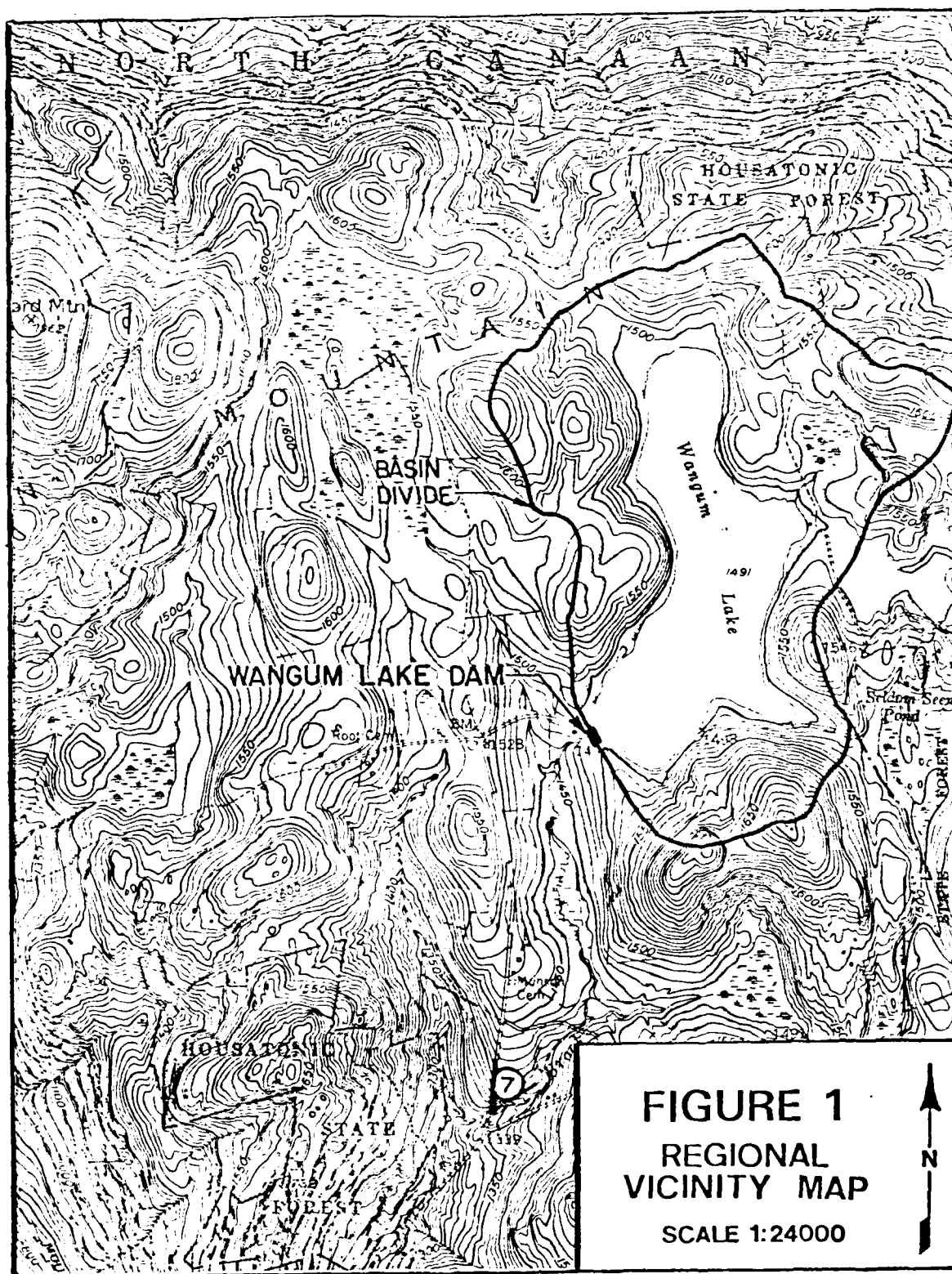
<u>LOCATION PLAN</u>	<u>Page No.</u>
Site Plan	A
Regional Plan	B
 <u>PHOTOGRAPHS</u>	
<u>No.</u>	<u>Page No.</u>
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2. The small pond immediately downstream of Wangum Lake Dam.	1
3. Spillway for the pond immediately downstream of Wangum Lake Dam.	2
4. Valve control for the pond immediately downstream of Wangum Lake Dam.	2
5. Overview of the dam for the pond immediately downstream of Wangum Lake Dam.	3
6. Terrain immediately downstream of Wangum Lake Dam and the small pond.	3
7. Stables about 1.3 miles downstream from the dam which represents a potential damage center.	4

