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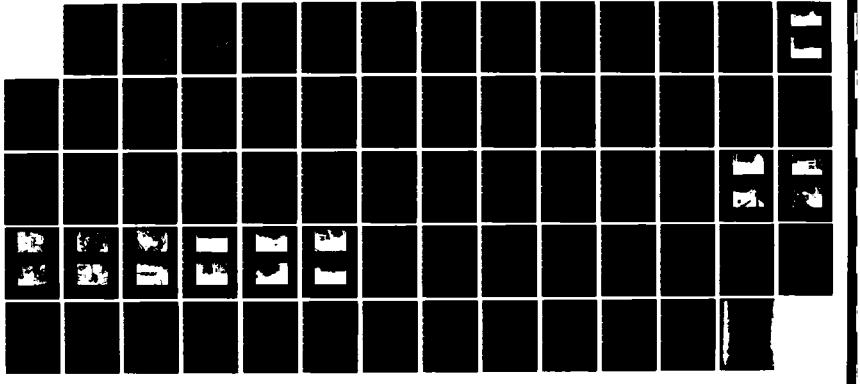

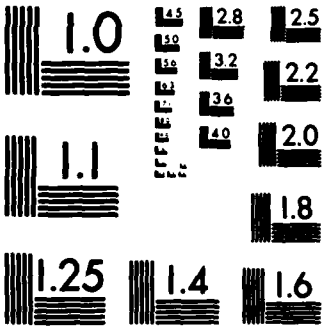

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NAUGATUCK RIVER BASIN
WATERTOWN, CONNECTICUT

LAKE WINNEMAUG DAM
CT 00123

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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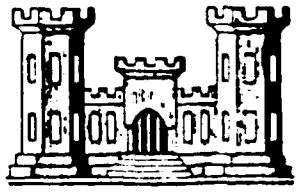

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: CT 00123	2. GOVT ACCESSION NO: AD-A143047
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): Naugatuck River Basin Watertown, Conn., Lake Winnemaug Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS	5. TYPE OF REPORT & PERIOD COVERED: INSPECTION REPORT
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

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

DAMS, INSPECTION, DAM SAFETY,
Naugatuck River Basin
Watertown, Conn.
Lake Winnemaug Dam

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

Lake Winnemaug Dam is an earth embankment approx. 500 ft. long with a maximum height of about 15 ft. The upstream slope of the embankment is approx. 1H:1V and the downstream slope is about 1.5H:1V. The top of the dam is about 20 ft. wide and is a paved road. The overflow drop spillway is located about 100 ft. from the right abutment and consists of an 18.5 ft. long concrete weir, a cascading step section and a 4 ft. high by 10 ft. wide culvert through the embankment. The original purpose of the dam is unknown; however, the lake is currently used for recreation purposes.

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

REPLY TO
ATTENTION OF
NEDED

MAY 13 1980

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

Dear Governor Grasso:

Inclosed is a copy of the Lake Winnemaug 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. Tnis 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, Mr. William Owen, Town Engineer, Town Hall, 37 DeForest Street, Watertown, Connecticut.

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 trom 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
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

LAKE WINNEMAUG DAM

CT 00123

NAUGATUCK RIVER BASIN
WATERTOWN, CONNECTICUT

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PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

Identification No.:	CT 00123
Name of Dam:	Lake Winnemaug Dam
Town:	Watertown
County and State:	Litchfield, Connecticut
Stream:	Wattles Brook
Date of Inspection:	November 20, 1979

BRIEF ASSESSMENT

Lake Winnemaug Dam is an earth embankment approximately 500 feet long with a maximum height of about 15 feet. The upstream slope of the embankment is approximately 1H:1V and the downstream slope is about 1.5H:1V. The top of the dam is about 20 feet wide and it is a paved road. The overflow drop spillway is located about 100 feet from the right abutment and consists of an 18.5-foot long concrete weir, a cascading step section and a 4-foot high by 10-foot wide culvert through the embankment. The original purpose of the dam is unknown; however, the lake is currently used for recreation purposes.

Lake Winnemaug Dam has a drainage area of approximately 1.1 square miles. The maximum storage capacity of 1,050 acre-feet places the dam in the "Intermediate" size category. A breach of the dam would cause excessive property damage and possible loss of more than a few lives at the initial downstream damage center. Therefore, the dam is classified in the "High" hazard potential category. The recommended test flood for a "Intermediate" size, "High" hazard dam is the full Probable Maximum Flood (PMF).

The peak test flood inflow for Lake Winnemaug Dam is 3,460 cfs. The routed test flood outflow of 2,010 cfs overtops the dam by about 0.8 feet. The spillway is capable of discharging 770 cfs or aboút 38 percent of the routed test flood outflow prior to overtopping of the dam. A breach of the dam would result in a 7.8-foot increase in the stream depth (3.8 feet above the channel banks) at the initial downstream damage area.

The dam appears to be in poor condition. Numerous structural deficiencies, such as slope failures, seepage, and toe erosion were observed during the visual inspection. The embankment is overgrown with brush and trees and contains a number of rodent holes. The reservoir can not be drained in an emergency since the outlet pipe control valve is inoperable.

Within one year (except as noted below) after receipt of this Phase I Inspection Report, the Owner, The Town of Watertown, should retain the services of a qualified registered professional engineer for the following: (1) the spillway outlet channel should be realigned downstream, the existing portion of channel along the downstream toe should be filled and the toe of the dam should be reconstructed where necessary within 6 months of receipt of this Phase I Inspection Report; (2) slope stability analyses should be performed to evaluate various means of stabilizing the embankment within 6 months of receipt of this Phase I Inspection Report; (3) investigation of the source and extent of the seepage along the downstream toe of the dam within 6 months of receipt of this Phase I Inspection Report. (4) An upstream control system for the reservoir outlet pipe should be designed and installed.

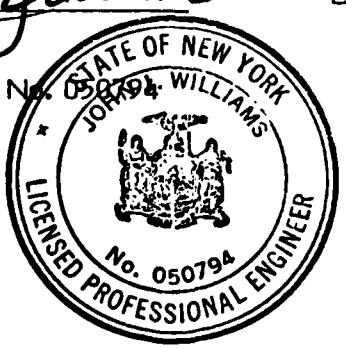
The Owner should also implement the following operation and maintenance procedures: (1) trees and bushes should be removed from both the upstream and downstream faces of the embankment and any remaining voids should be backfilled with suitable, thoroughly compacted materials; (2) the reservoir drain control valve should be repaired and operated periodically; (3) debris should be cleaned out of the spillway discharge culvert; (4) replace riprap where necessary on the upstream face of the dam; (5) rodent holes should be filled with suitable, thoroughly compacted material; (6) a program of annual periodic technical inspection should be instituted and, in conjunction, a regular maintenance program should be established; (7) a formal surveillance and flood warning plan, including round-the-clock monitoring during heavy precipitation, should be developed.

O'BRIEN & GERE ENGINEERS, INC.

John J. Williams

Date: 14 April 80

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



This Phase I Inspection Report on Lake Winnemaug 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 DIBUONO, MEMBER
Water Control Branch
Engineering Division

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, CHAIRMAN
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

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 theses 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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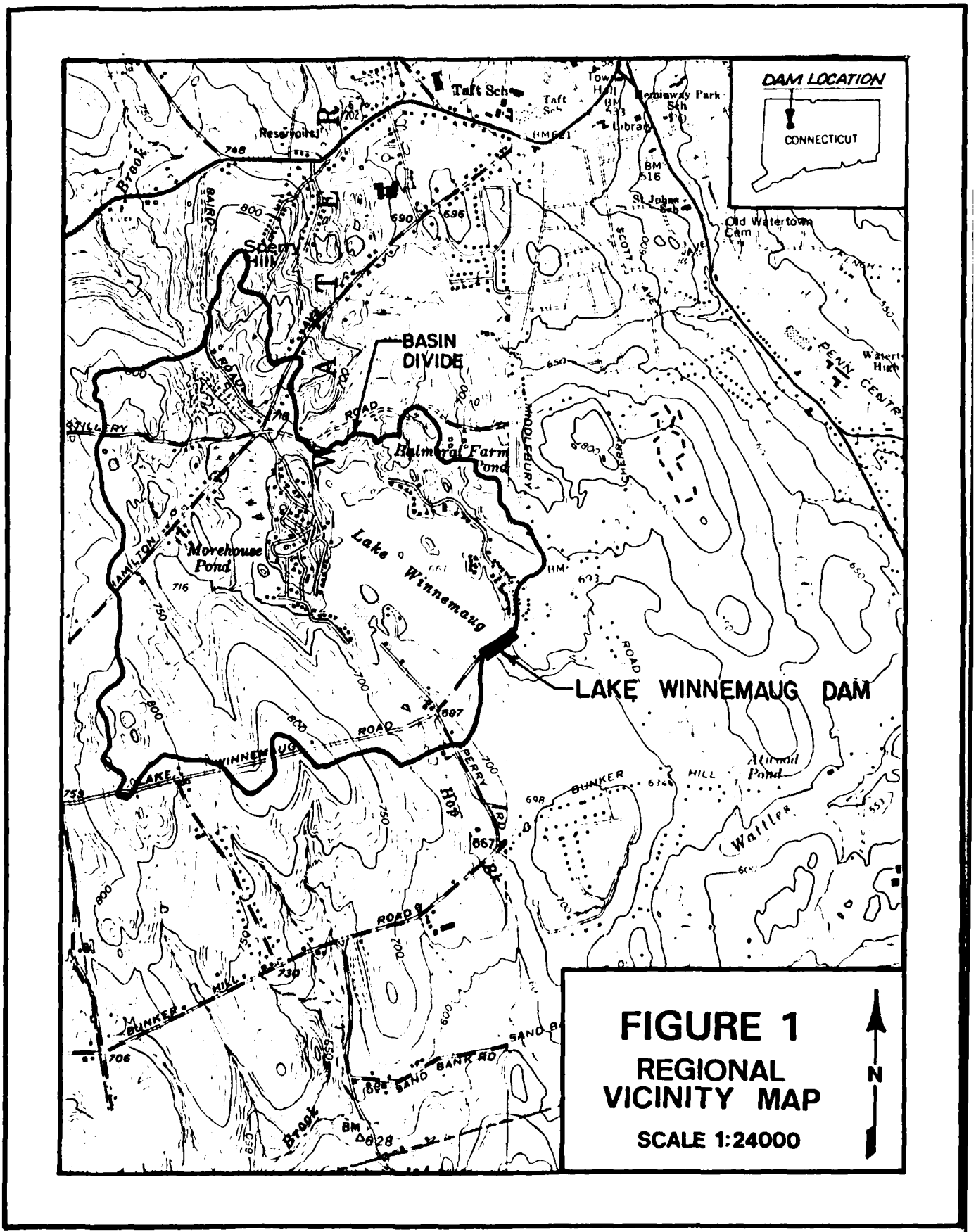
UPSTREAM OVERVIEW OF THE DAM AS VIEWED FROM THE RIGHT ABUTMENT. (11/20/79)

DOWNSTREAM OVERVIEW OF THE DAM AS VIEWED FROM THE RIGHT ABUTMENT. (11/20/79)


DAM LOCATION
CONNECTICUT
BASIN DIVIDE
LAKE WINNEMAUG DAM
Lake Winnemaug
Morehouse Pond
Balmoral Farm Pond
Admiral Pond
Taft Sch
Speary Hill
Reservoir
Old Watertown Cem
St Johns
Library
Town Hall
Remsenburg Park Sch
Waller
Bunker Hill
Sand Bank Rd
Hop Brook
Baird Brook
Hamilton Ave
Perry Rd
Bunker Hill Rd
Middlebury
Scott Ave
Penn Central
Road
FIGURE 1
REGIONAL VICINITY MAP
SCALE 1:24000
N

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
LAKE WINNEMAUG DAM

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. The National Dam Inspection Act (Public Law 92-367), of 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 to 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 the Town of Watertown, Connecticut)

a. Location. Lake Winnemaug Dam is located on Wattles Brook in the town of Watertown, Connecticut. Portions of the USGS Quadrangle maps entitled "Woodbury, Connecticut" and "Waterbury, Connecticut" have been included as Figure 1 on page vi of this report to illustrate the location. USGS reference coordinates for this dam are N 41° 34.9' and W 73° 7.6'

Wattles Brook outlets into Pin Shop Pond approximately 3.2 miles downstream of Lake Winnemaug Dam. Steele Brook flows from Pin Shop Pond to the Naugatuck River, a distance of about 2.3 miles. The first major hazard area consists of three homes located near Wattles Brook approximately 0.5 miles downstream of the dam (see Page C-6). Several other potential damage areas, including Swift Jr. High School, are located between 1.0 and 3.2 miles downstream of Lake Winnemaug Dam (see Pages C-7 and C-8).

b. Description of Dam and Appurtenances. Lake Winnemaug Dam is an earth embankment approximately 500 feet long with a maximum height of about 15 feet. The upstream slope of the embankment is approximately 1H:1V and is protected by small cobble riprap. The downstream slope is 1.5H:1V. A paved highway traverses the crest of the dam, which is about 20 feet wide.

