Suncook River Watershed
Merrimack River Basin
Gilmanton, New Hampshire

# Crystal Lake
## Dam-Break Flood Analysis

January 1989

**US Army Corps of Engineers**
New England Division

## Preface

This investigation was performed under the Corps of Engineers' Flood Plain Management Services Authority at the request of the State of New Hampshire. The Flood Plain Management Authority is contained in Section 206 of the Flood Control Act of 1960 which authorizes the U.S. Army Corps of Engineers "...to compile and disseminate information on floods and flood damages...and to provide engineering advice to local interests for their use in planning to ameliorate the flood hazard."

The Dam-Break Analysis study presented in this report was prepared under contract by Storch Associates of Boston, Massachusetts and Manchester, New Hampshire. Any questions concerning this report should be addressed to the the Chief of the Hydrology Engineering Section of the Corps of Engineers, New England Division.

CRYSTAL LAKE DAM

GILMANTON, NEW HAMPSHIRE

DAM-BREAK FLOOD ANALYSIS

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# CRYSTAL LAKE DAM

## DAM-BREAK FLOOD ANALYSIS

### 1. INTRODUCTION AND PURPOSE

This report presents the findings of a dam-break flood analysis performed for Crystal Lake Dam. Its purpose is to provide quantitative information for emergency planning use. The dam is owned, operated and maintained by the Water Resources Board of New Hampshire. Included in this report is a description of the pertinent features of the dam, the procedure used for the analysis, the assumed dam-break conditions and the resulting effects on downstream flooded areas. This study was not performed because of any known likelihood of a dam-break at Crystal Lake Dam.

### 2. DAM DESCRIPTION

| | |
|---|---|
| Identification No. | NH00018 |
| Name of Dam | Crystal Lake Dam |
| Town: | Gilmanton |
| Country and State: | Belknap County, New Hampshire |
| Stream: | Suncook River |
| Watershed: | Suncook River |
| Basin: | Merrimack River |

Crystal Lake Dam is located in the Town of Gilmanton, New Hampshire, on the upper reach of the Suncook River. The Suncook River flows in a generally southerly direction for a distance of approximately 28 miles to its confluence with the Merrimack River in Suncook, New Hampshire.

Crystal Lake Dam is a earth embankment structure with a concrete spillway located about halfway between the left and right abutment. The upstream face of the dam consists of a concrete retaining wall extending approximately 86 feet to the left of the spillway structure and 43 feet to the right of the spillway structure. The downstream face of the dam consists of vertical wingwalls which also form part of a concrete roadway bridge, vertical stone walls and an earth fill section sloping two feet horizontal to one foot vertical. Alton Mt. Road is located on top of the dam embankment. The structure is approximately 188 feet in length. The maximum structural height of the dam, according to the existing plans and the Phase 1 inspection report of the National Dam Safety Program, dated November, 1978 is about 16 feet.

The appurtenant structures consist of a pentagonal concrete spillway, a spillway channel and an outlet works consisting of a sluiceway with stoplogs. The outlet works stoplogs extend down to the original Suncook River bed.

3. PERTINENT DATA

Data is taken from "Phase I Inspection Report" for Crystal Lake Dam, dated November, 1978.

a. Drainage Area The drainage area consists of 27.0 square miles (17,280 acres) of rolling, heavily wooded hills.

b. Elevation (ft. above MSL)

| | |
|---|---|
| (1) Top of Dam: | 629.0 (lowpoint in the embankment) |
| (2) Recreation pool: | 623.3 |
| (3) Spillway crest: | 623.3 |
| (4) Spillway crest (ungated): | 623.3 |
| (5) Stream bed at centerline of dam (downstream toe): | 616.8 |
| (6) Maximum tailwater: | Unknown |

c. Spillway

| | |
|---|---|
| (1) Type: | Concrete, pentagonal with vertical downstream face. |
| (2) Length of weir : | 115.5 ft. |
| (3) Crest elevation: | 623.3 ft. |
| (4) U/S channel: | Crystal Lake |

| | |
|---|---|
| (5) Downstream channel: | 13 foot reach approximately 30 feet wide downstream of the spillway leading to a roadway bridge about 21 feet wide. Below the bridge, the downstream channel consists of a natural, rock bottom streambed with only a few overhanging trees. |

d. Reservoir (miles)

| | |
|---|---|
| (1) Length of maximum pool: | 2.3 ± |
| (2) Length of recreation pool: | 2.3 |

e. Storage (acre-feet)

| | |
|---|---|
| (1) Recreation pool: | 1,400 |
| (2) Top of dam: | 3,800 |

f. Reservoir Surface (acres)

| | |
|---|---|
| (1) Top of dam: | 458 |
| (2) Recreation pool: | 441 |
| (3) Spillway crest: | 441 |

g. Discharge at Dam Site

(1) The outlet works for the Crystal Lake Dam consists of a 6 foot wide sluiceway. The reservoir behind the dam can be lowered 6.5 feet below the spillway crest elevation 623.3 by the removal of the wooden stoplogs in the sluiceway. Removal of all stoplogs will lower the reservoir level to the original river bed elevation of 616.8.

| | |
|---|---|
| (2) Spillway capacity with water at top of dam and stoplogs in sluiceway set to height of spillway crest: | 2450 cfs (elev. 629.0) |
| (3) Maximum tailwater: | unknown |

h. Dam

| | | |
|---|---|---|
| (1) | Type: | stone, earth, concrete |
| (2) | Length: | 188 ft. (overall) |
| (3) | Height: | 16 ft. (maximum) |
| (4) | Top width: | 35 ± ft. (Alton Mt. Road on top of dam) |

i. Diversion and Regulating Tunnel: None.

j. Regulating Outlets. The regulating outlet consists of a 6 foot wide stoplog sluiceway which was designed to lower the reservoir to the original river bed elevation (616.8) by the removal of all stoplogs.

4. VALLEY DESCRIPTION

Crystal Lake Dam, located in Gilmanton, N.H., spans the upper reach of the Suncook River, approximately 28 miles upstream from confluence with the Merrimack River. The Suncook River Valley below the Crystal Lake Dam is a combination of residential and partially wooded area and has a moderate to moderately steep slope for the entire 6.9 mile study reach. The downstream channel valley is heavily covered with rocks and at several locations some streambed deposits of gravel. The downstream channel passes through the small population center of Gilmanton at mile 0.8 below the dam and through the significant population center of Center Barnstead at 6.9 miles below dam. Upper and Lower Suncook Lakes are located from mile 2.3 to mile 5.2 below the dam.

5. MODEL DESCRIPTION

The Crystal Lake Dam dam-break analysis was performed using the Microcomputer Version 9-86 of "DAM-BREAK" the National Weather Service DAM-BREAK Flood Forecasting Model 7-18-84. This microcomputer version is a transference from Dr. D. L. Fread's main frame version. The selected analysis option utilized was "Subcritical Dynamic Routing" for a single dam and input consisted of:

(a) Storage characteristics of the reservoir

(b) Selected dam breach geometry, and duration

(c) Surveyed geometry and observed characteristics of downstream valley presented in cross-sections and by selected Mannings "n" coefficients and initial flows.

(d) Active and inactive flow regions of the study reach. Based on the input data, the model computes the dam-break outflow hydrograph and routes it downstream. Dynamic routing of outflow hydrograph through entire reach of downstream valley is performed by a "honing" interative attenuation process governed by the requirements of both the principles of conservation of mass and momentum. The analysis provides output on the attenuation of the flood hydrograph, resulting flood stages, and timing of the flood wave as it progresses downstream.

## 6. ASSUMED DAM-BREAK CONDITIONS

The magnitude of a flood resulting from the hypothetical failure of Crystal Lake Dam is a function of many different parameters including size of breach, initial pool level and storage, rate of breach formation, channel and overbank roughness, and antecedent flow conditions. Engineering assumptions of conditions which could be reasonably expected to exist prior to a failure of Crystal Lake Dam, were used in the flood analysis as presented below:

(1) Initial Pool Level 627.5 feet MSL, 1.5 feet below top of dam during an inflow of 2,214 cfs.

(2) Breach Invert: 616.8 feet MSL

(3) Breach Base Width 60 feet; trapezoidal side slopes (1.0 vertical to 1.0 horizontal)

(4) Time to Complete Formation of Breach: 0.5 hour

(5) Downstream Channel Roughness Coefficient: Manning's "n" = 0.055 to 0.07

(6) Pre-Breach Flow: The pre-breach river flow was assumed equal to the March 1936 flood of record. Inflow into Crystal Lake was estimated to be 2,214 cfs (82 csm). The generated outflow during the initial conditions was 1900 cfs.

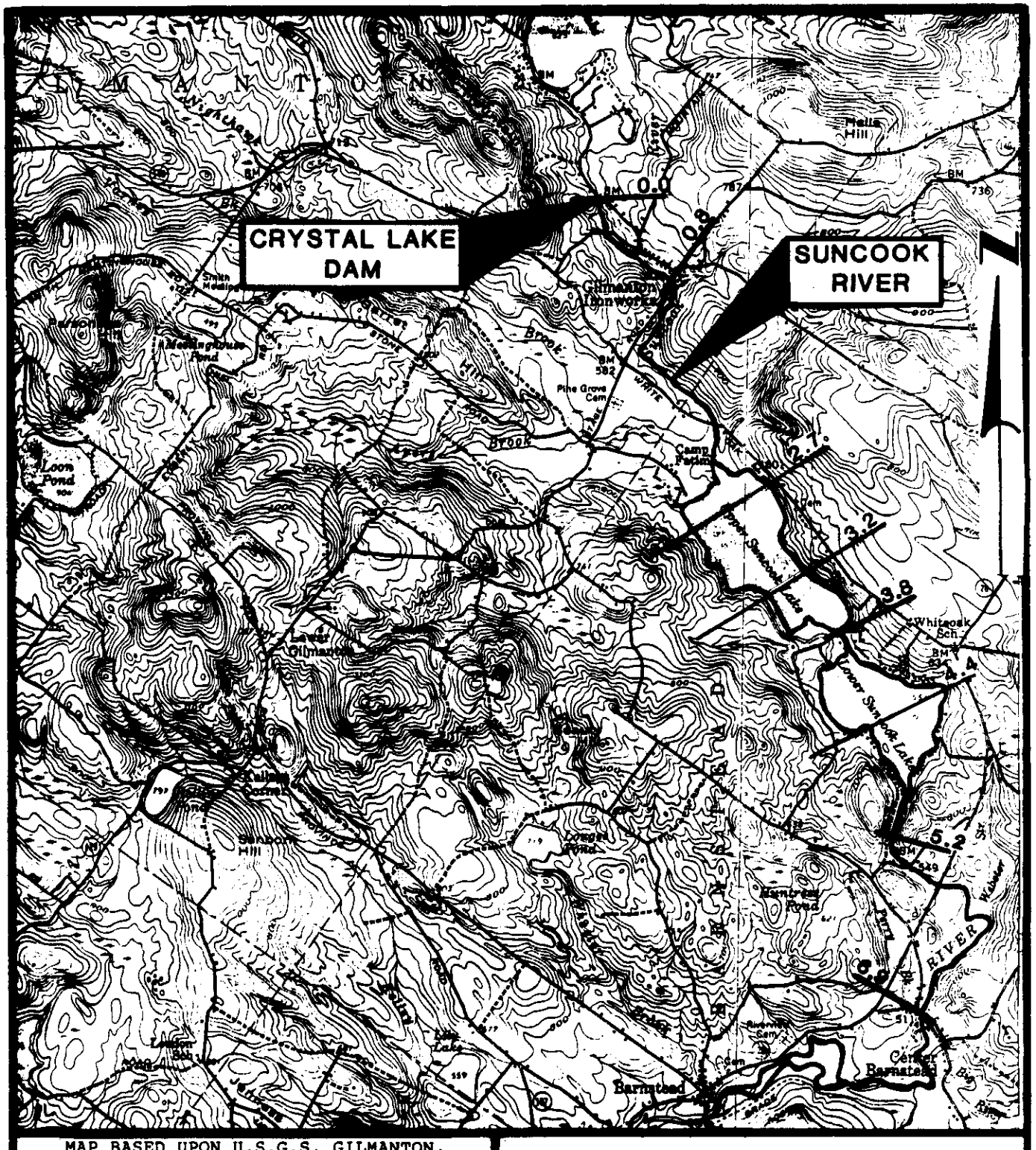
## 7. RESULTS

Resulting peak stage flood profiles, timing of the peak stage and leading edge of the flood wave are indicated on the profile and presented in the report. Because of the scarcity of good topographic mapping in the area, profiles are shown in feet above normal summertime (July-August) low water (NLW). Users of the information can establish depth of flooding at particular properties by establishing its relative elevation with respect to the adjacent stream level. Variations in depth above NLW progressing downstream, are attributable to changes in natural stream hydraulic capacity as well as changes in peak discharge.

The peak dam-break discharge (along with the pre-breach discharge from Crystal Lake Dam) and the resulting water surface stages throughout the study reach are shown on plate no. 2. The maximum dam-break water surface stages and maximum flows vs. time from start of dam failure are presented on plates 3 and 4 for selected stations of interest downstream from Crystal Lake Dam. The two stations are located 0.8 and 6.9 miles downstream from the dam.

The breach and pre-breach peak flows throughout the study reach resulting from Crystal Lake Dam breach are shown on plate no. 5.

