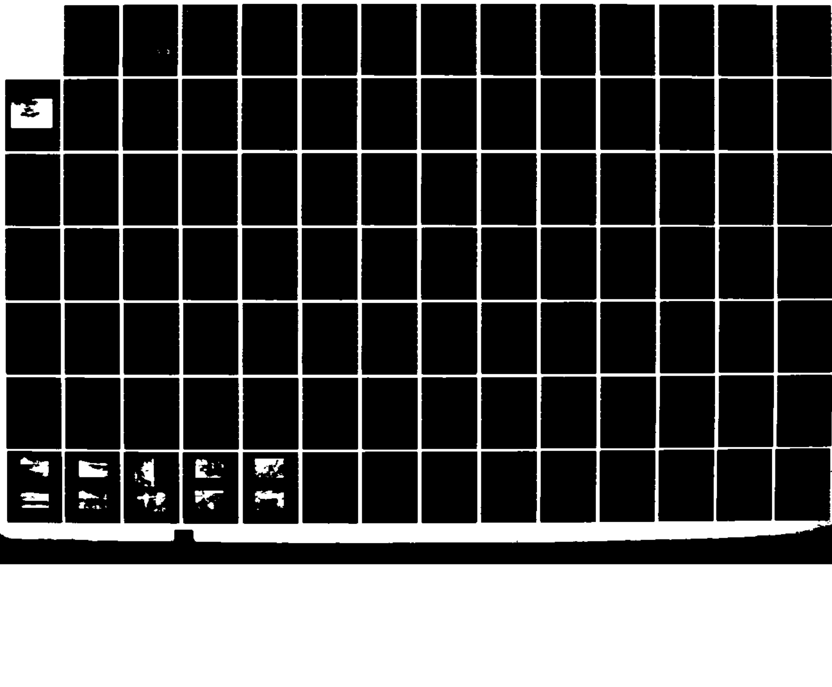
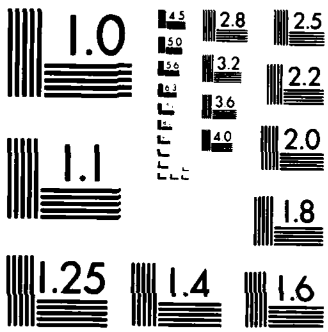
AD-A156 679 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 1/2
LAKE CLARA DAM (VT 00..(U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV AUG 78

UNCLASSIFIED F/G 13/13 NL




1.0
4.5
5.0
5.6
6.3
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

CONNECTICUT RIVER BASIN
WHITINGHAM

LAKE CLARA DAM
VT00011

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

AUGUST 1978

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

REPLY TO
ATTENTION OF

NEDED

DEC 22 1978

Honorable Richard A. Snelling
Governor of the State of Vermont
State Capitol
Montpelier, Vermont 05602

Dear Governor Snelling:

I am forwarding to you a copy of the Lake Clara 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 Water Resources , the cooperating agency for the State of Vermont. In addition, a copy of the report has also been furnished the owner, Mr. Joseph Proctor, 1053 Brush Hill Road, Milton, Massachusetts 02136.

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 Water Resources for your cooperation in carrying out this program.

Sincerely yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER VT 00011	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Lake Clara 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
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE August 1978 13. NUMBER OF PAGES 65
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

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,

Connecticut River Basin
Whitingham, VT

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

TXe dam is an earthfill dam about 370 ft. long and 31 ft. high. There are no operable appurtenant structures. The dam is judged to be in fair to poo r condition. The test flood falls between the ½ PMF and the PMF. There are various significant conditions which must be corrected. Alternatively, the lake should be lowered to a safe level until such time as repairs can be made.

DISCLAIMER NOTICE

LAKE CLARA DAM

VT00011

WHITINGHAM, VERMONT

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

INSPECTION REPORT

Identification No.: VT00011
Name of Dam: Lake Clara Dam
Town: Whitingham
County and State: Windham, Vermont
Stream: Unknown
Date of Inspection: June 16, 1978

BRIEF ASSESSMENT

GENERAL

Lake Clara dam is an earthfill dam approximately 370 feet in length and 31 feet high. There are no operable appurtenant structures. The dam is judged to be in fair to poor condition.

The lake level is controlled by a discharge channel at the southeasterly corner of the lake. Based on size and hazard classification (see Section 1) in accordance with the "Recommended Guidelines for Safety Inspections of Dams, Department of the Army November 1976" the test flood falls between the 1/2 PMF (Probable Maximum Flood) and the PMF. The test flood of 1/2 PMF overtops the dam by 0.2 foot.

STATEMENT OF SIGNIFICANT FINDINGS

The following significant conditions were observed:

1. The downstream slope of this dam is wet or damp over the lower two-thirds of its height and slight clear seepage occurs at, or somewhat downstream of the left abutment contact. The riprap upstream is in poor condition. A slough occurred on the downstream slope prior to June, 1961.

2. There are no functioning outlet works by which the level of Lake Clara could be lowered in the event of an emergency or for routine maintenance.

3. Evidence of extensive animal (beaver) occupation of the dam was observed, including burrows and beaver houses constructed in the dam.

4. The present owner has taken steps to remove the trees which were growing in the dam; however, stumps and root systems are still penetrating the dam, and are now dead and deteriorating.

STATEMENT OF RECOMMENDED ACTION

A severe combination of conditions could lead to failure of Lake Clara dam at any time. A detailed assessment and recommendations for remedial measures are contained in Section 7 of this report. In summary, it is recommended that a qualified consulting engineer be engaged to investigate and prepare construction drawings so that the following remedial actions can be carried out within the next year:

1. The dam should be made more stable by constructing a proper downstream shell and repairing or replacing the riprap upstream.

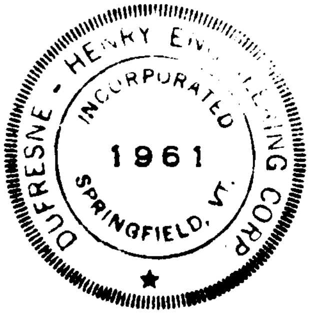
2. Further investigation should be undertaken to determine if the old control structure in the dam can be rehabilitated to act as an outlet control. If this is not possible an engineering study should be undertaken to determine the most feasible method of providing permanent outlet control.

3. A method should be developed for removing the existing stumps and root structures, and filling the resulting voids with suitable material.

4. A system should be established for round-the-clock surveillance of the dam during periods of unusually heavy precipitation. A formal warning system should also be developed for alerting downstream residents in the event an emergency situation develops.

Alternatively, the lake should be lowered to a safe level until such time as repairs can be made.

In addition, the dam maintenance program should be expanded to include yearly control of the vegetation growing in the area of the dam and outlet channel, removal of the animal population from the dam, and keeping the 4' conduit between the two sections of the lake clear of debris.



This Phase I Inspection Report on the Lake Clara 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.

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

SAUL COOPER, Member
Chief, Water Control 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 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 investigations, 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.

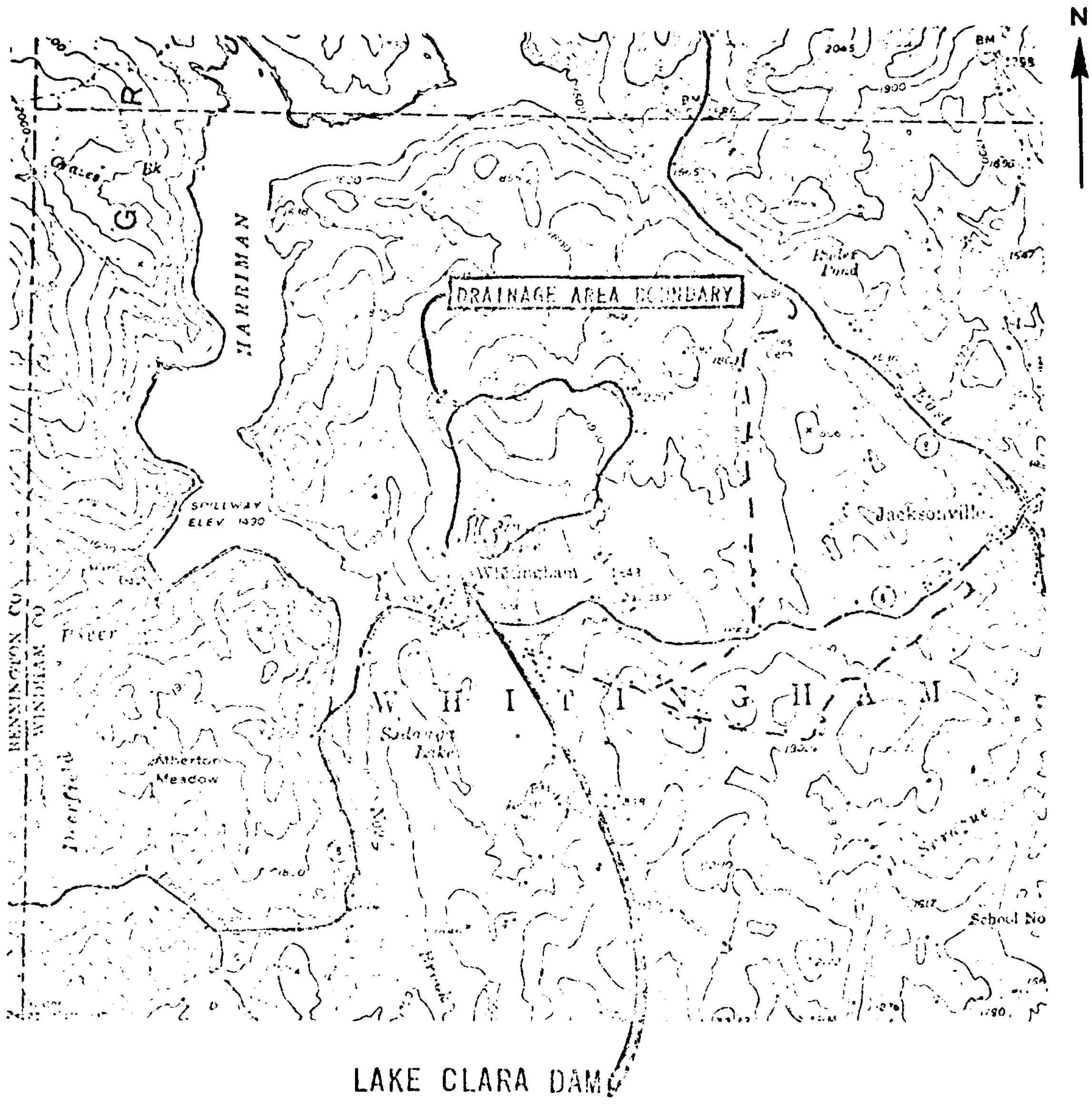
It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the 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.

TABLE OF CONTENTS

Page

OVERVIEW OF LAKE CLARA
WHITINGHAM, VERMONT



LAKE CLARA DAM

SOURCE OF MAP:

U.S. GEOLOGICAL SURVEY
WILMINGTON QUADRANGLE, VERMONT
15 MIN. SERIES
1:62500, 1954

	22-0554	
	JRS	LOCATION MAP
	LGF	LAKE CLAPA DAM
	7-11-78	VERMONT

LAKE CLARA

SECTION 1: PROJECT INFORMATION

1.1 GENERAL

a. Authority

The authority for this project is derived from PL-92-367 dated August 8, 1972 titled, National Program of Inspection of Dams, and E.C. 1110-2-188 dated December 30, 1977 titled, National Program of Inspection of Nonfederal Dams, both of which are on file in the Engineering Division, New England Division. The inspection was performed by Dufresne-Henry Engineering Corporation under Contract No. DACW33-78-C-0341 with the New England Division of the Army Corps of Engineers.

b. Purpose

The purpose of this project is to accomplish a technical inspection and evaluation of nonfederal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by nonfederal interest. Secondly, this project will serve to encourage and prepare the states to initiate quickly effective dam safety programs for nonfederal dams. Thirdly, the project will update, verify and complete the National Inventory of Dams.

1.2 DESCRIPTION OF PROJECT

a. Location

The Lake Clara Dam is located in southern Vermont in the Town of Whitingham, Windham County and is in the Connecticut River basin. More specifically the dam is located approximately 0.4 miles northeast of the Village of Whitingham.

b. Description of Dam and Appurtenances

Lake Clara Dam is a 370-foot long earth fill dam approximately 31 feet high. The dam has no functional appurtenant structures. There is reportedly a concrete core in the dam, see Figure 2 for details. The dam is overgrown with grass and brush up to 15 feet in height. Large boulders and stumps have been dumped on the upstream face of the dam at approximately the water level. There is also the remains of a conduit through the dam discharging at the old stream bed. A concrete slab on the upstream face is visible which may be part of the intake to the conduit.

The level of the lake is maintained by a channel constructed in natural ground. The discharge channel is located east of the dam on a portion of Lake Clara separated from the dam by Town Road No. 9 (gravel construction). Flow between the two portions of Lake Clara is controlled by a 48-inch steel boiler acting as a culvert under the road. Refer to Figure 3, Hydraulic Diagram of Lake Clara.

c. <u>Size Classification</u>

Lake Clara Dam has an 18-acre impoundment. The height of the dam is approximately 31 feet. The maximum storage potential is approximately 252 acre-feet. Therefore, the size category of the dam is "small".

d. <u>Hazard Classification</u>

A failure of Lake Clara Dam would route the resulting flood waters through Whitingham Village. Although Whitingham Village is a small rural community, as many as 20 lives might be lost and serious damage sustained by 3 homes in the event of a dam failure. The hazard category is therefore "high".

e. <u>Ownership</u>

The present owner of Lake Clara Dam is:

Mr. Joseph Proctor
1053 Brush Hill Road
Milton, Massachusetts 02136

Reportedly, the previous owner was Mr. Houghton Sawyer of Whitingham, Vermont.

f. <u>Operator</u>

The dam is operated by its owner, Mr. Joseph Proctor, telephone number 617-333-0338. His address is 1053 Brush Hill Road, Milton, Massachusetts.

g. <u>Purpose</u>

The Lake Clara Dam is presently maintained for recreational (primarily fishing) and aesthetic purposes.

The dam was originally constructed to impound and control water for hydropower purposes.

The outlet channel from Lake Clara feeds into Lake Sadawga, which was also constructed for hydropower purposes. Reportedly, the abandoned conduit under Lake Clara Dam was used to control flow in the stream bed at the toe of the dam, for other hydropower purposes in Whitingham Village.

h. Design and Construction History

Little information is available on the original design and construction of the Lake Clara Dam. In previous inspections it was reported that the dam was built between 1923 and 1928, and that the construction consisted of a concrete core resting on a ledge rock foundation upon which earth fill was placed. Reportedly, just prior to the purchase of the dam by the present owner (1963) fill consisting of earth, large boulders, and stumps was dumped on the dam to increase the top width.

i. Normal Operation Procedure(s)

Because there are no control structures associated with the Lake Clara Dam, there are no normal operational procedures. The present owner reported that he periodically employs someone to remove the beaver dams in the discharge channel so as to maintain as low a lake level as possible.

1.3 PERTINENT DATA

a. Drainage Area

The 0.7 square mile drainage area above Clara Lake is divided by Town Road No. 9 which runs approximately North-South through the watershed. The area west of Town Road No. 9 is approximately 0.2 square miles with an overall length of the watercourse of 0.8 miles and an average slope of 330 feet/mile. The easterly area is approximately 0.5 square miles with an overall length of the watercourse of 1.2 miles and an average slope of 220 feet/mile. The hills, covered mostly with woods and a few meadows, rise 300 feet above the pond. Soils within the drainage area have been identified as being predominantly glacial till with a hard pan or bedrock commonly within three feet of the surface.

b. Discharge at Dam Site

(1) Outlet Works

The inlet to the conduit has been plugged with earth fill. There are no plans available describing the conduit, valves or other appurtenant structures. The outlet consists of two fieldstone walls, three feet apart, covered with stone slabs. The height of the opening is about a foot and a half.

(2) Maximum Known Flood at Dam Site

No estimate is available for the flow resulting from the storm of June 30, 1973, but the stage reported is about 1.5 feet above the minimum elevation on Town Road No. 9. This stage was a result of the high flows as well as the partial blockage of the outlet canal by several beaver dams. Historically the dam has survived the floods of September 1938, March 1936, and November 1927.

(3) Spillway Capacity

There is no spillway in the dam. Water discharges only through the channel at the southeasterly corner of the easterly pond. This channel has a capacity of roughly 440 cfs with the pond at elevation 121.15. At higher elevations the discharge channel increases in width from 150 feet to over 400 feet which includes the saddle depicted in the meadow shown in the site plan for Lake Clara Dam (Figure 1). At full pond elevation (122.7), the total discharge estimated passing through the saddle and outlet canal is 2360 cfs. However, the left end of the dam has been noted by others to be 0.7 foot lower than the section at the old outlet. Therefore, the dam would be overtopped at stages in excess of 122.0. The flow released for this condition is estimated to be 1000 cfs which is 350 cfs less than the Test Flood of 1350 cfs (50% of the Probable Maximum Flood).

c. Elevation (feet above crest of Lake Sadawga Dam as assumed by ANCO in 1961)

(1) Top of Dam

122.7

(2) Maximum Pool

West of Town Road No. 9 - 122.7
East of Town Road No. 9 - 121.2

(3) Full Flood Control Pool

West of Town Road No. 9 - 122.7

(4) Recreation Pool

West of Town Road No. 9 - 118.2
East of Town Road No. 9 - 116.9

(5) Spillway Crest (Gated)

(There is no spillway.)
Thalweg Outlet Canal - 116.7

(6) Upstream Portal Invert Diversion Tunnel

Not applicable

(7) Streambed at Centerline of Dam

91.7

(8) Maximum Tailwater

Not applicable

d. Reservoir

(1) Length of Maximum Pool

1000 feet

(2) Length of Recreation Pool

Same as above

(3) Length of Flood Control Pool

Same as above

e. Storage (acre-feet)

(1) Recreation Pool[1]

216

(2) Maximum Pool[1]

252

[1] State of Vermont Department of Water Resources estimate.

f. Reservoir Surface (acres)

(1) Recreation Pool

18

(2) Maximum Pool[2]

18

(3) Top of Dam

18

Note: Approximately 7 acres West of Town Road No. 9
11 acres East of Town Road No. 9

g. Dam

(1) Type

Earth dam, according to the correspondence.

(2) Length

370 feet

(3) Height

31 feet

(4) Top Width

20 feet

(5) Side Slopes

Downstream slope - 2:1
Upstream slope - 3:1

(6) Zoning

None known

(7) Impervious Core

Concrete wall, reportedly 1 foot wide at top, 2 feet wide at bottom, thought to be 15 feet above streambed.

[2] Assumed due to lack of local topographic information.

(8) Cutoff

None known. Foundation of concrete core not known.

(9) Grout Curtain

None known

i. Spillway

(1) Type

Natural open channel - See Figure 2 for typical section

(2) Length

150 feet

(3) Crest Elevation

116.7

(4) Gates

None

(5) Upstream Channel

Pond

(6) Downstream Channel

Normal flows: 6'-8' wide, approximately 2' deep.
Overbank flows: available average width of 150' with heavy grass vegetation and light brush.

j. Regulating Outlets

Plugged and buried with no known plans showing construction details.