The spillway consists of a 12-inch thick concrete weir, a cascading step section, and a 10-foot wide by 4-foot high culvert through the base of the embankment. The crest length of the spillway, which is located approximately 100 feet left of the right abutment of the dam, is 18.5 feet. The concrete sidewalls of the spillway are sloped from the weir to the top of the dam approximately in line with the upstream face of the dam.

A 20-inch diameter cast iron pipe is provided for emergency drawdown of the reservoir. Flow through the pipe is controlled by a 20-inch diameter valve which is operated by a hand wheel located at the downstream toe of the dam.

c. Size Classification. Lake Winnemaug Dam has a maximum embankment height of 15 feet, which places it in the "Small" size category for height since it is less that 40 feet high. However, the maximum pool storage capacity of 1,050 acre-feet places the dam in the "Intermediate" size category for storage since it is greater than 1,000 acre-feet and less than 50,000 acre-feet of storage. Therefore, Lake Winnemaug Dam is classified as "Intermediate" in size for the purposes of this inspection program.

d. Hazard Classification. Several potential damage areas are located downstream of Lake Winnemaug Dam. A hydraulic breach analysis indicates that a failure of the dam (with the reservoir surface at the crest of the dam) would result in a stream depth of 7.8 feet (3.8 feet above the channel banks) at the nearest potential damage area, located about 0.5 miles downstream of the dam along Middlebury Road. Due to the proximity of 3 houses to the stream at this location, a flood of this magnitude could result in at least 2 feet of water in their first floors. Excessive property damage and the possible loss of more than a few lives could occur. Therefore, the dam is classified as a "High" hazard potential structure.

Photos of the downstream hazard area are included in Appendix C.

e. Ownership. Lake Winnemaug Dam is owned by the Town of Watertown, with offices in Town Hall, 37 DeForest St., Watertown, Connecticut, 06795, Telephone 203-274-5411.

f Operator. Operations would be performed under the direction of Mr. William Owen, the Town Engineer.

g. Purpose of Dam. According to Mr. Owen, the Owner's Representative, Lake Winnemaug is used solely for recreational purposes.

h. Design and Construction History. According to the Owner's Representative, the design and construction history of the dam is unknown.

i Normal Operating Procedures. According to the Owner's Representative, no operating procedures are in effect at this site.

1.3 Pertinent Data

a. Drainage Area. The area draining to Lake Winnemaug encompasses approximately 1.1 square miles to the northwest of the reservoir. The watershed is relatively hilly with some residential development. Morehouse Pond, an 11 acre impoundment, is located upstream of Lake Winnemaug within the watershed. The reservoir surfaces make up approximately 18 percent of the drainage area.

b. Discharge at Damsite

1. Outlet Works. The discharge capacity of the drain pipe is estimated at 12 cfs fromthe SCS Hydraulics Handbood 5, Dwg. No. ES-54.

2. Maximum Known Flood. According to the Owner's Representative, no recorded flood data is available for this site.

3. Ungated Spillway Capacity at Top of Dam. The ungated spillway capacity at top of dam Elev. 666 is 774 cfs.

4. Ungated Spillway Capacity at Test Flood Elevation. The ungated spillway capacity at test flood Elev. 666.8 is 1010 cfs.

5. Gated Spillway Capacity at Normal Pool Elevation. Not Applicable.

6. Gated Spillway Capacity at Test Flood Elevation. Not Applicable.

7. Total Spillway Capacity at Test Flood Elevation. The total spillway capacity at test flood Elev. 666.8 is 1010 cfs.

8. Total Project Discharge at Top of Dam. The ungated spillway capacity at top of dam Elev. 666 is 774 cfs.

9. Total Project Discharge at Test Flood Elevation. The total project discharge at test flood Elev. 666.8 is 2012 cfs.

c. Elevation. (NGVD)

1.	Streambed at Toe of Dam	651±
2.	Bottom of Cutoff	Unknown
3.	Maximum Tailwater	Unknown
4.	Recreation Pool	661.0
5.	Full Flood Control Pool	N/A
6.	Spillway Crest (Ungated)	661.0
7.	Design Surcharge (Original Design)	Unknown
8.	Top of Dam	666.0
9.	Test Flood Surcharge	666.8

d. Reservoir Length. (Feet)

1.	Normal Pool	3,800
2.	Flood Control Pool	N/A
3.	Spillway Crest Pool	3,800
4.	Top of Dam	3,900
5.	Test Flood Pool	3,920

e. Storage. (Acre-Feet)

1.	Normal Pool	407
2.	Flood Control Pool	N/A
3.	Spillway Crest Pool	407
4.	Top of Dam	1,050
5.	Test Flood Pool	1,155

f. Reservoir Surface. (Acres)

1.	Normal Pool	122
2.	Flood Control Pool	N/A
3.	Spillway Crest Pool	122
4.	Top of Dam	135
5.	Test Flood Pool	137

g. Dam.

1.	Type	Earth Embankment
2.	Length	500 feet
3.	Height	15 feet
4.	Top Width	20 feet
5.	Side Slopes	1H:1V (upstream) 1.5H:1V (downstream)
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	Concrete overflow drop spillway
2.	Length of Weir	18.5 feet
3.	Crest Elevation	661
4.	Gates	None
5.	Upstream Channel	None
6.	Downstream Channel	A cascading step section leads down to a 4-foot high by 10-foot wide culvert through the toe of the embankment. From the outlet of the culvert to Wattles Brook the discharge follows a route along the toe of the dam.

j. Regulating Outlets.

1.	Invert	651±
2.	Size	20-inch diameter
3.	Description	Cast Iron Pipe
4.	Control Mechanism	Hand wheel at downstream toe

SECTION 2

ENGINEERING DATA

2.1 Design

According to Mr. William Owen, the Town Engineer and the Owner's Representative, no design information is available for Lake Winnemaug Dam.

2.2 Construction

According to the Owner's Representative, no information concerning the construction of Lake Winnemaug Dam is available.

2.3 Operation

According to the Owner's Representative, the town has established no operating procedures for Lake Winnemaug Dam. The 20-inch outlet pipe provides for energency drawdown of the reservoir. However, Mr. Owen stated that the control valve for the outlet pipe is inoperable.

2.4 Evaluation

a. Availability. No engineering data on Lake Winnemaug Dam is available from the Owner, the Town of Watertown.

b. Adequacy. Sufficient information was obtained during the field investigation to conduct a Phase I dam evaluation.

c. Validity. No information is available to compare with the field investigation findings.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. Lake Winnemaug Dam was inspected on November 20, 1979. At the time of the inspection, the reservoir surface was less than one inch above the spillway crest. Underwater areas were not 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 appeared to be in poor condition of the date of the inspection. The embankment slopes are steep (approximately 1H:1V upstream and 1.5H:1V downstream) and toe failures have occurred in several locations along the downstream slope (see photograph on Page C-4). During the inspection, a zone of seepage (5 gpm) was observed at the downstream toe within 10 feet of the outlet pipe (located near the longitudinal center of the dam). The water in this area is rust-colored, up to 6 inches deep and with ifne soil particles presumed to be from the embankment settled on the bottom of the seepage pool (see photograph on Page C-4). No soil boils were observed during the inspection. The unlined spillway outlet channel is aligned parallel to the downstream toe of the embankment for a distance of about 200 feet (see Page C-2). The channel appears to have been constructed at the downstream toe of the dam and the toe has been eroded and undermined along a 100-foot length of the channel. In addition, the embankment is overgrown with brush and some small trees. Rodent holes were also observed in the downstream face of the dam.

c. Appurtenant Structures. On the date of the inspection, the spillway and the 4-foot wide by 10-foot high culvert which is located under the dam embankment appeared to be in good condition and capable of functioning as designed. Debris consisting of rocks and logs was observed in the culvert.

According to the Owner's Representative, the control valve for the reservoir drawdown pipe is inoperable. The control valve is located on the downstream side of the embankment which causes the outlet pipe to be in the pressure flow condition. This could account for a portion of the seepage observed at the downstream toe of the dam.

d. Reservoir Area. Approximately 50 homes are located along the shores of Lake Winnemaug. The ground elevation immediately upstream of the left abutment appears to be below the top of dam elevation. A tavern located in the vicinity would be subject to flooding in the event of a rise in reservoir elevation (see photograph on Page C-5). The slope of the terrain along the perimeter of the reservoir varies from nearly level to slopes as steep as 30 percent. There is no evidence of excessive siltation in the reservoir.

e. Downstream Channel. The spillway outlet channel extends along the downstream toe of the dam for a distance of about 200 feet as described in Section 3.1b. The channel is constricted by boulders and trees in several locations along this reach. Near the longitudinal center of the dam, in the flood of the valley, the discharge channel changes direction and directs flows essentially perpendicular to the axis of the dam through a marshy meadow for about 600 feet downstream of the dam. From the region to the initial flood impact area, about 0.5 miles downstream of the dam, Wattles Brook flows through underveloped fields on an estimated one percent slope. The channel averages about 10 feet wide with 4H:1V side slopes.

3.2 Evaluation

Based upon the visual inspection on November 20, 1979, Lake Winnemaug Dam is considered to be in poor condition. The steep embankment slopes do not appear to have adequate stability and the rust-colored seepage with fine soil particles in evidence may be indicative of the removal of fine earth material from the embankment. Continued erosion of the downstream toe by the spillway discharge could result in more severe failures of the downstream slope. The rodent holes and the roots of the trees and bushes create potential seepage paths through the embankment. The thick vegetative cover hinders detection of differential settlement problems on the embankment. The inoperable control valve in the reservoir drain pipe prohibits drawdown of the reservoir in the event of an emergency condition, thereby creating a potentially hazardous situation. Since the control valve is located on the downstream side of the embankment, the outlet pipe is in the pressure flow condition. This could account for a portion of the sepage observed at the downstream toe of the dam.