The peak dam-break discharge from Crystal Lake Dam was computed to be 8,866 cfs. At a mile 0.8 below the dam, a rise of 10.67 feet above NLW stage was produced by a peak dam-break discharge of 8,375 cfs. Because of the relatively large natural storage of the Suncook River Valley including the surcharge storage in Upper and Lower Suncook Lakes the peak dam break discharge is significantly attenuated with a peak outflow from the Suncook Lakes of about 3,900 cfs and peak stage of 7 to 9 feet. Further downstream at mile 6.9, the peak dam-break discharge decreases to 3,853 cfs with a rise of 12.11 feet above NLW.




MAP BASED UPON U.S.G.S. GILMANTON, N.H. QUADRANGLE (1957)

**CROSS-SECTION LOCATION**

**IN MILES BELOW DAM**

**CROSS-SECTION 5.2 MI-INTERPOLATED**

1000 0 4000

SCALE IN FEET

1 1/2 0 1

SCALE IN MILES

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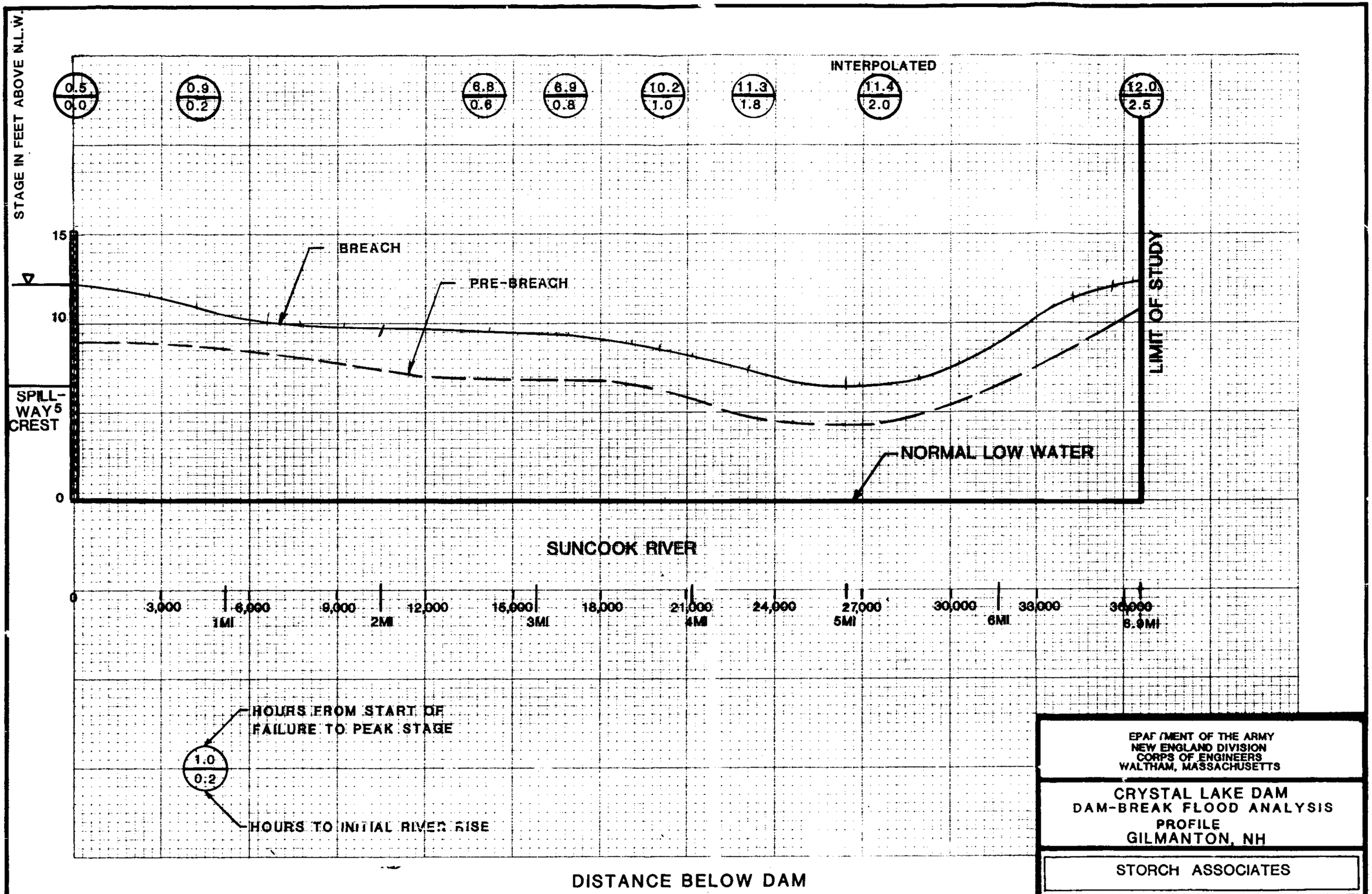
**NEW ENGLAND DIVISION**
**CORPS OF ENGINEERS**
**WALTHAM, MASSACHUSETTS**

**CRYSTAL LAKE DAM**
**DAM-BREAK FLOOD ANALYSIS**

# INDEX MAP

**GILMANTON, N.H.**

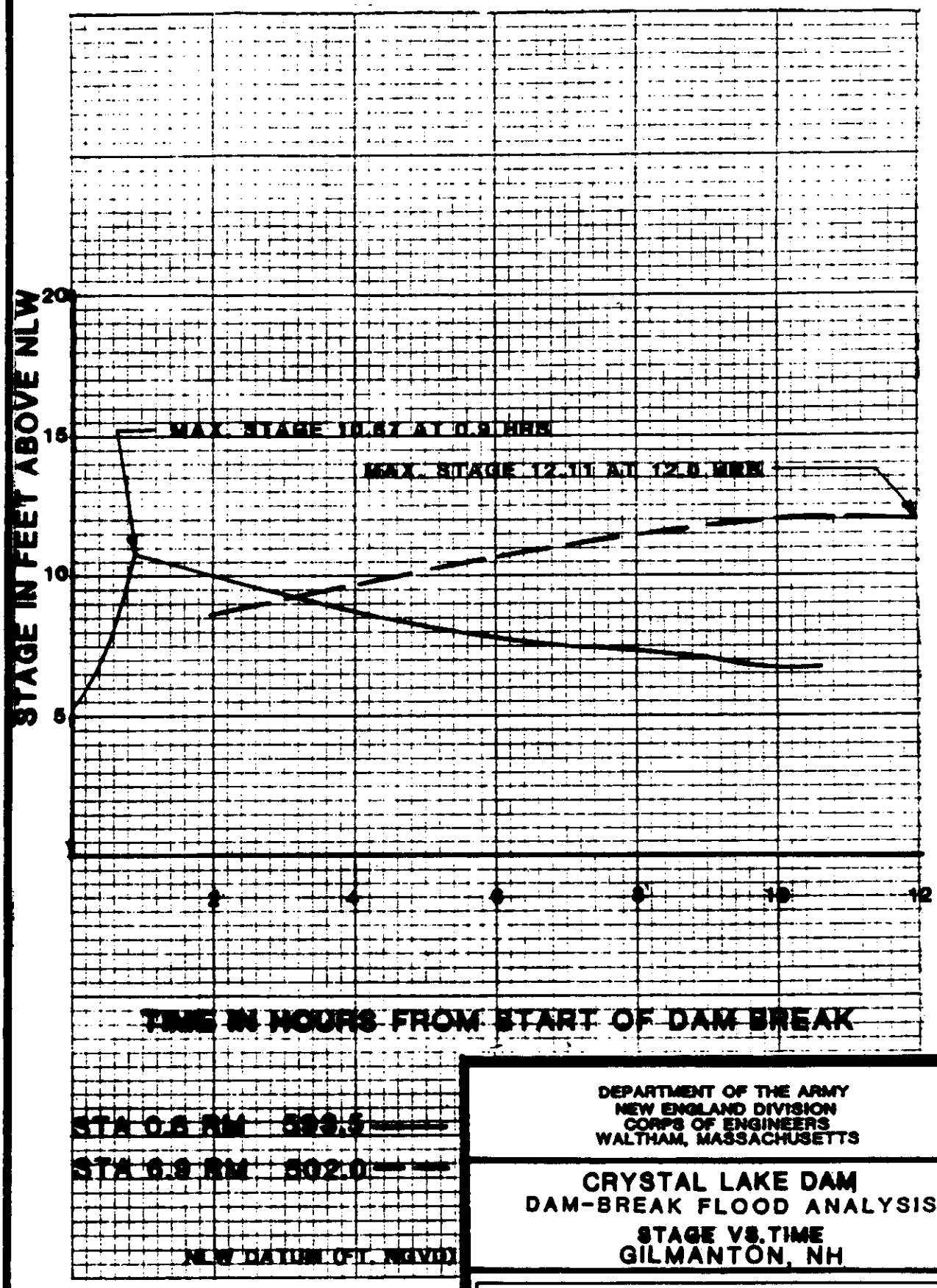
**STORCH ASSOCIATES**




EPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

CRYSTAL LAKE DAM
DAM-BREAK FLOOD ANALYSIS
PROFILE
GILMANTON, NH

STORCH ASSOCIATES

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CRYSTAL LAKE DAM
DAM-BREAK FLOOD ANALYSIS
STAGE VS. TIME
GILMANTON, NH

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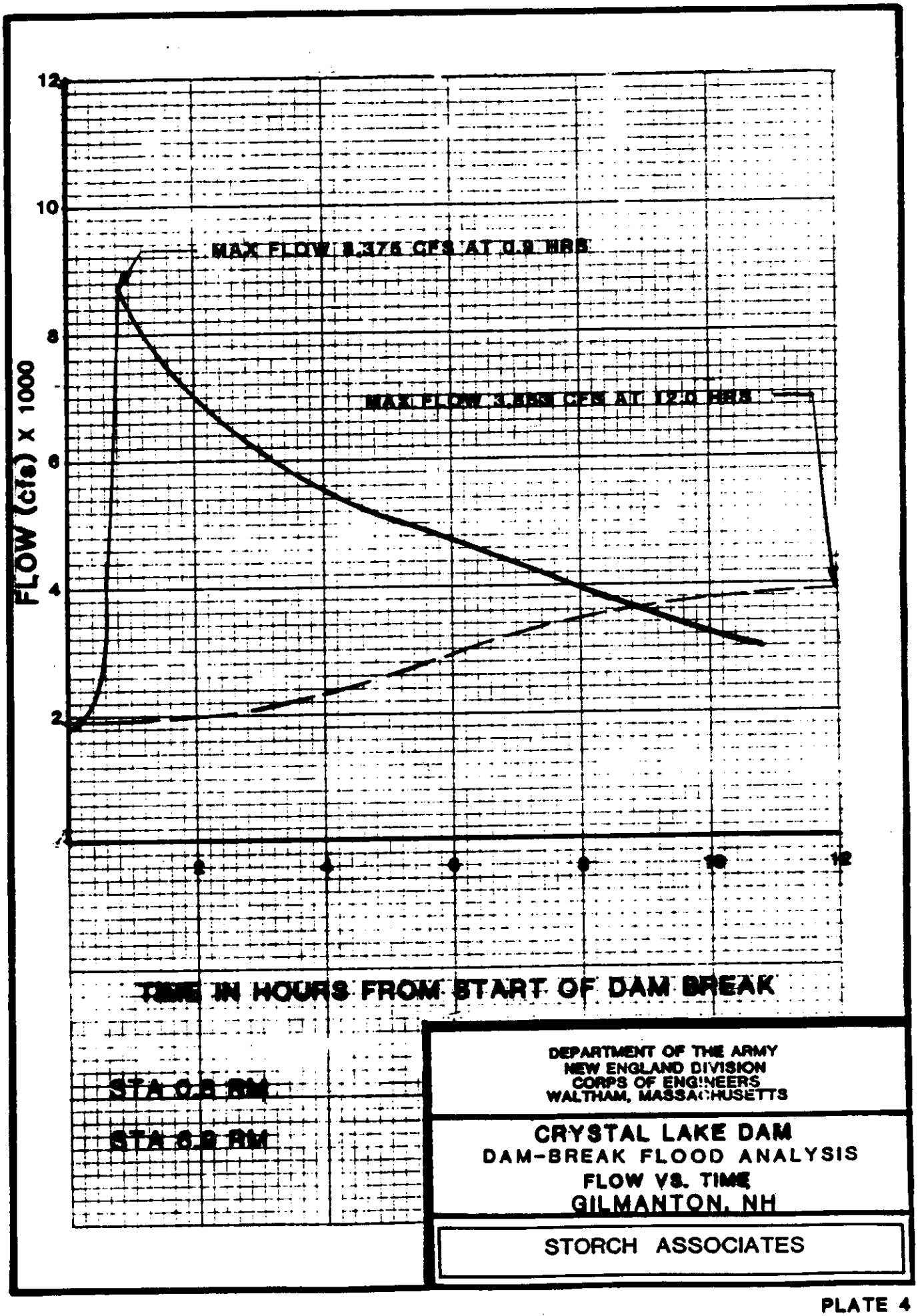
FLOW (cfs) X 1000
12
10
8
6
4
2
MAX FLOW 8,376 CFS AT 0.9 HRS
MAX FLOW 3,855 CFS AT 12.0 HRS
2
4
6
8
10
12
TIME IN HOURS FROM START OF DAM BREAK
STA 0.3 RM
STA 6.2 RM
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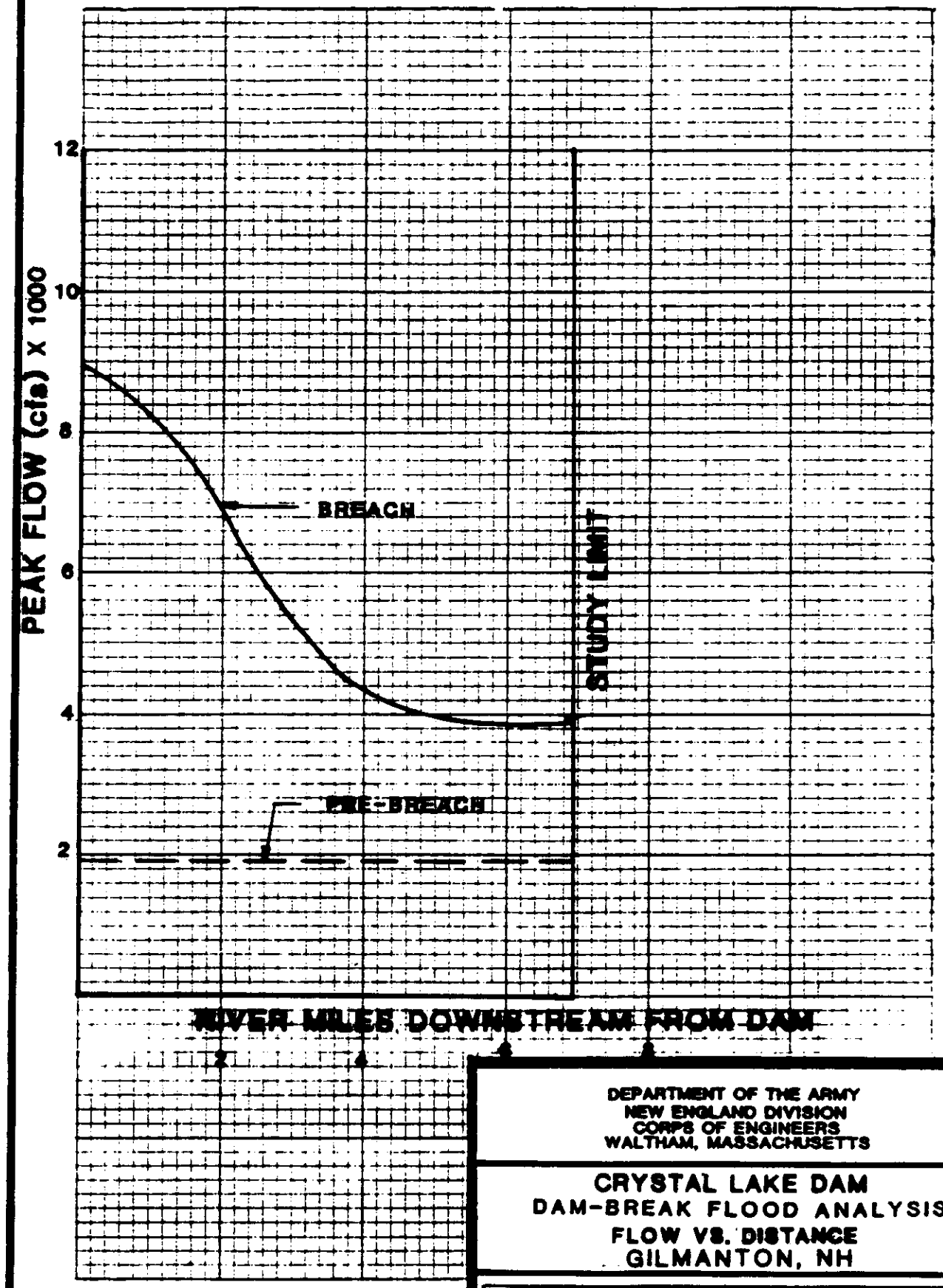
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS
CRYSTAL LAKE DAM
DAM-BREAK FLOOD ANALYSIS
FLOW VS. TIME
GILMANTON, NH
STORCH ASSOCIATES