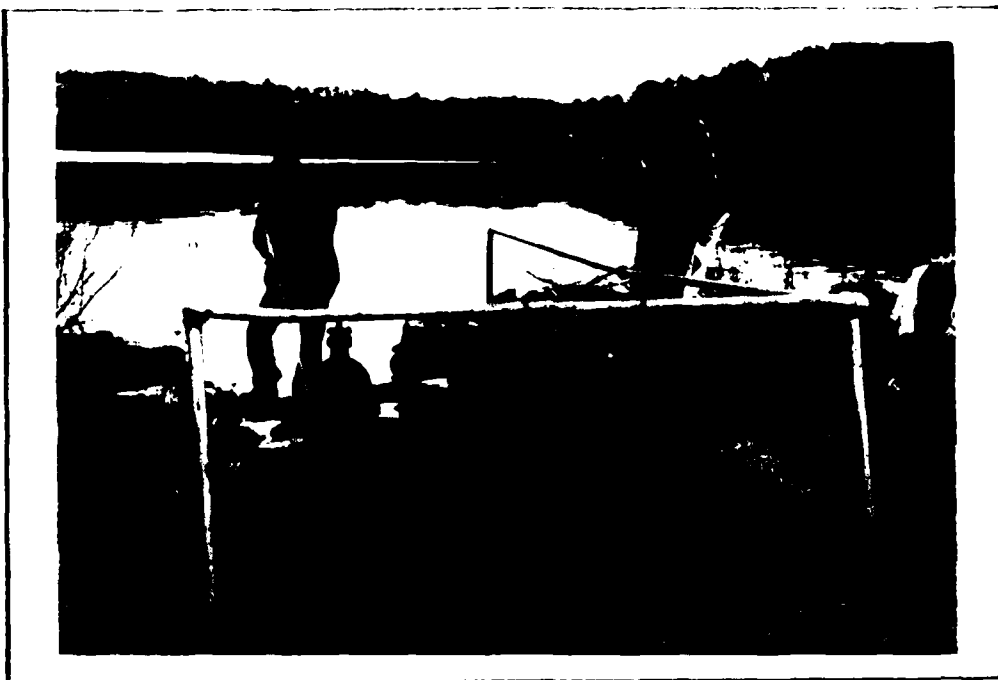


THE LOCATION AND DIRECTION IN
WHICH EACH PHOTO WAS TAKEN
AND THE NUMBER OF THE PHOTO

LEGEND ①

WANGUM LAKE DAM
Not To Scale





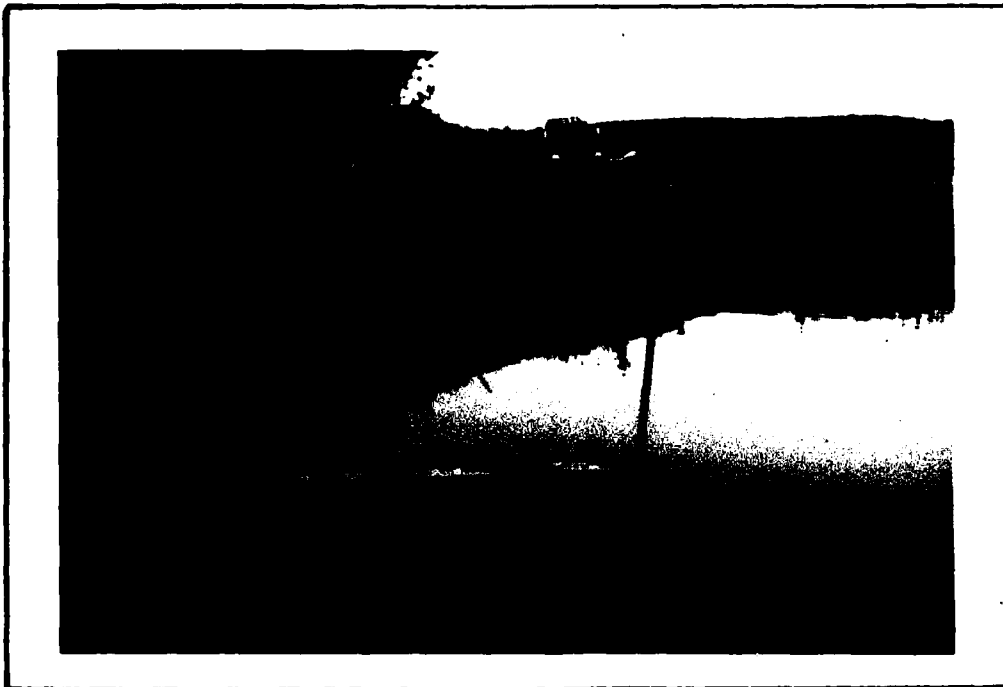
1. THE SPILLWAY SYSTEM. (11/19/79)



2. THE SMALL POND IMMEDIATELY DOWNSTREAM OF WANGUM LAKE DAM.
(11/19/79)



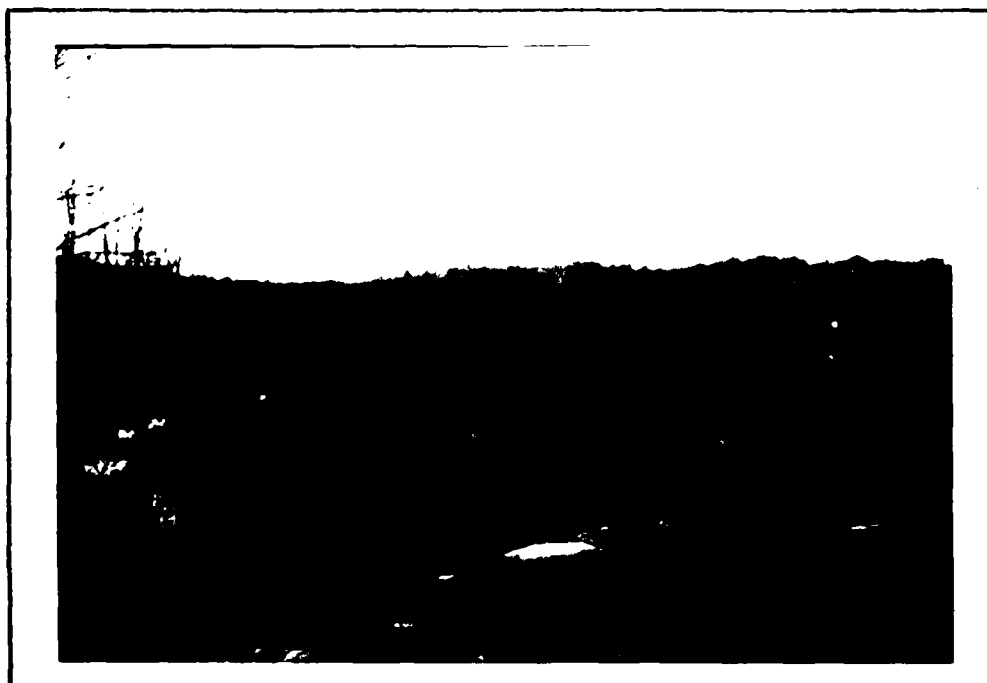
3. SPILLWAY FOR THE POND
IMMEDIATELY DOWNSTREAM OF
WANGUM LAKE DAM. (11/19/79)