SECTION 4

OPERATION AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General. According to Mr. William Owen, Town of Watertown Engineer and the Owner's Representative, no operational procedures are followed on a routine basis. Mr. Owen also stated that the reservoir drain control valve is inoperable.

b. Description of Any Warning System in Effect. According to the Owner's Representative, there is no warning system currently in effect which would alert downstream residents of an impending dam failure.

4.2 Maintenance Procedures

a. General. According to the Owner's Representative, no maintenance procedures are performed on a routine basis.

b. Operating Facilities. The only existing operating facility at this site is the reservoir drain control valve. According to the Owner's Representative, this control valve is not operable.

4.3 Evaluation

According to the Owner's Representative no operational or maintenance procedures are in effect for Lake Winnemaug Dam. A regular inspection and maintenance program should be established and the reservoir drain control valve should be made operational.

SECTION 5

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General

The drainage area for Lake Winnemaug Dam is 1.14 square miles. The watershed is relatively hilly with a fair amount of residential development. Morehouse Pond, an 11 acre impoundment, is located approximately 2000 feet upstream of Lake Winnemaug. Both reservoir surfaces make up about 18 percent of the drainage area. The topography ranges from Elev. 870 in the upper reaches to Elev. 661, which is the normal pool elevation at the damsite.

5.2 Design Data

No hydrologic or hydraulic design information is available for Lake Winnemaug Dam.

5.3 Experience Data

No rainfall or reservoir level records are maintained at this site. The Owner's Representative stated that the dam has not been overtopped in the 5 years that Watertown has owned the dam.

5.4 Test Flood Analysis

The recommended test flood for an "Intermediate" size, "High" hazard dam is the full Probable Maximum Flood (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 hydrographs 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 Lake Winnemaug 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 the spillway crest elevation at the beginning of the storm event.

The peak inflow and outflow rates for the test flood at Lake Winnemaug Dam were computed to be 3,460 cfs and 2,010 cfs, respectively. The peak outflow corresponds to a reservoir stage of 5.8 feet above the spillway crest, or 0.8 feet above the top of dam elevation. The spillway is capable of discharging 770 cfs or about 38 percent of the routed test flood outflow prior to overtopping of the dam.

The routed outflow for one half of the PMF is 470 cfs, which would peak at a level 1.3 feet below the crest of the dam.

It is also noted that a flood equivalent to 73 percent of the PMF could be routed through the dam without overtopping the dam.

5.5 Dam Failure Analysis

A failure of the embankment was simulated by the HEC-1-DB computer program assuming a 100 feet wide by 12 feet deep breach with vertical side slopes developing within one hour. Failures are assumed to occur with the reservoir surface at the top of the dam and at the spillway crest. The resulting outflows of 8,290 cfs and 4,240 cfs with the reservoir surface at the top of the dam and at the spillway crest, respectively, were routed to the initial damage center, which was assumed to be 3 houses about 0.5 miles downstream of the dam along Middlebury Road. Discharges at the damage center prior to breaching of the dam were 770 cfs (3.9 foot depth of flow) and 20 cfs (0.5 foot depth of flow) for the two conditions, respectively. The channel cross-section used in the breach analysis for the hazard area was obtained from the USGS Quadrangle Map entitled Waterbury, Conn." and is shown on page D-5. The stream depth at this point with breaching was computed to be 7.0 feet (4.0 feet above the channel banks) with the reservoir surface at the top of the dam and 5.9 feet or (2.9 feet above the channel banks) with the reservoir surface at the spillway crest. For failure with the reservoir surface at the top of the dam, at least 2 feet of water could be in the first floor of the homes in the damage center. Excessive property damage and the possible loss of more than a few lives could be expected.

SECTION 6

EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

Several conditions of potential structural instability were observed during the visual inspection. The downstream slope has failed in a number of locations in the vicinity of the toe. The condition of the upstream slope could not be inspected below the reservoir level; however, above the water surface some of the riprap slope protection has been displaced. In addition, a section of the downstream toe has been eroded and undermined due to the alignment of the spillway outlet channel. During the inspection, seepage was observed in the vicinity of the outlet pipe at the downstream toe. This seepage showed evidence of migration of fine material through the embankment and/or foundation. Trees and bushes from the embankment also pose a potential hazard to the structural integrity of the dam. The roots of these trees and bushes could create seepage paths through the embankment and portions of the embankment could be damaged if the trees were uprooted during high winds.

6.2 Design and Construction Data

According to Mr. William Owen, The Owner's Representative, no design or construction information is available for Lake Winnemaug Dam.

6.3 Post Construction Changes

According to the Owner's Representative, no records of any modifications to the original structure are available.

6.4 Seismic Stability

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

SECTION 7

ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. Based upon the visual inspection of the site on November 20, 1979, the dam appears to be in poor condition. Numerous structural deficiencies are described in Section 3.1 and in Section 6.1. Recommendations and remedial measures are discussed in Section 7.2 and 7.3.

The spillway and culvert appear to be in good condition and capable of functioning as designed.

b. Adequacy of Information. No design information or records are available from the Owner for Lake Winnemaug Dam. However, the information obtained during the field investigation is considered adequate for a Phase I evaluation.

c. Urgency. The recommendations and remedial measures described in this Section should be implemented within one year of receipt of this Phase I Inspection Report, except as noted below.

7.2 Recommendations

The Owner, the Town of Watertown, should retain the services of a qualified, registered professional engineer experienced in the design and construction of dams for the following:

1. Within 6 months of receipt of this Phase I Inspection Report the spillway outlet channel should be realigned to direct discharge downstream and not along the toe of the dam. The existing portion of the outlet channel along the downstream toe should be backfilled and the toe should be reconstructed in locations where it has been undermined or eroded.

2. Slope stability analyses should be performed in order to evaluate various means of stabilizing the embankment within 6 months of receipt of this Phase I Inspection Report.

3. The source and extent of the seepage should be investigated within 6 months of receipt of this Phase I Inspection Report.

4. An upstream control system for the reservoir outlet pipe should be designed and installed.

7.3 Remedial Measures

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

1. Trees and bushes should be removed from both the upstream and downstream faces of the embankment. Resulting voids should be backfilled with suitable thoroughly compacted material.

2. The control valve for the reservoir drain pipe should be repaired. The operability of this valve should be checked on an annual basis.

3. Debris should be cleaned out of the spillway discharge culvert.

4. Replace riprap where necessary on the upstream face of the dam.

5. Rodent holes should be filled with suitable, thoroughly compacted material.

6. A program of annual period technical inspection should be instituted. A regular maintenance program should be established in conjunction with the technical inspection.

7. A formal surveillance and flood warning plan, including round-the-clock monitoring during heavy precipitation, should be developed.

7.4 Alternatives

As an alternative to the above recommendations and remedial measures, the dam could be breached and the lake drained.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST

INSPECTION TEAM ORGANIZATION

Project: Lake Williamaug Dam

National I.D. #: CT 00123

Location: Town of Watertown, Connecticut

Type of Dam: Earth Fill

Inspection Date(s): November 20, 1979

Weather: Clear ≈50°F

Pool Elevation: 661

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. William B. Owen, Town Engineer, Town of Watertown, Connecticut.

VISUAL INSPECTION CHECK LIST

Project: Lake Winnemaug Dam

National I.D. #: CT 00123

Date(s): November 20, 1979

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	666 ±
Current Pool Elevation	661 ±
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed, difficult to tell under heavy vegetation
Pavement Condition	Satisfactory, no potholes or crack
Movement or Settlement of Crest	None observed, difficult to tell under heavy vegetation
Lateral Movement	None observed, difficult to tell under heavy vegetation
Vertical Alignment	No vertical misalignment observe
Horizontal Alignment	No horizontal misalignment observe
Condition at Abutment and at Concrete Structures	Satisfactory, no settlement or erosion observed.
Indications of Movements of Structural Items on Slopes	Utility poles & guard rail posts are not plumb
Trespassing on Slopes	bare paths worn on slopes
Vegetation on Slopes	Several trees (to 12"ϕ), many brush uncut grass upstr. & downstr.
Sloughing or Erosion of Slopes or Abutments	Downstream slope eroded by discharge from spillway
Rock Slope Protection - Riprap Failures	Some riprap displaced on upstream face of dam

VISUAL INSPECTION CHECK LIST

Project: Lake Winnemaug Dam

National I.D. #: CT 00123

Date(s): November 20, 1979

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT (Con't)	
Unusual Movement or Cracking at or near Toes	None observed, difficult to tell under heavy vegetation
Unusual Embankment or Downstream Seepage	Seepage in pools up to 6" deep, iron oxide colored, evidence of fines migration thru the ends.
Piping or Boils	None observed, difficult to see in heavy vegetation
Foundation Drainage Features	None observed
Toe Drains	None observed
Instrumentation System	Not applicable

VISUAL INSPECTION CHECK LIST

Project: Lake Winnemaug Dam

National I.D. #: CT 00123

Date(s): November 20, 1979

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	Not applicable
General Condition	
Loose Rock Overhanging Channel	
Trees Overhanging Channel	
Floor of Approach Channel	
b. Weir and Training Walls	
General Condition of Concrete	Good
Rust or Staining	None observed
Spalling	None observed
Any Visible Reinforcing	None observed
Any Seepage or Efflorescence	None observed
Drain Holes	None observed
c. Discharge Channel	
General Condition	Good from weir through box culvert to downstream toe of the dam. Beyond this pt. discharge is in very poor condition

VISUAL INSPECTION CHECK LIST

Project: Lake Winnemaug Dam

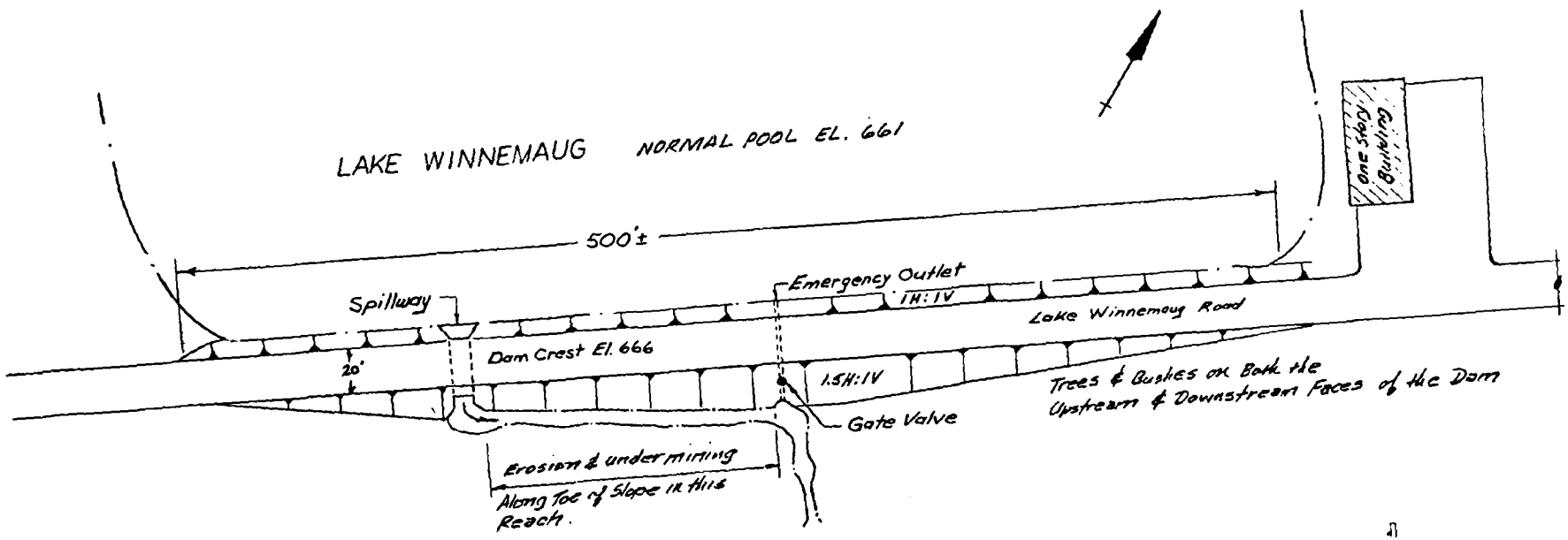
National I.D. #: CT 00123

Date(s): November 20, 1979

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS (Con't)	
Loose Rock Overhanging Channel	Loose in the channel, but not overhanging channel.
Trees Overhanging Channel	Trees and brush overhanging channel from outlet of box culvert to floor of valley
Floor of Channel	Smooth concrete to outlet of box culvert then stones and branches obstruct channel until floor of valley is reached.