PLATE 4

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CRYSTAL LAKE DAM
DAM-BREAK FLOOD ANALYSIS
FLOW VS. DISTANCE
GILMANTON, NH

STORCH ASSOCIATES

# APPENDIX A

# INPUT DATA FILE

CRYSTAL LAKE DAM  SUNCOOK RIVER WATERSHED  STORCH ASSOCIATES
994 CANDIA ROAD, MANCHESTER, N.H. 03103

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 0 | 0 | 5 | 2 | | |
| | 0.00 | | | | | | |
| 583. | 500. | 441. | 441. | 0. | | | |
| 624.2 | 630.5 | 629. | 623.3 | 616.8 | | | |
| 2.3 | 627.5 | 1. | 616.8 | 60. | 0.5 | 515.8 | 0. |
| 627.5 | 629. | 623.3 | 0. | 0. | 0. | 581. | 0. |
| 15. | 200. | 1300. | 2100. | 2800. | 3600. | 4450. | 5160. |
| .2 | .7 | 2.7 | 4.7 | 6.7 | 8.7 | 10.7 | 12.7 |
| 0. | 20. | | | | | | |
| 2214. | 2214. | | | | | | |
| 0. | 20. | | | | | | |
| | 9 | 5 | 5 | 0 | 0 | 0 | 0 | 0 |
| | 1 | 2 | 5 | 7 | 8 | | |
| 0.01 | | | | | | | |
| 612.5 | 613.5 | 625. | 627.5 | 680. | | | |
| 40. | 50. | 100. | 100. | 100. | | | |
| 0. | 0. | 0. | 150. | 900. | | | |
| 0.8 | | | | | | | |
| 593.5 | 599. | 604. | 612. | 650. | | | |
| 15. | 35. | 80. | 80. | 80. | | | |
| 0. | 0. | 100. | 210. | 1070. | | | |
| 2.7 | | | | | | | |
| 552. | 560. | 600. | 640. | 700. | | | |
| 3300. | 3310. | 3310. | 3310. | 3310. | | | |
| 0. | 0. | 890. | 1490. | 2290. | | | |
| 3.2 | | | | | | | |
| 551.7 | 560. | 600. | 640. | 700. | | | |
| 1600. | 1800. | 1800. | 1800. | 1800. | | | |
| 0. | 0. | 500. | 1400. | 6200. | | | |
| 3.8 | | | | | | | |
| 551.5 | 558. | 560. | 580. | 600. | | | |
| 50. | 60. | 100. | 100. | 100. | | | |
| 0. | 0. | 500. | 800. | 1100. | | | |
| 4.4 | | | | | | | |
| 551.2 | 560. | 580. | 600. | 640. | | | |
| 3200. | 3500. | 3500. | 3500. | 3500. | | | |
| 0. | 0. | 500. | 800. | 1100. | | | |
| 5.2 | | | | | | | |
| 551. | 554. | 560. | 580. | 600. | | | |
| 120. | 120. | 120. | 120. | 120. | | | |
| 0. | 0. | 290. | 420. | 680. | | | |
| 6.9 | | | | | | | |
| 502. | 509.5 | 511. | 520. | 560. | | | |
| 22. | 35. | 160. | 160. | 160. | | | |
| 0. | 0. | 0. | 320. | 640. | | | |
| .055 | .055 | .055 | .055 | .055 | | | |
| .055 | .05 | .055 | .055 | .055 | | | |
| .05 | .05 | .05 | .05 | .05 | | | |
| .05 | .05 | .05 | .05 | .05 | | | |
| .07 | .07 | .07 | .07 | .07 | | | |
| .05 | .05 | .05 | .05 | .05 | | | |
| .07 | .07 | .07 | .07 | .07 | | | |
| .0395 | .025 | .025 | .025 | .025 | .1 | .1 | |
| 0. | -.5 | -1.0 | .1 | -.5 | .3 | .1 | |
| 0. | 0. | 0. | 0. | 23.75 | | | |

# APPENDIX B

# OUTPUT DATA FILE

PROGRAM DAMBRK---VERSION-07/18/84
MICROCOMPUTER VERSION - R.G. TRAVER

# ANALYSIS OF THE DOWNSTREAM FLOOD HYDROGRAPH

PRODUCED BY THE DAM BREAK OF

CRYSTAL LAKE DAM

ON

SUNCOOK RIVER WATERS

ANALYSIS BY

HED STORCH ASSOCIATES
994 CANDIA ROAD, MANCHESTER, N.H. 03103

BASED ON PROCEDURE DEVELOPED BY

DANNY L. FREAD, PH.D., RESEARCH HYDROLOGIST
HYDROLOGIC RESEARCH LABORATORY
W23, OFFICE OF HYDROLOGY
NOAA, NATIONAL WEATHER SERVICE
SILVER SPRING, MARYLAND 20910

```
******************************
******************************
***                        ***
***  SUMMARY OF INPUT DATA  ***
***                        ***
******************************
******************************
```

INPUT CONTROL PARAMETERS FOR CRYSTAL LAKE DAM

| PARAMETER | VARIABLE | VALUE |
|---|---|---|
| NUMBER OF DYNAMIC ROUTING REACHES | KKN | 1 |
| TYPE OF RESERVOIR ROUTING | KUI | 0 |
| MULTIPLE DAM INDICATOR | MULDAM | 0 |
| PRINTING INSTRUCTIONS FOR INPUT SUMMARY | KDMP | 5 |
| NO. OF RESERVOIR INFLOW HYDROGRAPH POINTS | ITEH | 2 |
| INTERVAL OF CROSS-SECTION INFO PRINTED OUT WHEN JNK=9 | NPRT | 0 |
| FLOOD-PLAIN MODEL PARAMETER | KFLP | 0 |
| LANDSLIDE PARAMETER | KSL | 0 |

IOPUT= 0 0 0 0 0 0 0 0 0 0 0 0

CRYSTAL LAKE DAM RESERVOIR

TABLE OF ELEVATION VS SURFACE AREA

| SURFACE AREA (ACRES) SA(K) | ELEVATION (FT) HSA(K) |
|---|---|
| 583.0 | 634.20 |
| 500.0 | 630.50 |
| 441.0 | 629.00 |
| 441.0 | 623.30 |
| .0 | 616.80 |
| .0 | .00 |
| .0 | .00 |
| .0 | .00 |

CRYSTAL LAKE DAM RESERVOIR AND BREACH PARAMETERS

| PARAMETER | UNITS | VARIABLE | VALUE |
|---|---|---|---|
| LENGTH OF RESERVOIR | MI | RLM | 2.30 |
| ELEVATION OF WATER SURFACE | FT | YO | 627.50 |
| SIDE SLOPE OF BREACH | | Z | 1.00 |
| ELEVATION OF BOTTOM OF BREACH | FT | YBMIN | 616.80 |
| WIDTH OF BASE OF BREACH | FT | BB | 60.00 |
| TIME TO MAXIMUM BREACH SIZE | HR | TFH | .50 |
| ELEVATION (MSL) OF BOTTOM OF DAM | FT | DATUM | 616.80 |
| VOLUME-SURFACE AREA PARAMETER | | VOL | .00 |
| ELEVATION OF WATER WHEN BREACHED | FT | HF | 627.50 |
| ELEVATION OF TOP OF DAM | FT | HD | 629.00 |
| ELEVATION OF UNCONTROLLED SPILLWAY CREST | FT | HSP | 623.30 |
| ELEVATION OF CENTER OF GATE OPENINGS | FT | HGT | .00 |
| DISCHARGE COEF. FOR UNCONTROLLED SPILLWAY | | CS | .00 |
| DISCHARGE COEF. FOR GATE FLOW | | CG | .00 |
| DISCHARGE COEF. FOR UNCONTROLLED WEIR FLOW | | CDO | 581.00 |
| DISCHARGE THRU TURBINES | CFS | QT | .00 |

| QSPILL(K,1) | HEAD(K,1) |
|---|---|
| 15. | .2 |
| 200. | .7 |
| 1300. | 2.7 |
| 2100. | 4.7 |
| 2800. | 6.7 |
| 3600. | 8.7 |
| 4450. | 10.7 |
| 5160. | 12.7 |

DHF(INTERVAL BETWEEN INPUT HYDROGRAPH ORDINATES) = .00 HRS.

TEH(TIME AT WHICH COMPUTATIONS TERMINATE) = 20.0000 HRS.