SECTION 2: ENGINEERING DATA

2.1 DESIGN

There is no design data available for this dam.

2.2 CONSTRUCTION

According to the records, this dam was constructed between 1923 and 1928 of earth fill that was placed on both sides of a concrete core wall. The core wall, 1 foot thick at the top and 2 feet thick at the bottom, was extended to about 15 feet above stream bed. Above the core wall, the earth fill was continued across the entire section to the top of the dam. Figure 2 was drawn, based on visual inspection and the verbal descriptions in the records, to demonstrate the approximate construction of the dam.

2.3 OPERATION

The original purpose of Lake Clara was for hydropower. Since the impoundment has not been used for this purpose for several decades, there has been no operation of the dam. The highest known lake level in recent years is reported to be approximately 1.5 feet above Town Road No. 9 at the lowest point, which would be approximately 1.7 feet below the crest of the dam.

2.4 EVALUATION

a. Availability

The design and construction records for this dam are not available.

b. Adequacy

The lack of indepth engineering data does not allow for a definitive review. Therefore the adequacy of this dam, structurally and hydraulically, can not be assessed from the standpoint of review of design calculations, but must be based primarily on the visual inspection, past performance history and sound hydrologic and hydraulic engineering judgement.

c. Validity

Not applicable.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General

The on-site inspection of Lake Clara Dam was performed on June 16, 1978. Weather conditions were ideal for the inspection; clear, temperatures in the 70's. Runoff in streams was considered to be about average for that time of the year. Visual inspection of the dam was somewhat hampered by the thick growth of vegetation which is normal for the late spring and summer months. No emergency conditions were observed on the day of the inspection.

b. Dam

The downstream face of this dam is damp or wet, and soft underfoot, from about one-third the way down the downstream slope to the bottom (see Figure 2). The wet zone extends about 100 feet along the slope between the center of the dam and the left abutment. Clear seepage was observed exiting from a point several feet downstream from the downstream contact line at the left abutment. This zone of seepage extends down to the stream bed, exiting near and around the fieldstone outlet structure.

The downstream slope of the dam is generally about 2H:1V, but near the top it is very steep, approaching 1H:1V. It appears that this steep slope near the top, Figure 2, may have been constructed when the crest was widened, apparently following the 1961 report by Anderson-Nichols.

The upstream slope is not visible, although a 1973 report by Southern Vermont Engineering, Inc. indicates that it is about 3H:1V. The slope above water is somewhat steeper than 1H:1V, probably due to wave cutting of the unprotected upstream face. The face was riprapped with large boulders; however, the riprap is discontinuous and there was no filter material evident. The riprap was placed directly against the earth embankment.

The downstream slope of the dam is covered with small and large trees and stumps, shrubs, and grass. The upstream slope also has a few trees on it, and in one location a 10-inch stump exists just under the lake surface near the left end of the dam.

Animal holes are numerous. In one location about 188 feet right of the centerline of Town Road No. 9, a hole on the downstream slope extends at least 6 feet upstream, approximately horizontally into the dam. This hole coincides in location with an observed one foot dip in the crest on the upstream side. In addition, the concrete top of the old inlet structure apparently is located approximately at the same location. Also observed was what appeared to be a beaver house approximately 300 feet right of the centerline of Town Road No. 9, on the upstream face of the dam at the waterline. This beaver house was apparently inhabited by several beavers at the time of the inspection. It was impossible to tell how far the beaver house encroaches into the dam structure.

c. Appurtenant Structures

The only structure appurtenant to the dam is an abandoned conduit of unknown size and construction. The conduit is evidenced by a fieldstone wall at the toe of the dam in the area of the old brook bed. Exposed concrete was also observed on the upstream face of the dam which may have been the entrance to the conduit.

The conduit reportedly included a butterfly valve which was used to control the flow. The valve apparently leaked; therefore, the previous owner had the upstream entrance to the conduit plugged with earth.

A small continuous flow of water was observed coming out of the fieldstone wall. Also several springs or seeps, were evident in the area of the fieldstone wall.

d. Reservoir Area

The most significant finding is the presence of an active beaver population. They have in the past been responsible for dams along the outlet canal which could raise the water level to within 3 feet of the crest of the dam. Banks around the reservoir are heavily vegetated. Town Road No. 9 which runs through the pond has riprap dumped along the road embankment. The inlet to the 4-foot culvert under Town Road

No. 9 was partially obstructed by rocks and branches, indicating that both human and beaver activity was responsible. This slight blockage was responsible for raising the westerly pond level approximately 1.0 feet above the invert of the 4-foot diameter culvert.

e. Downstream Channel

(1) Outlet Canal

The outlet canal has within the last three years had heavy brush growth removed along with several old beaver dams over a 1500 foot length. The channel is reasonably clear of obstructions with some aquatic grasses becoming established in some of the quiet pools.

(2) Old Stream Bed Downstream of Dam

Flow in the stream was approximately 0.2 cfs coming from seeps through the dam and some leakage through the plugged outlet. This channel is approximately 20 feet wide and two to three feet deep and has become partially overgrown with trees. The house over this stream bed shown by ANCO in their 1961 study still stands and would definitely sustain catastrophic damamge should the Lake Clara Dam fail.

3.2 *EVALUATION*

The seepage exits on the downstream face of this dam substantially higher than would be expected based on the assumption of homogeneity of the embankment soils. This high exit point, combined with the characteristics of the soil in the embankment, probably led to the slough described in the 1961 Anderson-Nichols report. There have not been sufficient changes made in the dam subsequently to conclude that it is any more stable now than at that time.

In addition, animal holes and rotting roots in the embankment are both continuously creating potential pathways for internal erosion of this dam.

The riprap on the upstream face is intermittent and has no filter behind it, a condition that should be alleviated.

Water flowing from the end of the abandoned conduit is evidence that, despite being plugged, there is still leakage into the conduit. The springs or seeps occurring in the area of the fieldstone wall are indications that seepage maybe occurring along the outside of the conduit. This condition has apparently existed since the dam was built. Not enough information exists on the construction and condition of the conduit to evaluate the seriousness of the condition.

SECTION 4: OPERATIONAL PROCEDURES

4.1 PROCEDURES

None.

4.2 MAINTENANCE OF DAM

The only maintenance program in effect is, reportedly a periodic inspection of the discharge channel, and, if necessary, clearing of debris in the channel to maintain the lake level as low as possible. The vegetation had been cut from the top and sides of the dam several years ago, however, this has not been done on a regular basis.

4.3 MAINTENANCE OF OPERATING FACILITIES

Not applicable to this dam.

4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

None exists for this dam.

4.5 EVALUATION

The maintenance of the discharge channel appears to be effective in controlling the level of the lake and should be continued. An annual maintenance program should be developed, to include:

(1) Cutting of all brush and vegetation in the area of the dam.

(2) Removal of the animal population from the dam.

(3) Maintain the conduit between the two sections of the lake clear of debris.

SECTION 5: HYDRAULIC AND HYDROLOGIC EVALUATION

5.1 EVALUATION OF FEATURES

a. Design Data

There is no known design data. Details of the dam and outlet canal from the East Pond were examined from three sources. The outlet channel section used for this study (see Figure 2) was taken from a study done by Southern Vermont Engineering, Inc. in October, 1973, as is the dam cross section. The hydraulic features of this impoundment were previously evaluated with a design outflow of 650 cfs determined by Anderson-Nichols Company, Inc. based on envelope curves of the November, 1927 and September, 1938 floods (see Section 16 of their report dated June, 1961). The inlet of the regulating outlet works has been permanently blocked by large amounts of fill and is consequently not further evaluated.

The dam is classified to be small size with a high hazard rating due to the number of people and local secondary roads which are in the hazard area. Since the hazard category is borderline, the test flood of 1/2 Probable Maximum Flood was selected as a criterion for this study. The computations for the PMF were carried out using the HEC-1 Generalized Computer Program. The input data computations and results are contained in Appendix D to this report. The inflow from the two tributaries was routed through their respective ponds. The outflow, which is the combination of the hydrographs, results in a test flood of 1350 cfs, (1930 csm). The relatively small (18-acre) pond offers little flood regulation for the 0.7 square mile drainage area.

Town Road No. 9 which runs through the impoundment does not adversely impede flood flows. This is shown on the rating curves for the hydraulic structures of Lake Clara in Appendix D. The most significant hydraulic control is the open channel flowing from the East Pond. The rating curve for this channel section was computed using the HEC-2 Generalized Computer Program assuming that the slope of the energy grade line would be equal to the normal water surface slope of 0.00427 feet/foot as determined by Southern Vermont

Engineering, Inc. in October, 1973. The overbank n-value of 0.08 was selected to represent tall grass combined with the stumps (See Photo No. 4) and the channel n-value of 0.045 represents the narrow silty sand channel with some vegetation and debris fallen into it.

b. Experience Data

There is no known overtopping of the structure even though it has been in place through four of the most significant floods in the history of Southern Vermont. These floods are November, 1927, September, 1938, June, 1973 and August, 1976. During the June, 1973 flood the water was reported to have been 1.5' to 2' over Town Road No. 9. This elevation would be about 122[3]. This would have almost overtopped the dam and also caused water to flow through the saddle shown in the easterly meadow. Water from this saddle will flow across the meadow and Town Road No. 9 to enter the old brook channel downstream of the dam.

c. Visual Observations

The outlet canal from the East Pond has been cleared of the debris and dead conifers shown by ANCO in 1961. This represents a significant improvement in the outlet capacity.

There is still an active beaver population which, combined with some human activity, have partially blocked the culvert under Town Road No. 9.

d. Overtopping Potential

Based on a SDF of 1350 cfs the water in Lake Clara could rise to elevation 122.8 if all water were confined to the outlet canal or elevation 122.2 if we allow for outflow through the saddle and the outlet canal. Consequently, the dam is in danger of being overtopped slightly at the east end which was reported to have an elevation of 122.

e. Dam-Break Flood

If the Lake Clara Dam were to fail, a wave of water approximately 20 feet high would be released. This wave would travel down a relatively steep valley for a distance of less than

[3] Datum as assumed by ANCO, 1961.

1,000 feet before hitting the house over the old brook bed.

The wave may remain concentrated to a 40-foot wide path which would result in depths of flow being 5-7 over the road. Depths of this magnitude would cause damage to the town highways and two to three buildings at this impact point. The remaining structures in the Village of Whitingham would not be damaged as they are more than 10 feet above the stream bed.

SECTION 6: STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Based on visual observations one cannot evaluate the structural stability. However, there are no cracks, scarps, or movements now evident to indicate structural instability. There is some evidence of the past sloughing that is recorded in the 1961 Anderson-Nichols report. One 6 inch tree is bowed (concave upstream) as if it had been tilted downstream and then grew towards the vertical. This tree is in the central part of the downstream slope.

The animal holes, rotting tree roots, and intermittent upstream riprap all indicate that failure by internal erosion is a possibility. The combination of these weak features and the high water levels within the dam make this dam subject to potential failure at any time that a severe combination of conditions occurs.

b. Design and Construction Data

There are no design and construction data on which to base an evaluation of stability of this dam.

c. Operating Records for the Dam

There are no operating records for the dam.

d. Post-Construction Changes

At some time prior to the 1961 report by Anderson-Nichols, the downstream face of this dam sloughed to form a 3 foot high escarpment just downstream of the crest. At that time the crest was 10 feet wide. The slough extended 25-30 feet downslope and was about 30 feet wide. This slough was wet and soft.

Subsequently, this slough was either covered or trimmed to a smooth slope, and the crest was widened to 15 to 20 feet, as it exists today. The character of fill used is not known. The many old stumps presently on the downstream slope indicate that whatever fill was placed was not very thick, and no grubbing was done in advance of filling.

Thus there is no reason to expect that the stability of the downstream slope is any greater now than it was prior to the old slough.

e. Seismic Stability

The dam is in Seismic Zone 2 and need not be evaluated for earthquake induced stresses, according to the USCE Guidelines.

SECTION 7: ASSESSMENT, RECOMMENDATIONS/ REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Condition

Based on the records and the visual inspection, this dam requires remedial work to improve its stability.

b. Adequacy of Information

The lack of indepth engineering data does not allow for a definitive review. Therefore the adequacy of this dam, structurally and hydraulically, can not be assessed from the standpoint of review of design calculations, but must be based primarily on the visual inspection, past performance history and sound hydrologic and hydraulic engineering judgement.

c. Urgency

The remedial measures should be carried out this season, or measures should be taken to partially drain the lake until repairs are designed and constructed. A combination of wet weather and other conditions, such as an animal hole, root hole, or a frozen downstream face, could lead to failure of this dam.

d. Necessity for Additional Information

The additional investigations described in Section 7.2 below are necessary.

7.2 RECOMMENDATIONS

It is recommended that an engineer qualified in the design of earth dams be engaged to investigate and design the items listed below and that a contractor be engaged to reconstruct the dam according to the design:

(1) Removal of roots.

(2) Partial excavation of downstream slope and placement of a properly filtered downstream shell with drainage provisions.

(3) New riprap protection for upstream face.

(4) A control structure to allow the lake level to be varied and to allow the lake to be drained in an emergency condition, or for periodic maintenance.

7.3 REMEDIAL MEASURES

a. Alternatives

None.

b. O & M Maintenance and Procedures

A systematic program should be developed to cut brush from the entire dam at least annually and to monitor and eliminate animal activity in the area of the dam. If the animal holes are not controlled, design provisions should be made to render such holes harmless. In addition, the area along the outlet canal should be mowed annually to keep the overbanks clear of brush, and the 4' conduit between the two lake sections should be kept clear of debris.

Arrangements should be made to have a local resident provide 24-hour surveillance of the dam during periods of unusually heavy precipitation. In the event an emergency condition develops a procedure should be formalized with local officials for warning residents downstream of the dam.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT LAKE CLARA DAM

DATE June 16, 1978

TIME 0900

WEATHER Clear 70°

W.S. ELEV.______U.S.____DN.S.

PARTY:

1. Walter Henry D&H
2. John Spencer D&H
3. Morris Root D&H
4. Steve Poulos GEI
5.
6.
7.
8.
9.
10.

PROJECT FEATURE	INSPECTED BY	REMARKS
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE CLARA DAM

DATE June 16, 1978

PROJECT FEATURE

NAME

DISCIPLINE Geotechnical

NAME S. J. Poulos

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	None observed.
Pavement Condition	No pavement. Grass and shrubs.
Movement or Settlement of Crest	Approx. 1 ft. deep dip in crest 185' rt. of centerline of town road. Downstream crestline is not depressed.
Lateral Movement	Not possible to discern.
Vertical Alignment	See above. Too irregular to discern.
Horizontal Alignment	Too irregular to discern.
Condition at Abutment and at Concrete Structures	Left abut. contact: no seepage observed. Rt. abut. contact: zone of seepage starts slightly ds of contact line and extends along contact down to outlet structure.
Indications of Movement of Structural Items on Slopes	No indications of movement observed
Trespassing on Slopes	Free access. Several animal holes. At about 188 ft. rt. of road one hole extends into ds face at least 6 ft. Another hole 255 ft. rt. on us side.
Sloughing or Erosion of Slopes or Abutments	US slope slightly wave cut at water level. One 6 in. ∅ tree on ds face is bowed downstream in vicinity of old slough noted in correspondence.
Rock Slope Protection - Riprap Failures	Riprap is discontinuous. No filter material apparent behind riprap.
Unusual Movement or Cracking at or near Toes	None discernable
Unusual Embankment or Downstream Seepage	Downstream slope in central portion of dam is damp or wet 2/3 of the way up from the toe to crest.

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE CLARA DAM

DATE June 16, 1978

PROJECT FEATURE

NAME

DISCIPLINE Geotechnical

NAME S. J. Poulos

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Piping or Boils	None observed.
Foundation Drainage Features	Outlet conduit could act as partial drain. No other drainage features found.
Toe Drains	None
Instrumentation System	None
Vegetation	Numerous old stumps to 24 in. size on upstream and downstream side. One 10 in. stump underwater upstream.

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE CLARA DAM

DATE June 16, 1978

PROJECT FEATURE

NAME

DISCIPLINE Geotechnical

NAME S. J. Poulos

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	None
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection - Riprap Failures	
Unusual Movement or Cracking at or near Toes	
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
Instrumentation System	

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE CLARA DAM

DATE June 16, 1978

PROJECT FEATURE

NAME

DISCIPLINE Geotechnical

NAME S. J. Poulos

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	
Slope Conditions	According to records, the intake structure was filled with earth because the outlet valve (butterfly) was leaking. Structure not now visible, although it could be the concrete noted about 185 ft. right of centerline of Town Road No. 9.
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	N/A
Drains or Weep Holes	N/A
b. Intake Structure	N/A
Condition of Concrete	
Stop Logs and Slots	

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE CLARA DAM

DATE June 16, 1978

PROJECT FEATURE

NAME

DISCIPLINE Geotechnical

NAME S. J. Poulos

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - CONTROL TOWER</u>	
a. Concrete and Structural	None
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE CLARA DAM

DATE June 16, 1978

PROJECT FEATURE

NAME

DISCIPLINE Geotechnical

NAME S. J. Poulos

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	Not functioning. See page 4.
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE CLARA DAM

DATE June 16, 1978

PROJECT FEATURE

NAME

DISCIPLINE Geotechnical

NAME S. J. Poulos

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Stone walls about 3 ft. apart with flat stone lintel on top.
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain Holes	
Channel	
Loose Rock or Trees Overhanging Channel	No rocks. Overgrown with trees.
Condition of Discharge Channel	Fair
	Small flow exiting from outlet structure, perhaps 25 to 50 gpm, even though intake was plugged. Rust colored bottom in outlet channel.

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE CLARA DAM

DATE June 16, 1978

PROJECT FEATURE

NAME

DISCIPLINE Geotechnical

NAME S. J. Poulos

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Lake bottom
b. Weir and Training Walls	None
General Condition of Concrete	
Rust or Staining	
Spalling	
Any Visible Reinforcing	
Any Seepage or Efflorescence	
Drain Holes	
c. Discharge Channel	
General Condition	
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Channel	Silty bottom where water is flowing. Remainder, at higher elevation, is grass, stumps and low shrubs.
Other Obstructions	Beaver dam on higher elevation portion.

PERIODIC INSPECTION CHECK LIST

PROJECT LAKE CLARA DAM

DATE June 16, 1978

PROJECT FEATURE

NAME

DISCIPLINE Geotechnical

NAME S. J. Poulos

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	None
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Conditon of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

APPENDIX B

A. Listing of Design, Construction, and Maintenance Records

None

B. Copies of Past Inspection Reports

1. "Inspection of Clara Lake Dam Whitingham, Vermont" by Anderson-Nichols and Company, Inc., June, 1961.

2. "Amended Report Lake Clara Dam" by Donald H. Spies, Dam Construction Engineer, Vermont Department of Water Resources; February 3, 1972.

3. "Engineering Report on Lake Clara Dam and Outlet Canal" by Southern Vermont Engineering, Inc., October, 1973.