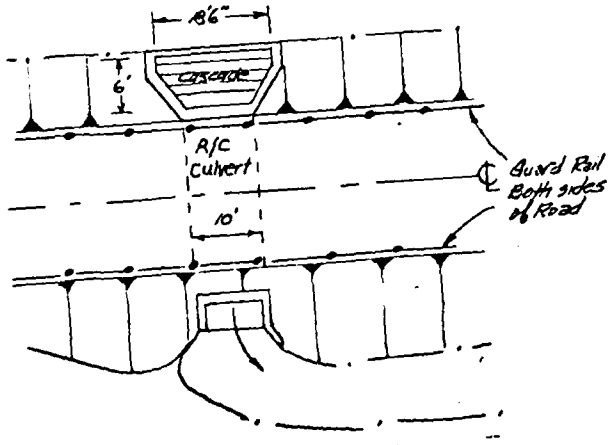
APPENDIX B

ENGINEERING DATA

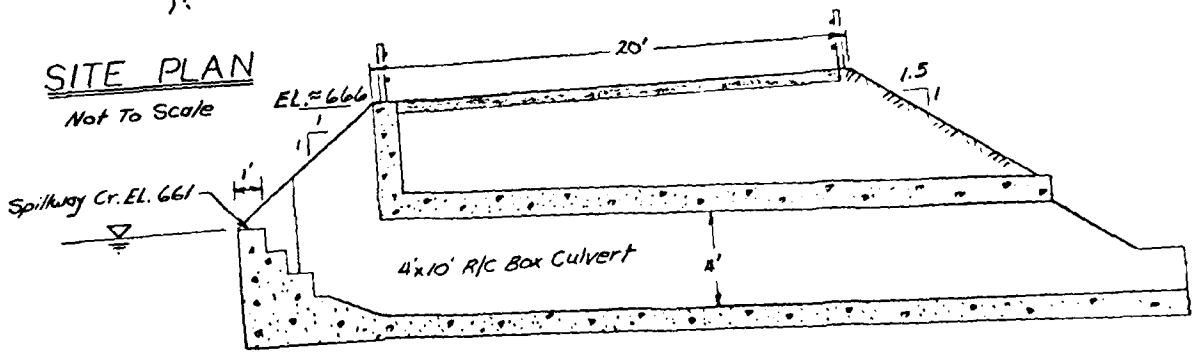


SITE PLAN

Not To Scale



SPILLWAY DETAIL



SPILLWAY SECTION

Not To Scale

LAKE WINNEMAUG DAM
CT 00123

APPENDIX C

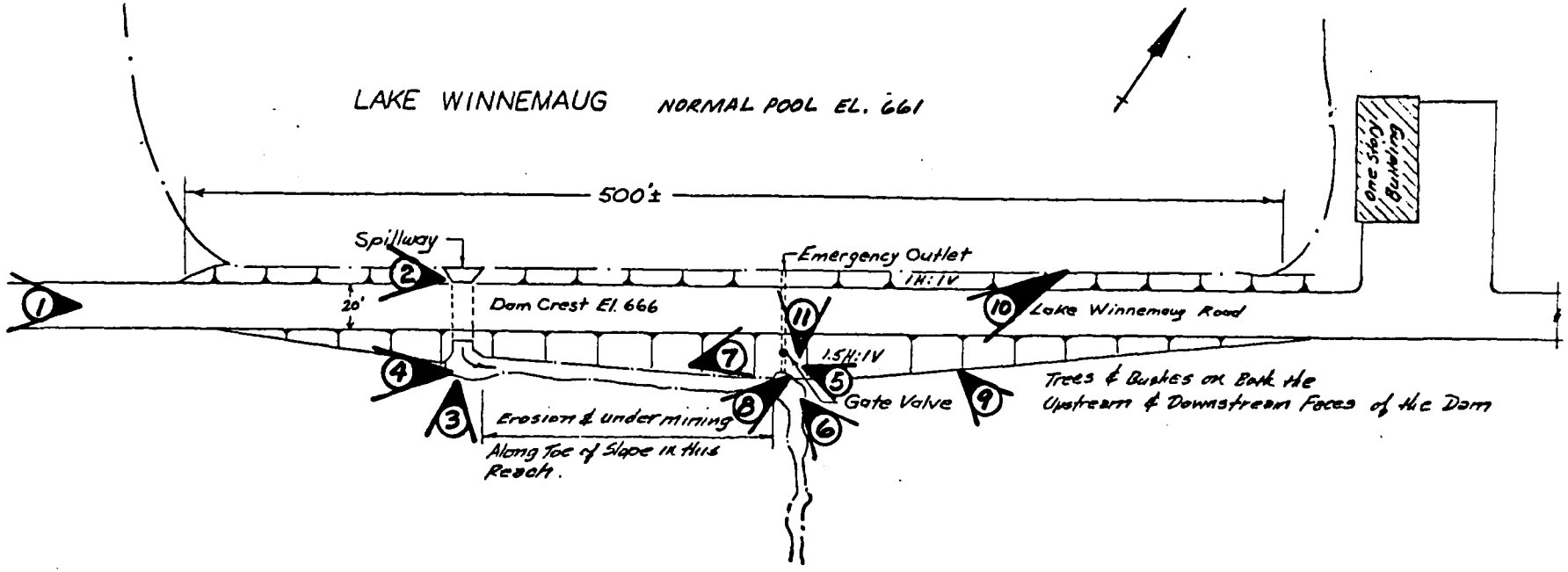
PHOTOGRAPHS

APPENDIX C
SELECTED PHOTOGRAPHS OF PROJECT

LOCATION PLAN	Page No.
Site Plan Sketch	A

PHOTOGRAPHS

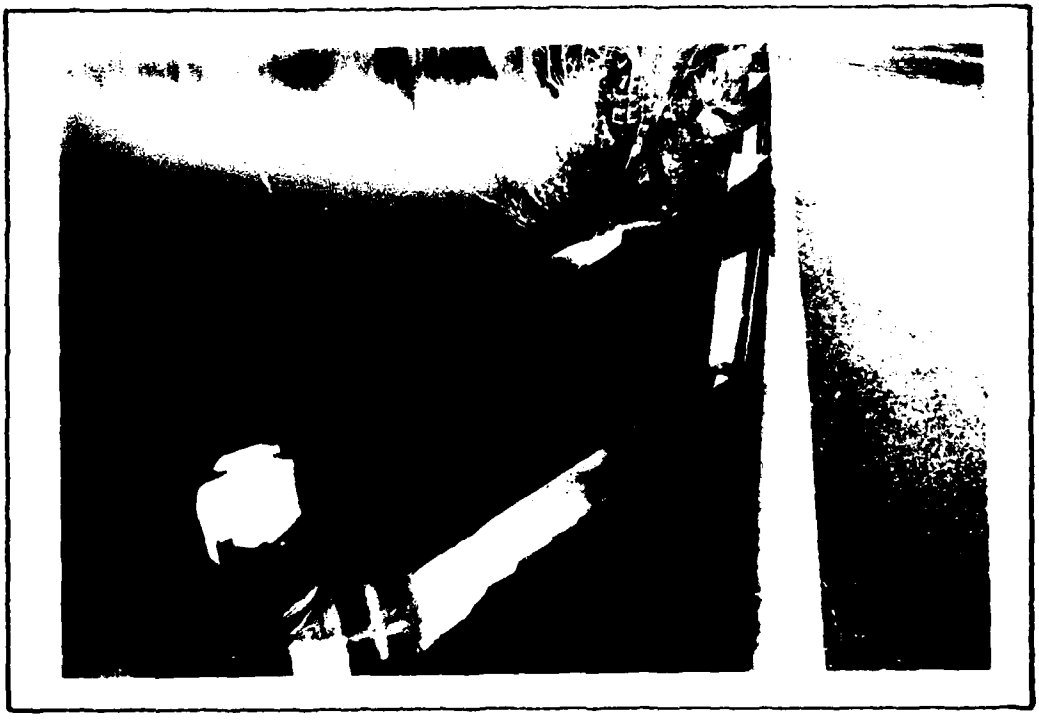
No.		Page No.
1.	View along the top of the dam as observed from the right abutment.	1
2.	Spillway weir and training walls.	1
3.	Looking upstream through the road culvert towards the spillway weir.	2
4.	Spillway outlet channel immediately downstream of the dam.	2
5.	Control wheel for the reservoir drain valve.	3
6.	Reservoir drain conduit outlet.	3
7.	Sloughing of the downstream face of the dam.	4
8.	Typical seepage at the downstream toe of the dam.	4
9.	Typical rodent hole in the downstream face of the dam.	5
10.	Building near the left abutment of the dam with the threshold of the door less than one foot above normal pool.	5
11.	Downstream conditions as viewed from the top of the dam.	6
12.	Potential damage area about 0.5 miles downstream from the dam.	6
13.	Potential damage area about 1.0 miles downstream from the dam.	7
14.	Potential damage area at Swift Jr. High School about 2.8 miles downstream from the dam.	7
15.	Potential damage area about 3.0 miles downstream from the dam.	8
16.	Potential damage area about 3.1 miles downstream from the dam.	8



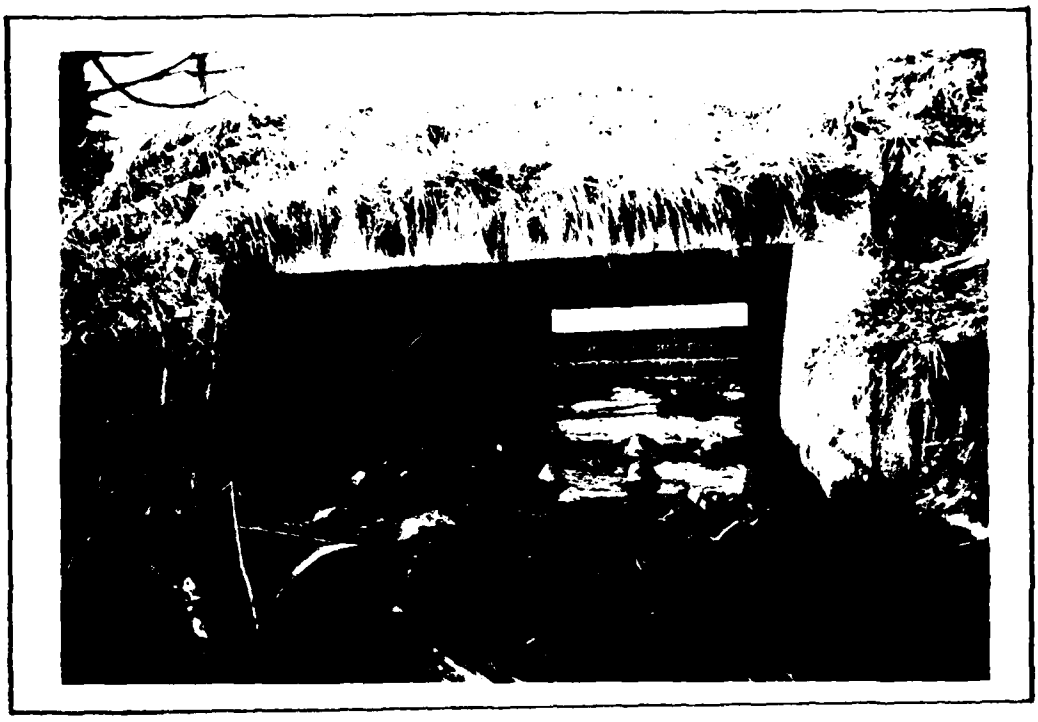
LEGEND ① THE LOCATION AND DIRECTION IN WHICH EACH PHOTO WAS TAKEN AND THE NUMBER OF THE PHOTO.