INFLOW HYDROGRAPH TO CRYSTAL LAKE DAM
**********

2214.00  2214.00

TIME OF INFLOW HYDROGRAPH ORDINATES

.0000  20.0000

CROSS-SECTIONAL PARAMETERS FOR SUNCOOK RIVER WATERS
BELOW CRYSTAL LAKE DAM

| PARAMETER | VARIABLE | VALUE |
|---|---|---|
| NUMBER OF CROSS-SECTIONS | NS | 8 |
| MAXIMUM NUMBER OF TOP WIDTHS | NCS | 5 |
| NUMBER OF CROSS-SECTIONAL HYDROGRAPHS TO PLOT | NTT | 5 |
| TYPE OF OUTPUT OTHER THAN HYDROGRAPH PLOTS | JNK | 0 |
| CROSS-SECTIONAL SMOOTHING PARAMETER | KSA | 0 |
| DOWNSTREAM SUPERCRITICAL OR NOT | KSUPC | 0 |
| NO. OF LATERAL INFLOW HYDROGRAPHS | LQ | 0 |
| NO. OF POINTS IN GATE CONTROL CURVE | KCG | 0 |

NUMBER OF CROSS-SECTION WHERE HYDROGRAPH DESIRED
(MAX NUMBER OF HYDROGRAPHS = 6)

1 2 5 7 8

CROSS-SECTIONAL VARIABLES FOR SUNCOOK RIVER WATERS
BELOW CRYSTAL LAKE DAM

PARAMETER LQ 0

| | | |
|---|---|---|
| NO. OF POINTS IN GATE CONTROL CURVE | KCG | 0 |

NUMBER OF CROSS-SECTION WHERE HYDROGRAPH DESIRED
(MAX NUMBER OF HYDROGRAPHS = 6)

1 2 5 7 8

CROSS-SECTIONAL VARIABLES FOR SUNCOOK RIVER WATERS
BELOW CRYSTAL LAKE DAM

PARAMETER (OFF-CHANNEL PORTION)

| | | |
|---|---|---|
| SURFACE AREA CORRESPONDING TO EACH ELEV (ACTIVE FLOW PORTION) | ACRES | DSA(K,I) |
| SURFACE AREA CORRESPONDING TO EACH ELEV | ACRES | SSA(K,I) |

(OFF-CHANNEL PORTION)

| | |
|---|---|
| NUMBER OF CROSS-SECTION | I |
| NUMBER OF ELEVATION LEVEL | K |

CROSS-SECTION NUMBER 1
**********

XS(I) = .010 FSTG(I) = .00 XSL(I) = .0 XSR(I) = .0

| | | | | | |
|---|---|---|---|---|---|
| HS ... | 612.5 | 613.5 | 625.0 | 627.5 | 680.0 |
| BS ... | 40.0 | 50.0 | 100.0 | 100.0 | 100.0 |
| BSS ... | .0 | .0 | .0 | 150.0 | 900.0 |

CROSS-SECTION NUMBER 2
**********

XS(I) = .800 FSTG(I) = .00 XSL(I) = .0 XSR(I) = .0

| | | | | | |
|---|---|---|---|---|---|
| HS ... | 593.5 | 599.0 | 604.0 | 612.0 | 650.0 |
| BS ... | 15.0 | 35.0 | 80.0 | 80.0 | 80.0 |
| BSS ... | .0 | .0 | 100.0 | 210.0 | 1070.0 |

CROSS-SECTION NUMBER 3
**********

XS(I) = 2.700 FSTG(I) = .00 XSL(I) = .0 XSR(I) = .0

| | | | | | |
|---|---|---|---|---|---|
| HS ... | 552.0 | 560.0 | 600.0 | 640.0 | 700.0 |
| BS ... | 3300.0 | 3310.0 | 3310.0 | 3310.0 | 3310.0 |
| BSS ... | .0 | .0 | 890.0 | 1490.0 | 2390.0 |

CROSS-SECTION NUMBER 4
**********

XS(I) = 3.200 FSTG(I) = .00 XSL(I) = .0 XSR(I) = .0

| | | | | | |
|---|---|---|---|---|---|
| HS ... | 551.7 | 560.0 | 600.0 | 640.0 | 700.0 |
| BS ... | 1600.0 | 1800.0 | 1800.0 | 1800.0 | 1800.0 |
| BSS ... | .0 | .0 | 500.0 | 1400.0 | 6200.0 |

CROSS-SECTION NUMBER 5
**********

XS(I) = 3.800 FSTG(I) = .00 XSL(I) = .0 XSR(I) = .0

| | | | | | |
|---|---|---|---|---|---|
| HS ... | 551.5 | 558.0 | 560.0 | 580.0 | 600.0 |
| BS ... | 50.0 | 60.0 | 100.0 | 100.0 | 100.0 |
| BSS ... | .0 | .0 | 500.0 | 800.0 | 1100.0 |

CROSS-SECTION NUMBER 6
**********

XS(I) = 4.400 FSTG(I) = .00 XSL(I) = .0 XSR(I) = .0

| | | | | | |
|---|---|---|---|---|---|
| HS ... | 551.2 | 560.0 | 580.0 | 600.0 | 640.0 |
| BS ... | 3200.0 | 3500.0 | 3500.0 | 3500.0 | 3500.0 |
| BSS ... | .0 | .0 | 500.0 | 800.0 | 1100.0 |

CROSS-SECTION NUMBER 7
**********

XS(I) = 5.200 FSTG(I) = .00 XSL(I) = .0 XSR(I) = .0

| | | | | | |
|---|---|---|---|---|---|
| HS ... | 551.0 | 554.0 | 560.0 | 580.0 | 600.0 |
| BS ... | 120.0 | 120.0 | 120.0 | 120.0 | 120.0 |
| BSS ... | .0 | .0 | 290.0 | 420.0 | 680.0 |

CROSS-SECTION NUMBER 8
**********

XS(I) = 6.900 FSTG(I) = .00 XSL(I) = .0 XSR(I) = .0

| | | | | | |
|---|---|---|---|---|---|
| HS ... | 502.0 | 509.5 | 511.0 | 520.0 | 560.0 |
| BS ... | 22.0 | 35.0 | 160.0 | 160.0 | 160.0 |
| BSS ... | .0 | .0 | .0 | 320.0 | 640.0 |

MANNING N ROUGHNESS COEFFICIENTS FOR THE GIVEN REACHES
(CM(K,I),K=1,NCS) WHERE I = REACH NUMBER

**********

| | | | | | | |
|---|---|---|---|---|---|---|
| REACH | 1 ... | .055 | .055 | .055 | .055 | .055 |
| REACH | 2 ... | .055 | .050 | .055 | .055 | .055 |
| REACH | 3 ... | .050 | .050 | .050 | .050 | .050 |
| REACH | 4 ... | .050 | .050 | .050 | .050 | .050 |
| REACH | 5 ... | .070 | .070 | .070 | .070 | .070 |
| REACH | 6 ... | .050 | .050 | .050 | .050 | .050 |
| REACH | 7 ... | .070 | .070 | .070 | .070 | .070 |

CROSS-SECTIONAL VARIABLES FOR SUNCOOK RIVER WATERS
BELOW CRYSTAL LAKE DAM

| PARAMETER | UNITS | VARIABLE |
|---|---|---|
| MINIMUM COMPUTATIONAL DISTANCE USED BETWEEN CROSS-SECTIONS | MI | DXM(I) |
| CONTRACTION - EXPANSION COEFFICIENTS BETWEEN CROSS-SECTIONS | | FKC(I) |

| REACH NUMBER | DXM(I) | FKC(I) |
|---|---|---|
| 1 | .040 | .000 |
| 2 | .025 | -.500 |
| 3 | .025 | -1.000 |
| 4 | .025 | .100 |
| 5 | .025 | -.500 |
| 6 | .100 | .300 |
| 7 | .100 | .100 |

DOWNSTREAM FLOW PARAMETERS FOR SUNCOOK RIVER WATERS
BELOW CRYSTAL LAKE DAM

| PARAMETER | UNITS | VARIABLE | VALUE |
|---|---|---|---|
| MAX DISCHARGE AT DOWNSTREAM EXTREMITY | CFS | QMAXD | .0 |
| MAX LATERAL OUTFLOW PRODUCING LOSSES | CFS/FT | QLL | .000 |
| INITIAL SIZE OF TIME STEP | HR | DTHM | .0000 |
| INITIAL WATER SURFACE ELEVATION DOWNSTREAM | FT | YDW | .00 |
| SLOPE OF CHANNEL DOWNSTREAM OF DAM | FT/MI | SOM | 23.75 |
| THETA WEIGHTING FACTOR | | THETA | .00 |
| CONVERGENCE CRITERION FOR STAGE | FT | EPSY | .000 |
| TIME AT WHICH DAM STARTS TO FAIL | HR | TFI | 20.00 |

TOTAL NUMBER OF CROSS SECTIONS (ORIGINAL+INTERPOLATED) (N) = 190 (MAXIMUM ALLOWABLE = 200

TOTAL VOLUME IN RESERVOIR BEHIND
CRYSTAL LAKE DAM = 3285.5 ACRE-FEET

DEFINITION OF VARIABLES IN RESERVOIR DEPLETION TABLE

| PARAMETER | UNITS | VARIABLE |
|---|---|---|
| TIME STEP FROM START OF ANALYSIS | | I |
| ITERATIONS NECESSARY TO SOLVE FLOW EQUATIONS | | K |
| ELAPSED TIME FROM START OF ANALYSIS | HRS | TTP(I) |
| TOTAL OUTFLOW FROM DAM | CFS | Q(I) |
| ELEVATION OF WATER SURFACE AT DAM | FT | H2 |
| ELEVATION OF BOTTOM OF BREACH | FT | YB |
| EST DEPTH OF FLOW IMMEDIATELY DOWNSTREAM | FT | D |
| SUBMERGENCE COEFFICIENT | | SUB |

| | | |
|---|---|---|
| VELOCITY CORRECTION | | VCOR |
| TOTAL VOLUME DISCHARGED FROM TIME OF BREACH | AC-FT | OUTVOL |
| BREACH WIDTH FT BB | | |
| RECTANGULAR BREACH DISCHARGE COEFFICIENT | | COFR |
| INFLOW TO RESERVOIR | CFS | QI(I) |
| BREACH OUTFLOW | CFS | QBRECH |
| SPILLWAY OUTFLOW | CFS | QSPIL |