C. Listing of Plans

1. Figure 1 - Lake Clara Dam

2. Figure 2 - Lake Clara Dam, Typical Section Dam and Discharge Channel

3. Figure 3 - Lake Clara Dam, Hydraulic Profile

4. Figure 4 - Village of Whitingham Street Map

INSPECTION OF

CLARA LAKE DAM

WHITINGHAM, VERMONT

Prepared by:

Anderson-Nichols & Company, Inc.
150 Causeway Street
Boston 14, Massachusetts

June 1961

CLARA LAKE DAM

1. General - History of major floods in Vermont indicates that loss of life and extensive property damage have been experienced. Structural failure of many existing dams has contributed significantly to peak flood flows and associated losses. In general, these failures resulted from inadequacies in spillway capacities, structural design and maintenance repair. To minimize flood damages associated with possible future dam failures, the Water Resources Division of the Vermont Water Conservation Board is directed to undertake a program of periodic inspection of existing dams. The firm of Anderson-Nichols & Company, Inc. has been retained to assist the Board in performing these inspections and evaluating the adequacy of the structures. A visual examination of the Clara Lake Dam site was made on May 18, 1961. Photographs taken during the examination are appended to this report.

2. Purpose - The purpose of this report is to:

(a) Summarize the investigation of Clara Lake Dam and Canal in the Township of Whitingham, Windsor County, Vermont.

(b) Evaluate the adequacy of the dam and canal.

(c) Recommend to the Board appropriate action to be taken in view of the flood hazards associated with the existing dam and canal.

3. Scope - The scope of this investigation includes a field inspection of the dam structure, the reservoir area and the outlet channel, an office review of survey data furnished by the Water Resources Division of the Vermont State Water Conservation Board, studies to determine the adequacy of the dam and facilities for passing flood flows and a report summarizing the investigations.

4. Photographs - The attached photographs taken on May 18, 1961, show the following:

Photograph No. 1 - Flagged outlet works on the upstream face of the dam and extensive growth of trees and vegetation.

Photograph No. 2 - Stone outlet of conduit and brook channel at downstream toe of dam.

Photograph No. 3 - View of canal and fallen timber obstructing flow from Clara Lake to Lake Sadawga.

Photograph No. 4 - View of house over brook channel approximately 2,000 feet downstream of the dam.

5. Watershed Description - The watershed tributary to the dam includes about 448 acres, or 0.7 square mile of which a large part is wooded. The highest elevations are about 300 feet above the lake

level. The shape of the drainage area is roughly rectangular, with the most remote part about a mile from the northern periphery of the lake.

4. Site Description - The dam is located in the Township of Whitingham about two-tenths of a mile north of the Village of Whitingham, and about four-tenths of a mile north of Lake Sadawga. The lake, or pond, created by the dam is roughly rectangular in shape, with a surface area of about 15 acres. The dam is at the southwest corner of the pond, and a road which serves a few farm houses runs northerly through the westerly part of the pond. A four-foot diameter steel pipe serves to pass normal discharges under the road from the west side to the east side of the pond. (See Exhibit 1).

7. Before the dam was constructed, the water from the tributary drainage area passed southerly from the dam site to join the outflow from Lake Sadawga in the northerly part of Whitingham Village. When the dam was constructed, a canal was also built to divert water from Clear Lake into Lake Sadawga. Water from Lake Sadawga was carried by a pipe line to generate electric power at a power house located westerly of the Village of Whitingham.

8. <u>Structure Description</u> - The dam is of earth fill construction with a total length of approximately 370 feet, top width varying from six to twelve feet and a maximum height above the brook bed of about 31 feet. No plans of the structure were made available. Mr. Houghton Sawyer, the present owner, stated that the dam was built about 1923. Its construction consisted of a concrete core resting on a ledge rock foundation upon which earth fill was placed. He further stated that a butterfly valve located in a conduit through the dam leaked badly and that several years ago he had the entrance to the conduit filled with earth. Since that time there has been no means of discharging water at the dam.

9. When the dam was inspected, a concrete box with open top and open at the side, facing the pond was located just above the water line on the upstream side of the earth embankment, directly opposite the conduit at the downstream side of the dam. (See Photograph No. 1.) It is probable that this concrete box structure is part of the entrance to the original conduit which Mr. Sawyer had filled to prevent loss of water. There was no visible waterway at the bottom of the box on the date of inspection. The downstream portion of the conduit at the old brook bed consists of two fieldstone walls, three feet apart, running into the dam perpendicular to its axis.

Flat pieces of fieldstone resting on these walls span the opening between them. These stone slabs serve to support the earth fill over the conduit. (See Photograph No. 2.) The length of this conduit could not be determined. The height of the opening is about 1.5 feet. A very small amount of clear water was flowing from the conduit.

10. The top elevation of the embankment which forms the dam varies from 123.6 to 122 (local datum based on elevation 100 at the crest of Lake [illegible] Dam), with the lowest point at the east end near the gravel road. The top width varies from a minimum of about six feet at the location of the original brook channel to about twelve feet at a location 65 feet southeasterly of the old channel location. At the location of the maximum top width, the downstream portion of the fill was very soft and light. It appeared to be composed of peat, or decayed wood waste. There are small trees growing on much of the downstream side of the earth embankment throughout the length of the dam.

11. In the vicinity of the old brook channel, which is also the highest portion of the dam, the downstream face of the embankment had slumped, leaving a nearly vertical cleavage line at the downstream shoulder. (See Exhibit II, Section A.) The vertical height of this

cleavage plane was about three feet. The slumped area extended down along the slope a distance of 25 or 30 feet, and parallel to the axis of the dam for a distance of about 28 feet. The earth was soft and saturated with water. At one point, about ten or twelve feet in elevation below the top of the dam and a few feet southeasterly of the alignment of the old conduit, there was a shallow pool of standing water about a foot in [illegible]. There was no indication that the pond water had overtopped the dam during the past spring.

12. At a location about 110 feet from the easterly end of the dam, the toe of the dam is about 15 feet in elevation below the top of the embankment. At this location, there was water standing on the surface of the ground about 20 feet out from the toe of the dam. Mr. Sawyer stated that there is a spring at this location, and that he had constructed a stone drain to carry the water toward the brook bed from the spring. It is probable that this so-called spring is leakage from the dam.

13. Canal Description - The canal which conveys the water from Lake Cl[illegible] to Lake Sadawga has its entrance at the southeasterly arm of the pond. The shore of the pond in this area, and the area through which the upper end of the canal passes, is covered with a thick growth of conifers, which are all now dead. At a point

approximately 1,200 feet downstream of the entrance to the canal, the conifers in the vicinity of the channel had been killed, and many of them had fallen down, so that the channel was nearly covered with fallen trees. (See Photograph No. 3.) The canal is about eight or ten feet wide with a maximum depth of about 1.5 feet. (See Exhibit II, Sections D and E.) The flow in the canal was very sluggish. There was evidence along the low right bank that the water had been about a foot higher during the spring high runoff than on the date of the inspection. The slope of the bottom of the canal is very flat at the upper end, but at a point about halfway from Lake Clara to [illegible] Lake, the slope increases, so that the water flows swiftly. There is a total drop of about 18 feet between the two lakes.

14. Discharge Facilities Available - At the present time, there is no facility for passing water at the dam. Mr. Houghton Sawyer stated on May 18, 1961, that in case of a flood, water from the lake would flow through a low saddle in the field between the road and the canal and return to the brook channel a short distance downstream of the dam. (See Exhibit I.) The survey made by the Water Resources Division engineering party on May 23, 1961, indicates that the controlling elevation in this saddle is 121.15 for a distance of about 60 feet in the direction that the water would flow from the

lake. With water at elevation 121, or only one foot below the top of the low part of the earth dam, no water would flow through the saddle.

15. The discharge capacity of the canal in its present condition can not be accurately computed, because of the trees and brush that obstruct flow. With one foot of freeboard at the dam, the discharge capacity through the canal is estimated to be less than 25% of any reasonable design flood.

16. <u>Discharge Capacity Required.</u> - As flood records are not available for this stream, an analysis was made of maximum floods of record on nearby watersheds with similar hydrologic characteristics. The unit rates of runoff for the 19[illegible]7 and 1938 flood peaks were plotted ag[illegible] drainage areas on logarithmic paper, and an envelope curve w[illegible]ed. From this curve, it was found that a runoff of 650 c[illegible] per second for the Clara Lake drainage area of 0.7 square mi[illegible], m[illegible] reasonably be expected in the future, based on discha[illegible] have occurred.

17. Only about one-fifth of the watershed drains into the lake on the west side of the road which runs northerly through the pond. A stretch of this road, about 600 feet long, varies in elevation

from 119.60 to 120.60. The existing culvert, four feet in diameter, crosses under the road at the north end of this low stretch. There is, therefore, ample capacity to pass the inflow from the west side of the road to the east side without raising the water at the dam above elevation 121, as long as the water on the east side of the road is kept slightly below elevation 121.

18. Adequacy of the Dam - Approximately 2,000 feet south of the dam the present brook channel passes under a house (see Photograph No. 4) and then under a highway before it joins the outlet brook from Lake Sadawga. The combined brooks then flow through the Village of Whitingham. Failure of the dam would cause extensive property damage and jeopardize human lives. Section A of Exhibit II, taken through the dam at the location of the outlet conduit, shows the present outlines of the embankment in solid lines. The dashed line at the top and on the downstream side shows the outline which would be required for an acceptable design. The present section is inadequate as evidenced by the serious slump which has occurred.

19. Recommendations - In view of the hazards associated with the condition of the dam and canal, our recommendations are as follows:

(a) The fallen trees and debris be cleared from the canal and adjacent banks, and that a waterway be created in the canal adequate to discharge 650 cubic feet per second with one foot of freeboard at the dam.

(b) The trees and brush on the top and downstream face of the dam be cut.

(c) The entire downstream portion of the embankment be built up with compacted pervious material, and an outside slope of one vertical on two horizontal. A minimum top width of embankment be provided which shall conform to the formula

$$W = \frac{H + 35}{5},$$

where W is the top width of embankment and H is the height of the embankment. At locations where new or ba[illegible] material is required, stripping shall be carried out to remove all top soil, vegetable material and any unstable material before the new fill is placed.

(d) The portion of the dam between the slumped area and the easterly end of the embankment be investigated to determine if the embankment contained sufficient stable material to meet the section requirements of (c) above before the decayed vegetable material was added on the downstream side.

The alternate to these recommendations is to breach the dam and drain the pond above it slowly.

Harry [illegible]
Project Engineer

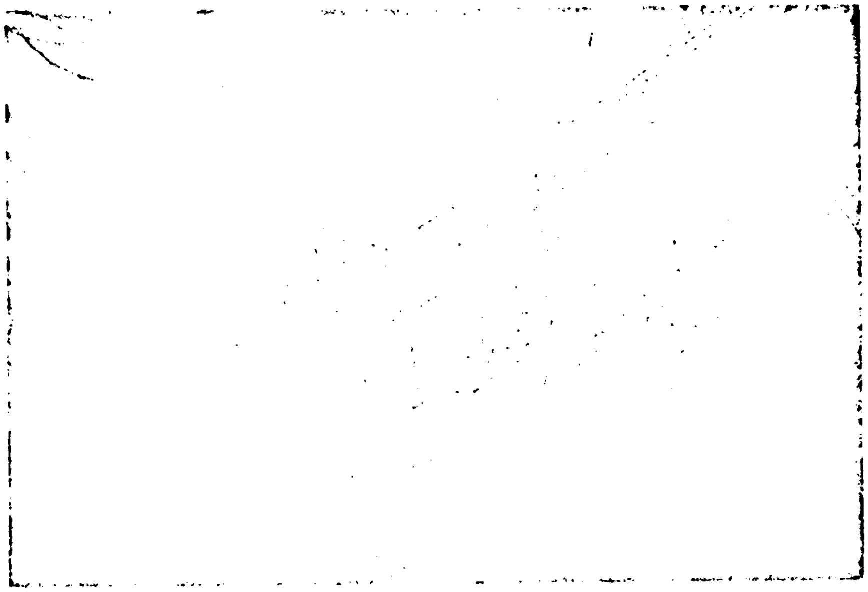
Registered Professional Engineer - Vermont 1120

Herm[illegible]
Vice President
Anderson-Nichols & Company, Inc.

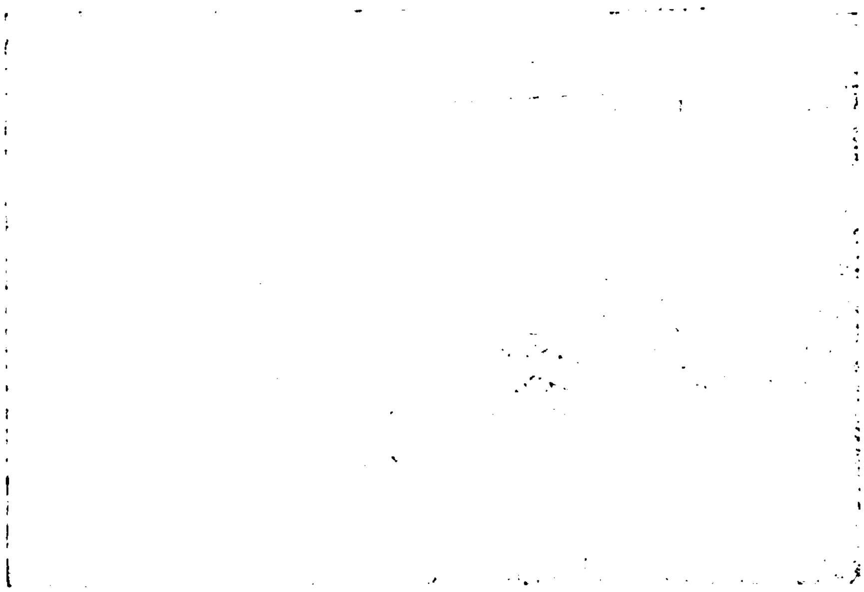
Registered Professional Engineer - Vermont 773

1

2



2



4

AMENDED REPORT

LAKE CLARA DAM

February 3, 1972

Donald H. Spies
Dam Construction Engineer

The purpose of this report is to update the information given in the 1961 report by Anderson-Nichols & Company, Inc. Since that report, the dam has changed ownership and it was principally due to the concern of the new owner for the safety of the dam that this investigation was undertaken. There was also some concern by the Town Selectmen for the dam's safety and about the flooding of the road.

The investigation included two field trips and an office review of the information gathered. The first trip was on November 19, 1971 and was only to make visual observations. The second trip, on December 14, 1971, was to make a topographic survey of the dam.

As a result, the following amendments and additions are made.

Paragraph 8. The present survey indicates that the height of the dam is approximately 35 feet and that some fill had been placed so as to increase the top width.

Paragraph 9. The concrete box is no longer visible and is assumed to be covered over by the new fill.

Paragraph 10. The top elevation is essentially the same. The top width has been increased to about twenty feet and is fairly constant over the entire length of the dam.

Paragraph 12. No investigation was made of this situation this time.

Paragraph 13. No field investigation was made of the canal this time. However, measurements were made of the culvert under Vermont Ro[illegible] 00. This culvert is downstream of the control section of the canal.

drainage area above the culvert, including that of the lake, is 0.85 square mile.

Paragraph 15. If anything, this condition could only have worsened due to the continued brush and tree growth. Also, according to the present owner, there is a considerable amount of beaver activity in the canal area. The capacity of the culvert is estimated to be about one-half of the possible flood runoff for its drainage area.

Paragraph 19.

Subparagraph (a) - The canal should be constructed to allow three feet of freeboard on the dam.

Subparagraph (c) - This report used the formula $W + \frac{H}{5} + 10$ from Chapter 5 of Design of Small Dams by the U. S. Department of the Interior, Bureau of Reclamation.

ENGINEERING REPORT

ON

LAKE CLARA DAM AND OUTLET CANAL

by

SOUTHERN VERMONT ENGINEERING, INC.

19 Harris Place

Brattleboro, Vermont 05301

October, 1973

SOUTHERN VERMONT ENGINEERING, INC.

• *Civil Engineering* •
• *Surveying and Mapping* •
• *Soil Boring and Testing* •

Box 266 (Vernon Rd.)
Brattleboro, Vermont
05301

Tel. 802/257-0274
802/254-5910
evenings

October 2, 1973

Mr. Joseph Proctor
1053 Brush Hill Road
Milton, Massachusetts 02186

Dear Mr. Proctor:

In accordance with our agreement dated July 11, 1973, we are submitting our report on the Lake Clara Dam and Outlet Canal together with recommended improvements and estimated costs.

For convenience and brevity, a Summary of Conclusions, Recommendations and Associated Costs follows this letter.

This report can be used as a basis for initiating a meaningful program of improvements and continuing future maintenance of Lake Clara Dam and Outlet Canal.

Should you desire further assistance relative to the Dam or find a more detailed study at the dam embankment itself necessary, do not hesitate to contact us.

Very truly yours,

SO. VERMONT ENGINEERING, INC.

Thaddeus Betts, P.E.

TB:pc

SUMMARY OF CONCLUSIONS, RECOMMENDATIONS

AND ASSOCIATED COST ESTIMATES

From the results of limited studies made on the Lake Clara Dam and Outlet Structure, it is concluded that:

1. Design flood flows of 650 cfs can not be passed by the Outlet Canal without creating an unsafe condition at the Dam.

2. Lives and property in jeopardy during flood conditions warrant improvements to the facility.

3. Safety of the dam can be substantially enhanced by improvements to the outlet canal.

4. The dam and outlet canal act as a flood control structure.

5. The impoundment behind the dam is an existing recreational facility used by the public.

6. More benefit would be derived from the improvement of the facility than elimination thereof.

It is, therefore, recommended that:

1. Improvement of the outlet canal be initiated immediately. The estimated cost is $4,500.

2. The downstream slope of the dam embankment be cleared of all brush and trees and the stumps be removed. The estimated cost is $550.

3. A maintenance program be immediately initiated to mow the dam embankment, to mow the outlet canal and to watch and curtail beaver activity in the outlet canal.

4. A five year program be set up to improve and stabilize the embankment. The estimated cost is $7,175.

5. The facility be offered to a municipal or State agency as these bodies are much better organized to maintain such a structure. The benefits derived from the dam, both as a flood control structure and a recreational facility, are enjoyed by the public. It, therefore, would seem equitable that the public share in the cost of maintenance.

TABLE OF CONTENTS

ENGINEERING REPORT

ON

LAKE CLARA DAM AND OUTLET CANAL

PURPOSE

The purpose of this study is to determine the safety of Lake Clara Dam and the ability of the outlet canal to pass flood flows, to make recommendations for necessary improvements and to estimate the costs of constructing the recommended improvements and modifications.

GENERAL DESCRIPTION

The Dam - Lake Clara Dam and Outlet Canal was constructed between 1926 and 1928. According to the previous owner, Mr. Houghton Sawyer, who assisted in the dam's construction, a poured concrete core was built to an elevation approximately 15 feet above the stream bed. The concrete core is reportedly one foot thick at its top and about two feet thick at the bottom. Earth fill was placed on both sides of the core wall and brought up over it to an elevation approximately 30 feet above the stream bed. The original construction of the earth embankment resulted in a cross-section with a top width of approximately 10 feet, downstream slope of 2 horizontal to 1 vertical and upstream slopes of 3 horizontal to 1 vertical. The total length of the embankment section is about 370 feet from the town road in a westerly direction to the West shore of the impoundment. The maximum depth of water in the 13-acre impoundment is approximately 22 feet located in the original stream channel some 150 feet from the water's edge at the dam.