PG. A

1. VIEW ALONG THE TOP OF THE DAM AS OBSERVED FROM THE RIGHT ABUTMENT. (11/20/79)



2. SPILLWAY WEIR AND TRAINING WALLS. (11/20/79)



3. LOOKING UPSTREAM THROUGH THE ROAD CULVERT TOWARDS THE SPILLWAY WEIR. (11/20/79)

4. SPILLWAY OUTLET CHANNEL IMMEDIATELY DOWNSTREAM OF THE DAM. (11/20/79)

5. CONTROL WHEEL FOR THE RESERVOIR DRAIN VALVE. (11/20/79)

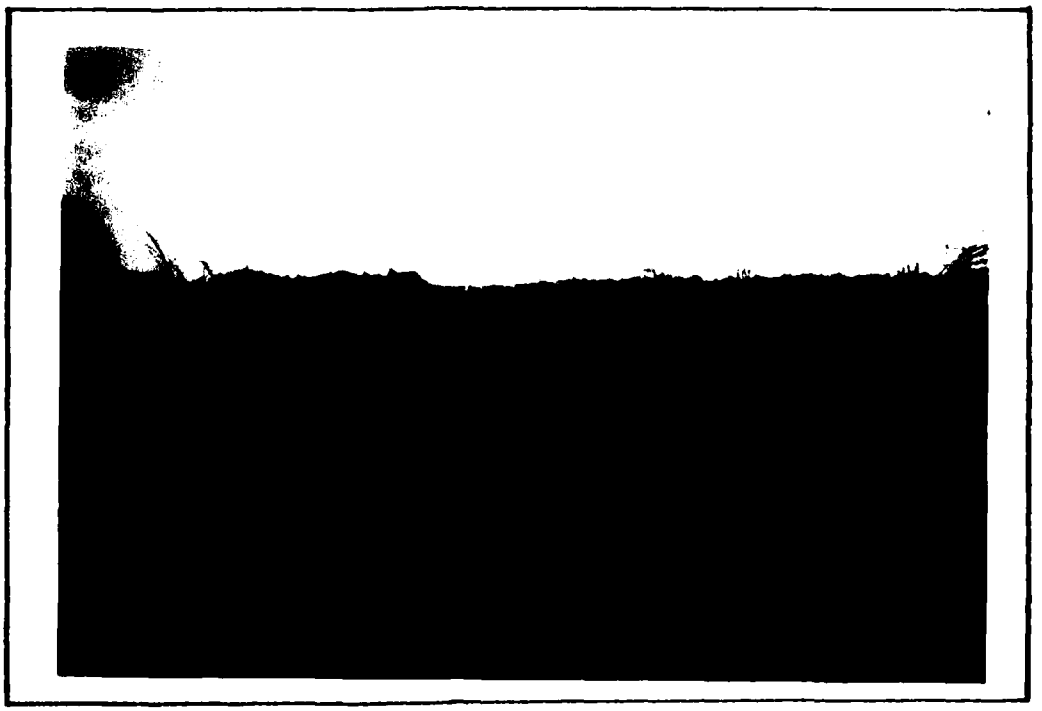
6. RESERVOIR DRAIN CONDUIT OUTLET. (11/20/79)

7. SLOUGHING OF THE DOWNSTREAM FACE OF THE DAM. (11/20/79)

8. TYPICAL SEEPAGE AT THE DOWNSTREAM TOE OF THE DAM. (11/20/79)

9. TYPICAL RODENT HOLE IN THE DOWNSTREAM FACE OF THE DAM. (11/20/79)

10. BUILDING NEAR THE LEFT ABUTMENT OF THE DAM WITH THE THRESHOLD OF THE DOOR LESS THAN ONE FOOT ABOVE NORMAL POOL. (11/20/79)



11. DOWNSTREAM CONDITIONS AS VIEWED FROM THE TOP OF THE DAM. (11/20/79)

12. POTENTIAL DAMAGE AREA ABOUT 0.5 MILES DOWNSTREAM FROM THE DAM. (11/20/79)

13. POTENTIAL DAMAGE AREA ABOUT 1.0 MILES DOWNSTREAM FROM THE DAM. (11/20/79)

14. POTENTIAL DAMAGE AREA AT SWIFT JR. HIGH SCHOOL ABOUT 2.8 MILES DOWNSTREAM FROM THE DAM. (11/20/79)

15. POTENTIAL DAMAGE AREA ABOUT 3.0 MILES DOWNSTREAM FROM THE DAM. (11/20/79)

16. POTENTIAL DAMAGE AREA ABOUT 3.1 MILES DOWNSTREAM FROM THE DAM. (11/20/79)

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

O'BRIEN & GERE
ENGINEERS, INC.

SUBJECT	SHEET	BY	DATE	JOB NO
LAKE WINNEMAUG DAM				

APPENDIX D

HYDROLOGIC & HYDRAULIC COMPUTATIONS

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	PAGE
REGIONAL VICINITY MAP, FIG. 1, SHOWING FLOOD IMPACT AREA	D-1
T_p COMPUTATIONS, PMP DATA & ADDITIONAL HYDROLOGIC DATA	D-2
SPILLWAY PLAN & SECTION	D-3
STAGE-DISCHARGE COMPUTATIONS & STAGE-STORAGE DATA	D-4
STAGE-DISCHARGE TABULATION & HAZARD AREA CROSS-SECTION	D-5
STAGE-DISCHARGE & STAGE-STORAGE GRAPHS	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-17

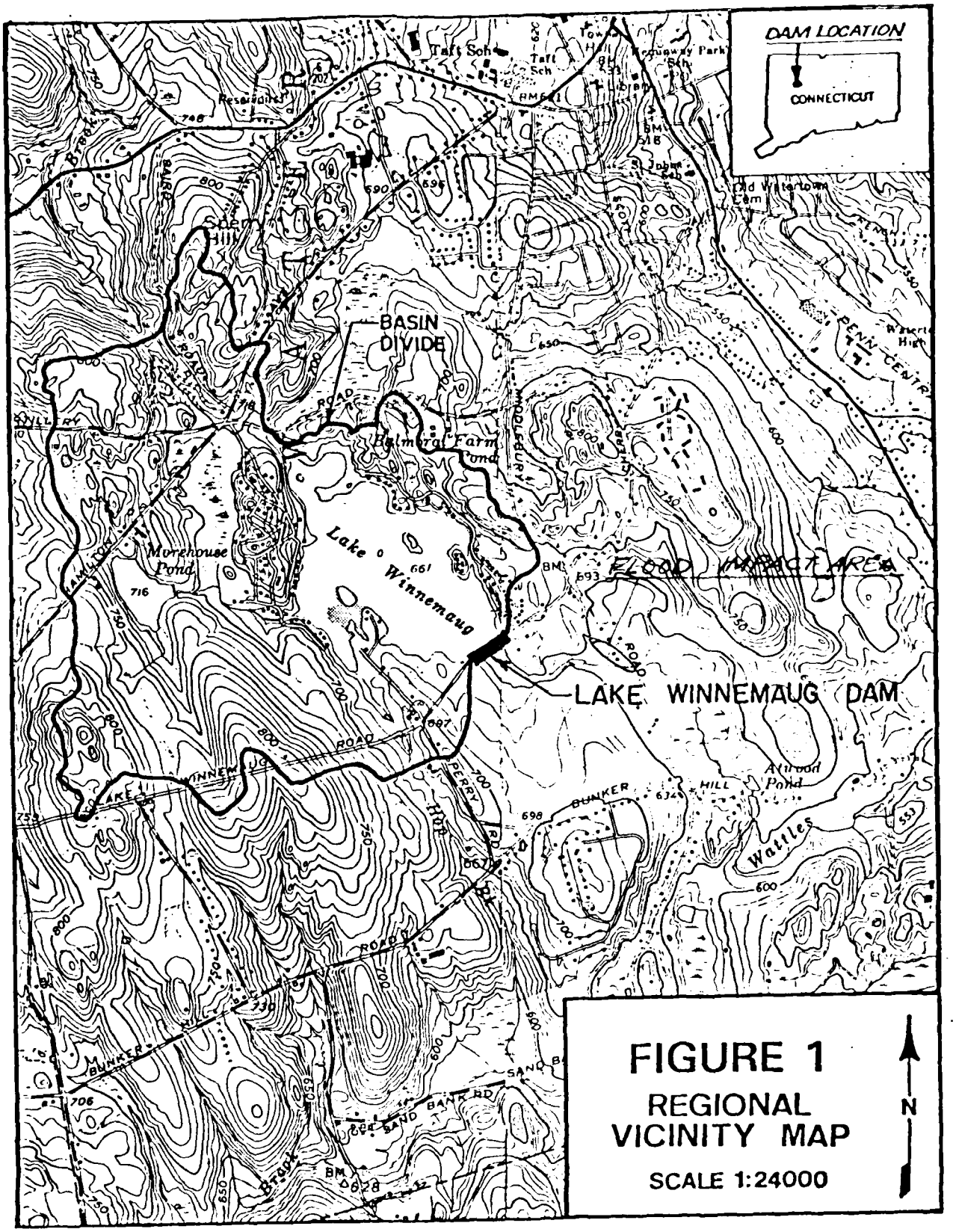


FIGURE 1

REGIONAL VICINITY MAP

SCALE 1:24000

O'BRIEN & GERE ENGINEERS, INC.

SUBJECT	SHEET	BY	DATE	JOB NO
LAKE WINNEMAUG DAM - H&H	D-2	SHS	2/14/80	2060-001

HYDROLOGIC & HYDRAULIC CALCULATIONS

Drainage Area - 1.14 sq. miles

Reservoir Area - 0.19 sq. miles = 122 acres — Normal Pool
Reservoir Area - 0.23 sq. miles = 147 acres — El. 670

Tp Computations:

Snyder Coefficients:

L = 5600 ft. = 1.1 mi. — $C_t = 2.0$

L_{CA} = 600 ft. = 0.1 mi. — $C_p = 0.5$

$$T_p = C_t (L L_{CA})^{0.3} = 2.0 (1.1 \times 0.1)^{0.3}$$

∴ Lag Time (T_p) = 1.0 Hours

PMP DATA:

The 24 hr., 200 sq. mi. Index Rainfall is 21.5 inches.