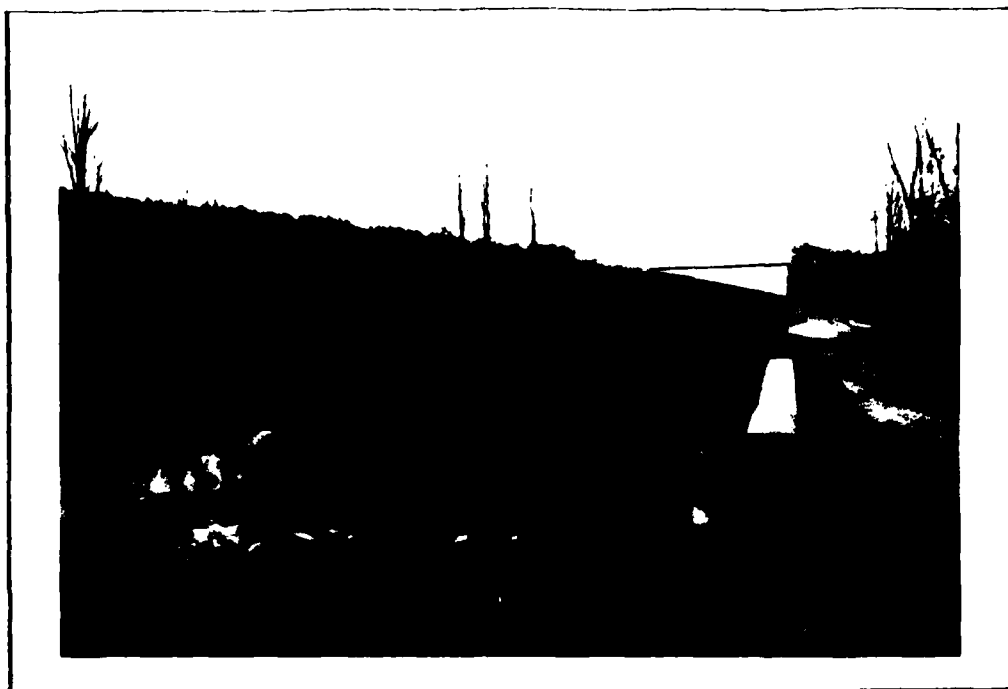
4. VALVE CONTROL FOR THE POND IMMEDIATELY DOWNSTREAM OF WANGUM
LAKE DAM. (11/19/79)



5. OVERVIEW OF THE DAM FOR THE POND IMMEDIATELY DOWNSTREAM OF WANGUM LAKE DAM. (11/19/79)



6. TERRAIN IMMEDIATELY DOWNSTREAM OF WANGUM LAKE DAM AND THE SMALL POND. (11/19/79)



7. STABLES ABOUT 1.3 MILES DOWNSTREAM FROM THE DAM WHICH REPRESENTS A POTENTIAL DAMAGE CENTER. (11/19/79)

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

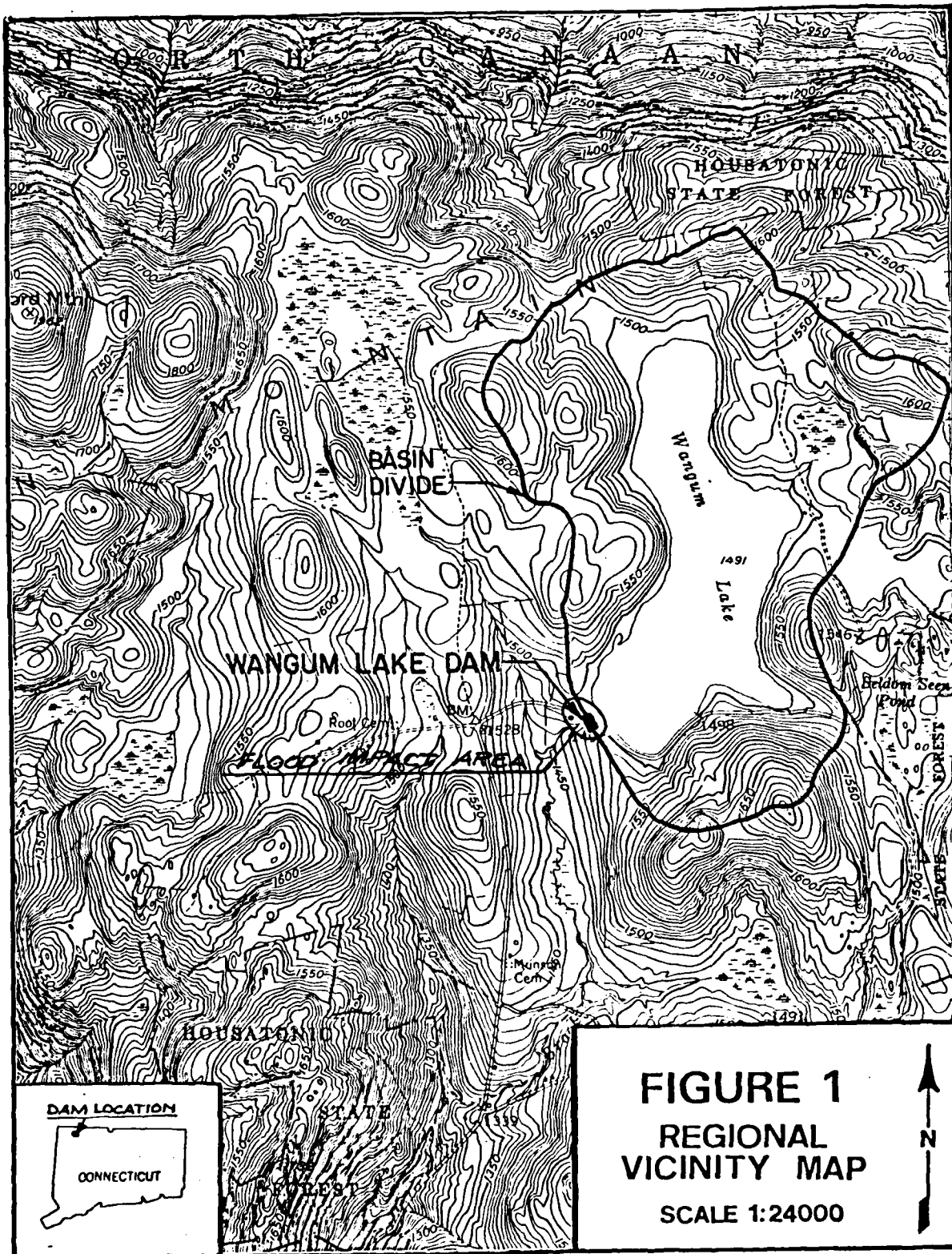
SUBJECT	WANGUM LAKE DAM	SHEET	BY	DATE	JOB NO
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APPENDIX D