The original construction included an outlet structure at the dam reportedly consisting of vertical concrete box with a valved pipe at the bottom passing through the concrete core to a stone culvert which outlets in the original stream channel at the downstream toe of the embankment. No record is available indicating where the pipe ends and the stone culvert begins, the size of the pipe, the type of valve installed, or the amount of fluctuation, if any, that this outlet arrangement afforded. Problems were encountered with the valve leaking, consequently the box structure was filled with earth to seal off the leaky valve. A small amount of flow was noted during an inspection in August, 1973, coming from the stone culvert. Mr. Sawyer reported that a high-volume spring was encountered by a large rock in the original stream bed just downstream from the concrete core at the time of construction.

In recent years, following the report on the dam prepared by Anderson, Nichols and Company in 1961, fill material was hauled in to increase the top width of the dam. At the present time, the dam section is between 15 and 20 feet wide at the top. The concrete outlet structure is completely hidden. Heavy stone fill has been dumped along the upstream water line.

The present normal lake level is approximately 4 feet below the high point on the top of the dam or approximate elevation 122.0 assumed survey datum. The assumed datum is referenced to a bronze tablet in the bridge over the stream at the outlet to Lake Sadawga; assumed elevation 100.00.

Where the dam is at its greatest height, the downstream slope is saturated at a point approximately one half way from the top to the toe. At some time prior to the Anderson, Nichols survey, this saturated condition caused a slope failure of a section of the downstream slope. This failure occurred in the form of a slide during which the fill material with an excessive water content flowed down the slope creating a steep area at the top and flatter area near the bottom.

The downstream slope of the dam is becoming overgrown with trees.

<u>The Outlet Canal</u> - The outlet canal flows from the southeasterly corner of the impoundment in a southerly direction to Lake Sadawga. From recent observations, it appears that this canal was completely cleared of trees to a width of approximately 150 feet and cut about 2 feet below original grade for the first 1,000 feet. The channel is about 2,000 feet in length from Lake Clara to Route 100. The first 600 feet slopes at approximately 4.25 feet per 1,000 feet. The slope increases to about 7.75 feet per 1,000 feet to the road crossing. The stream passes beneath the highway through a concrete box culvert. The culvert is not large enough to pass expected flood flows but is located far enough below the lake so that it would have no detrimental affect on the lake during flood stages.

At the present time, the outlet canal is restricted by beaver dams and brush. Behind the numerous low beaver dams, the canal has been allowed to slowly fill in with sedimentation; consequently, the effective canal is a brook 10 or 12 feet in width.

ADEQUACY OF THE DAM

The overall dimensions of the embankment structure appear to be sufficient. The general section through the dam, if the data we have been able to obtain is correct, may have some weak characteristics. Firstly, the concrete core was evidently not continued to the full height of the embankment section and there has been no mention of an impervious core being constructed of other materials above the top of the concrete. From the most accurate information to date, it would seem that the embankment section above the concrete core was constructed of fairly homogeneous earth and that selected materials at different locations were not used as normal in earth and rock dam embankments. The downstream slope is saturated and somewhat unstable, probably due to water passing through this fairly impervious homogeneous embankment above the concrete core. Since the entire embankment is apparently of this same relatively tight material, the water level stays up in the section and tends to surface on the downstream slope. Since most dams made entirely of earth will leak to some extent, it is normal to fill a considerable portion of the downstream slope with pervious material which drains much more rapidly than the core and upstream slope. This method of construction keeps the water level well within the embankment section with the drier pervious material acting as a brace against the less stable saturated impervious core.

At the present time, the downstream slope of the dam has apparently reached a comparatively stable condition as the saturated material sluffed down the face of the dam to result in a flatter slope at the bottom. The steeper slope near the top was not saturated during the inspection in August, 1973. If it is possible to maintain the water level from rising in any extreme amount, the downstream slope will not become saturated at a higher level creating the potential to cause another slide.

From available data to date, it would seem that the downstream slope of the dam could be stabilized with the addition of coarse granular fill. More detailed studies should be made to determine how much slope stabilization is necessary. These studies should include determination of the exact location and height of the existing concrete core, determination of types of materials used in the dam's construction, and possible installation of vertical pipes along the embankment section to monitor the water flow through the structure.

ADEQUACY OF THE OUTLET CANAL

At the present time, the outlet canal is severely restricted in its ability to pass flood flows without creating a dangerously high water condition at the dam. Approximately seven low beaver dams have been constructed across the entire width of the original canal. On occasion, these dams have been breached to allow the normal stream flow to pass. The width of the openings in these dams ranges from 10 to 15 feet and constitutes a restriction to the passage of flood flows. In its present condition, the outlet canal is inadequate to pass flood flows without causing an undue rise in lake level. This rise in lake level causes an unhealthy condition at the dam as previously explained.

RECOMMENDED IMPROVEMENTS - The Canal

The most urgently needed improvement is to clear and regrade the outlet canal so that flood flows can be transported out of the impoundment without causing a dangerous condition at the dam. The present normal water freeboard at the dam is approximately 4 feet. It is estimated that flood flows of 650 cubic feet per second should create no more than a 2 foot differential in lake level to avoid jeopardizing the dam. A minimum freeboard at maximum flood stage would be 2 feet.

To accomplish this, the initial 1,500 feet of outlet canal must be cleared. The present stream bed should be deepened approximately 1.5 feet to allow the adjacent relatively flat area of the canal to dry. The excess material and low beaver dams in the original canal can then be pushed back with a bulldozer and the area can be graded smooth and seeded with grass. The channel section should generally conform to the section shown on Exhibit 1 of this report.

After the improvements have been made to the canal, a maintenance program should be instituted. The grass cover crop in the canal should be mowed at least once a year. It may be necessary to mow by hand scythe but it is our opinion that, if the construction generally conforms to the section shown on the exhibit, light machinery can be used to mow the canal.

In addition, frequent surveillance should be made to determine the existence of new beaver activity.

The Dam

Immediate improvements at the dam should consist of clearing the downstream slope of all trees and shrubs and mowing the grass on the embankment frequently. Tree roots create flow paths through the structure if allowed to become well established; therefore, the stumps of the trees now on the embankment should be removed. Stump removal should only be attempted when the water is at its lowest level.

A five year improvement program should include determination of the amount and type of granular slope stabilization necessary for the downstream slope of the embankment and placement of this material.

Rough estimates of materials involved to stabilize the dam's embankment in critical areas are as follows: Excavation - 200 cu. yd., Stone fill - 200 cu. yd., Granular fill - 1000 cu. yd., 6" Crushed rock - 50 cu. yd., Impervious fill - 200 cu. yd., Loaming and Seeding - 2000 sq. yd.

ESTIMATED COSTS OF RECOMMENDED IMPROVEMENTS:

Canal Rehabilitation

Clearing and Burning Brush	$1,000
Beaver Dam Demolition and Grading	3,000
Seeding	500
TOTAL	$4,500

Dam Improvements

Stage #1

Clearing and Stump Removal	$ 500
Mowing	50
TOTAL	$ 550

Stage #2

Excavation 200 cu. yd. @ 2.50	$ 500
Granular Fill 1000 cu. yd. @ 2.50	2,500
Stone Fill (6" to 24") 200 cu.yd. @ 6.00	1,200
Crushed Rock (6") 50 cu. yd. @ 7.50	375
Impervious Fill 200 cu. yd. @ 3.00	600
Loam and Seed 2000 sq. yd. @ 1.00	2,000
TOTAL	$7,175

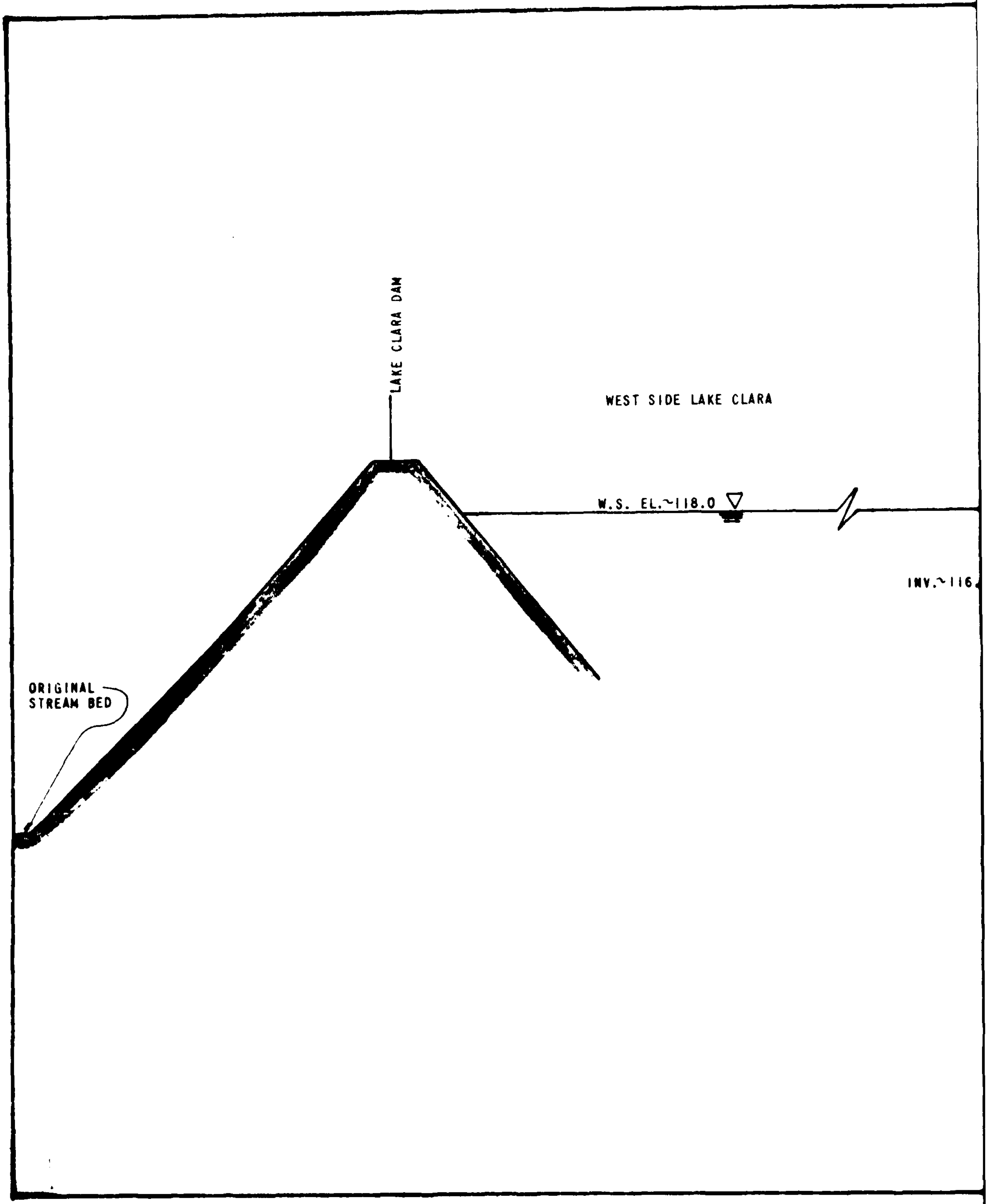
[illegible]

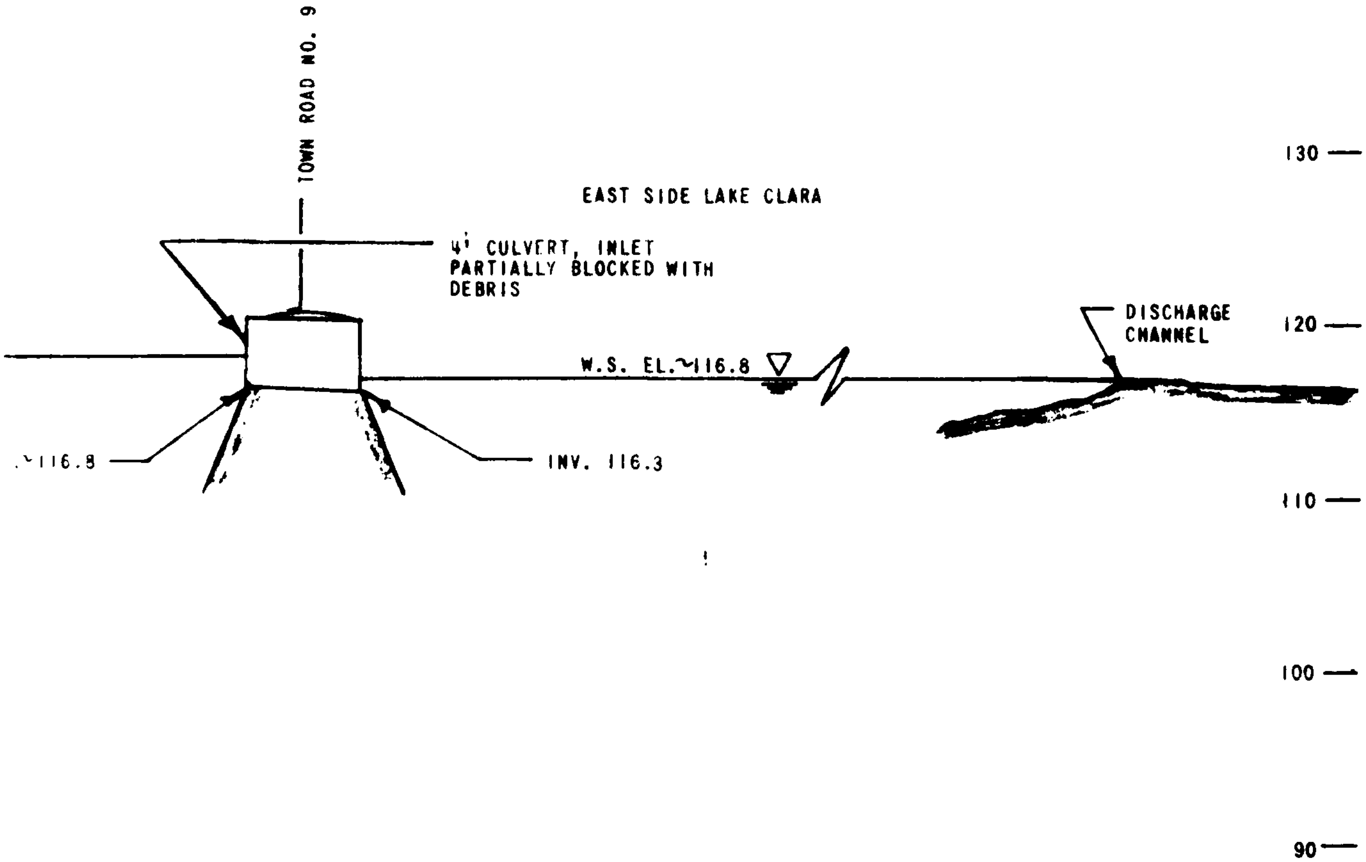
Numerous alternatives have been suggested to solve the various problems associated with the Lake [illegible] Dam and Outlet Canal.

One suggestion has been to drain the pond and breach the dam. It is estimated that if one were to use a 2500 gpm engin driven centrifugal pump that it would require between three weeks and a month of relatively dry weather to drain the pond running the pump continuously. A rough estimate of the costs involved yields figures of $3,000 for draining the pond and $4,500 for breaching the dam. While being quite costly, benefits derived from the pond's existence would be sacrificed. Namely, the fact that not only is this body of water an excellent recreational facility but it also is a very important flood control structure protecting the small hamlet of Whitingham. It would not seem to be a reasonable solution to allow the stream to run again in its natural watercourse as potential damage by anticipated flood flows would be excessive.

For the reason given above, we would not recommend constructing an emergency spillway at the dam.

Partial draining of the pond and constructing the top portion of concrete core is another alternative. If unlimited funds were available, this would make feasible the inclusion of some method to control the pond's level. While this option is attractive, the associated costs of an estimated $20,000 to $25,000 seem to outweigh the benefit of limited level control at the dam.


LAKE CLARA DAM
WEST SIDE LAKE CLARA
W.S. EL.~118.0
INV.~116.
ORIGINAL STREAM BED



SCALE: 1"=50' HORIZ.
1"=10' VERT.

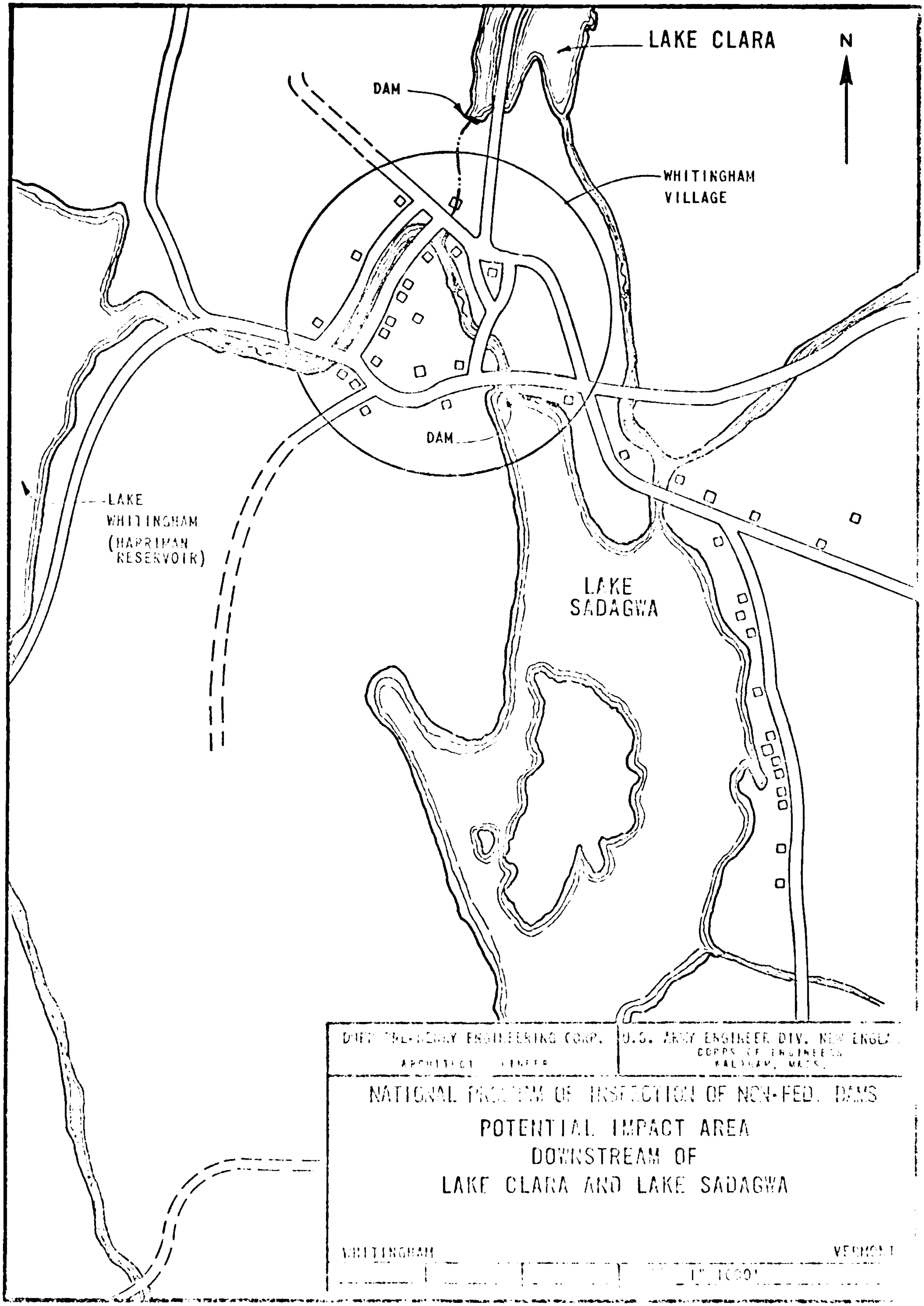
DUFRESNE-HENRY ENGINEERING CORP. ARCHITECT-ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