6 hr. % = 111
12 hr. % = 124
24 hr. % = 133

Ref: HMS Report #33

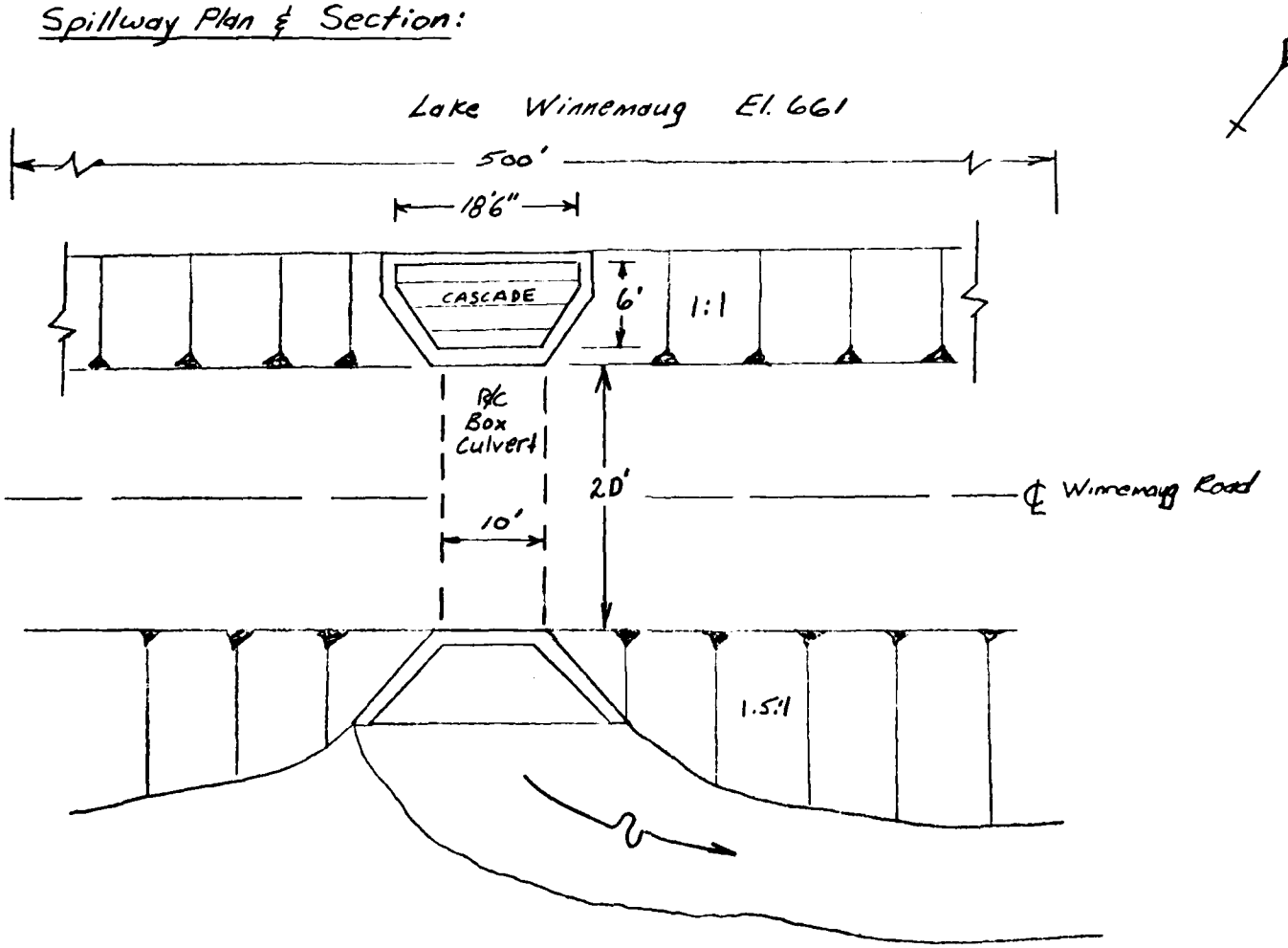
ADDITIONAL HYDROLOGIC DATA:

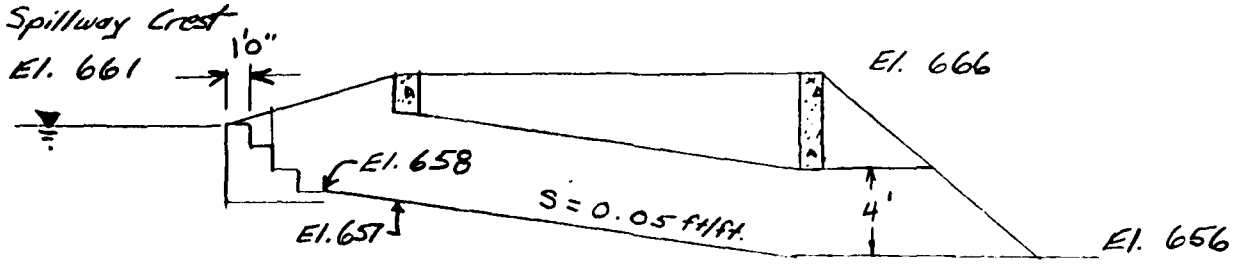
Initial Loss - 0.0 in.
Constant Loss Rate - 0.05 in./hr.
Hop Brook Adj. Factor - 0.80 ; D.A. < 10 sq. mi
Hydrograph Computation Interval - 15 min.
% BASIN IMPERVIOUS - 18 %

O'BRIEN & GERE ENGINEERS, INC.

SUBJECT	SHEET	BY	DATE	JOB NO
LAKE WINNEMAUG DAM - H&H	D-3	SHS	2/14/80	2060-001

Spillway Plan & Section:





O'BRIEN & GERE ENGINEERS, INC.

SUBJECT	SHEET	BY	DATE	JOB NO
LAKE WINNEMAUG DAM - H&H	D-4	SHS	2/14/80	2060-001

Stage-Discharge Computations:

Sharp-crested Weir - $Q_1 = CLH^{3/2}$ $C = 3.1$ $L = 18.5$ ft.

4'x10' R/C Culvert - $Q(full) = \frac{1.49}{n} AR^{2/3} S^{1/2}$

$$= \frac{1.49}{0.013} \times 40\,(1.43)^{0.67}(0.05)^{0.5}$$

$$Q_{full} = 1302 \text{ cfs}$$

Q_1 (Pool @ Dam Crest) $= 3.1\,(18.5)(5)^{1.5} = 641$ cfs

With pool at dam crest the downstream training walls and upstream culvert headwall act as a drop inlet:

$Q = CLH^{3/2}$ $C = 2.8$ $L = 2(6) = 12$ ft.

Q_2 (Pool at Dam Crest) $= 2.8\,(12)\left(\frac{5}{2}\right)^{1.5} = 133$ cfs.

Q_2 (Pool 1.5' above Dam Crest) $= 2.8\left[(10)\left(\frac{5}{2}+1.5\right)^{1.5} + 12\,(1.5)^{3/2}\right] = 286$ cfs

∴ Since $Q_1 + Q_2 <$ 4'x10' Culvert flowing full, $Q_1 + Q_2$ control discharge to and above top of dam.

Discharge over Dam Crest - $Q_3 = CLH^{3/2}$ $C = 2.8$ $L = 500$ ft.

STAGE - STORAGE DATA

RESERVOIR SURF. ELEV.	SURFACE AREA (ACRES)	STORAGE (ACRE FEET) (COMPUTED BY HEC-1 PROGRAM)
651	0	0
661	122	407
670	147	1,615

O'BRIEN & GERE
ENGINEERS, INC.

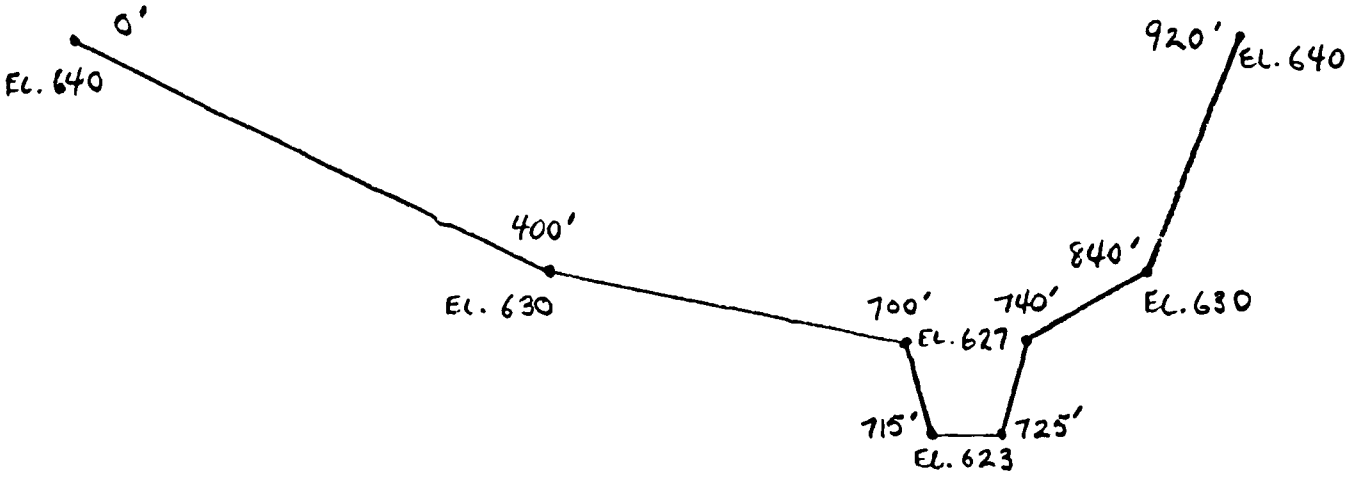
SUBJECT	SHEET	BY	DATE	JOB NO
LAKE WINNEMAUG DAM - H & H	D-5	SHS	2/14/80	2060-001

STAGE-DISCHARGE TABULATION

POOL ELEVATION	Q_1 CFS	Q_2 CFS	Q_3 CFS	ΣQ CFS
661 (NORMAL POOL)	0	0	0	0
662	57	3	0	60
663	162	11	0	173
664	298	37	0	335
665	459	76	0	535
666 (TOP OF DAM)	641	133	0	774
667	843	144	1,400	2,387
668	1062	362	3,960	5,384
669	1298	536	7,275	9,109
670	1548	733	11,200	13,481

HAZARD AREA CROSS-SECTION : 2100 FT. DOWNSTREAM

S = 0.013 FT/FT.