RESERVOIR DEPLETION TABLE

| I | K | TTP(I) | Q(I) | H2 | YB | D | SUB | VCOR | OUTVOL | BB | COFR | QI(I) | QBRECH | QSPIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ### | ## | ###### | ######## | ####### | ####### | ####### | #### | #### | ######### | #### | #### | ##### | ###### | ##### |
| 1 | 0 | .000 | 1900 | 627.50 | 627.50 | 618.65 | 1.00 | 1.00 | .0 | .0 | 3.10 | 2214. | 0. | 1900. |
| 2 | 1 | .010 | 1900 | 627.50 | 627.29 | 618.64 | 1.00 | 1.72 | 1.6 | 1.2 | 3.10 | 2214. | 0. | 1900. |
| 3 | 1 | .020 | 1904 | 627.50 | 627.07 | 618.64 | 1.00 | 1.36 | 3.1 | 2.4 | 3.10 | 2214. | 4. | 1900. |
| 4 | 1 | .030 | 1909 | 627.50 | 626.86 | 618.65 | 1.00 | 1.24 | 4.7 | 3.6 | 3.10 | 2214. | 9. | 1901. |
| 5 | 1 | .040 | 1917 | 627.50 | 626.64 | 618.67 | 1.00 | 1.18 | 6.3 | 4.8 | 3.10 | 2214. | 17. | 1901. |
| 6 | 1 | .050 | 1929 | 627.50 | 626.43 | 618.69 | 1.00 | 1.15 | 7.9 | 6.0 | 3.10 | 2214. | 28. | 1901. |
| 7 | 1 | .060 | 1944 | 627.50 | 626.22 | 618.71 | 1.00 | 1.13 | 9.5 | 7.2 | 3.10 | 2214. | 43. | 1901. |
| 8 | 1 | .070 | 1963 | 627.50 | 626.00 | 618.75 | 1.00 | 1.11 | 11.1 | 8.4 | 3.10 | 2214. | 62. | 1902. |
| 9 | 1 | .080 | 1986 | 627.50 | 625.79 | 618.79 | 1.00 | 1.10 | 12.7 | 9.6 | 3.10 | 2214. | 85. | 1902. |
| 10 | 1 | .090 | 2014 | 627.50 | 625.57 | 618.84 | 1.00 | 1.09 | 14.4 | 10.8 | 3.10 | 2214. | 113. | 1902. |
| 11 | 1 | .100 | 2047 | 627.51 | 625.36 | 618.89 | 1.00 | 1.08 | 16.1 | 12.0 | 3.10 | 2214. | 145. | 1902. |
| 12 | 1 | .110 | 2085 | 627.51 | 625.15 | 618.96 | 1.00 | 1.08 | 17.8 | 13.2 | 3.10 | 2214. | 183. | 1902. |
| 13 | 1 | .120 | 2129 | 627.51 | 624.93 | 619.03 | 1.00 | 1.07 | 19.5 | 14.4 | 3.10 | 2214. | 227. | 1902. |
| 14 | 1 | .130 | 2178 | 627.51 | 624.72 | 619.11 | 1.00 | 1.07 | 21.3 | 15.6 | 3.10 | 2214. | 276. | 1902. |
| 15 | 1 | .140 | 2233 | 627.51 | 624.50 | 619.21 | 1.00 | 1.07 | 23.1 | 16.8 | 3.10 | 2214. | 331. | 1902. |
| 16 | 1 | .150 | 2295 | 627.51 | 624.29 | 619.31 | 1.00 | 1.07 | 25.0 | 18.0 | 3.10 | 2214. | 393. | 1902. |
| 17 | 1 | .160 | 2363 | 627.51 | 624.08 | 619.42 | 1.00 | 1.07 | 26.9 | 19.2 | 3.10 | 2214. | 461. | 1902. |
| 18 | 1 | .170 | 2438 | 627.51 | 623.86 | 619.54 | 1.00 | 1.07 | 28.9 | 20.4 | 3.10 | 2214. | 537. | 1902. |
| 19 | 1 | .180 | 2520 | 627.50 | 623.65 | 619.66 | 1.00 | 1.07 | 31.0 | 21.6 | 3.10 | 2214. | 619. | 1902. |
| 20 | 1 | .190 | 2610 | 627.50 | 623.43 | 619.80 | 1.00 | 1.07 | 33.1 | 22.8 | 3.10 | 2214. | 709. | 1902. |
| 21 | 1 | .200 | 2707 | 627.50 | 623.22 | 619.95 | 1.00 | 1.07 | 35.3 | 24.0 | 3.10 | 2214. | 806. | 1901. |
| 22 | 1 | .210 | 2812 | 627.50 | 623.01 | 620.10 | 1.00 | 1.07 | 37.6 | 25.2 | 3.10 | 2214. | 912. | 1901. |
| 23 | 1 | .220 | 2925 | 627.50 | 622.79 | 620.27 | 1.00 | 1.08 | 39.9 | 26.4 | 3.10 | 2214. | 1026. | 1900. |
| 24 | 1 | .230 | 3048 | 627.50 | 622.58 | 620.44 | 1.00 | 1.08 | 42.4 | 27.6 | 3.10 | 2214. | 1148. | 1900. |
| 25 | 1 | .240 | 3179 | 627.50 | 622.36 | 620.63 | 1.00 | 1.08 | 45.0 | 28.8 | 3.10 | 2214. | 1280. | 1899. |
| 26 | 1 | .250 | 3319 | 627.50 | 622.15 | 620.82 | 1.00 | 1.09 | 47.6 | 30.0 | 3.10 | 2214. | 1421. | 1898. |
| 27 | 1 | .260 | 3470 | 627.49 | 621.94 | 621.02 | 1.00 | 1.09 | 50.5 | 31.2 | 3.10 | 2214. | 1573. | 1897. |
| 28 | 1 | .270 | 3630 | 627.49 | 621.72 | 621.23 | 1.00 | 1.10 | 53.4 | 32.4 | 3.10 | 2214. | 1734. | 1896. |
| 29 | 1 | .280 | 3802 | 627.49 | 621.51 | 621.45 | 1.00 | 1.10 | 56.5 | 33.6 | 3.10 | 2214. | 1907. | 1895. |
| 30 | 1 | .290 | 3985 | 627.48 | 621.29 | 621.67 | 1.00 | 1.11 | 59.7 | 34.8 | 3.10 | 2214. | 2091. | 1894. |
| 31 | 1 | .300 | 4180 | 627.48 | 621.08 | 621.91 | 1.00 | 1.12 | 63.1 | 36.0 | 3.10 | 2214. | 2288. | 1893. |
| 32 | 1 | .310 | 4388 | 627.48 | 620.87 | 622.16 | 1.00 | 1.12 | 66.6 | 37.2 | 3.10 | 2214. | 2497. | 1891. |
| 33 | 1 | .320 | 4609 | 627.47 | 620.65 | 622.41 | 1.00 | 1.13 | 70.3 | 38.4 | 3.10 | 2214. | 2721. | 1889. |
| 34 | 1 | .330 | 4845 | 627.47 | 620.44 | 622.68 | 1.00 | 1.14 | 74.2 | 39.6 | 3.10 | 2214. | 2958. | 1887. |
| 35 | 1 | .340 | 5097 | 627.46 | 620.22 | 622.95 | 1.00 | 1.15 | 78.3 | 40.8 | 3.10 | 2214. | 3212. | 1885. |
| 36 | 1 | .350 | 5366 | 627.46 | 620.01 | 623.24 | 1.00 | 1.17 | 82.7 | 42.0 | 3.10 | 2214. | 3483. | 1883. |
| 37 | 1 | .360 | 5653 | 627.45 | 619.80 | 623.54 | 1.00 | 1.18 | 87.2 | 43.2 | 3.10 | 2214. | 3773. | 1881. |
| 38 | 1 | .370 | 5960 | 627.44 | 619.58 | 623.85 | 1.00 | 1.20 | 92.0 | 44.4 | 3.10 | 2214. | 4083. | 1878. |
| 39 | 1 | .380 | 6290 | 627.44 | 619.37 | 624.17 | 1.00 | 1.21 | 97.1 | 45.6 | 3.10 | 2214. | 4415. | 1875. |
| 40 | 1 | .390 | 6644 | 627.43 | 619.15 | 624.51 | 1.00 | 1.23 | 102.4 | 46.8 | 3.10 | 2214. | 4772. | 1872. |
| 41 | 1 | .400 | 7023 | 627.42 | 618.94 | 624.86 | 1.00 | 1.25 | 108.1 | 48.0 | 3.10 | 2214. | 5155. | 1868. |
| 42 | 1 | .410 | 7391 | 627.41 | 618.73 | 625.16 | .99 | 1.27 | 114.0 | 49.2 | 3.10 | 2214. | 5527. | 1865. |
| 43 | 1 | .420 | 7712 | 627.40 | 618.51 | 625.38 | .97 | 1.29 | 120.3 | 50.4 | 3.10 | 2214. | 5852. | 1861. |
| 44 | 1 | .430 | 7979 | 627.39 | 618.30 | 625.56 | .94 | 1.31 | 126.7 | 51.6 | 3.10 | 2214. | 6123. | 1856. |
| 45 | 1 | .440 | 8191 | 627.38 | 618.08 | 625.70 | .91 | 1.32 | 133.4 | 52.8 | 3.10 | 2214. | 6339. | 1852. |
| 46 | 1 | .450 | 8379 | 627.37 | 617.87 | 625.81 | .87 | 1.33 | 140.3 | 54.0 | 3.10 | 2214. | 6532. | 1847. |
| 47 | 1 | .460 | 8535 | 627.36 | 617.66 | 625.90 | .84 | 1.33 | 147.3 | 55.2 | 3.10 | 2214. | 6692. | 1843. |
| 48 | 1 | .470 | 8642 | 627.34 | 617.44 | 625.97 | .81 | 1.33 | 154.4 | 56.4 | 3.10 | 2214. | 6804. | 1838. |
| 49 | 1 | .480 | 8729 | 627.33 | 617.23 | 626.03 | .77 | 1.34 | 161.5 | 57.6 | 3.10 | 2214. | 6896. | 1833. |
| 50 | 1 | .490 | 8802 | 627.32 | 617.01 | 626.08 | .74 | 1.34 | 168.8 | 58.8 | 3.10 | 2214. | 6975. | 1828. |

RESERVOIR DEPLETION TABLE

| I | K | TTP(I) | Q(I) | H2 | YB | D | SUB | VCOR | OUTVOL | BB | COFR | QI(I) | QBRECH | QSPIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | 1 | .500 | 8865 | 627.31 | 616.80 | 626.12 | .72 | 1.33 | 176.1 | 60.0 | 3.10 | 2214. | 7044. | 1822. |
| 52 | 1 | .510 | 8847 | 627.30 | 616.80 | 626.11 | .72 | 1.33 | 183.4 | 60.0 | 3.10 | 2214. | 7034. | 1814. |
| 53 | 1 | .520 | 8831 | 627.28 | 616.80 | 626.10 | .72 | 1.33 | 190.7 | 60.0 | 3.10 | 2214. | 7022. | 1809. |
| 54 | 1 | .530 | 8814 | 627.27 | 616.80 | 626.09 | .72 | 1.34 | 198.0 | 60.0 | 3.10 | 2214. | 7011. | 1804. |
| 55 | 1 | .540 | 8798 | 627.26 | 616.80 | 626.07 | .72 | 1.34 | 205.3 | 60.0 | 3.10 | 2214. | 6999. | 1800. |
| 56 | 1 | .550 | 8782 | 627.25 | 616.80 | 626.06 | .72 | 1.34 | 212.5 | 60.0 | 3.10 | 2214. | 6988. | 1795. |
| 57 | 1 | .560 | 8766 | 627.23 | 616.80 | 626.05 | .72 | 1.34 | 219.8 | 60.0 | 3.10 | 2214. | 6976. | 1790. |
| 58 | 1 | .570 | 8750 | 627.22 | 616.80 | 626.04 | .72 | 1.34 | 227.0 | 60.0 | 3.10 | 2214. | 6965. | 1785. |
| 59 | 1 | .580 | 8734 | 627.21 | 616.80 | 626.03 | .72 | 1.34 | 234.3 | 60.0 | 3.10 | 2214. | 6954. | 1781. |
| 60 | 1 | .590 | 8718 | 627.20 | 616.80 | 626.02 | .72 | 1.34 | 241.5 | 60.0 | 3.10 | 2214. | 6942. | 1776. |
| 61 | 1 | .600 | 8702 | 627.19 | 616.80 | 626.01 | .72 | 1.34 | 248.7 | 60.0 | 3.10 | 2214. | 6931. | 1771. |
| 62 | 1 | .610 | 8686 | 627.17 | 616.80 | 626.00 | .72 | 1.34 | 255.9 | 60.0 | 3.10 | 2214. | 6920. | 1767. |
| 63 | 1 | .620 | 8670 | 627.16 | 616.80 | 625.99 | .72 | 1.34 | 263.0 | 60.0 | 3.10 | 2214. | 6908. | 1762. |
| 64 | 1 | .630 | 8654 | 627.15 | 616.80 | 625.97 | .72 | 1.34 | 270.2 | 60.0 | 3.10 | 2214. | 6897. | 1757. |
| 65 | 1 | .640 | 8639 | 627.14 | 616.80 | 625.96 | .72 | 1.34 | 277.3 | 60.0 | 3.10 | 2214. | 6886. | 1753. |
| 66 | 1 | .650 | 8623 | 627.12 | 616.80 | 625.95 | .72 | 1.34 | 284.5 | 60.0 | 3.10 | 2214. | 6875. | 1748. |
| 67 | 1 | .660 | 8607 | 627.11 | 616.80 | 625.94 | .72 | 1.34 | 291.6 | 60.0 | 3.10 | 2214. | 6864. | 1743. |
| 68 | 1 | .670 | 8592 | 627.10 | 616.80 | 625.93 | .72 | 1.34 | 298.7 | 60.0 | 3.10 | 2214. | 6853. | 1739. |
| 69 | 1 | .680 | 8576 | 627.09 | 616.80 | 625.92 | .72 | 1.34 | 305.8 | 60.0 | 3.10 | 2214. | 6842. | 1734. |
| 70 | 1 | .690 | 8560 | 627.08 | 616.80 | 625.91 | .72 | 1.34 | 312.9 | 60.0 | 3.10 | 2214. | 6831. | 1729. |
| 71 | 1 | .700 | 8545 | 627.06 | 616.80 | 625.90 | .72 | 1.34 | 319.9 | 60.0 | 3.10 | 2214. | 6821. | 1725. |
| 72 | 1 | .710 | 8529 | 627.05 | 616.80 | 625.89 | .72 | 1.34 | 327.0 | 60.0 | 3.10 | 2214. | 6810. | 1720. |
| 73 | 1 | .720 | 8514 | 627.04 | 616.80 | 625.88 | .72 | 1.34 | 334.0 | 60.0 | 3.10 | 2214. | 6799. | 1716. |
| 74 | 1 | .730 | 8499 | 627.03 | 616.80 | 625.87 | .72 | 1.34 | 341.1 | 60.0 | 3.10 | 2214. | 6788. | 1711. |
| 75 | 1 | .740 | 8483 | 627.02 | 616.80 | 625.86 | .72 | 1.34 | 348.1 | 60.0 | 3.10 | 2214. | 6777. | 1706. |
| 76 | 1 | .750 | 8468 | 627.01 | 616.80 | 625.85 | .72 | 1.34 | 355.1 | 60.0 | 3.10 | 2214. | 6767. | 1702. |
| 77 | 1 | .760 | 8453 | 626.99 | 616.80 | 625.83 | .72 | 1.34 | 362.1 | 60.0 | 3.10 | 2214. | 6756. | 1697. |
| 78 | 1 | .770 | 8438 | 626.98 | 616.80 | 625.82 | .72 | 1.34 | 369.1 | 60.0 | 3.10 | 2214. | 6746. | 1692. |
| 79 | 1 | .780 | 8422 | 626.97 | 616.80 | 625.81 | .72 | 1.34 | 376.0 | 60.0 | 3.10 | 2214. | 6735 | 3.10 2214. 6777. 1706 |
| 76 | 1 | .750 | 8468 | 627.01 | 616.80 | 625.85 | .72 | 1.34 | 355.1 | 60.0 | 3.10 | 2214. | 6767. | 1702. |
| 77 | 1 | .760 | 8453 | 626.99 | 616.80 | 625.83 | .72 | 1.34 | 362.1 | 60.0 | 3.10 | 2214. | 6756. | 1697. |
| 78 | 1 | .770 | 8438 | 626.98 | 616.80 | 625.82 | .72 | 1.34 | 369.1 | 60.0 | 3.10 | 2214. | 6746. | 1692. |
| 79 | 1 | .780 | 8422 | 626.97 | 616.80 | 625.81 | .72 | 1.34 | 376.0 | 60.0 | 3.10 | 2214. | 6735 | .830 8347 626.91 616.8 |
| 85 | 1 | .840 | 8333 | 626.90 | 616.80 | 625.75 | .72 | 1.34 | 417.6 | 60.0 | 3.10 | 2214. | 6673. | 1660. |
| 86 | 1 | .850 | 8318 | 626.89 | 616.80 | 625.74 | .72 | 1.34 | 424.5 | 60.0 | 3.10 | 2214. | 6662. | 1656. |
| 87 | 1 | .860 | 8303 | 626.88 | 616.80 | 625.73 | .72 | 1.34 | 431.3 | 60.0 | 3.10 | 2214. | 6652. | 1651. |
| 88 | 1 | .870 | 8288 | 626.87 | 616.80 | 625.72 | .72 | 1.34 | 438.2 | 60.0 | 3.10 | 2214. | 6642. | 1647. |
| 89 | 1 | .880 | 8273 | 626.86 | 616.80 | 625.71 | .72 | 1.34 | 445.0 | 60.0 | 3.10 | 2214. | 6632. | 1642. |
| 90 | 1 | .890 | 8259 | 626.84 | 616.80 | 625.70 | .72 | 1.34 | 451.9 | 60.0 | 3.10 | 2214. | 6621. | 1638. |
| 91 | 1 | .900 | 8244 | 626.83 | 616.80 | 625.69 | .72 | 1.34 | 458.7 | 60.0 | 3.10 | 2214. | 6611. | 1633. |
| 92 | 1 | .910 | 8230 | 626.82 | 616.80 | 625.68 | .72 | 1.34 | 465.5 | 60.0 | 3.10 | 2214. | 6601. | 1629. |
| 93 | 1 | .920 | 8215 | 626.81 | 616.80 | 625.67 | .72 | 1.34 | 472.3 | 60.0 | 3.10 | 2214. | 6591. | 1624. |
| 94 | 1 | .930 | 8200 | 626.80 | 616.80 | 625.66 | .72 | 1.34 | 479.1 | 60.0 | 3.10 | 2214. | 6581. | 1620. |
| 95 | 1 | .940 | 8186 | 626.79 | 616.80 | 625.65 | .72 | 1.34 | 485.8 | 60.0 | 3.10 | 2214. | 6571. | 1615. |
| 96 | 1 | .950 | 8171 | 626.78 | 616.80 | 625.64 | .72 | 1.34 | 492.6 | 60.0 | 3.10 | 2214. | 6561. | 1611. |
| 97 | 1 | .960 | 8157 | 626.77 | 616.80 | 625.63 | .72 | 1.34 | 499.3 | 60.0 | 3.10 | 2214. | 6551. | 1606. |
| 98 | 1 | .970 | 8143 | 626.75 | 616.80 | 625.62 | .72 | 1.34 | 506.1 | 60.0 | 3.10 | 2214. | 6541. | 1602. |
| 99 | 1 | .980 | 8128 | 626.74 | 616.80 | 625.61 | .72 | 1.34 | 512.8 | 60.0 | 3.10 | 2214. | 6531. | 1598. |
| 100 | 1 | .990 | 8114 | 626.73 | 616.80 | 625.60 | .72 | 1.34 | 519.5 | 60.0 | 3.10 | 2214. | 6522. | 1593. |