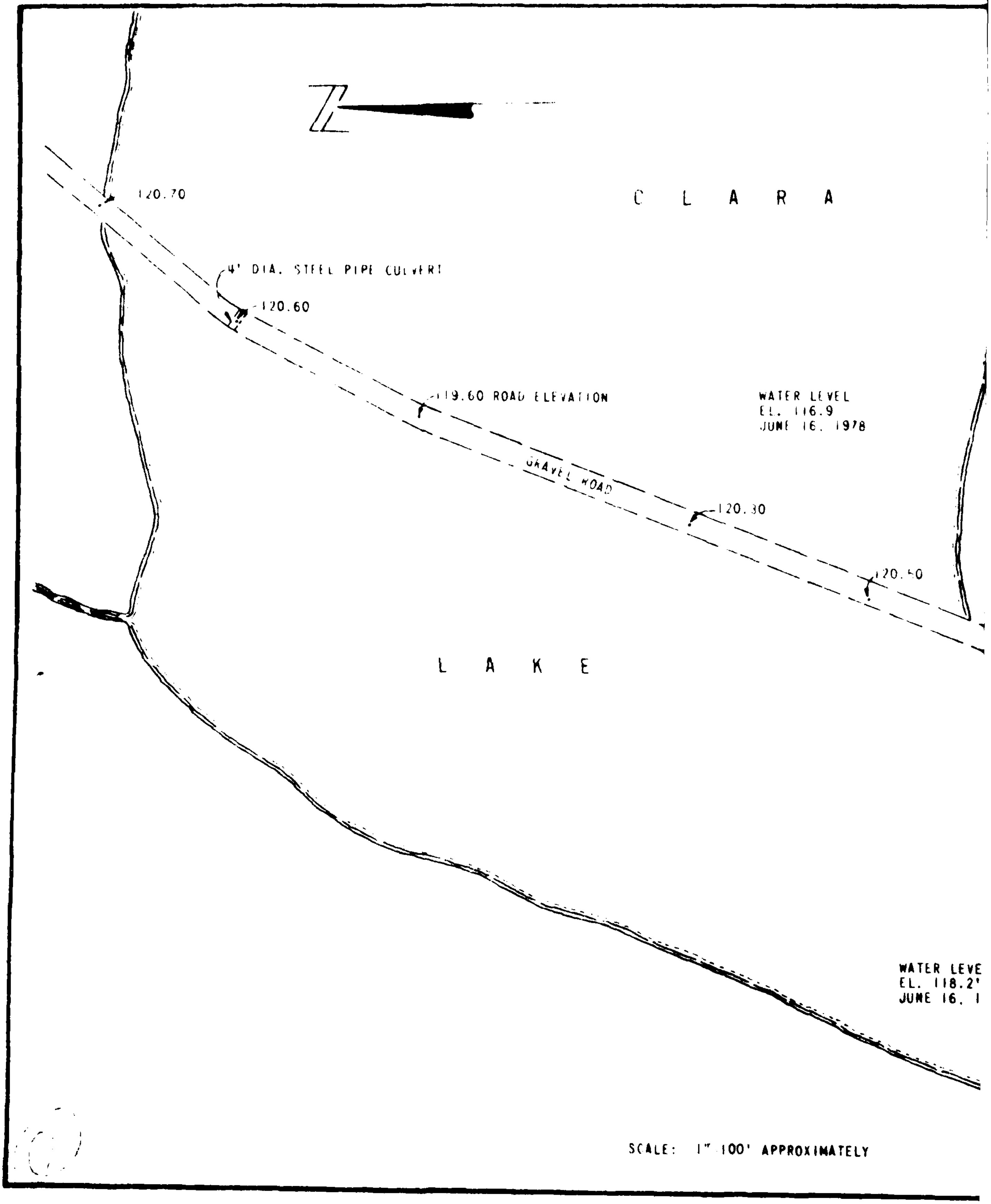
LAKE CLARA DAM
HYDRAULIC PROFILE

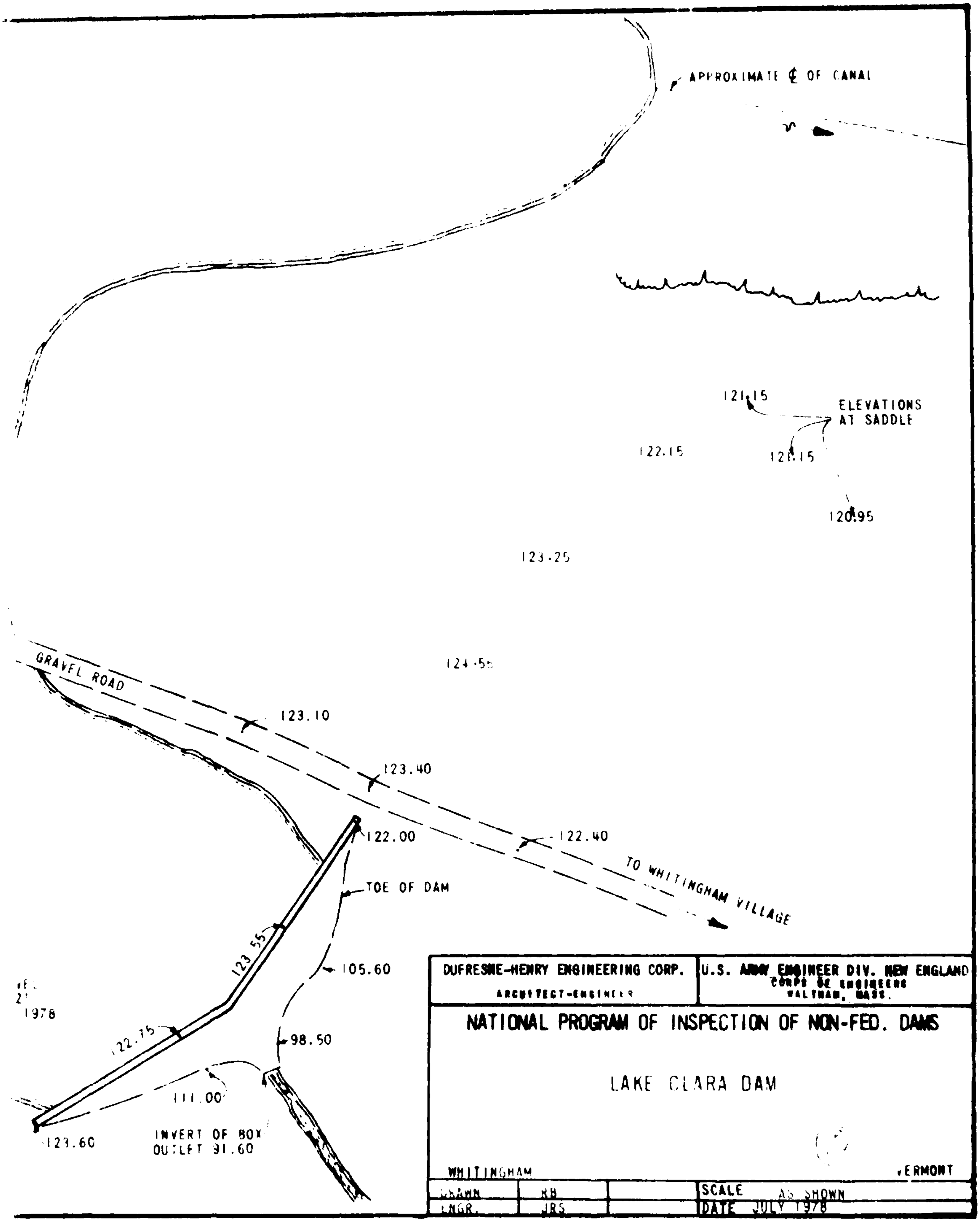
WHITINGHAM VERMONT

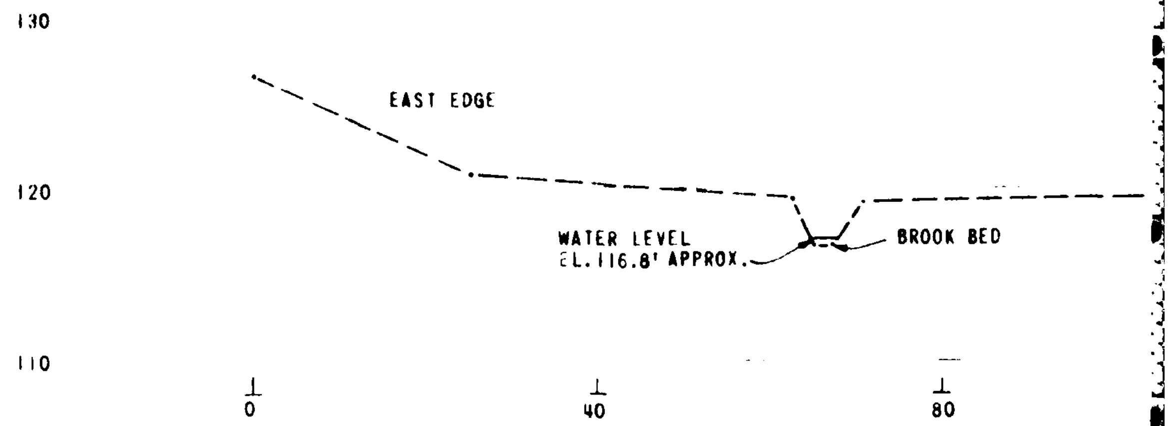
DRAWN	JRS.		SCALE	AS SHOWN
ENGR.	JRS		DATE	JULY 1978



LAKE CLARA
N
DAM
WHITINGHAM VILLAGE
DAM
LAKE WHITINGHAM (HARRIMAN RESERVOIR)
LAKE SADAGWA
U.S. ARMY ENGINEER DIV.
POTENTIAL IMPACT AREA
DOWNSTREAM OF
LAKE CLARA AND LAKE SADAGWA

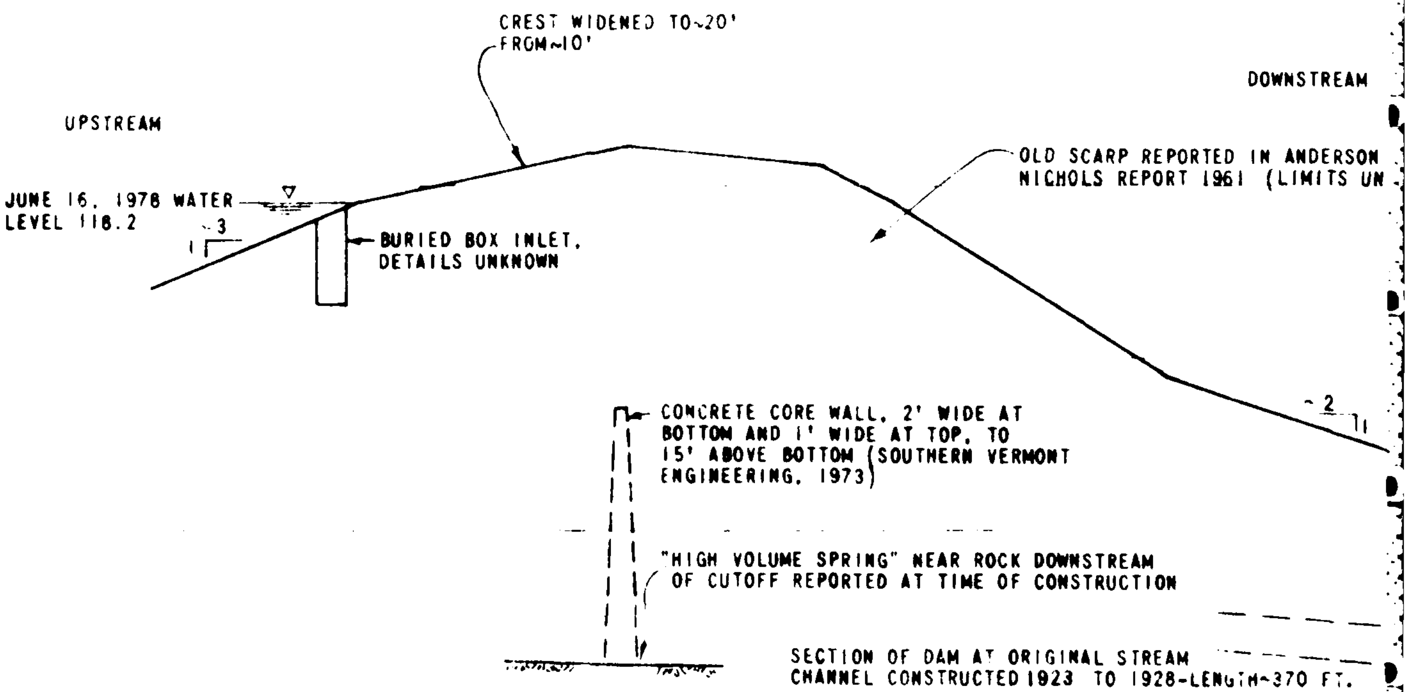

120.70
C L A R A
4' DIA. STEEL PIPE CULVERT
120.60
119.60 ROAD ELEVATION
WATER LEVEL
EL. 116.9
JUNE 16, 1978
GRAVEL ROAD
120.30
120.60
L A K E
WATER LEVE
EL. 118.2'
JUNE 16, 1
SCALE: 1" 100' APPROXIMATELY


APPROXIMATE ℄ OF CANAL
ELEVATIONS AT SADDLE
121.15
121.15
120.95
122.15
123.25
124.55
GRAVEL ROAD
123.10
123.40
122.40
TO WHITINGHAM VILLAGE
122.00
TOE OF DAM
123.55
105.60
122.75
98.50
111.00
123.60
INVERT OF BOX OUTLET 91.60
1978
DUFRESNE-HENRY ENGINEERING CORP.
ARCHITECT-ENGINEER
U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
LAKE CLARA DAM
WHITINGHAM
VERMONT
DRAWN RB
ENGR. JRS
SCALE AS SHOWN
DATE JULY 1978



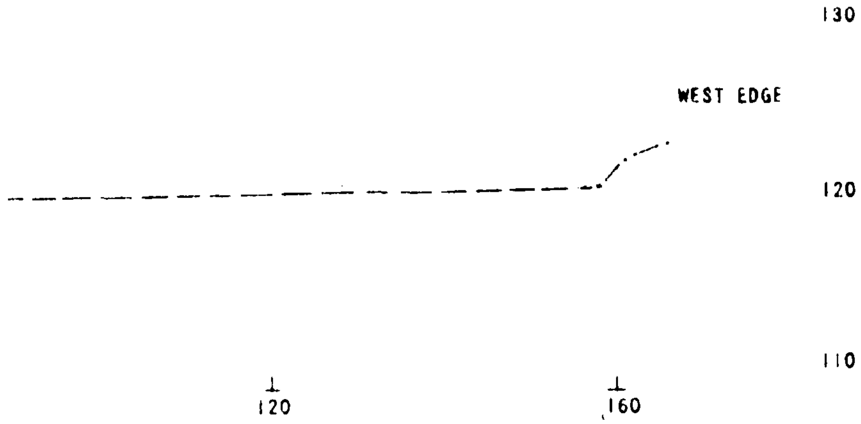
TYPICAL DISCHARGE CHAN

SCALE: 1"=20' HORI
1"=10' VER



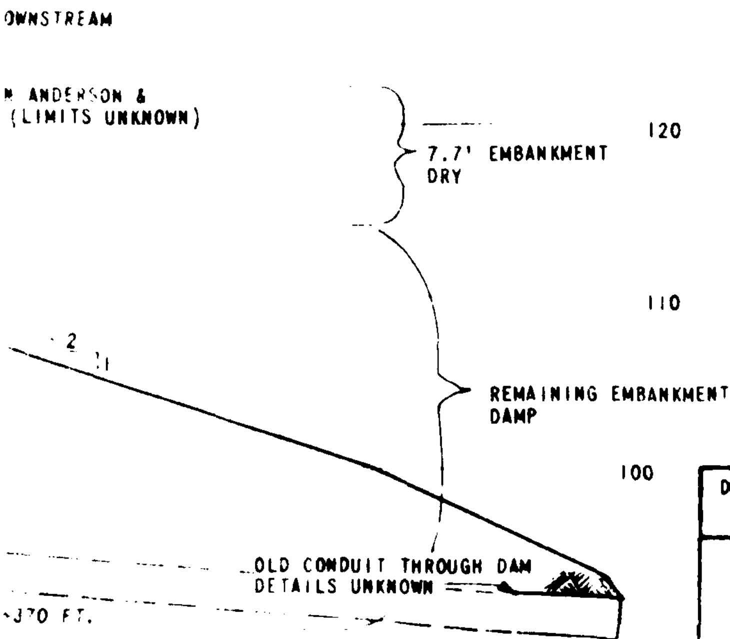
TYPICAL DAM SECTION

SCALE: 1"=10' HORIZONTAL AND VERTICAL



GE CHANNEL SECTION

":20' HORIZ.
1" 10' VERT.



NOTES:

1. ELEVATIONS ARE SAME AS ANDERSON-NICHOLS & COMPANY REPORT OF 1961.
2. SECTION AS DRAWN BY SOUTHERN VERMONT ENGINEERING, INC., 1973.