HYDROLOGIC & HYDRAULIC COMPUTATIONS

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T _P COMPUTATIONS, PMP DATA & ADDITIONAL HYDROLOGIC DATA	D-2
SPILLWAY PLAN & PROFILE	D-3
STAGE-DISCHARGE COMPUTATIONS	D-3
STAGE-DISCHARGE TABULATION	D-4
STAGE-STORAGE DATA	D-4
STAGE-DISCHARGE & STAGE-STORAGE GRAPHS	D-5
HAZARD AREA CROSS-SECTION	D-6
HEC-1 DAM SAFETY VERSION, COMPUTER OUTPUT	D-7 to D-10
HEC-1 DAM SAFETY VERSION, BREACH ANALYSIS, COMPUTER OUTPUT	D-11 to D-14



SUBJECT	SHEET	BY	DATE	JOB NO
WANGUM LAKE DAM - H&H	D-2	SHS	2/13/80	2060-001

HYDROLOGIC & HYDRAULIC CALCULATIONS

Drainage Area - 1.07 sq. miles

Reservoir Area - 0.28 sq. miles = 178 acres

T_p Computations:

$$L = 3,200 \text{ ft.} = 0.61 \text{ mi.}$$

$$L_{CA} = 800 \text{ ft.} = 0.15 \text{ mi.}$$

$$T_p = C_t (LL_{CA})^{0.3} = 2.0 (0.61 \times 0.15)^{0.3}$$

$$\therefore \text{Log Time, } T_p = 1.0 \text{ Hours}$$

Snyder Coefficients:

$$C_t = 2.0$$

$$C_p = 0.5$$

PMP DATA:

The 24 hr., 200 sq. mi. Index Rainfall is 20.8 inches.

$$6 \text{ hr. } \% = 111$$

$$12 \text{ hr. } \% = 124$$

$$\text{(Duration) } 24 \text{ hr. } \% = 133$$

Ref.: H/MS Report #33

ADDITIONAL HYDROLOGIC DATA:

Initial Loss - 0.0 in.

Constant Loss Rate - 0.05 in./hr.

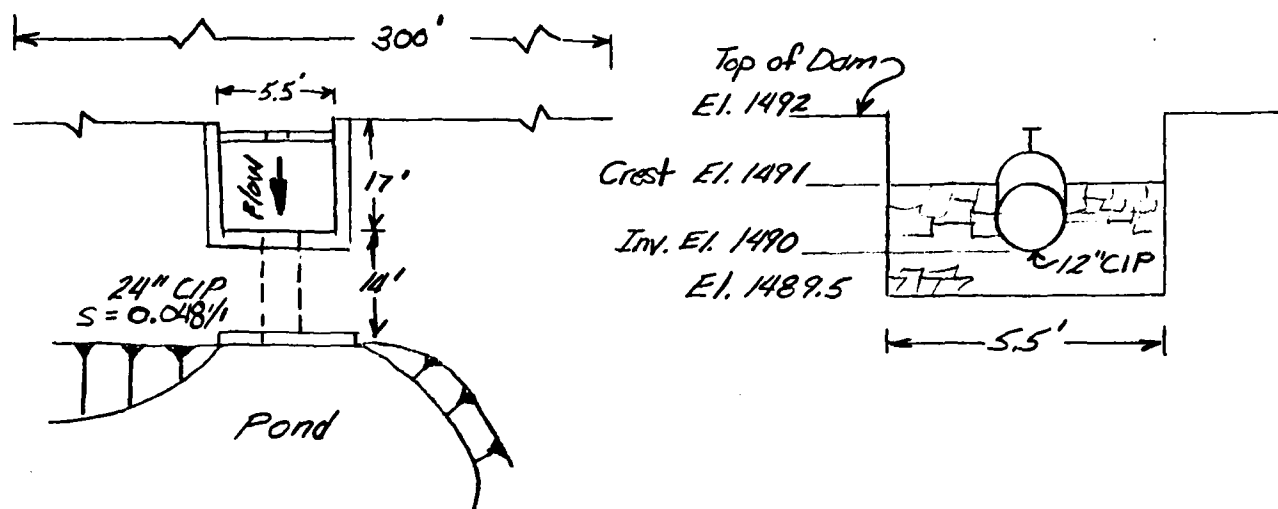
Hop Brook Adj. Factor - 0.80

% Basin Impervious - 24%

Computation Interval - 15 min.

SUBJECT	SHEET	BY	DATE	JOB NO
WANGUM LAKE DAM - H&H	D-3	SHS	2/13/80	2060-001

Spillway Plan & Profile:



Stage-Discharge Computations:

12" CIP - $Q_1 = CA\sqrt{2gh}$ $C = 0.60$

Sharp-crested Weir - $Q_2 = CLH^{3/2}$ $C = 3.0$

24" CIP Culvert - $Q_3 = CA\sqrt{2gh}$ $C \approx 0.72$ Ref.: Handbook of Hyd.
Assume free discharge at outlet. King & Brater
Section 4

$Q_3 = 0.72 (3.14) [64.4 (4.7)]^{1/2} = 39 \text{ cfs}$

$Q_1 \text{ (Pool @ Dam Crest)} = 0.6 (0.79) [2(32.2) 1.5]^{0.5} = 4.7 \text{ cfs}$

$Q_2 \text{ (Pool @ Dam Crest)} = 3.0 (4.5) (1.0)^{3/2} = 13.5 \text{ cfs}$

$Q_1 + Q_2 = 18.2 \text{ cfs}$ $\therefore$ The weir and 12" CIP control to
top of dam and the culvert controls
above top of dam.