RESERVOIR DEPLETION TABLE

| I | K | TTP(I) | Q(I) | H2 | YB | D | SUB | VCOR | OUTVOL | BB | COFR | QI(I) | QBRECH | QSPIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *** | ** | ****** | ******** | ******* | ******* | ******* | **** | **** | ********* | **** | **** | ***** | ****** | ***** |
| 101 | 1 | 1.000 | 8100 | 626.72 | 616.80 | 625.59 | .72 | 1.34 | 526.2 | 60.0 | 3.10 | 2214. | 6512. | 1589. |
| 102 | 1 | 1.010 | 8086 | 626.71 | 616.80 | 625.58 | .72 | 1.35 | 532.9 | 60.0 | 3.10 | 2214. | 6502. | 1584. |
| 103 | 1 | 1.021 | 8070 | 626.70 | 616.80 | 625.57 | .72 | 1.35 | 540.2 | 60.0 | 3.10 | 2214. | 6491. | 1579. |
| 104 | 1 | 1.033 | 8053 | 626.69 | 616.80 | 625.55 | .72 | 1.35 | 548.3 | 60.0 | 3.10 | 2214. | 6479. | 1574. |
| 105 | 1 | 1.046 | 8034 | 626.67 | 616.80 | 625.54 | .72 | 1.35 | 557.2 | 60.0 | 3.10 | 2214. | 6466. | 1568. |
| 106 | 1 | 1.061 | 8014 | 626.65 | 616.80 | 625.53 | .72 | 1.35 | 566.9 | 60.0 | 3.10 | 2214. | 6452. | 1562. |
| 107 | 1 | 1.077 | 7991 | 626.64 | 616.80 | 625.51 | .72 | 1.35 | 577.5 | 60.0 | 3.10 | 2214. | 6437. | 1555. |
| 108 | 1 | 1.095 | 7967 | 626.62 | 616.80 | 625.49 | .72 | 1.35 | 589.2 | 60.0 | 3.10 | 2214. | 6420. | 1547. |
| 109 | 1 | 1.114 | 7939 | 626.60 | 616.80 | 625.47 | .72 | 1.35 | 602.0 | 60.0 | 3.10 | 2214. | 6401. | 1539. |
| 110 | 1 | 1.136 | 7910 | 626.57 | 616.80 | 625.45 | .72 | 1.35 | 616.0 | 60.0 | 3.10 | 2214. | 6381. | 1530. |
| 111 | 1 | 1.159 | 7878 | 626.55 | 616.80 | 625.43 | .72 | 1.35 | 631.4 | 60.0 | 3.10 | 2214. | 6359. | 1520. |
| 112 | 1 | 1.185 | 7843 | 626.52 | 616.80 | 625.40 | .72 | 1.35 | 648.3 | 60.0 | 3.10 | 2214. | 6335. | 1509. |
| 113 | 1 | 1.214 | 7804 | 626.49 | 616.80 | 625.38 | .72 | 1.35 | 666.7 | 60.0 | 3.10 | 2214. | 6308. | 1497. |
| 114 | 1 | 1.245 | 7762 | 626.46 | 616.80 | 625.35 | .72 | 1.35 | 686.9 | 60.0 | 3.10 | 2214. | 6279. | 1484. |
| 115 | 1 | 1.280 | 7717 | 626.42 | 616.80 | 625.31 | .73 | 1.35 | 709.0 | 60.0 | 3.10 | 2214. | 6248. | 1469. |
| 116 | 1 | 1.318 | 7667 | 626.38 | 616.80 | 625.28 | .73 | 1.35 | 733.1 | 60.0 | 3.10 | 2214. | 6214. | 1454. |
| 117 | 1 | 1.359 | 7613 | 626.34 | 616.80 | 625.24 | .73 | 1.35 | 759.5 | 60.0 | 3.10 | 2214. | 6177. | 1437. |
| 118 | 1 | 1.405 | 7555 | 626.30 | 616.80 | 625.20 | .73 | 1.35 | 788.3 | 60.0 | 3.10 | 2214. | 6137. | 1418. |
| 119 | 1 | 1.456 | 7491 | 626.25 | 616.80 | 625.15 | .73 | 1.35 | 819.8 | 60.0 | 3.10 | 2214. | 6093. | 1398. |
| 120 | 1 | 1.512 | 7422 | 626.19 | 616.80 | 625.10 | .73 | 1.35 | 854.0 | 60.0 | 3.10 | 2214. | 6046. | 1376. |
| 121 | 1 | 1.573 | 7347 | 626.13 | 616.80 | 625.05 | .73 | 1.35 | 891.3 | 60.0 | 3.10 | 2214. | 5995. | 1353. |
| 122 | 1 | 1.640 | 7267 | 626.07 | 616.80 | 624.99 | .73 | 1.36 | 932.0 | 60.0 | 3.10 | 2214. | 5940. | 1327. |
| 123 | 1 | 1.714 | 7190 | 626.00 | 616.80 | 624.92 | .73 | 1.36 | 976.2 | 60.0 | 3.10 | 2214. | 5892. | 1299. |
| 124 | 1 | 1.795 | 7105 | 625.92 | 616.80 | 624.85 | .74 | 1.36 | 1024.3 | 60.0 | 3.10 | 2214. | 5848. | 1258. |
| 125 | 1 | 1.885 | 7013 | 625.84 | 616.80 | 624.77 | .74 | 1.36 | 1076.5 | 60.0 | 3.10 | 2214. | 5801. | 1213. |
| 126 | 1 | 1.983 | 6915 | 625.75 | 616.80 | 624.68 | .74 | 1.36 | 1133.2 | 60.0 | 3.10 | 2214. | 5751. | 1165. |
| 127 | 1 | 2.092 | 6810 | 625.66 | 616.80 | 624.59 | .75 | 1.37 | 1194.7 | 60.0 | 3.10 | 2214. | 5697. | 1113. |
| 128 | 1 | 2.211 | 6698 | 625.56 | 616.80 | 624.48 | .75 | 1.37 | 1261.2 | 60.0 | 3.10 | 2214. | 5641. | 1057. |
| 129 | 1 | 2.342 | 6578 | 625.45 | 616.80 | 624.38 | .76 | 1.37 | 1333.1 | 60.0 | 3.10 | 2214. | 5580. | 998. |
| 130 | 1 | 2.486 | 6450 | 625.33 | 616.80 | 624.26 | .76 | 1.38 | 1410.8 | 60.0 | 3.10 | 2214. | 5517. | 934. |
| 131 | 1 | 2.645 | 6315 | 625.21 | 616.80 | 624.13 | .77 | 1.38 | 1494.4 | 60.0 | 3.10 | 2214. | 5450. | 866. |
| 132 | 1 | 2.819 | 6172 | 625.08 | 616.80 | 624.00 | .78 | 1.39 | 1584.5 | 60.0 | 3.10 | 2214. | 5379. | 794. |
| 133 | 1 | 3.011 | 6022 | 624.94 | 616.80 | 623.86 | .79 | 1.39 | 1681.2 | 60.0 | 3.10 | 2214. | 5306. | 717. |
| 134 | 1 | 3.223 | 5891 | 624.79 | 616.80 | 623.70 | .80 | 1.40 | 1785.2 | 60.0 | 3.10 | 2214. | 5256. | 636. |
| 135 | 1 | 3.455 | 5732 | 624.64 | 616.80 | 623.54 | .81 | 1.40 | 1896.7 | 60.0 | 3.10 | 2214. | 5182. | 550. |
| 136 | 1 | 3.710 | 5563 | 624.47 | 616.80 | 623.37 | .82 | 1.41 | 2016.0 | 60.0 | 3.10 | 2214. | 5104. | 460. |
| 137 | 1 | 3.991 | 5387 | 624.30 | 616.80 | 623.19 | .83 | 1.42 | 2143.1 | 60.0 | 3.10 | 2214. | 5022. | 365. |
| 138 | 1 | 4.300 | 5204 | 624.12 | 616.80 | 623.00 | .85 | 1.42 | 2278.5 | 60.0 | 3.10 | 2214. | 4937. | 267. |
| 139 | 1 | 4.640 | 5013 | 623.94 | 616.80 | 622.80 | .86 | 1.43 | 2422.0 | 60.0 | 3.10 | 2214. | 4836. | 177. |
| 140 | 1 | 5.014 | 4824 | 623.75 | 616.80 | 622.60 | .88 | 1.44 | 2574.1 | 60.0 | 3.10 | 2214. | 4718. | 107. |
| 141 | 1 | 5.426 | 4634 | 623.56 | 616.80 | 622.40 | .89 | 1.45 | 2734.9 | 60.0 | 3.10 | 2214. | 4599. | 35. |
| 142 | 1 | 5.879 | 4442 | 623.36 | 616.80 | 622.18 | .91 | 1.45 | 2904.7 | 60.0 | 3.10 | 2214. | 4480. | -38. |
| 143 | 1 | 6.376 | 4294 | 623.16 | 616.80 | 622.01 | .91 | 1.47 | 3084.4 | 60.0 | 3.10 | 2214. | 4294. | 0. |
| 144 | 2 | 6.924 | 4125 | 622.94 | 616.80 | 621.82 | .91 | 1.49 | 3275.0 | 60.0 | 3.10 | 2214. | 4125. | 0. |
| 145 | 1 | 7.526 | 3969 | 622.72 | 616.80 | 621.63 | .91 | 1.52 | 3476.5 | 60.0 | 3.10 | 2214. | 3969. | 0. |
| 146 | 1 | 8.189 | 3804 | 622.49 | 616.80 | 621.43 | .92 | 1.55 | 3689.3 | 60.0 | 3.10 | 2214. | 3805. | 0. |
| 147 | 1 | 8.918 | 3637 | 622.25 | 616.80 | 621.22 | .92 | 1.58 | 3913.5 | 60.0 | 3.10 | 2214. | 3638. | 0. |
| 148 | 1 | 9.720 | 3471 | 622.00 | 616.80 | 621.01 | .93 | 1.62 | 4149.1 | 60.0 | 3.10 | 2214. | 3472. | 0. |
| 149 | 1 | 10.602 | 3308 | 621.75 | 616.80 | 620.79 | .93 | 1.66 | 4396.2 | 60.0 | 3.10 | 2214. | 3309. | 0. |
| 150 | 1 | 11.572 | 3152 | 621.51 | 616.80 | 620.57 | .94 | 1.72 | 4655.2 | 60.0 | 3.10 | 2214. | 3152. | 0. |

RESERVOIR DEPLETION TABLE

| I | K | TTP(I) | Q(I) | H2 | YB | D | SUB | VCOR | OUTVOL | BB | COFR | QI(I) | QBRECH | QSPIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *** | ** | ****** | ******** | ******* | ******* | ******* | **** | **** | ********* | **** | **** | ***** | ****** | ***** |
| 151 | 1 | 12.639 | 3003 | 621.26 | 616.80 | 620.36 | .94 | 1.78 | 4926.7 | 60.0 | 3.10 | 2214. | 3004. | 0. |
| 152 | 1 | 13.813 | 2866 | 621.02 | 616.80 | 620.16 | .94 | 1.86 | 5211.4 | 60.0 | 3.10 | 2214. | 2866. | 0. |
| 153 | 2 | 15.104 | 2742 | 620.79 | 616.80 | 619.99 | .94 | 1.94 | 5510.7 | 60.0 | 3.10 | 2214. | 2742. | 0. |
| 154 | 2 | 16.525 | 2633 | 620.58 | 616.80 | 619.82 | .94 | 2.00 | 5826.2 | 60.0 | 3.10 | 2214. | 2633. | 0. |
| 155 | 2 | 18.087 | 2521 | 620.40 | 616.80 | 619.65 | .95 | 2.00 | 6159.1 | 60.0 | 3.10 | 2214. | 2522. | 0. |
| 156 | 2 | 19.806 | 2405 | 620.25 | 616.80 | 619.47 | .97 | 2.00 | 6509.0 | 60.0 | 3.10 | 2214. | 2406. | 0. |
| 157 | 2 | 21.697 | 2323 | 620.14 | 616.80 | 619.34 | .98 | 2.00 | 6878.5 | 60.0 | 3.10 | 2214. | 2323. | 0. |

| PARAMETER | UNITS | VARIABLE | VALUE |
|---|---|---|---|
| INITIAL FLOW | CFS | Q(1) | 1900. |
| MAX FLOW | CFS | QM | 8866. |
| FINAL FLOW | CFS | Q(NU) | 2323. |
| TIME TO MAX FLOW | HRS | TP | .50 |
| NUMBER OF TIME STEPS | | NNU | 157 |
| TOTAL VOLUME DISCHARGED FROM RESERVOIR | AC-FT | DISVOL | 6878. |