DUFRESNE-HENRY ENGINEERING CORP.
ARCHITECT-ENGINEER

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

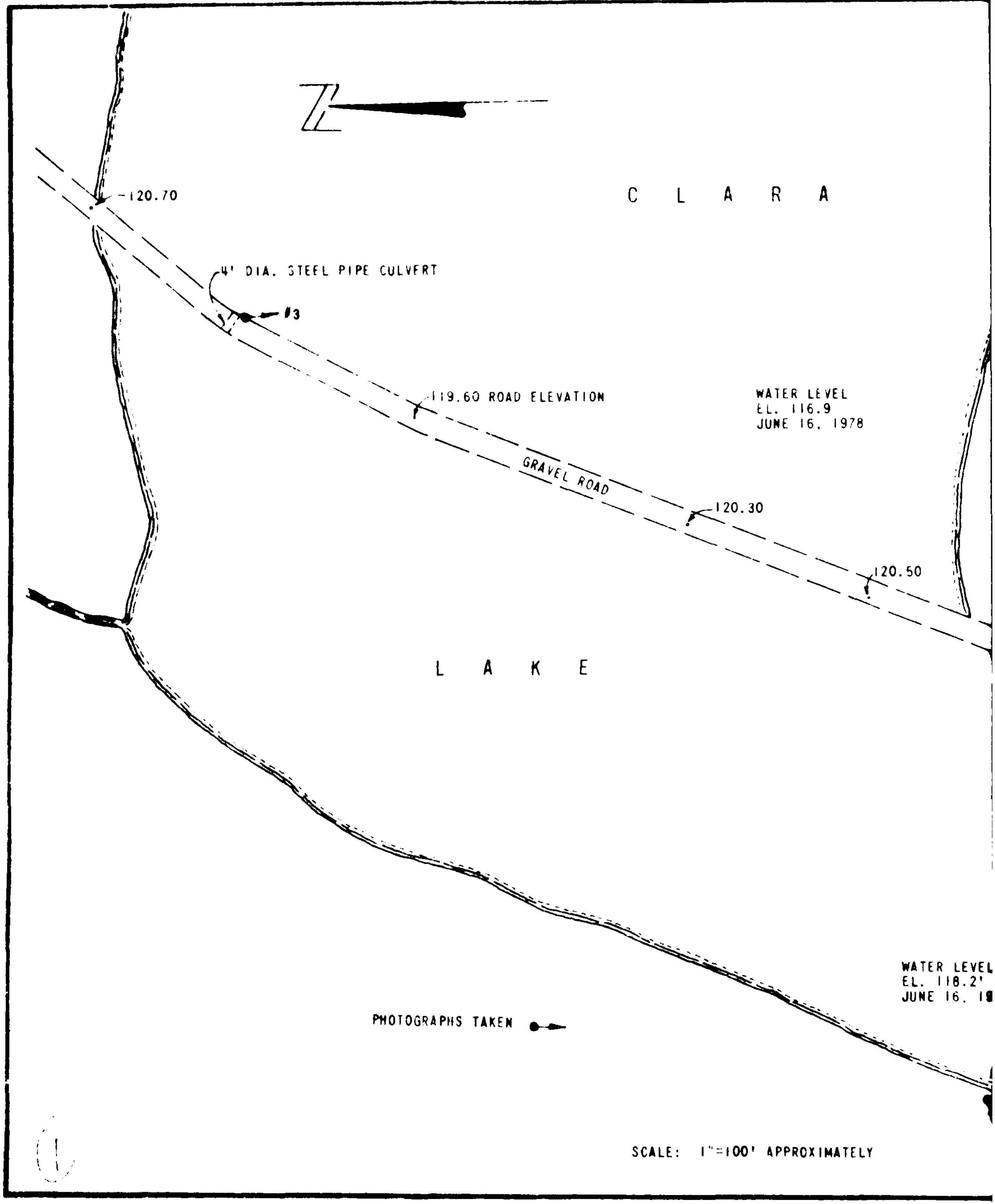
LAKE CLARA DAM
TYPICAL SECTION DAM AND DISCHARGE CHANNEL

WHITINGHAM VERMONT

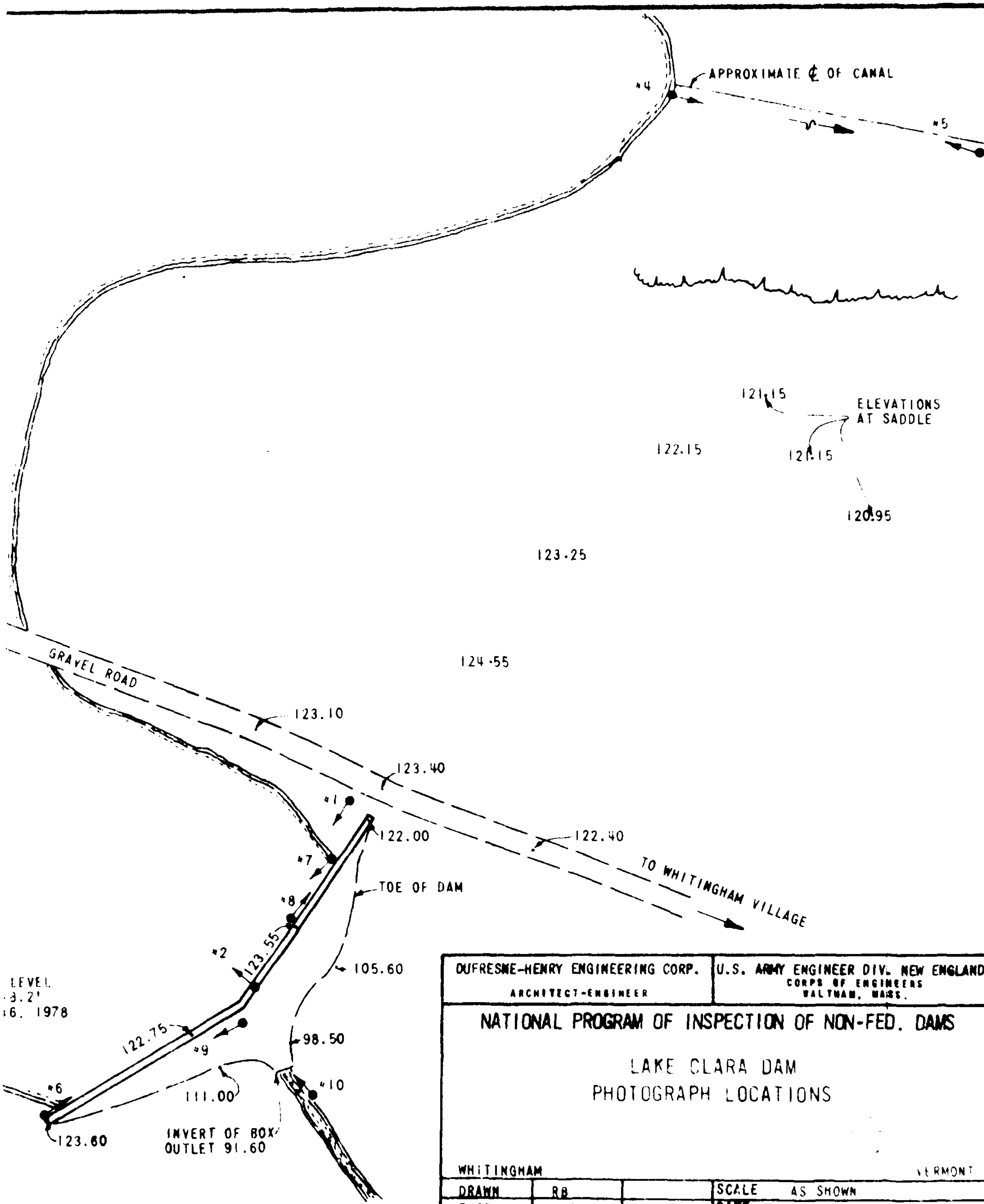
C-N	22-0554		SCALE	AS SHOWN
ENGR.	JRS		DATE	JULY 1978

APPENDIX C

PHOTOGRAPHS



-120.70
C L A R A
4' DIA. STEEL PIPE CULVERT
#3
119.60 ROAD ELEVATION
WATER LEVEL
EL. 116.9
JUNE 16, 1978
GRAVEL ROAD
120.30
120.50
L A K E
WATER LEVEL
EL. 118.2'
PHOTOGRAPHS TAKEN
SCALE: 1"=100' APPROXIMATELY



DUFRESNE-HENRY ENGINEERING CORP. ARCHITECT-ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LAKE CLARA DAM
PHOTOGRAPH LOCATIONS

WHITINGHAM VERMONT

DRAWN	RB		SCALE	AS SHOWN
ENGR.	JRS		DATE	JULY 1978

#1 VIEW OF LAKE CLARA DAM FROM TOWN ROAD 9 LOOKING WEST

#2 VIEW OF LAKE CLARA FROM DAM LOOKING NORTHEAST.
NOTE TOWN ROAD NO. 9 BISECTING LAKE CLARA.

#3 EAST PORTION OF LAKE CLARA FROM TOWN ROAD NO. 9 LOOKING SOUTHEAST, SHOWING ENTRANCE TO OUTLET CHANNEL.

#4 OUTLET CHANNEL, LOOKING SOUTH, SHOWING OVERBANK PORTION.

#5

OUTLET CHANNEL, LOOKING NORTH, SHOWING LOW FLOW PORTION

#6 LAKE CLARA DAM LOOKING EAST. NOTE POSSIBLE BEAVER HOUSE IN FOREGROUND, AND BRUSH ON CREST OF DAM.

#7 LAKE CLARA DAM LOOKING WEST

#8 RIPRAP ON UPSTREAM FACE OF LAKE CLARA DAM

#9 DOWNSTREAM SLOPE LAKE CLARA DAM, SHOWING RELATIVE STEEPNESS

#10 OUTLET OF ABANDONED CONDUIT. NOTE FLOW OUT OF CONDUIT AND FROM LEFT AND RIGHT SIDES OF STREAM BANK.

APPENDIX D

HYDRAULIC COMPUTATIONS

Index to computations

Size Classification

34-35' High 216-252 Ac-ft small

Hazard Potential

small number of inhabitable structures significant/high

From Table 3
SDF = 100-yr to ½ PMF // ½ PMF to PMF

considering potential for loss of life - use ½ PMF = SDF

Hydrologic Characteristics

note split in drainage area -

1.) into pond regulated by canal directly -
0.35 1.37 .49+ .48 sq. miles L = 1.2 miles

2.) into pond regulated by 4' culvert -
0.19 .37 = .18 square miles
L = .8 miles

total = .63 sq. miles

① S = $\frac{1900 - 1700}{.9}$ = 222'/mile

L = 1.2 miles $\hat{L}_c$ = .6L = .72 miles

T_p = 2.2 $\left(\frac{L L_c}{\sqrt{S}}\right)^{.37}$ = .77 hours C_p = .75 A = .48 square mil

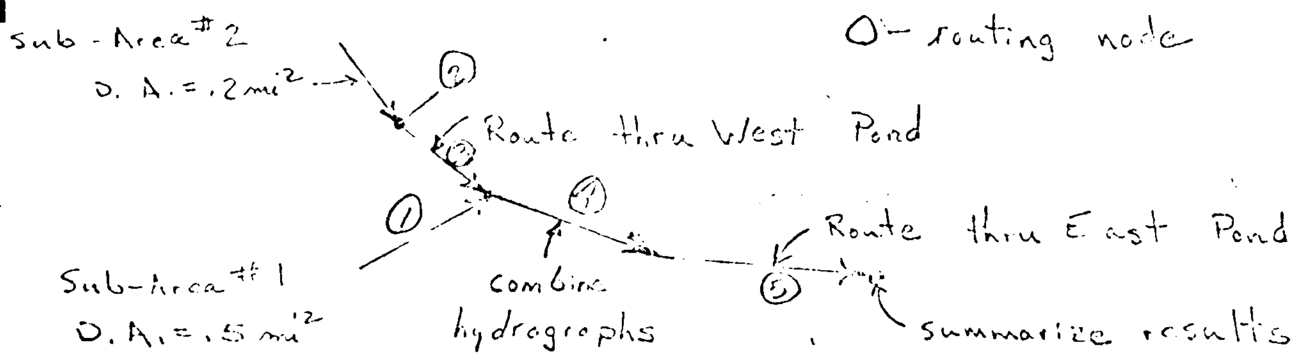
② S = $\frac{1910 - 1710}{.6}$ = 333'/mile

L = .8 miles $\hat{L}_c$ = .6L = .48 miles

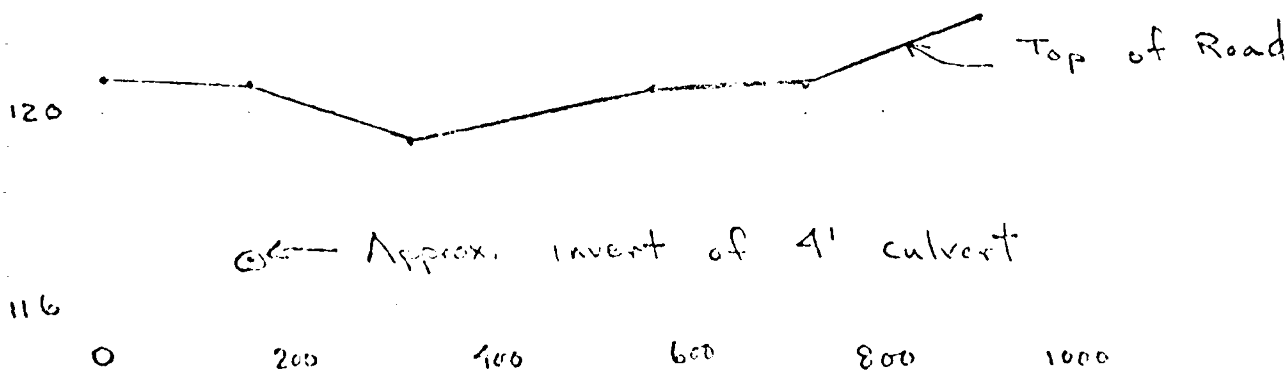
T_p = 0.53 hours C_p = .75 A = .18 square mil

PMP = 18" - Plate No. 1 EM 1110-2-1411 .64 sq

Routing Diagram for HEC-1



Hydraulic Control at Town Highway No. 9



Scale; H; 1" = 200'
V = 1" = 4'

** ********************
VERSION DATED JAN 1973
ED AUG 74
E NO. 01
****

FLOOD ROUTING THROUGH LAKE CLARA, WHITINGHAM, VERMONT

PREPARED FOR USE IN DAM SAFETY EVALUATION PHASE I

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
144	0	10	0	0	0	0	2	0	0

JOPER	NWT
3	0

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

SUB-AREA RUNOFF COMPUTATION

HYDROGRAPH FOR TRIBUTARY NUMBER 2

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	0.20	0.0	0.0	1.00	0.500	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	18.00	110.00	122.00	132.00	0.0	0.0	0.0

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.33	0.07	0.0	0.0

UNIT HYDROGRAPH DATA

TP= 0.50 CP=0.75 NTA= 0

RECESSION DATA

STRTQ= 2.00 QRCSN= -0.10 RTIOR= 1.50

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 4.08 AND R= 1.53 INTERVALS

UNIT HYDROGRAPH 11 END-OF-PERIOD ORDINATES, LAG= 0.50 HOURS, CP= 0.75 VOL= 1.00

33.	109.	176.	167.	132.	68.	34.	18.	9.	5.
2.									

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.02	0.00	2.
2	0.02	0.00	2.
3	0.02	0.00	2.
4	0.02	0.00	2.
5	0.02	0.00	2.
6	0.02	0.00	2.
7	0.02	0.00	2.
8	0.02	0.00	1.
9	0.02	0.00	1.
10	0.02	0.00	1.
11	0.02	0.00	1.
12	0.02	0.00	1.

[illegible]	[illegible]	[illegible]	[illegible]
14	0.02	0.00	1.
15	0.02	0.00	1.
16	0.02	0.00	1.
17	0.02	0.00	1.
18	0.02	0.01	2.
19	0.02	0.01	3.
20	0.02	0.01	4.
21	0.02	0.01	6.
22	0.02	0.01	6.
23	0.02	0.01	7.
24	0.02	0.01	7.
25	0.02	0.01	7.
26	0.02	0.01	7.
27	0.02	0.01	7.
28	0.02	0.01	7.
29	0.02	0.01	7.
30	0.02	0.01	7.
31	0.02	0.01	7.
32	0.02	0.01	7.
33	0.02	0.01	7.
34	0.02	0.01	7.
35	0.02	0.01	7.
36	0.02	0.01	7.
37	0.06	0.05	8.
38	0.06	0.05	13.
39	0.06	0.05	20.
40	0.06	0.05	27.
41	0.06	0.05	32.
42	0.06	0.05	35.
43	0.06	0.05	36.
44	0.06	0.05	37.
45	0.06	0.05	37.
46	0.06	0.05	38.
47	0.06	0.05	38.
48	0.06	0.05	38.
49	0.06	0.05	38.
50	0.06	0.05	33.
51	0.06	0.05	38.
52	0.06	0.05	38.
53	0.06	0.05	38.
54	0.06	0.05	38.
55	0.06	0.05	38.
56	0.06	0.05	38.
57	0.06	0.05	37.
58	0.06	0.05	37.
59	0.06	0.05	37.
60	0.06	0.05	37.
61	0.06	0.05	37.
62	0.06	0.05	37.
63	0.06	0.05	37.
64	0.06	0.05	37.
65	0.06	0.05	37.
66	0.06	0.05	37.
67	0.06	0.05	37.
68	0.06	0.05	37.
69	0.06	0.05	37.
70	0.06	0.05	37.
71	0.06	0.05	37.
72	0.06	0.05	37.
73	0.33	0.32	46.
74	0.33	0.32	76.
75	0.33	0.32	123.
76	0.33	0.32	174.
77	0.33	0.32	209.
78	0.33	0.32	227.
[illegible]	[illegible]	[illegible]	[illegible]

79	0.40	0.38	239.
80	0.40	0.38	251.
81	0.40	0.38	265.
82	0.40	0.38	278.
83	0.40	0.38	288.
84	0.40	0.38	292.
85	0.49	0.48	298.
86	0.49	0.48	310.
87	0.49	0.48	328.
88	0.49	0.48	346.
89	0.49	0.48	360.
90	0.49	0.48	366.
91	1.25	1.24	394.
92	1.25	1.24	479.
93	1.25	1.24	613.
94	1.25	1.24	756.
95	1.25	1.24	856.
96	1.25	1.24	907.
97	0.46	0.45	908.
98	0.46	0.45	835.
99	0.46	0.45	702.
100	0.46	0.45	557.
101	0.46	0.45	455.
102	0.46	0.45	401.
103	0.36	0.35	371.
104	0.36	0.35	346.
105	0.36	0.35	321.
106	0.36	0.35	297.
107	0.36	0.35	285.
108	0.36	0.35	270.
109	0.03	0.02	254.
110	0.03	0.02	226.
111	0.03	[illegible]	16[illegible]
112	0.03	[illegible]	10[illegible]
113	0.03	[illegible]	[illegible]
114	[illegible]	[illegible]	[illegible]
115	0.03	[illegible]	[illegible]
116	0.03	[illegible]	[illegible]
117	0.03	0.02	7[illegible]
118	0.03	0.02	72.
119	0.03	0.02	69.
120	0.03	0.02	66.
121	0.03	0.02	64.
122	0.03	0.02	61.
123	0.03	0.02	59.
124	0.03	0.02	58.
125	0.03	0.02	5[illegible]
126	0.03	0.02	52.
127	0.03	0.02	50.
128	0.03	0.02	48.
129	0.03	0.02	46.
130	0.03	0.02	44.
131	0.03	0.02	43.
132	0.04	0.02	41.
133	0.03	0.02	39.
134	0.03	0.02	38.
135	0.03	0.02	36.
136	0.03	0.02	35.
137	0.03	0.02	33.
138	0.03	0.02	32.
139	0.03	0.02	31.
140	0.03	0.02	30.
141	0.03	0.02	28.
142	0.0[illegible]	0.02	27.
143	0.0[illegible]	[illegible]	26.
144	0.0[illegible]	0.02	25.

SUM 23.70 22.03 18008.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	908.	407.	125.	125.	18009.
INCHES		18.92	23.27	23.27	23.27
AC-FT		202.	248.	248.	248.