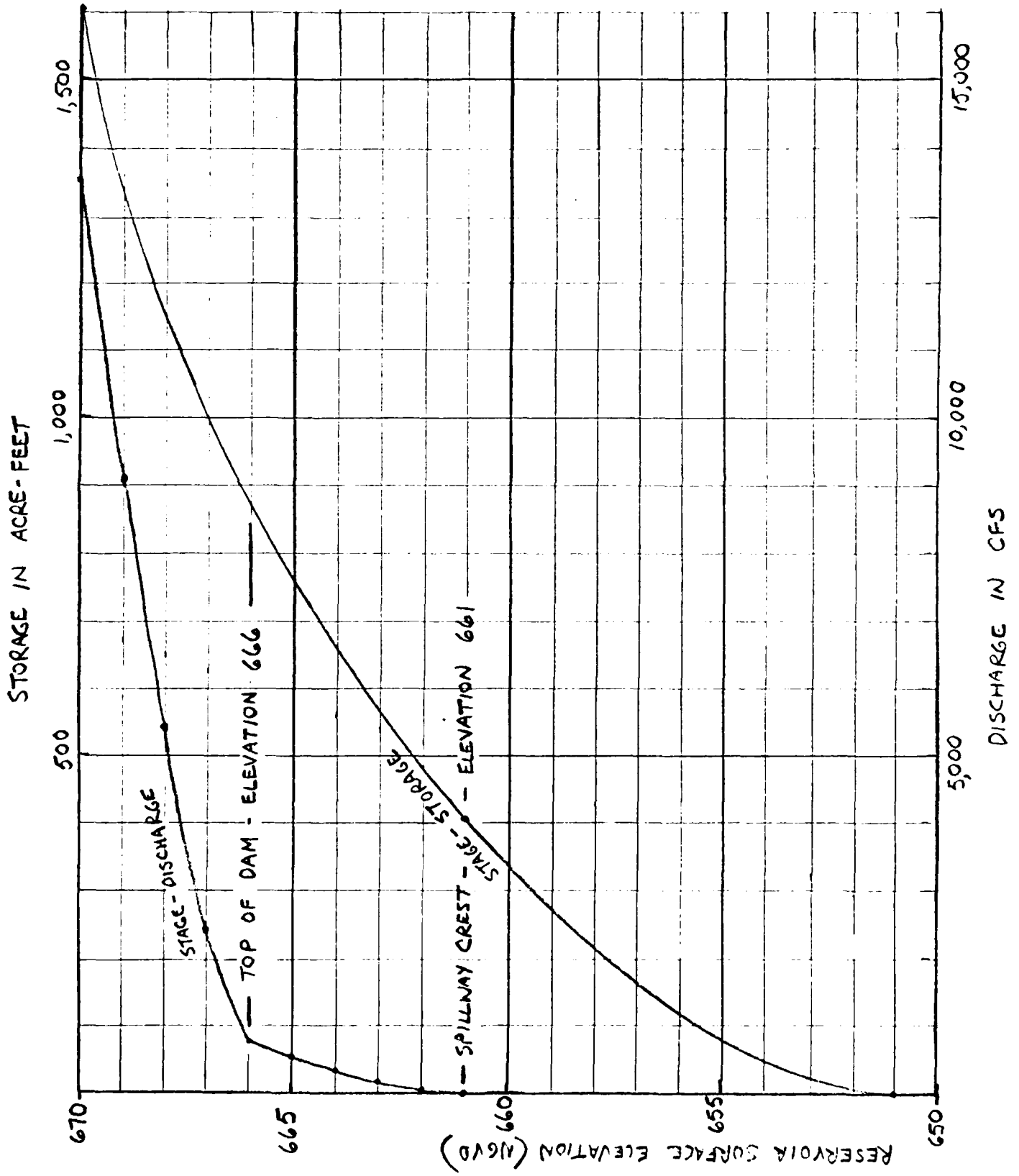
MANNING'S COEFFICIENTS :

STREAM - 0.040

OVERBANKS - 0.055

O'BRIEN & GERE
ENGINEERS, INC.

SUBJECT	SHEET	BY	DATE	JOB NO
STAGE-STORAGE & STAGE-DISCHARGE CURVES	D-6	RRB	3/10/80	2060-001



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

FLOOD ROUTINGS THROUGH LAKE WINNEMAUG WITHOUT BREACHING OF DAM

INPUT

```
     1     A     HYDROLOGIC ANALYSIS OF LAKE WINNEMAUG DAM
     2     A       NATIONAL DAM INSPECTION PROGRAM
     3     A       NEW ENGLAND DIVISION - CORPS OF ENGINEERS
     4     B   200    0    15    0    0    0    0    0   -4    0
     5     B1    5
     6     J     1    9    1
     7     J1  0.1  0.2  0.3  0.4  0.5  0.6  0.7  0.8  1.0
     8     K     0 WINN                          1
     9     K1      INFLOW TO LAKE WINNEMAUG
    10     M     1    1 1.14                                 1
    11     P     0 21.5  111  124  133
    12     T                                    0 0.05      0.18
    13     W   1.0  0.5
    14     X  -1.7 -0.1    2
    15     K     1 WINN                          1
    16     K1      ROUTED OUTFLOW FROM LAKE WINNEMAUG
    17     Y                          1    1
    18     Y1    1                                -661   -1
    19     Y4  661  662  663  664  665  666  667  668  669  670
    20     Y5    0   60  173  335  535  774 2387 5384 9109 13481
    21     $A    0  122  147
    22     $E  651  661  670
    23     $$  661
    24     $D  666
    25     K    99
```

D-1

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

 RUN  DATE0 03/07/80.
      TIME0 12.35.53.

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

                                    JOB SPECIFICATION
          NQ     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
         200       0      15       0       0       0       0       0      -4       0
                                JOPER     NWT   LROPT   TRACE
                                    5       0       0       0

                                MULTI-PLAN ANALYSES TO BE PERFORMED
                                          NPLAN= 1 NRTIO= 9 LRTIO= 1
PERCENTAGES OF PMF USED  -->  RTIOS=    .10     .20     .30     .40     .50     .60     .70     .80    1.00

**********      **********      **********      **********      **********
INFLOW HYDROGRAPH DEVELOPMENT FOR LAKE WINNEMAUG
                                SUB-AREA RUNOFF COMPUTATION
                          INFLOW TO LAKE WINNEMAUG
                    ISTAQ   ICOMP   IECON   ITAPE   JPLT   JPRT  INAME  ISTAGE  IAUTO
                    WINN        0       0       0      0      0      1       0      0
                                    HYDROGRAPH DATA
          IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO  ISNOW  ISAME  LOCAL
              1       1    1.14    0.00    1.14    0.00   0.000      0      1      0
                                    PRECIP DATA
            SPFE     PMS      R6     R12     R24     R48     R72     R96
            0.00   21.50  111.00  124.00  133.00    0.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS  .800
                                    LOSS DATA
          LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
              0    0.00    0.00    1.00    0.00    0.00    1.00    0.00     .05    0.00     .18
                                UNIT HYDROGRAPH DATA
                            TP=  1.00    CP= .50    NTA=  0
                                RECESSION DATA
                        STRTQ=   -1.70    QRCSN=    -.10    RTIOR= 2.00
UNIT HYDROGRAPH 30 END-OF-PERIOD ORDINATES, LAG=   1.00 HOURS, CP=  .50  VOL= 1.00
      39.     141.     267.     357.     364.     313.     254.     212.     175.     144.
     119.      98.      80.      66.      54.      45.      37.      30.      25.      21.
      17.      14.      11.       9.       8.       6.       5.       4.       4.       3.
   0                            END-OF-PERIOD FLOW

  MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q      MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q

                                                  SUM   22.88  21.89    .98    64427.
                                                        ( 581.)( 556.)( 25.)( 1881.00)
```

HYDROGRAPH ROUTING

ROUTED OUTFLOW FROM LAKE WINNEMAUG

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

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-661.	-1

STAGE	661.00	662.00	663.00	664.00	665.00	666.00	667.00	668.00	669.00	670.00
FLOW	0.00	60.00	173.00	335.00	535.00	774.00	2387.00	5384.00	9109.00	13481.00

STAGE-DISCHARGE DATA FOR LAKE WINNEMAUG DAM

SURFACE AREA=	0.	122.	147.
CAPACITY=	0.	407.	1615.
ELEVATION=	651.	661.	670.

STAGE-STORAGE DATA FOR LAKE WINNEMAUG DAM

SPILLWAY CREST ELEVATION →

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
661.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
666.0	0.0	0.0	0.

TOP OF DAM ELEVATION →

PEAK OUTFLOW IS 51. AT TIME 20.50 HOURS

PEAK OUTFLOW IS 132. AT TIME 20.25 HOURS

PEAK OUTFLOW IS 232. AT TIME 20.00 HOURS

PEAK OUTFLOW IS 344. AT TIME 19.75 HOURS

PEAK OUTFLOW IS 473. AT TIME 19.75 HOURS

PEAK OUTFLOW IS 608. AT TIME 19.50 HOURS

PEAK OUTFLOW IS 750. AT TIME 19.50 HOURS

PEAK OUTFLOW IS 1235. AT TIME 19.00 HOURS

PEAK OUTFLOW IS 2032. AT TIME 18.50 HOURS

ROUTED OUTFLOWS FROM LAKE WINNEMAUG DAM FOR VARIOUS FLOODS

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	RATIOS APPLIED TO FLOWS								
				RATIO 1 .10	RATIO 2 .20	RATIO 3 .30	RATIO 4 .40	RATIO 5 .50	RATIO 6 .60	RATIO 7 .70	RATIO 8 .80	RATIO 9 1.00
HYDROGRAPH AT	WINN	1.14	1	346.	693.	1039.	1386.	1732.	2079.	2425.	2772.	3465.
		(2.95)	(	9.81) (	19.62) (	29.43) (	39.25) (	49.06) (	58.87) (	68.68) (	78.49) (	98.11)
ROUTED TO	WINN	1.14	1	51.	132.	232.	344.	473.	608.	750.	1235.	2032.
		(2.95)	(	1.44) (	3.73) (	6.56) (	9.73) (	13.38) (	17.22) (	21.23) (	34.99) (	57.55)

PEAK INFLOWS

ROUTED OUTFLOWS

FLOOD ROUTING RESULTS FOR LAKE WINNEMAUG DAM

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	661.00	661.00	666.00
STORAGE	407.	407.	1050.
OUTFLOW	0.	0.	774.

774. → SPILLWAY CAPACITY

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	661.85	0.00	511.	51.	0.00	20.50	0.00
.20	662.63	0.00	610.	132.	0.00	20.25	0.00
.30	663.36	0.00	702.	232.	0.00	20.00	0.00
.40	664.04	0.00	790.	344.	0.00	19.75	0.00
.50	664.69	0.00	875.	473.	0.00	19.75	0.00
.60	665.31	0.00	957.	608.	0.00	19.50	0.00
.70	665.90	0.00	1037.	750.	0.00	19.50	0.00
.80	666.29	.29	1089.	1235.	2.50	19.00	0.00
1.00	666.78	.78	1157.	2032.	4.00	18.50	0.00

666.78 → TEST FLOOD ELEVATION

2032. → ROUTED TEST FLOOD OUTFLOW

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

LAKE WINNEMAUG DAM BREACH (WITH RESERVOIR AT TOP OF DAM)
OUTFLOW ROUTED TO DOWNSTREAM DAMAGE AREA

INPUT