Discharge over Dam Crest - $Q_4 = CLH^{3/2}$ $C = 2.8$

SUBJECT	SHEET	BY	DATE	JOB NO
WANGUM LAKE DAM - H&H	D-4	SHS	2/13/80	2060-001

STAGE - DISCHARGE TABULATION

Pool Elevation	Q_1	Q_2	Q_3	Q_4	ΣQ (cfs)
1490	-	-	-	-	0
Normal Pool, 1491	3	-	-	-	3
Top of Dam, 1492	5	14	-	-	19
1492.6	-	-	42	390	432
1493	-	-	43	840	883
1494	-	-	47	2400	2447
1495	-	-	50	4365	4415
1497	-	-	57	9391	9448

STAGE - STORAGE DATA

RESERVOIR SURFACE ELEV.

SURFACE AREA (ACRES)

STORAGE (ACRE-Feet)
(COMPUTED BY HEC-1 PROGRAM)

1482

0

0

1491

178

534

1500

216

2,304



O'BRIEN & GERE
ENGINEERS, INC.

SUBJECT

STAGE-STORAGE & STAGE-DISCHARGE CURVES

SHEET

D-5

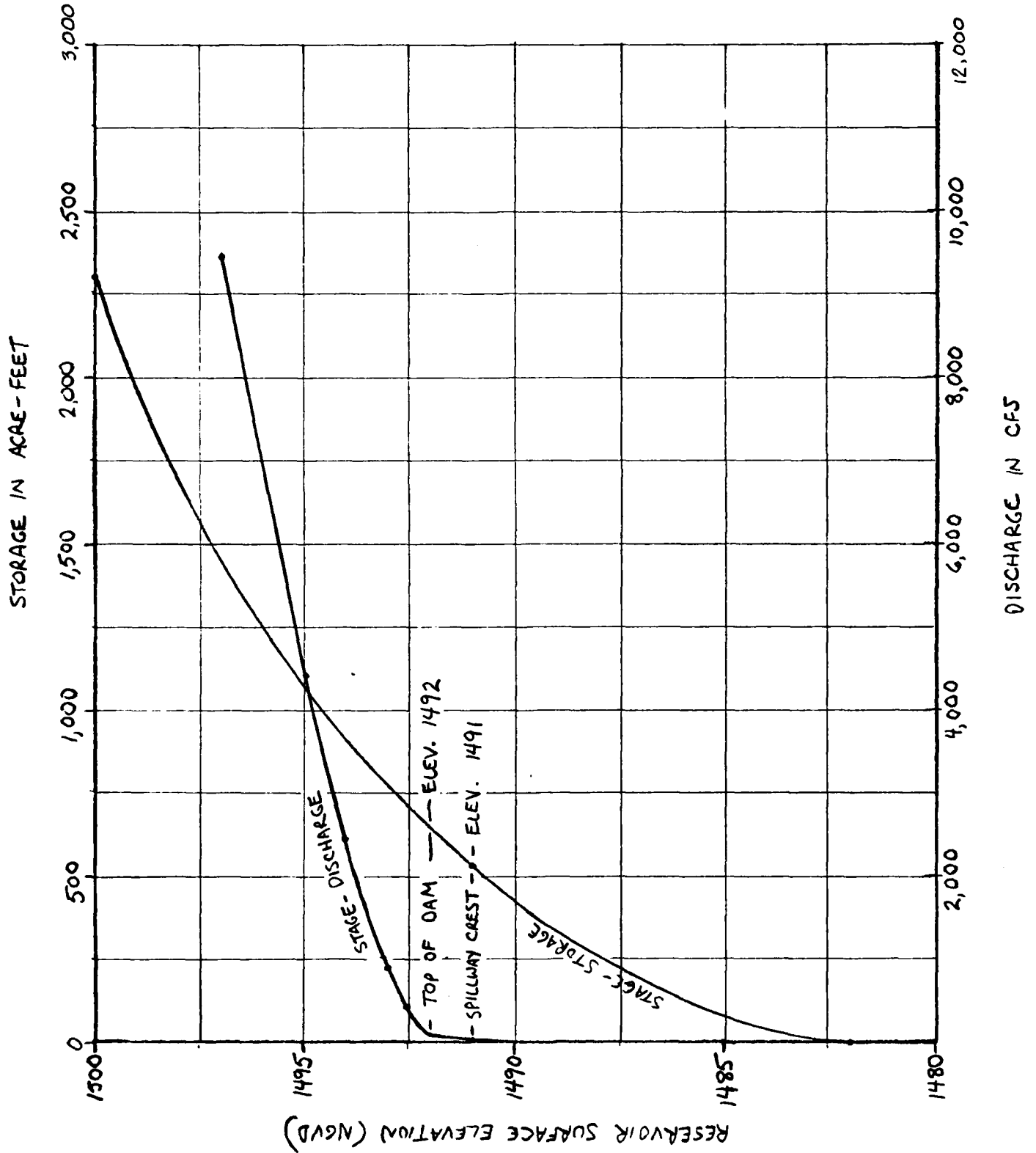
BY

RRB

DATE

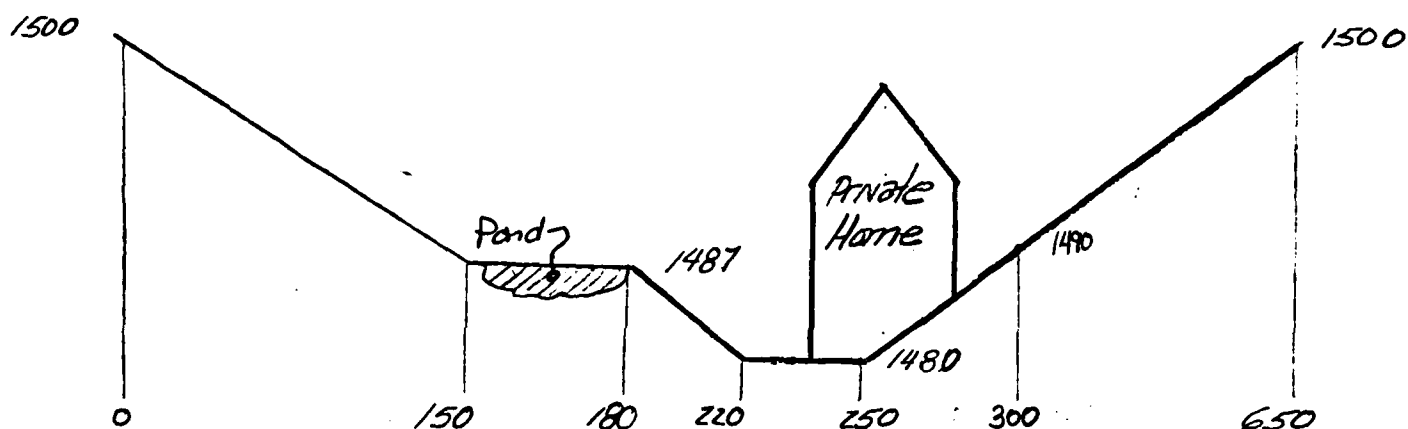
JOB NO

2060-001



SUBJECT	SHEET	BY	DATE	JOB NO
WANGUM LAKE DAM - H&H	D-6	SHS	2/13/80	2060-001

Hazard Area Cross-Section: 150 ft. downstream
 $S = 0.043 \text{ ft./ft.}$