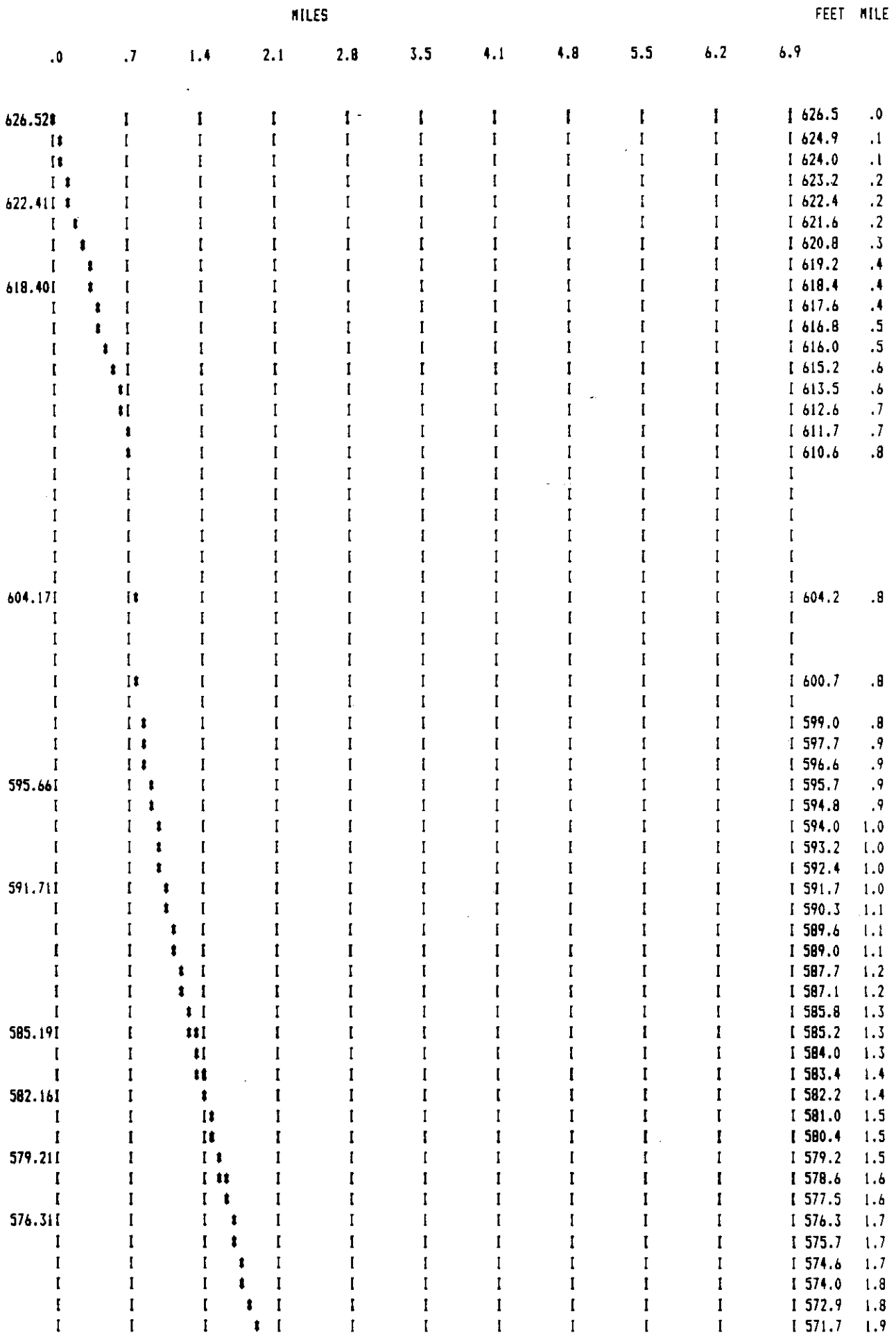
INITIAL STEADY FLOW BACKWATER COMPUTATION AT CROSS-SECTION NO.= 21 DID NOT CONVERGE.
CHANGE CROSS-SECTION PROPERTIES AND/OR INCREASE INITIAL STEADY FLOW AND RERUN.

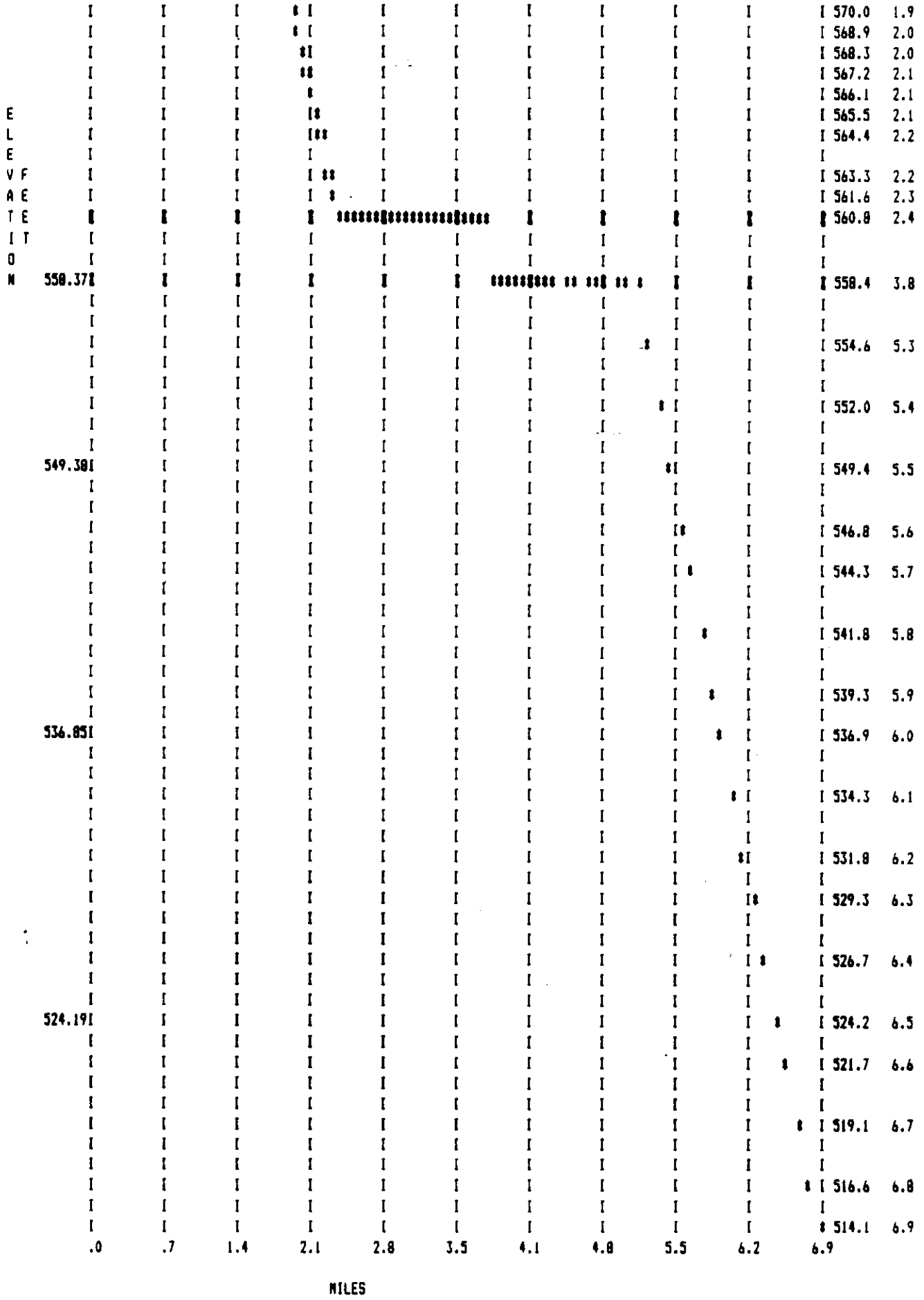
TIME PARAMETERS OF OUTFLOW HYDROGRAPH IMMEDIATELY DOWNSTREAM OF DAM

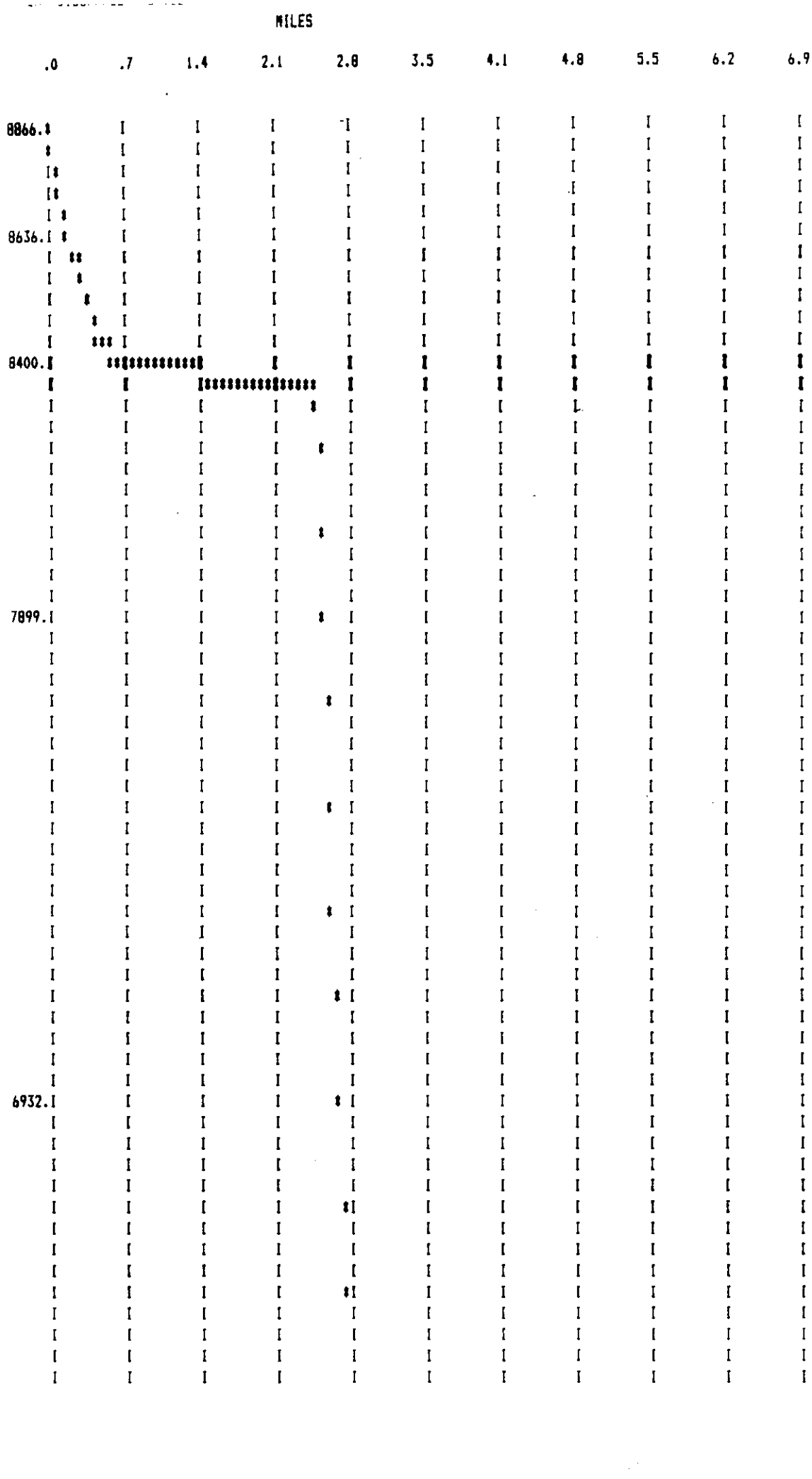
| PARAMETER | UNITS | VARIABLE | VALUE |
|---|---|---|---|
| TIME TO FAILURE | HR | TFH | .500 |
| TIME TO START OF RISING LIMB OF HYDROGRAPH | HR | TFO | .000 |
| TIME TO PEAK | HR | TP | .500 |
| TIME STEP SIZE | HR | DTHI | .025 |