```
     1          A       HYDROLOGIC ANALYSIS OF LAKE WINNEMAUG DAM
     2          A         NATIONAL DAM INSPECTION PROGRAM
     3          A       NEW ENGLAND DIVISION - CORPS OF ENGINEERS
     4          B   300       0       5       0       0       0       0       0      -4       0
     5          B1    5
     6          J     2       1       1
     7          J1    0
     8          K     1   WINN                                            1
     9          K1        ROUTED OUTFLOW FROM LAKE WINNEMAUG
    10          Y                                       1       1
    11          Y1    1                                                 -666      -1
    12          Y4  651     662     663     664     665     666     667     668     669     670
    13          Y5    0      60     173     335     535     774    2387    5384    9109   13481
    14          $A    0     122     147
    15          $E  651     661     670
    16          $$  661
    17          $D  666
    18          $R  100    0.01     654       1     666     666
    19          $R  100     .01     654       1     666     670
    20          K     1   HAZARD                                          1
    21          K1        CHANNEL ROUTING TO HAZARD AREA
    22          Y                                       1       1
    23          Y1    1                                                   -1
    24          Y6 0.055    0.04   0.055     623     640    2100   0.0133
    25          Y7    0     640     400     630     700     627     715     623     125     623
    26          Y7  740     627     840     630     920     640
    27          K    99
```


UNITED COMPUTING SYSTEMS, INC.

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

RUN DATE= 04/02/80.
TIME= 14.54.44.

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

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	5	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 2 NRTIO= 1 LRTIO= 1

NO INFLOW ⟶ RTIOS= 0.00

****

HYDROGRAPH ROUTING

ROUTED OUTFLOW FROM LAKE WINNEMAUG

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

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-666.	-1

STAGE	661.00	662.00	663.00	664.00	665.00	666.00	667.00	668.00	669.00	670.00
FLOW	0.00	60.00	173.00	335.00	535.00	774.00	2387.00	5384.00	9104.00	13481.00

STAGE - DISCHARGE DATA FOR LAKE WINNEMAUG DAM

SURFACE AREA=	0.	122.	147.
CAPACITY=	0.	407.	1615.
ELEVATION=	651.	661.	670.

STAGE - STORAGE DATA FOR LAKE WINNEMAUG DAM

SPILLWAY CREST ELEVATION ⟶

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
661.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOP OF DAM ELEVATION ⟶

TOPEL	COQD	EXPD	DAMWID
666.0	0.0	0.0	0.

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	MSEL	FAILEL
100.	.01	654.00	1.00	666.00	666.00

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

UNITED COMPUTING SYSTEMS, INC.

BEGIN DAM FAILURE AT 0.00 HOURS

PEAK OUTFLOW IS 8805. AT TIME 1.00 HOURS

↳ MAXIMUM BREACH DISCHARGE

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	MSEL	FAILEL
100.	.01	654.00	1.00	666.00	670.00

BREACH DIMENSIONS - NO FAILURE OCCURS

PEAK OUTFLOW IS 774. AT TIME 0.00 HOURS ⟶ MAXIMUM SPILLWAY DISCHARGE

FLOWS ROUTED TO DOWN-STREAM DAMAGE AREA

HYDROGRAPH ROUTING

CHANNEL ROUTING TO HAZARD AREA

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

ALL PLANS HAVE SAME ROUTING DATA

	QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
	0.0	0.000	0.00	1	1	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

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0550	.0400	.0550	623.0	640.0	2100.	.01300

} DOWNSTREAM CHANNEL CHARACTERISTICS

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 640.00 400.00 630.00 700.00 627.00 715.00 623.00 725.00 623.00
740.00 627.00 840.00 630.00 920.00 640.00

} CHANNEL CROSS-SECTION AT HAZARD CENTER

STORAGE	0.00	.58	1.44	2.60	4.04	6.46	13.48	25.65	42.41	63.14
	85.23	109.16	134.95	162.60	192.09	223.44	256.64	291.69	329.60	367.36
OUTFLOW	0.00	40.21	147.51	331.78	605.61	1044.50	1991.19	3376.80	5837.41	9511.00
	14143.02	19737.88	26313.82	33896.15	42514.08	52199.09	62983.93	74902.14	87947.60	102274.39
STAGE	623.00	623.89	624.79	625.68	626.58	627.47	628.37	629.24	630.16	631.05
	631.95	632.84	633.74	634.63	635.53	636.42	637.32	638.21	639.11	640.00
FLOW	0.00	40.21	147.51	331.78	605.61	1044.50	1991.19	3376.80	5837.41	9511.00
	14143.02	19737.88	26313.82	33896.15	42514.08	52199.09	62983.93	74902.14	87947.60	102274.39

} STAGE-STORAGE AND STAGE-DISCHARGE DATA FOR THE DOWNSTREAM CHANNEL

MAXIMUM STAGE IS 630.8 → MAXIMUM STREAM ELEVATION AT DAMAGE CENTER DUE TO DAM BREACH

MAXIMUM STAGE IS 626.9 → MAXIMUM STREAM ELEVATION AT DAMAGE CENTER DUE TO SPILLWAY DISCHARGE

BREACH OUTFLOW RESULTS FOR LAKE WINNEMAUG DAM

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	666.00	661.00	666.00
STORAGE	1050.	407.	1050.
OUTFLOW	774.	0.	774.

	RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
SPILLWAY DISCHARGE	0.00	665.99	0.00	1050.	8805.	0.00	1.00	0.00

8805. → PEAK BREACH DISCHARGE

RESULTS FOR LAKE WINNEMAUG DAM

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	666.00	661.00	666.00
STORAGE	1050.	407.	1050.
OUTFLOW	774.	0.	774.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.00	665.96	0.00	1050.	774.	0.00	0.00	0.00

774. → PEAK SPILLWAY DISCHARGE

FLOW CONDITIONS AT DAMAGE CENTER DUE TO DAM BREACH → PLAN 1 STATION HAZARD

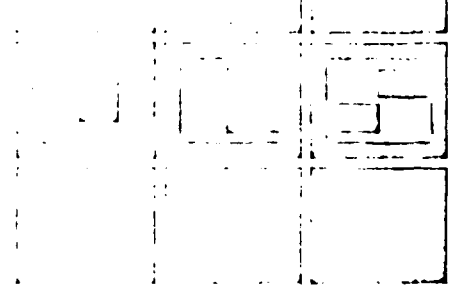
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.00	8410.	630.8	1.08

8410. → PEAK FLOW AT HAZARD AREA DUE TO DAM BREACH

FLOW CONDITIONS AT DAMAGE CENTER DUE TO SPILLWAY DISCHARGE → PLAN 2 STATION HAZARD

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.00	765.	626.9	.08

765. → PEAK FLOW AT HAZARD AREA DUE TO SPILLWAY DISCHARGE



UNITED COMPUTING SYSTEMS, INC.

LAKE WINNEMAUG DAM BREACH (WITH RESERVOIR AT SPILLWAY CREST)
OUTFLOW ROUTED TO DOWNSTREAM DAMAGE CENTER

INPUT

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
LAST MODIFICATION  26 FEB 79
**********
     1     A        HYDROLOGIC ANALYSIS OF LAKE WINNEMAUG DAM
     2     A          NATIONAL DAM INSPECTION PROGRAM
     3     A          NEW ENGLAND DIVISION - CORPS OF ENGINEERS
     4     B   200      0      15      0      0      0      0      0     -4      0
     5     B1    5
     6     J     1      1       1
     7     J1    0
     8     K     1   WINN                                          1
     9     K1        ROUTED OUTFLOW FROM LAKE WINNEMAUG
    10     Y                                    1      1
    11     Y1    1                                                -661    -1
    12     Y4  661    662     663     664     665     666     667    668     669     670
    13     Y5    0     60     173     335     535     774    2387   5384    9109   13481
    14     $A    0    122     147
    15     $E  651    661     670
    16     $S  661
    17     $D  666
    18     $R  100   0.01     654       1     661     661
    19     K     1   HAZARD                                        1
    20     K1        CHANNEL ROUTING TO HAZARD AREA
    21     Y                                    1      1
    22     Y1    1                                                  -1
    23     Y6 0.055  0.04   0.055     623     640    2100  0.013
    24     Y7    0   640     400     630     700     627    715    623     725     623
    25     Y7  740   627     840     630     920     640
    26     K    99
```

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

RUN  DATE0 03/07/80.
     TIME0 12.39.05.

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

                                  JOB SPECIFICATION
          NQ     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT   IPRT   NSTAN
         200       0      15       0       0       0       0       0     -4       0
                                JOPER     NWT   LROPT   TRACE
                                    5       0       0       0

                              MULTI-PLAN ANALYSES TO BE PERFORMED
                                  NPLAN= 1 NRTIO= 1 LRTIO= 1
NO INFLOW ---> RTIOS=    0.00

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

                                HYDROGRAPH ROUTING

                        ROUTED OUTFLOW FROM LAKE WINNEMAUG

                    ISTAQ   ICOMP   IECON   ITAPE   JPLT   JPRT  INAME  ISTAGE  IAUTO
                    WINN        1       0       0      0      0      1       0      0
                                          ROUTING DATA
                   QLOSS   CLOSS     AVG    IRES   ISAME   IOPT   IPMP          LSTR
                     0.0   0.000    0.00       1       1      0      0             0

                   NSTPS  NSTOL     LAG   AMSKK       X    TSK  STORA  ISPRAT
                       1      0       0   0.000   0.000  0.000   -661.      -1

  STAGE     661.00    662.00    663.00    664.00    665.00    666.00    667.00    668.00    669.00    670.00
  FLOW        0.00     60.00    173.00    335.00    535.00    774.00   2387.00   5384.00   9109.00  13481.00

  SURFACE AREA=     0.      122.      147.
    CAPACITY=       0.      407.     1615.
   ELEVATION=     651.      661.      670.

                    CREL    SPWID    COOW    EXPW   ELEVL   COOL   CAREA   EXPL
SPILLWAY CREST ELEVATION --> 661.0      0.0     0.0     0.0     0.0     0.0     0.0     0.0

                                    DAM DATA
                                TOPEL    COOD    EXPD   DAMWID
TOP OF DAM ELEVATION ---------> 666.0     0.0     0.0       0.

                                DAM BREACH DATA
                                BRWID       Z    ELBM   TFAIL    MSEL   FAILEL
                                 100.     .01  654.00    1.00  661.00  661.00

BEGIN DAM FAILURE AT  0.00 HOURS
PEAK OUTFLOW IS    4474.  AT TIME    1.00 HOURS ---> MAXIMUM BREACH DISCHARGE
```

STAGE-DISCHARGE DATA FOR LAKE WINNEMAUG DAM

STAGE-STORAGE DATA FOR LAKE WINNEMAUG DAM

BREACH DIMENSIONS - FAILURE BEGINS IMMEDIATELY WITH RESERVOIR SURFACE AT SPILLWAY CREST

BREACH OUTFLOW ROUTED TO DOWNSTREAM DAMAGE CENTER

HYDROGRAPH ROUTING

CHANNEL ROUTING TO HAZARD AREA

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

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	TORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0550	.0400	.0550	623.0	640.0	2100.	.01300

} DOWNSTREAM CHANNEL CHARACTERISTICS

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 640.00 400.00 630.00 700.00 627.00 715.00 623.00 725.00 623.00
740.00 627.00 840.00 630.00 920.00 640.00

} CHANNEL CROSS-SECTION AT HAZARD CENTER

STORAGE	0.00	.58	1.44	2.60	4.04	6.46	13.48	25.65	42.91	63.14
	85.23	109.16	134.95	162.60	192.09	223.44	256.64	291.69	328.60	367.36
OUTFLOW	0.00	40.21	147.51	331.78	605.61	1044.50	1891.19	3396.80	5837.41	9511.00
	14143.02	19737.88	26313.82	33896.15	42514.08	52199.09	62983.93	74902.14	87987.60	102274.39
STAGE	623.00	623.99	624.79	625.68	626.58	627.47	628.37	629.26	630.16	631.05
	631.95	632.84	633.74	634.63	635.53	636.42	637.32	638.21	639.11	640.00
FLOW	0.00	40.21	147.51	331.78	605.61	1044.50	1891.19	3396.80	5837.41	9511.00
	14143.02	19737.88	26313.82	33896.15	42514.08	52199.09	62983.93	74902.14	87987.60	102274.39

} STAGE-STORAGE AND STAGE-DISCHARGE DATA FOR THE DOWNSTREAM CHANNEL

MAXIMUM STAGE IS 629.6 → MAXIMUM STREAM ELEVATION AT DAMAGE AREA

BREACH OUTFLOW RESULTS FOR LAKE WINNEMAUG DAM

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	661.00	661.00	666.00
STORAGE	407.	407.	1050.
OUTFLOW	0.	0.	774.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.00	661.00	0.00	407.	676.	0.00	1.00	0.00

PLAN 1 STATION HAZARD

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

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