Normal discharge from Wangum Lake is directed into a pond which has apparently been constructed on the south slope of the old stream channel. However, a dam breach or over-topping would direct floodwaters down the old channel in which a private dwelling is currently located.

Manning's Coefficients:

Stream - 0.030

Overbanks - 0.040

RUN DATE 02/26/80.
TIME 09.22.35.

HYDROLOGIC ANALYSIS OF WANGOM LAKE DAM
NATIONAL DAM INSPECTION PROGRAM
NEW ENGLAND DIVISION - CORPS OF ENGINEERS

NO		NHH	NMIN	IDAY	IHR	IMIN	JOB SPECIFICATION	
200	0	15	0	0	0	0	NWT	LROPT
				5			0	0
				JOVER				

MULTI-PLAN ANALYSES TO BE PERFORMED

PERCENTAGES OF									
	$\rightarrow$ RATIOS =		NFCANE = 1 NATIO = 9 LATIO = 1						
	.10	.20	.30	.40	.50	.60	.70	.80	1.00

INFLOW HYDROGRAPH DEVELOPMENT
FOR WANGUM LAKE DAM

SUB-AREA RUNOFF COMPUTATION

U WANGUM LAKE
ISTAG ICUMP
U WANG

HYDROGRAPH DATA

TIME	TUNG	PEREA	SNAP	TRSDA	TRSPC	RATIO	ISNOA	ISAME	LOCAL
TIME	1	1.07	0.00	1.07	0.00	0.000	0	1	0

PRECIP DATA

	PMS	H6	R12	R24	R48	R96
SPFE	0.00					
	20.80	111.00	124.00	133.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