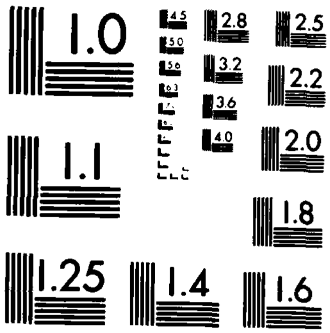
RUNOFF MULTIPLIED BY 0.50

1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	2.
3.	3.	3.	3.	4.	4.	4.	4.	4.	4.
3.	3.	3.	5.	5.	5.	4.	6.	10.	14.
16.	17.	18.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	23.	38.	62.	87.	105.	114.	119.	125.
132.	139.	144.	[illegible]	149.	155.	164.	173.	180.	183.
197.	[illegible]	307.	378.	428.	454.	454.	417.	351.	279.
227.	201.	185.	173.	161.	150.	142.	139.	132.	113.
83.	52.	46.	42.	41.	39.	37.	36.	35.	33.
32.	31.	29.	28.	27.	26.	25.	[illegible]	23.	22.
21.	20.	20.	19.	18.	18.	17.	16.	15.	15.
14.	14.	13.	13.						

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	454.	203.	63.	63.	9095.
INCHES		9.60	11.63	11.63	11.63
AC-FT		101.	124.	124.	124.

AD-A156 679   NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS   2/2
LAKE CLARA DAM (VT 00..(U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV AUG 78

UNCLASSIFIED   F/G 13/13   NL



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS 1963 A

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

HYDROGRAPH ROUTING

ROUTING THROUGH WEST POND

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
3	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

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

STORAGE=	0.	3.	6.	11.	15.	17.	18.	22.	25.	29.
OUTFLOW=	2.	5.	10.	20.	35.	60.	100.	235.	400.	600.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	1.	1.
2	-0.	1.	2.
3	-0.	1.	2.
4	-0.	1.	2.
5	-0.	1.	2.
6	-0.	1.	2.
7	-0.	1.	2.
8	-0.	1.	2.
9	-0.	1.	2.
10	-0.	1.	2.
11	-0.	1.	2.
12	-0.	1.	2.
13	-0.	1.	2.
14	-0.	1.	2.
15	-0.	1.	2.
16	-0.	1.	2.
17	-0.	1.	2.
18	-0.	1.	2.
19	-0.	1.	2.
20	-0.	2.	2.
21	-0.	2.	2.
22	-0.	3.	2.
23	-0.	3.	2.
24	-0.	3.	2.
25	-0.	4.	2.
26	-0.	4.	2.
27	-0.	4.	2.
28	-0.	4.	2.
29	-0.	4.	2.
30	-0.	4.	2.
31	-0.	4.	2.
32	-0.	3.	2.
33	0.	3.	2.
34	0.	3.	2.
35	0.	3.	2.
36	0.	3.	2.
37	0.	4.	2.
38	0.	5.	2.
39	0.	6.	2.
40	0.	12.	2.
41	1.	15.	3.

[illegible]	[illegible]	[illegible]	[illegible]
43	1.	18.	3.
44	1.	18.	3.
45	1.	19.	3.
46	2.	19.	4.
47	2.	19.	4.
48	2.	19.	4.
49	2.	19.	4.
50	2.	19.	5.
51	3.	19.	5.
52	3.	19.	5.
53	3.	19.	5.
54	3.	19.	6.
55	3.	19.	6.
56	3.	19.	6.
57	4.	19.	6.
58	4.	19.	7.
59	4.	19.	7.
60	4.	19.	7.
61	4.	19.	8.
62	4.	19.	8.
63	5.	19.	8.
64	5.	19.	8.
65	5.	19.	9.
66	5.	19.	9.
67	5.	19.	9.
68	5.	19.	9.
69	5.	19.	10.
70	6.	19.	10.
71	6.	19.	10.
72	6.	19.	10.
73	6.	21.	11.
74	6.	30.	11.
75	7.	50.	12.
76	8.	74.	14.
77	9.	96.	16.
78	10.	109.	19.
79	11.	117.	22.
80	13.	122.	26.
81	14.	129.	31.
82	15.	136.	35.
83	17.	142.	58.
84	18.	145.	85.
85	18.	147.	100.
86	19.	152.	126.
87	19.	159.	140.
88	20.	169.	152.
89	20.	176.	162.
90	20.	181.	170.
91	20.	190.	179.
92	21.	218.	195.
93	22.	273.	228.
94	23.	342.	283.
95	24.	403.	342.
96	25.	441.	390.
97	26.	454.	425.
98	26.	436.	431.
99	25.	384.	404.
100	24.	315.	360.
101	23.	253.	308.
102	22.	214.	262.
103	22.	193.	229.
104	21.	179.	208.
105	21.	167.	191.
106	20.	155.	176.
107	20.	146.	163.
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
109	19.	135.	146.
110	19.	122.	136.
111	19.	98.	120.
112	18.	67.	98.
113	18.	48.	82.
114	17.	43.	69.
115	17.	41.	60.
116	17.	40.	56.
117	16.	38.	52.
118	16.	37.	49.
119	16.	35.	46.
120	16.	34.	43.
121	16.	33.	41.
122	16.	31.	39.
123	15.	30.	37.
124	15.	29.	35.
125	15.	28.	35.
126	15.	27.	34.
127	15.	26.	34.
128	15.	24.	34.
129	15.	24.	33.
130	15.	23.	33.
131	15.	22.	32.
132	14.	21.	32.
133	14.	20.	31.
134	14.	19.	31.
135	14.	18.	30.
136	14.	18.	30.
137	14.	17.	29.
138	13.	16.	29.
139	13.	16.	28.
140	13.	15.	28.
141	13.	14.	27.
142	13.	14.	27.
143	12.	13.	26.
146	12.	13.	25.
SUM			8119.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	431.	189.	56.	56.	8119.
INCHES		8.70	10.49	10.49	10.49
AC-FT		94.	112.	112.	112.

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

SUB-AREA RUNOFF COMPUTATION

HYDROGRAPH FOR TRIBUTARY NUMBER 1

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

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	0.50	0.0	0.0	1.00	0.500	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	18.00	110.00	122.00	132.00	0.0	0.0	0.0

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.33	0.07	0.0	0.0

UNIT HYDROGRAPH DATA

TP= 0.80 CP=0.75 NTA= 0

RECESSION DATA

STRTQ= 2.00 QRCSN= -0.10 RTIOR= 1.50

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 5.91 AND R= 2.94 INTERVALS

UNIT HYDROGRAPH 19 END-OF-PERIOD ORDINATES, LAG= 0.80 HOURS, CP= 0.74 VOL= 1.00

28.	98.	186.	262.	299.	285.	226.	160.	114.	81.
57.	41.	29.	20.	15.	10.	7.	5.	4.	

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.02	0.00	2.
2	0.02	0.00	2.
3	0.02	0.00	2.
4	0.02	0.00	2.
5	0.02	0.00	2.
6	0.02	0.00	2.
7	0.02	0.00	2.
8	0.02	0.00	1.
9	0.02	0.00	1.
10	0.02	0.00	1.
11	0.02	0.00	1.
12	0.02	0.00	1.
13	0.02	0.00	1.
14	0.02	0.00	1.
15	0.02	0.00	1.
16	0.02	0.00	1.
17	0.02	0.00	1.
18	0.02	0.01	2.
19	0.02	0.01	3.
20	0.02	0.01	5.
21	0.02	0.01	7.
22	0.02	0.01	9.
23	0.02	0.01	11.
24	0.02	0.01	13.
25	0.02	0.01	14.
26	0.02	0.01	15.

[illegible]	[illegible]	[illegible]	[illegible]
28	0.02	0.01	16.
29	0.02	0.01	16.
30	0.02	0.01	16.
31	0.02	0.01	16.
32	0.02	0.01	16.
33	0.02	0.01	16.
34	0.02	0.01	17.
35	0.02	0.01	17.
36	0.02	0.01	17.
37	0.06	0.05	18.
38	0.06	0.05	22.
39	0.06	0.05	29.
40	0.06	0.05	39.
41	0.06	0.05	51.
42	0.06	0.05	63.
43	0.06	0.05	72.
44	0.06	0.05	78.
45	0.06	0.05	83.
46	0.06	0.05	86.
47	0.06	0.05	88.
48	0.06	0.05	90.
49	0.06	0.05	91.
50	0.06	0.05	92.
51	0.06	0.05	92.
52	0.06	0.05	93.
53	0.06	0.05	93.
54	0.06	0.05	93.
55	0.06	0.05	93.
56	0.06	0.05	93.
57	0.06	0.05	93.
58	0.06	0.05	93.
59	0.06	0.05	93.
60	0.06	0.05	93.
61	0.06	0.05	93.
62	0.06	0.05	93.
63	0.06	0.05	93.
64	0.06	0.05	93.
65	0.06	0.05	93.
66	0.06	0.05	93.
67	0.06	0.05	93.
68	0.06	0.05	93.
69	0.06	0.05	93.
70	0.06	0.05	93.
71	0.06	0.05	93.
72	0.06	0.05	93.
73	0.33	0.32	101.
74	0.33	0.32	127.
75	0.33	0.32	177.
76	0.33	0.32	248.
77	0.33	0.32	328.
78	0.33	0.32	405.
79	0.40	0.38	468.
80	0.40	0.38	518.
81	0.40	0.38	561.
82	0.40	0.38	600.
83	0.40	0.38	635.
84	0.40	0.38	665.
85	0.49	0.48	691.
86	0.49	0.48	716.
87	0.49	0.48	746.
88	0.49	0.48	780.
89	0.49	0.48	816.
90	0.49	0.48	848.
91	1.25	1.24	894.
92	1.25	1.24	986.
[illegible]	[illegible]	[illegible]	[illegible]

93	1.25	1.24	1139.
94	1.25	1.24	1346.
95	1.25	1.24	1579.
96	1.25	1.24	1800.
97	0.46	0.45	1952.
98	0.46	0.45	1999.
99	0.46	0.45	1940.
100	0.46	0.45	1795.
101	0.46	0.45	1602.
102	0.46	0.45	1408.
103	0.36	0.35	1248.
104	0.36	0.35	1127.
105	0.36	0.35	1029.
106	0.36	0.35	947.
107	0.36	0.35	878.
108	0.36	0.35	822.
109	0.03	0.02	770.
110	0.03	0.02	705.
111	0.03	0.02	621.
112	0.03	0.02	517.
113	0.03	0.02	406.
114	0.03	0.02	303.
115	0.03	0.02	222.
116	0.03	0.02	195.
117	0.03	0.02	187.
118	0.03	0.02	180.
119	0.03	0.02	173.
120	0.03	0.02	166.
121	0.03	0.02	159.
122	0.03	0.02	153.
123	0.03	0.02	147.
124	0.03	0.02	141.
125	0.03	0.02	135.
126	0.03	0.02	130.
127	0.03	0.02	125.
128	0.03	0.02	120.
129	0.03	0.02	115.
130	0.03	0.02	111.
131	0.03	0.02	106.
132	0.03	0.02	102.
133	0.03	0.02	98.
134	0.03	0.02	94.
135	0.03	0.02	90.
136	0.03	0.02	87.
137	0.03	0.02	83.
138	0.03	0.02	80.
139	0.03	0.02	77.
140	0.03	0.02	74.
141	0.03	0.02	71.
142	0.03	0.02	68.
143	0.03	0.02	65.
144	0.03	0.02	63.
SUM	23.70	22.03	44072.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1999.	999.	306.	306.	44018.
INCHES		18.58	22.78	22.78	22.78
AC-FT		496.	607.	607.	607.

RUNOFF MULTIPLIED BY 0.50

1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	2.
3.	5.	6.	6.	7.	7.	8.	8.	8.	8.
8.	8.	8.	8.	8.	8.	9.	11.	14.	20.
26.	31.	36.	39.	41.	43.	44.	45.	45.	46.
46.	46.	46.	47.	47.	47.	47.	47.	47.	47.
47.	47.	47.	47.	47.	47.	47.	47.	47.	47.
47.	47.	50.	64.	89.	124.	164.	203.	234.	259.
281.	300.	318.	333.	345.	358.	373.	390.	408.	424.
447.	493.	56[illegible].	673.	789.	900.	976.	999.	970.	897.
801.	704.	624.	564.	515.	474.	439.	411.	385.	353.
310.	259.	203.	152.	111.	98.	94.	90.	86.	83.
80.	77.	73.	71.	68.	65.	62.	60.	58.	55.
53.	51.	49.	47.	45.	43.	42.	40.	38.	37.
35.	34.	33.	31.						

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	999.	499.	153.	153.	22039.
INCHES		9.29	11.39	11.39	11.39
AC-FT		248.	304.	304.	304.

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

COMBINE HYDROGRAPHS

COMBINE INFLOW FROM WEST POND WITH TRIBUTARY NO. 1

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
4	2	0	0	0	0	1

SUM OF 2 HYDROGRAPHS AT 4

2.	3.	3.	3.	3.	3.	3.	3.	3.	3.
2.	2.	2.	2.	2.	2.	2.	3.	3.	4.
5.	6.	7.	8.	9.	9.	10.	10.	10.	10.
10.	10.	10.	10.	10.	10.	11.	13.	17.	22.
28.	34.	39.	42.	45.	47.	48.	49.	50.	50.
51.	51.	52.	52.	53.	53.	53.	53.	54.	54.
54.	55.	55.	55.	55.	56.	56.	56.	56.	56.
57.	57.	61.	75.	101.	138.	180.	222.	256.	285.
311.	335.	376.	418.	453.	484.	513.	542.	570.	594.
626.	688.	797.	956.	1131.	1290.	1401.	1430.	1374.	1257.
1109.	966.	853.	772.	706.	650.	602.	565.	531.	489.
430.	357.	285.	221.	171.	153.	145.	138.	132.	126.
120.	115.	110.	106.	102.	99.	96.	94.	91.	88.
85.	83.	80.	78.	75.	73.	71.	69.	67.	65.
63.	61.	59.	57.						

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1430.	684.	209.	209.	30150.
INCHES		9.09	11.13	11.13	11.13
AC-FT		339.	416.	416.	416.

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

HYDROGRAPH ROUTING

ROUTE THROUGH EAST POND

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
5	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

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

STORAGE	0.	6.	10.	16.	24.	29.	31.	39.	47.	56.
OUTFLOW	2.	5.	10.	20.	40.	80.	100.	300.	600.	1050.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	2.	2.
2	0.	2.	2.
3	0.	3.	2.
4	0.	3.	2.
5	0.	3.	2.
6	0.	3.	2.
7	0.	3.	2.
8	0.	3.	2.
9	0.	3.	2.
10	0.	3.	2.
11	0.	3.	2.
12	0.	2.	2.
13	0.	2.	2.
14	0.	2.	2.
15	0.	2.	2.
16	0.	2.	2.
17	0.	2.	2.
18	0.	2.	2.
19	0.	3.	2.
20	0.	4.	2.
21	0.	5.	2.
22	0.	6.	2.
23	0.	7.	2.
24	0.	8.	2.
25	0.	9.	2.
26	1.	9.	2.
27	1.	9.	2.
28	1.	10.	2.
29	1.	10.	2.
30	1.	10.	3.
31	1.	10.	3.
32	1.	10.	3.
33	1.	10.	3.
34	1.	10.	3.
35	1.	10.	3.
36	2.	10.	3.
37	2.	11.	3.
38	2.	12.	3.
39	2.	15.	3.
40	2.	19.	3.
41	3.	25.	3.

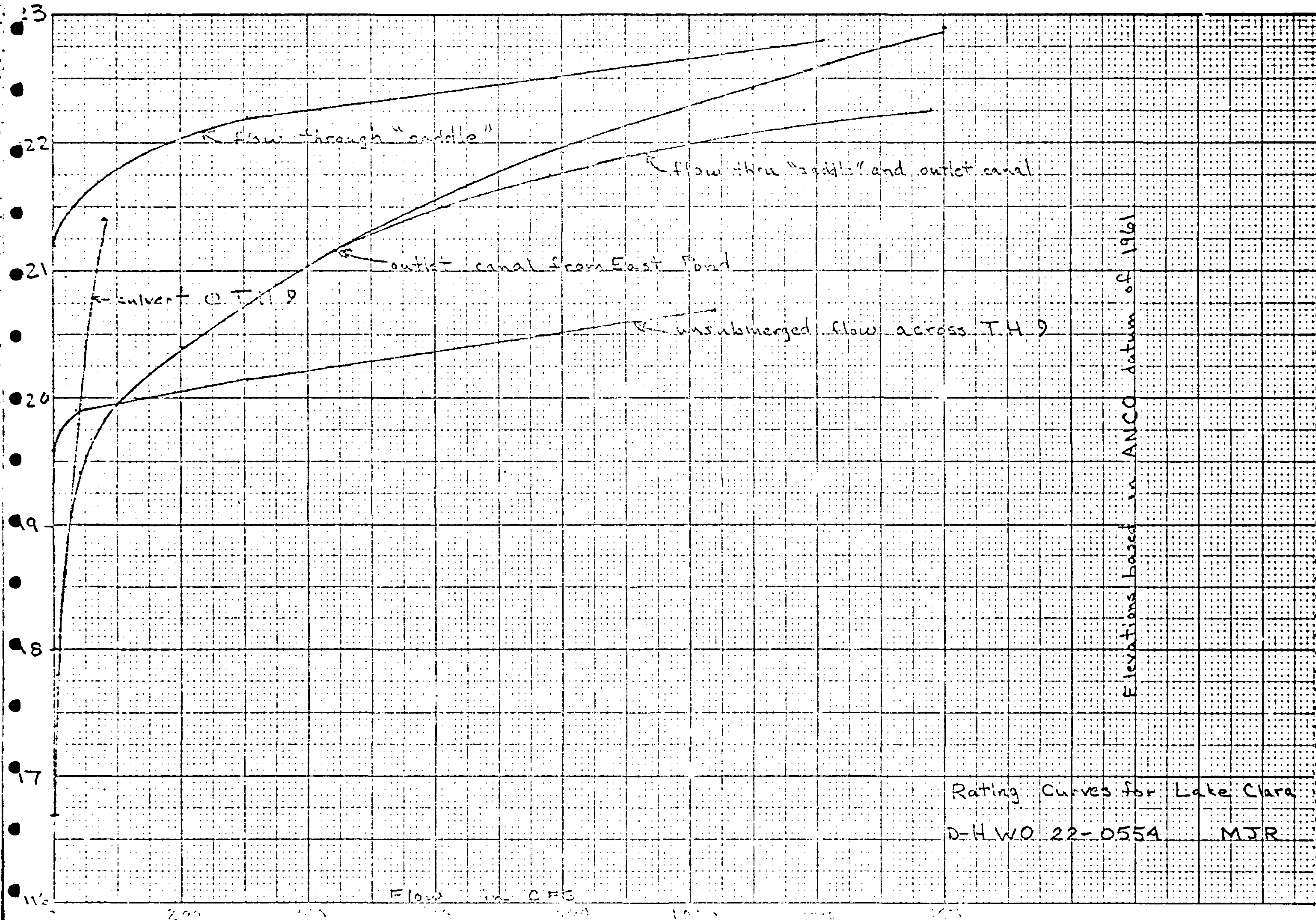
[illegible]	[illegible]	[illegible]	[illegible]
43	3.	36.	4.
44	4.	41.	4.
45	4.	44.	4.
46	5.	46.	5.
47	6.	47.	5.
48	6.	48.	6.
49	7.	49.	6.
50	7.	50.	7.
51	8.	51.	8.
52	9.	51.	8.
53	9.	51.	9.
54	10.	52.	10.
55	10.	52.	10.
56	11.	53.	11.
57	11.	53.	12.
58	12.	53.	13.
59	13.	54.	13.
60	13.	54.	14.
61	14.	54.	15.
62	14.	54.	16.
63	15.	55.	16.
64	15.	55.	17.
65	16.	55.	18.
66	16.	55.	18.
67	17.	56.	19.
68	17.	56.	20.
69	18.	56.	21.
70	18.	56.	22.
71	19.	57.	23.
72	19.	57.	25.
73	20.	55.	26.
74	20.	60.	22.
75	21.	88.	30.
76	22.	115.	34.
77	24.	159.	39.
78	26.	201.	56.
79	28.	239.	78.
80	31.	271.	102.
81	33.	298.	161.
82	35.	323.	210.
83	37.	355.	254.
84	38.	397.	298.
85	40.	436.	350.
86	41.	469.	395.
87	42.	499.	434.
88	43.	528.	470.
89	44.	556.	503.
90	45.	582.	533.
91	46.	610.	562.
92	47.	657.	598.
93	49.	743.	667.
94	51.	877.	767.
95	54.	1013.	899.
96	57.	1211.	1047.
97	60.	1345.	1190.
98	63.	1416.	1297.
99	64.	1402.	1347.
100	63.	1316.	1332.
101	62.	1183.	1261.
102	59.	1037.	1154.
103	57.	909.	1035.
104	55.	812.	930.
105	53.	739.	839.
106	51.	678.	762.
107	49.	626.	697.
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
109	47.	548.	598.
110	46.	510.	564.
111	45.	460.	525.
112	44.	394.	475.
113	42.	321.	416.
114	40.	253.	354.
115	38.	196.	295.
116	37.	162.	255.
117	36.	149.	225.
118	35.	142.	198.
119	34.	135.	179.
120	33.	129.	164.
121	33.	123.	152.
122	32.	118.	141.
123	32.	113.	133.
124	32.	108.	125.
125	32.	106.	119.
126	31.	101.	113.
127	31.	98.	109.
128	31.	95.	105.
129	31.	92.	101
130	31.	89.	99.
131	31.	87.	98.
132	30.	84.	96.
133	30.	82.	[illegible]
134	30.	79.	[illegible]
135	30.	78.	91.
136	30.	74.	89.
137	29.	72.	87.
138	29.	70.	85.
139	29.	68.	83.
140	29.	66.	81.
141	[illegible]	64.	[illegible]
142	28.	62.	77.
143	28.	60.	75.
144	26.	56.	[illegible]
SUM			28149.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1347.	672.	195.	195.	28149.
INCHES		8.93	10.39	10.39	10.39
AC-FT		333.	388.	388.	388.

RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	2	454.	203.	63.	63.	0.20
ROUTED TO	3	431.	189.	56.	56.	0.20
HYDROGRAPH AT	1	959.	499.	153.	153.	0.50
2 COMBINED	4	1430.	684.	209.	209.	0.70
ROUTED TO	5	1347.	672.	195.	195.	0.70



23
22
21
20
19
18
17
Flow in CFS
flow through "saddle"
flow thru "saddle" and outlet canal
outlet canal from East Pond
culvert @ T.H. 9
unsubmerged flow across T.H. 9
Elevations based on ANCO datum of 1961
Rating Curves for Lake Clara
D-HWO 22-0554 MJR

DUFRESNE-HENRY ENGINEERING CORPORATION

BY Morris Root SUBJECT HEC-2 Input SHEET NO. 21 OF 29

DATE 7-20-78 Slope-Area at East outlet JOB NO. 22-0554

```
  DAM SAFETY EVALUATION
  APPROXIMATE OUTLET CONTROL
  LAKE CLARA OUTLET
          2                      .00427
 1
 6       100      200      400      600      800      1000
03       .03     .045       .1       .3
.1         9       63       71
.2         0    120.7       25    119.2       63     116.7       65     116.7       67
.2        71    119.7      158    121.2      161     122.2      166

          3                      .00427
 2

          4                      .00427
 3

          4                      .00427
 4

          5                      .00427
 5

          6                      .00427
 6

          7                     .00427
 5
```

BY ______ SUBJECT *Summary for Q: 5- 80 cfs* SHEET NO. *22* OF

DATE ______ JOB NO. *22-0554*

```
**************** ****************************************
  HEC2 RELEASE DATED NOV 76 UPDATED  AUG1977
  ERROR CORR -  01,02
  MODIFICATION -  50,51,52,53
********************************************************


NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN
RY OF ERRORS LIST


LAKE CLARA OUTLET

SUMMARY PRINTOUT TABLE  150
```

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL
CRIWS	EG	10K*S	VCH	AREA	.01K		
	1.000	0.0	0.0	0.0	116.70	5.00	117.7
0.0	117.73	42.96	1.57	3.18	0.76		
	1.000	0.0	0.0	0.0	116.70	10.00	118.1
0.0	118.18	42.79	1.88	5.31	1.53		
	1.000	0.0	0.0	0.0	116.70	25.00	118.9
0.0	119.03	42.83	2.38	10.51	3.82		
	1.000	0.0	0.0	0.0	116.70	25.00	118.9
0.0	119.03	42.83	2.38	10.51	3.82		
	1.000	0.0	0.0	0.0	116.70	40.00	119.4
0.0	119.52	42.87	2.74	18.48	6.11		
	1.000	0.0	0.0	0.0	116.70	60.00	119.6
0.0	119.79	43.25	3.03	38.96	9.12		
	1.000	0.0	0.0	0.0	116.70	80.00	119.8
0.0	119.94	42.74	3.16	56.20	12.24		

```
******************************************************************
HEC2 RELEASE DATED NOV 76 UPDATED  AUG1977
ERROR CORR -  01,02
MODIFICATION -  50,51,52,53
******************************************************************

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

LAKE CLARA OUTLET

SUMMARY PRINTOUT TABLE  150
```

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL
RIWS	EG	10K*S	VCH	AREA	.01K		
	1.000	0.0	0.0	0.0	116.70	100.00	119.9[illegible]
0.0	120.06	43.23	3.30	69.95	15.21		
	1.000	0.0	0.0	0.0	116.70	200.00	120.4[illegible]
0.0	120.52	42.78	3.70	126.19	30.58		
	1.000	0.0	0.0	0.0	116.70	400.00	121.0[illegible]
0.0	121.15	42.61	4.23	209.64	61.28		
	1.000	0.0	0.0	0.0	116.70	400.00	121.0[illegible]
0.0	121.15	42.61	4.23	209.64	61.28		
	1.000	0.0	0.0	0.0	116.70	600.00	121.5[illegible]
0.0	121.64	42.74	4.62	275.37	91.78		
	1.000	0.0	0.0	0.0	116.70	800.00	121.92
0.0	122.06	42.79	4.94	333.31	122.29		
	1.000	0.0	0.0	0.0	116.70	1000.00	122.28
0.0	122.43	43.11	5.23	385.40	152.30		

BY ______ SUBJECT Summary for Q : 800 - 1400 cfs SHEET NO. 24 OF 2

DATE ______ JOB NO. 22-0554

```
************************************************************
HEC2 RELEASE DATED NOV 76 UPDATED  AUG1977
ERROR CORR -  01,02
MODIFICATION -  50,51,52,53
************************************************************

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN
ARY OF ERRORS LIST

LAKE CLARA OUTLET

SUMMARY PRINTOUT TABLE  150
```

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL
CRIWS	EG	10K*S	VCH	AREA	.01K	
1.000	0.0	0.0	0.0	116.70	800.00	121.92
0.0	122.06	42.79	4.94	333.31	122.29	
1.000	0.0	0.0	0.0	116.70	900.00	122.1[illegible]
0.0	122.25	42.93	5.08	359.98	137.37	
1.000	0.0	0.0	0.0	116.70	1000.00	122.2[illegible]
0.0	122.43	43.11	5.23	385.40	152.30	
1.000	0.0	0.0	0.0	116.70	1000.00	122.2[illegible]
0.0	122.43	43.11	5.23	385.40	152.30	
1.000	0.0	0.0	0.0	116.70	1100.00	122.4[illegible]
0.0	122.60	43.35	5.36	409.57	167.07	
1.000	0.0	0.0	0.0	116.70	1200.00	122.6[illegible]
0.0	122.78	42.68	5.45	435.78	183.68	
1.000	0.0	0.0	0.0	116.70	1400.00	122.9[illegible]
0.0	123.10	42.66	5.67	481.95	214.36	

Invert elevation at inlet ~ 117.0

Note: pipe has been deformed by lack of adequate cover as it measures 3.8'- high x 4.25'- wide. Pipe has no headwalls and is almost flush with embankment. Assume 4.0' diameter for computation purposes.

L ≈ 26'

Q	HW/D [2]	HW	El.	Tailwater [1]	d	d/D [3]	C_k	K	h
2			117.4	117.2	0.2	.05			
5			117.8	117.7	0.7	.18	.033	102.3	0.06
10			118.2	118.1	1.1	.28	.0792	295	0.07
20	~.5	2	118.9	118.8	1.8	.45	.1931	599	0.03
40	.69	2.8	119.8	119.4	2.4	.60	.3115	966	0.0[illegible]
~~Top of Road~~									
80	1.1	4.4	121.4	119.8	2.8				
160				120.2	3.2				
240				120.6	3.6				
320				120.8	3.8				
400				121.0	4.0				

1 from pond outlet rating – see page 20
2 from Bureau of Public Roads, HEC No. 5
3 from USGS, Open-File Report, "Indirect Measurement of Peak Discharge through Culverts."

$$K = C_k \frac{D^{8/3}}{n} = C_k \frac{(4)^{8/3}}{.013} = C_k(3100)$$

$$Q = K S^{1/2} \quad \therefore \quad S = \left(\frac{Q}{K}\right)^2 \qquad h = LS$$

TH 9

Road El.	For WSEL = 120.7 L	d	$\bar{d}$	A	For WSEL = 120.3 $\hat{L}$	d	$\bar{d}$	A	= 119.9 $\hat{L}$	d	$\bar{d}$	A
120.7		0				0						
120.6	151	.1	.05	7.6		0				0		
119.6	170	1.1	.6	102	119	.7	.35	42	51	.3	.15	8
120.3	241	.4	.75	181	241	0	.35	84	103	0	.15	15
120.5	164 (22)	.2	.3	49 (2)								
122.0	167	0	.1	342								

$Q = (2.9)(342)(1.1)^{1/2} = 1040$ @ 120.7

$Q = (2.9)(126)(.7)^{1/2} = 305$ @ 120.3

$Q = (2.9)(23)(.3)^{1/2} = 36$ @ 119.9

Flow through saddle

	$WSEL_L$ = 122.8 L	d	$\bar{d}$	A	WSEL = 122.2 d	$\bar{d}$	A	WSEL = 121.7 L	d	$\bar{d}$
122.2		.6			0				0	
121.2	200	1.6	1.1	220	1.0	0.5	100	100	.5	.25
122.2	80 (72)	.6	1.1	88	0	0.5	40	40	0	.25
123.2	120		.3	22			140			
				300						

$Q = (2.9)(300)(1.6)^{1/2} = 1210$ cfs 122.8
$Q = (2.9)(140)(1)^{1/2} = 406$ 122.2
$Q = (2.9)(35)(.5)^{1/2}$ 72 121.7

[1] from SCS, Field Engineering Manual

DUFRESNE-HENRY ENGINEERING CORPORATION

BY Morris Root SUBJECT Total Rating Curves SHEET NO. 27 OF 29

DATE 7-19-78 APPRVD ______ JOB NO. 26-0554

At. TH 9 West Pond Area ~ 7A Drainage Area ~ .2 sq. mi.

El.	Q	Storage (Ac-ft)
117.4	2 cfs	0
117.8	5	2.8
118.2	10	5.6
118.9	20	10.5
119.6	35	15.4
119.8	60	16.8
120.0	100	18.2 (flow out outlet canal governs)
120.5	235	21.7
121.0	400	25.2
121.5	600	28.7

Easterly Pond Pond Area ~ 11A Drainage Area ~ .5 sq. mi.

El.	Q	Storage (Ac-ft)
117.2	2 cfs	0
117.7	5	5.5
118.1	10	9.9
118.8	20	17.6
119.4	40	24.2
119.8	80	28.6
120.0	100	30.8
120.7	300	38.5
121.5	600	47.3
122.3	1000	56.1

Flood Flow from dam break

$Q_{P_1} = \frac{8}{27} W_b \sqrt{g} \; Y_0^{3/2}$

$Y_0 = 31'$

$W_b = .4(20) = 8'$

$Q_{P_1} = \frac{8}{27} (8)(32.2)^{1/2} (31)^{3/2} = 2322$ cfs

$Y_w = \frac{2}{3} Y_0 = 20.5'$

Volume stored = (10') (264) (924) = 56 Ac-ft (average depth, width, length)

(10) (40)(924) = 8.5

$S = 252$

$Q_{P_2} = Q_{P_1} \left(1 - \frac{56}{252}\right) = 1806$ cfs (.78)

$Q = CLH^{3/2}$

$1800 = (3.1)(250)(H)^{3/2}$

$H^{3/2} = 2.32$

$H = 1.8'$

$2244 = (3.1)(40)(H)^{3/2}$

$H = 5' \pm$

DUFRESNE-HENRY ENGINEERING CORPORATION

BY Morris Root SUBJECT Flows for Characteristics of Watershed SHEET NO. 29 OF 29

DATE 7-20-78 APPRVD JOB NO. 22-0554

Compare to Beaver Brook nr Wilmington, Vt.

Sta. no. 01167800

drainage area = 6.38 mi^2

minimum flow $(.7/6.1)(0.06) = .01$ cfs min. day

average flow $.7/6.1\ (15.7) = 1.7$ cfs average annu...

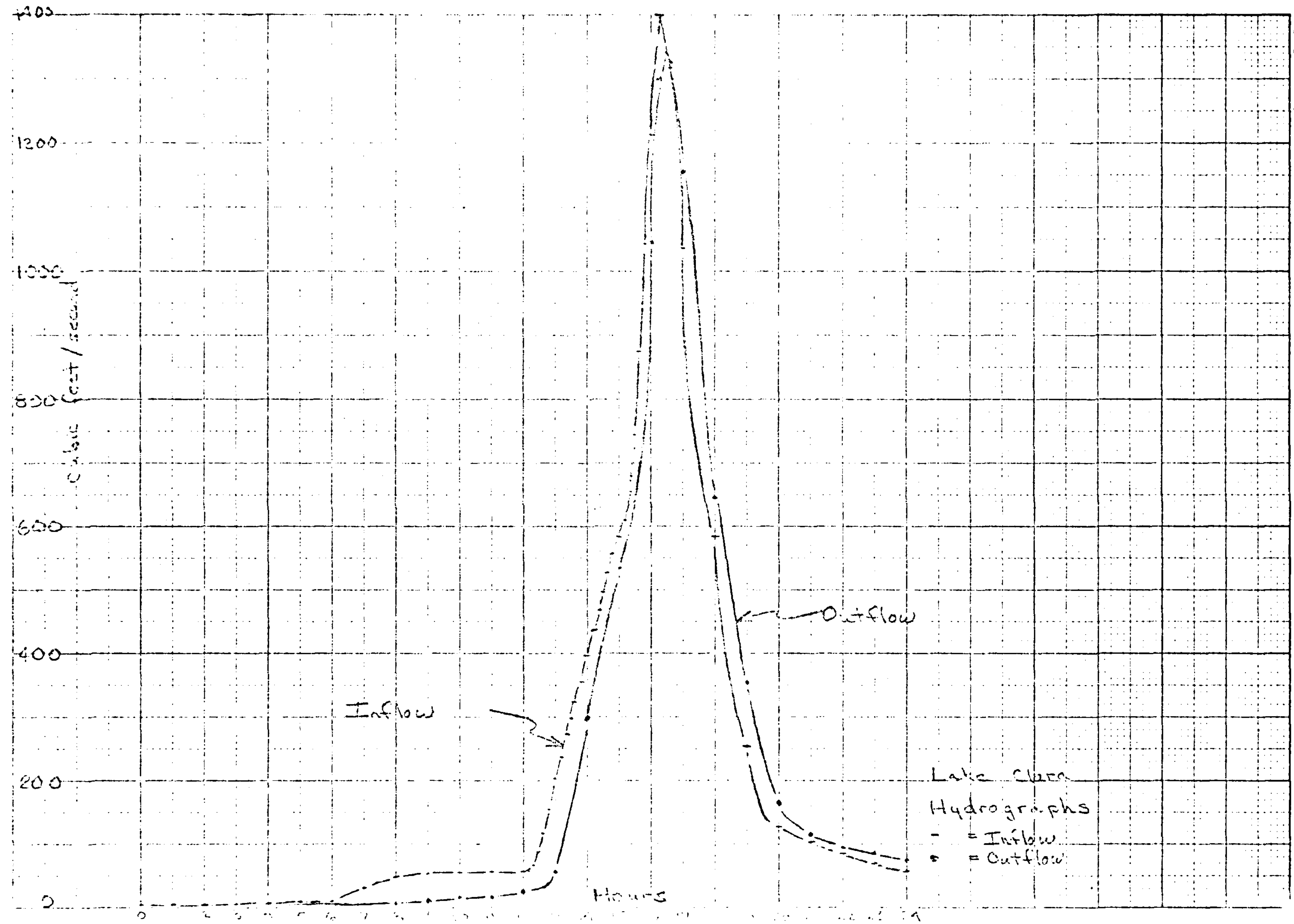
Maximum flow $(.7/6.1)^{.75}(1170) = 222$ cfs peak observed

No. Branch Hoosic, No. Adams

$(.7/31)^{.75}(8,950)$

(9,980) = 440

(8,450)


1400
1200
1000
800
600
400
200
0
Cubic feet / second
Hours
Inflow
Outflow
Lake Clara
Hydrographs
- = Inflow
• = Outflow

APPENDIX E

Information as contained in the National Inventory of Dams

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY MO YR
VT	11	NED	VT	025	01				LAKE CLARA DAM	4247.7	7252.9	18AUG78

POPULAR NAME	NAME OF IMPOUNDMENT
	LAKE CLARA

REGION BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01 08	TR-LAKE WHITINGHAM	WHITINGHAM VILLAGE	0	100

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
REPG	1928	R	32	31	252	216	NED	N	N	N	N	15AUG78

REMARKS

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NO.	NAVIGATION LOCKS LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
1	370	N			28000											

OWNER	ENGINEERING BY	CONSTRUCTION BY
JOSEPH PROCTOR		

REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

INSPECTION BY	INSPECTION DATE DAY MO YR	AUTHORITY FOR INSPECTION
DUFFRESNE-HENRY ENG CORP	16JUN78	PL 92-367

REMARKS

END

FILMED

8-85

DTIC