CROPT	STAKK	ULTRA	HTOL	EMAIN	STARS	HTOK	STRIL	CNSIL	ALSWX	HTIMP
U	0.00	0.00	1.00	0.00	0.00	1.00	0.00	.05	0.00	.24

UNIT HYDROGRAPH DATA
IP= 1.00 CP= .50 NTA= 0

RECEIVED

```
STRIG= -1.70  URCSN= -.10  RTIOR= 2.00
```

UNIT MICROGRAPH TO END OF PERIOD ORIGINATES; LMO= 1.00 HOURS; CP= .50 VOL= 1.00

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LUSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
01	00	00	0.0	0.0	0.0	0.0	01	00	00	0.0	0.0	0.0	0.0
01	01	00	0.0	0.0	0.0	0.0	01	01	00	0.0	0.0	0.0	0.0
01	02	00	0.0	0.0	0.0	0.0	01	02	00	0.0	0.0	0.0	0.0
01	03	00	0.0	0.0	0.0	0.0	01	03	00	0.0	0.0	0.0	0.0
01	04	00	0.0	0.0	0.0	0.0	01	04	00	0.0	0.0	0.0	0.0
01	05	00	0.0	0.0	0.0	0.0	01	05	00	0.0	0.0	0.0	0.0
01	06	00	0.0	0.0	0.0	0.0	01	06	00	0.0	0.0	0.0	0.0
01	07	00	0.0	0.0	0.0	0.0	01	07	00	0.0	0.0	0.0	0.0
01	08	00	0.0	0.0	0.0	0.0	01	08	00	0.0	0.0	0.0	0.0
01	09	00	0.0	0.0	0.0	0.0	01	09	00	0.0	0.0	0.0	0.0
01	10	00	0.0	0.0	0.0	0.0	01	10	00	0.0	0.0	0.0	0.0
01	11	00	0.0	0.0	0.0	0.0	01	11	00	0.0	0.0	0.0	0.0
01	12	00	0.0	0.0	0.0	0.0	01	12	00	0.0	0.0	0.0	0.0
01	13	00	0.0	0.0	0.0	0.0	01	13	00	0.0	0.0	0.0	0.0
01	14	00	0.0	0.0	0.0	0.0	01	14	00	0.0	0.0	0.0	0.0
01	15	00	0.0	0.0	0.0	0.0	01	15	00	0.0	0.0	0.0	0.0
01	16	00	0.0	0.0	0.0	0.0	01	16	00	0.0	0.0	0.0	0.0
01	17	00	0.0	0.0	0.0	0.0	01	17	00	0.0	0.0	0.0	0.0
01	18	00	0.0	0.0	0.0	0.0	01	18	00	0.0	0.0	0.0	0.0
01	19	00	0.0	0.0	0.0	0.0	01	19	00	0.0	0.0	0.0	0.0
01	20	00	0.0	0.0	0.0	0.0	01	20	00	0.0	0.0	0.0	0.0
01	21	00	0.0	0.0	0.0	0.0	01	21	00	0.0	0.0	0.0	0.0
01	22	00	0.0	0.0	0.0	0.0	01	22	00	0.0	0.0	0.0	0.0
01	23	00	0.0	0.0	0.0	0.0	01	23	00	0.0	0.0	0.0	0.0
01	24	00	0.0	0.0	0.0	0.0	01	24	00	0.0	0.0	0.0	0.0
01	25	00	0.0	0.0	0.0	0.0	01	25	00	0.0	0.0	0.0	0.0
01	26	00	0.0	0.0	0.0	0.0	01	26	00	0.0	0.0	0.0	0.0
01	27	00	0.0	0.0	0.0	0.0	01	27	00	0.0	0.0	0.0	0.0
01	28	00	0.0	0.0	0.0	0.0	01	28	00	0.0	0.0	0.0	0.0
01	29	00	0.0	0.0	0.0	0.0	01	29	00	0.0	0.0	0.0	0.0
01	30	00	0.0	0.0	0.0	0.0	01	30	00	0.0	0.0	0.0	0.0
01	31	00	0.0	0.0	0.0	0.0	01	31	00	0.0	0.0	0.0	0.0
02	00	00	0.0	0.0	0.0	0.0	02	00	00	0.0	0.0	0.0	0.0
02	01	00	0.0	0.0	0.0	0.0	02	01	00	0.0	0.0	0.0	0.0
02	02	00	0.0	0.0	0.0	0.0	02	02	00	0.0	0.0	0.0	0.0
02	03	00	0.0	0.0	0.0	0.0	02	03	00				

SUM 22.13 21.22 .91 ANALIS.

HYDROGRAPH ROUTING

ROUTED OUTFLOW FROM WANGUM LAKE

ISTAD	ICOMP	TECON	ITYPE	JPLT	JPR1	INAME	ISTAGE	IAUTU
WANG	1	0	0	0	0	1	0	0
ROUTING DATA								
OCROSS	CLROSS	AVG	IRCS	ISAME	TOPT	IPMP	LSTR	
0.0	0.000	0.00	1	1	0	0	0	
NSTPS								
1	0	0	0.000	0.000	0.000	0.000	-1491.	-1

STAGE	1490.00	1491.00	1492.00	1492.50	1493.00	1494.00	1495.00	1497.00
FLOW	0.00	3.00	19.00	432.00	883.00	2447.00	4415.00	9448.00

STAGE-STORAGE DATA
FOR WANGUM LAKE DAM

SURFACE AREA	0.	178.	216.
CAPACITY	0.	534.	2304.
ELEVATION	1482.	1491.	1500.

SPILLWAY CREST ELEVATION → 1491.0

DAM DATA									
TOPEL	COOD	EXPD	DAMWID						
1492.0	0.0	0.0	0.0						

Top of Dam Elevation → 1492.0

PEAK OUTFLOW IS	13. AT TIME 24.50 HOURS
PEAK OUTFLOW IS	107. AT TIME 20.25 HOURS
PEAK OUTFLOW IS	330. AT TIME 19.25 HOURS
PEAK OUTFLOW IS	584. AT TIME 19.00 HOURS
PEAK OUTFLOW IS	846. AT TIME 18.75 HOURS
PEAK OUTFLOW IS	1140. AT TIME 18.50 HOURS
PEAK OUTFLOW IS	1415. AT TIME 18.25 HOURS
PEAK OUTFLOW IS	1681. AT TIME 18.25 HOURS

ROUTED OUTFLOWS FROM
WANGUM LAKE DAM FOR
VARIOUS FLOODS

PEAK OUTFLOW IS 2104. AT TIME 18.00 MINIMS

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

OPERATION	STATION	AREA	PLAN	RATIO	RATIOS APPLIED TO FLOWS								
					1	2	3	4	5	6	7	8	9
					.10	.20	.30	.40	.50	.60	.70	.80	1.00
HYDROGRAPH AT	WANG	1.07	1	315.	629.	944.	1259.	1574.	1888.	2203.	2518.	3147.	3147.
					8.977	17.827	26.747	35.657	44.567	53.477	62.387	71.307	89.717
ROUTED TO	WANG	1.07	1	13.	107.	330.	584.	846.	1140.	1416.	1681.	2195.	2195.
					3.037	9.357	16.547	23.957	32.247	40.097	47.577	62.767	62.767

PEAK INFLOWS

ROUTED OUTFLOWS

PRINTED IN U.S.A.

FLOOD ROUTING RESULTS
FOR WANGUM LAKE DAM

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1										ELEVATION		INITIAL VALUE		SPILLWAY CREST		TOP OF DAM	
										STORAGE		1491.00		1491.00		1492.00	
										OUTFLOW		534.		534.		718.	
												3.				19.	

INPUT

HYDROLOGIC ANALYSIS OF WANGUM LAKE DAM									
NATIONAL DAM INSPECTION PROGRAM									
NEW ENGLAND DIVISION - CORPS OF ENGINEERS									
1	A								
2	A								
3	A								
4	B	200	0	15	0	0	0	0	0
5	B1	5							
6	J	1	1	1					
7	J1	0							
8	K	1							
9	K1								
10	Y								
11	Y1	1							
12	Y4	1490	1491	1492	1492.6	1493	1494	1495	1497
13	Y5	0	3	19	4.2	663	2447	-1492	-1
14	SA	0	178	216				1495	1497
15	SE	1482	1491	1500				4415	9448
16	SS	1491							
17	SD	1492							
18	SR	80	0.01	1485	1.0	1492	1492		
19	K	1							
20	K1								
21	Y								
22	Y1	1							
23	Y6	0.04	0.03	0.04	1480	1500	150	0.043	
24	Y7	0	1500	150	1487	180	1487	220	1480
25	Y7	300	1490	450	1495	630	1300	250	1480
26	K	99							

 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 26 FEB 79

RUN DATE 02/26/80
 TIME 09.23.33.

HYDROLOGIC ANALYSIS OF WANGUAM LAKE DAM
 NATIONAL DAM INSPECTION PROGRAM
 NEW ENGLAND DIVISION - CORPS OF ENGINEERS

NO	NHR	NMIN	IDAY	IHR	IMIN	MEIC	IPLT	IPRT	INSTAN
200	0	15	0	0	0	0	0	0	0
JUPER 5 0 0 0 0									

MULTI-PLAN ANALYSES TO BE PERFORMED

NO INFLOW → RTIOS = 0.00

HYDROGRAPH ROUTING

ROUTED OUTFLOW FROM WANGUAM LAKE

ISTAU	ICOMP	IECON	ITAPE	JPLT	JPRI	INAME	ISTAGE	IAUTO
WANG	0	0	0	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	INES	ISAME	IOPT	IPMP	LSTR
0.0	0.00	0.00	0	0	0	0	0

NSTPS	NSTOL	LAG	AMSKK	K	TSK	STORA	ISPRAT
0	0	0.000	0.000	0.000	0.000	0.000	-1

STAGE	1490.00	1491.00	1492.00	1492.60	1493.00	1494.00	1495.00	1497.00
FLOW	0.00	3.00	19.00	432.00	843.00	2447.00	4415.00	9448.00

STAGE - DISCHARGE DATA
 FOR WANGUAM LAKE DAM

SURFACE BREAK = 0. 178. 216.

CAPACITY = 0. 534. 2304.

ELEVATION = 1492. 1491. 1500.

SPILLWAY CREST ELEVATION → 1491.0

CHSL	SPWTD	CUW	EXPV	ELEV	COUL	CAREA	EXPL
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TOP OF DAM ELEVATION → 1492.0

TOVEL	COUD	EAPD	DAMWID
1492.0	0.0	0.0	0.0

DAM BREACH DATA

BRWID	Z	FLBM	TFAIL	WSEL	FAILEL
80.	.01	1495.00	1.00	1492.00	1492.00

BREACH DIMENSIONS - FAILURE BEGINS
 IMMEDIATELY WITH RESERVOIR SURFACE
 AT TOP OF DAM

BEGIN DAM FAILURE AT 0.00 HOURS

PEAK OUTFLOW IS 3453. AT TIME 1.00 HOURS

ROUTED BREACH OUTFLOW

PRINTED IN U.S.A.

BREACH OUTFLOW ROUTED DOWNSTREAM TO HAZARD CENTER

CHANNEL ROUTING TO HAZARD AREA

HYDROGRAPH ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLI	JPRT	INAME	ISTAGE	IAUTO
HAZARD	1	0	0	0	0	1	0	0
QLOSS	CLOSS	AVG	IPMP	IPMP	IPMP	IPMP	LSTR	
0.0	0.000	0.00	1	0	0	0	0	
NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT	
1	0	0	0.000	0.000	0.000	-1.	0	

NORMAL DEPTH CHANNEL ROUTING

QNI(1)	QNI(2)	QNI(3)	ELNVT	ELMAX	PLNTH	SEL
.0400	.0300	.0400	1480.0	1500.0	150.	.04300

DOWNSTREAM CHANNEL CHARACTERISTICS AT DAMAGE CENTER

CROSS SECTION COORDINATES--STATELEV--ELEV--ETC	220.00	1480.00	250.00	1480.00
0.00 1500.00	150.00	1487.00	150.00	1487.00
300.00 1490.00	450.00	1495.00	650.00	1500.00

STORAGE	0.00	3.63	4.46	5.45	6.59	7.89	9.37	1.05	1.39	1.80	2.35
OUTFLOW	0.00	361.37	4623.69	1245.32	2658.66	4651.49	7279.81	107475.09	128549.86	14886.53	20626.34
STAGE	1480.00	1491.05	1491.58	1492.63	1493.68	1494.74	1495.79	1496.84	1497.89	1498.94	1499.99
FLOW	0.00	361.37	4623.69	1245.32	2658.66	4651.49	7279.81	107475.09	128549.86	14886.53	20626.34
MAXIMUM STAGE IS	1483.8	1491.05	1491.58	1492.63	1493.68	1494.74	1495.79	1496.84	1497.89	1498.94	1499.99

MAXIMUM STREAM ELEVATION AT DAMAGE AREA

.....

.....

.....

.....

.....

.....

STAGE-STORAGE AND
STAGE-DISCHARGE DATA
FOR DOWNSTREAM
CHANNEL

BREACH OUTFLOW RESULTS FOR NANGUM LAKE DAM

PLAN 1

SUMMARY OF DAM SAFETY ANALYSIS

INITIAL VALUE
1492.00
71%
19.

SPILLWAY CREST
1491.00
53%
3.

TOP OF DAM
1492.00
71%
19.

ELEVATION
STORAGE
OUTFLOW

RATIO OF
PPH
0.00

MAXIMUM
RESERVOIR
W.S.ELEV
1492.00

MAXIMUM
DEPTH
OVER DAM
0.00

MAXIMUM
STORAGE
AC-FT
714.

MAXIMUM
OUTFLOW
CFS
3853.

DURATION
OVER TOP
HOURS
0.00

TIME OF
MAX OUTFLOW
HOURS
1.00

TIME OF
FAILURE
HOURS
0.00

PLAN 1 STATION HAZARD

RATIO
0.00

MAXIMUM
FLOW-CFS
3838.

MAXIMUM
STAGE-FT
1483.8

TIME
HOURS
1.00

→ FLOW AT HAZARD AREA

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

NOT AVAILABLE AT THIS TIME

END

FILMED

10-84

DTIC