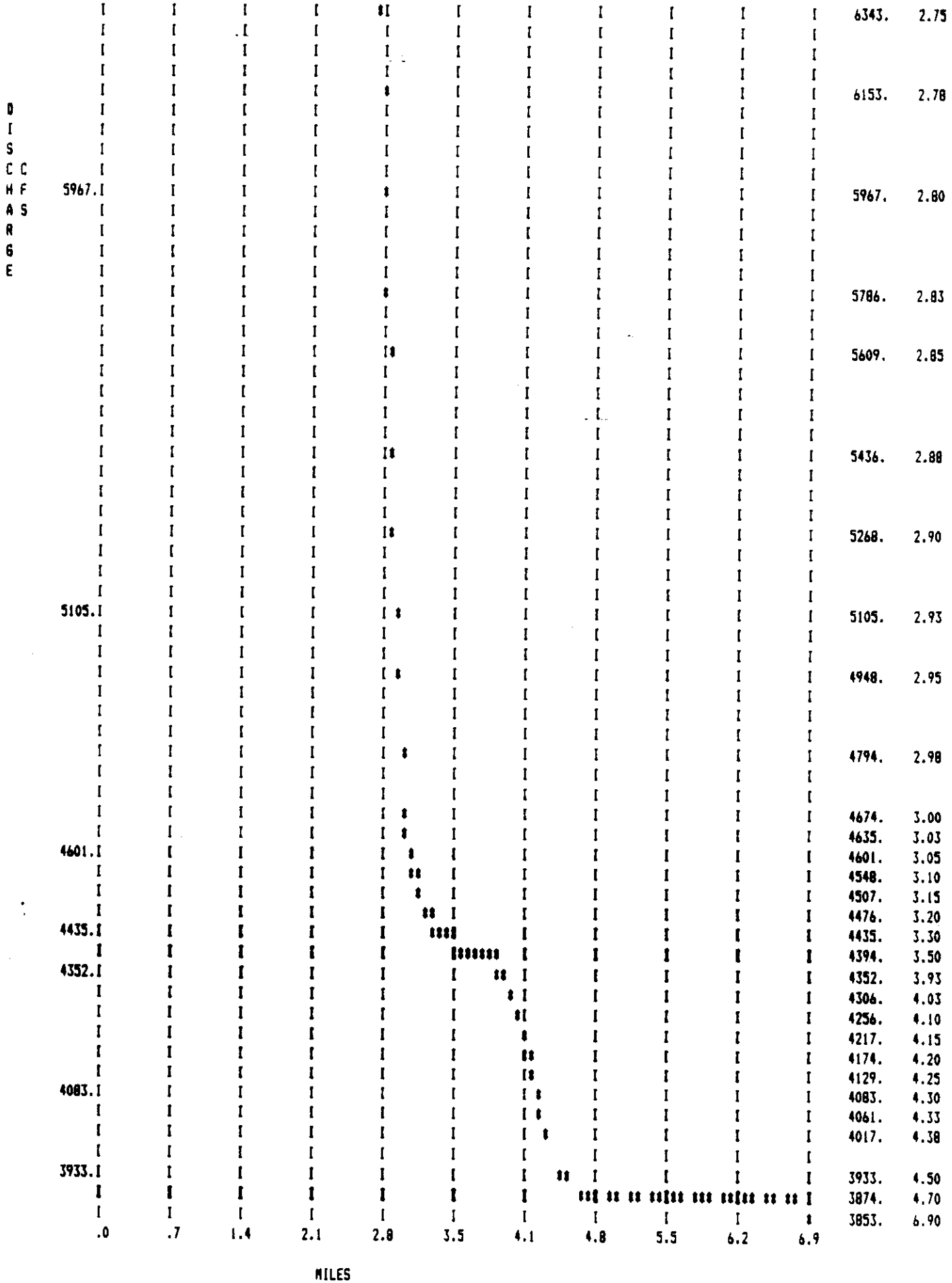
ROUTING COMPLETED.

KTIME=483 ALLOWABLE KTIME= 698 TT= 20.0


MILES
FEET
MILE
.0
.7
1.4
2.1
2.8
3.5
4.1
4.8
5.5
6.2
6.9
626.52
622.41
618.40
604.17
595.66
591.71
585.19
582.16
579.21
576.31
626.5 .0
624.9 .1
624.0 .1
623.2 .2
622.4 .2
621.6 .2
620.8 .3
619.2 .4
618.4 .4
617.6 .4
616.8 .5
616.0 .5
615.2 .6
613.5 .6
612.6 .7
611.7 .7
610.6 .8
604.2 .8
600.7 .8
599.0 .8
597.7 .9
596.6 .9
595.7 .9
594.8 .9
594.0 1.0
593.2 1.0
592.4 1.0
591.7 1.0
590.3 1.1
589.6 1.1
589.0 1.1
587.7 1.2
587.1 1.2
585.8 1.3
585.2 1.3
584.0 1.3
583.4 1.4
582.2 1.4
581.0 1.5
580.4 1.5
579.2 1.5
578.6 1.6
577.5 1.6
576.3 1.7
575.7 1.7
574.6 1.7
574.0 1.8
572.9 1.8
571.7 1.9
571.2 1.9

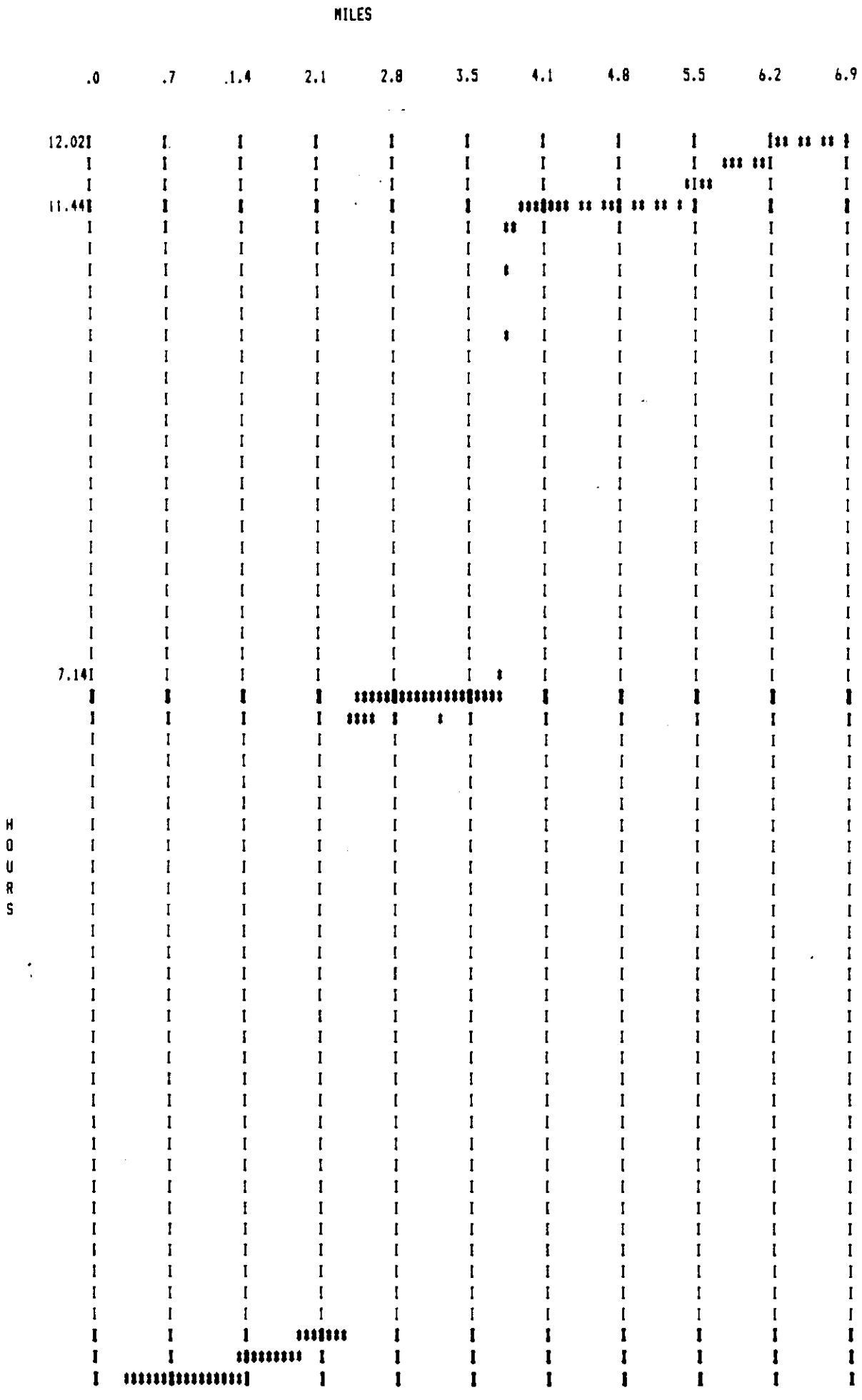

ELEVATION
570.0 1.9
568.9 2.0
568.3 2.0
567.2 2.1
566.1 2.1
565.5 2.1
564.4 2.2
563.3 2.2
561.6 2.3
560.8 2.4
558.37
558.4 3.8
554.6 5.3
552.0 5.4
549.38
549.4 5.5
546.8 5.6
544.3 5.7
541.8 5.8
539.3 5.9
536.85
536.9 6.0
534.3 6.1
531.8 6.2
529.3 6.3
526.7 6.4
524.19
524.2 6.5
521.7 6.6
519.1 6.7
516.6 6.8
514.1 6.9
.0 .7 1.4 2.1 2.8 3.5 4.1 4.8 5.5 6.2 6.9
MILES


MILES
.0 .7 1.4 2.1 2.8 3.5 4.1 4.8 5.5 6.2 6.9
CFS MILE
8866. 8866. .01
8799. .05
8759. .09
8704. .13
8666. .17
8636. 8636. .21
8603. .25
8546. .33
8519. .37
8468. .44
8447. .48
8400. 8400. .60
8364. 1.47
8319. 2.45
8209. 2.50
8072. 2.53
7899. 7899. 2.55
7710. 2.58
7515. 2.60
7318. 2.63
7127. 2.65
6932. 6932. 2.68
6734. 2.70
6536. 2.73


DISCHARGE
5967.
5105.
4601.
4435.
4352.
4083.
3933.
6343. 2.75
6153. 2.78
5967. 2.80
5786. 2.83
5609. 2.85
5436. 2.88
5268. 2.90
5105. 2.93
4948. 2.95
4794. 2.98
4674. 3.00
4635. 3.03
4601. 3.05
4548. 3.10
4507. 3.15
4476. 3.20
4435. 3.30
4394. 3.50
4352. 3.93
4306. 4.03
4256. 4.10
4217. 4.15
4174. 4.20
4129. 4.25
4083. 4.30
4061. 4.33
4017. 4.38
3933. 4.50
3874. 4.70
3853. 6.90
.0 .7 1.4 2.1 2.8 3.5 4.1 4.8 5.5 6.2 6.9
MILES

MILES

| HOUR | MILE | ELEV |
|---|---|---|
| 12.0 | 6.9 | 514.1 |
| 11.8 | 6.2 | 531.8 |
| 11.6 | 5.7 | 544.3 |
| 11.4 | 5.4 | 552.0 |
| 11.2 | 3.9 | 557.9 |
| 10.9 | 3.8 | 558.1 |
| 10.2 | 3.8 | 558.4 |
| 7.1 | 3.8 | 560.2 |
| 7.0 | 3.8 | 560.4 |
| 6.9 | 3.2 | 560.7 |
| 1.3 | 2.4 | 561.0 |
| 1.1 | 1.9 | 571.7 |
| 1.0 | 1.3 | 584.6 |

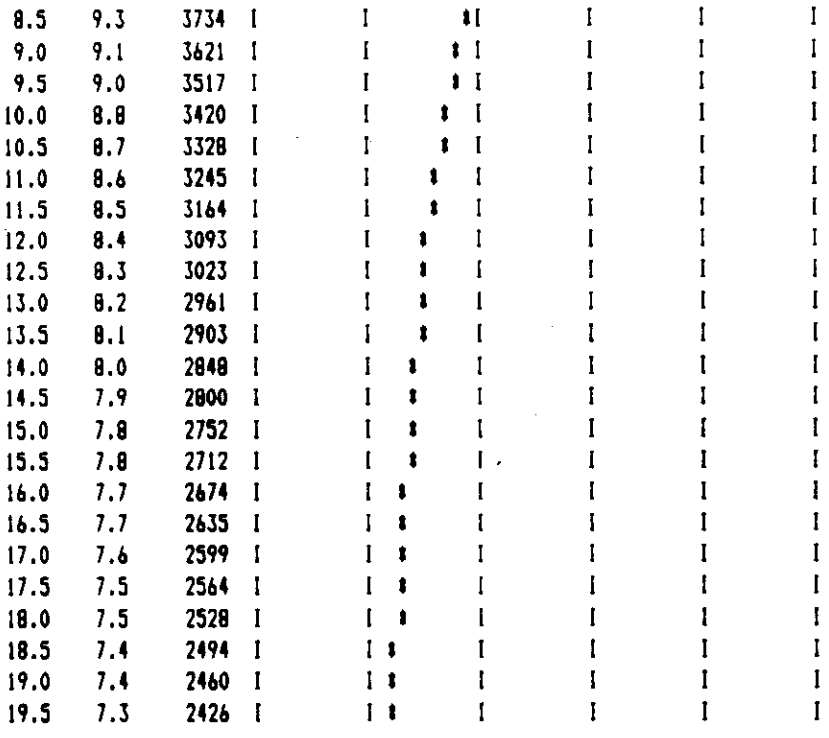


```
*****  I     I     I     I     I     I     I     I     I     I   .8   .3  620.8
*      I     I     I     I     I     I     I     I     I     I   .6   .0  626.5
.0    .7   1.4   2.1   2.8   3.5   4.1   4.8   5.5   6.2   6.9
                  MILES
```

DISCHARGE HYDROGRAPH FOR SUNCOOK RIVER WATERS ... STATION NUMBER 1
BELOW CRYSTAL LAKE DAM AT MILE .01

GAGE ZERO = 612.50 MAX ELEVATION REACHED BY FLOOD WAVE = 626.52
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 14.02 AT TIME = .600 HOURS
MAX FLOW = 8866 AT TIME = .500 HOURS

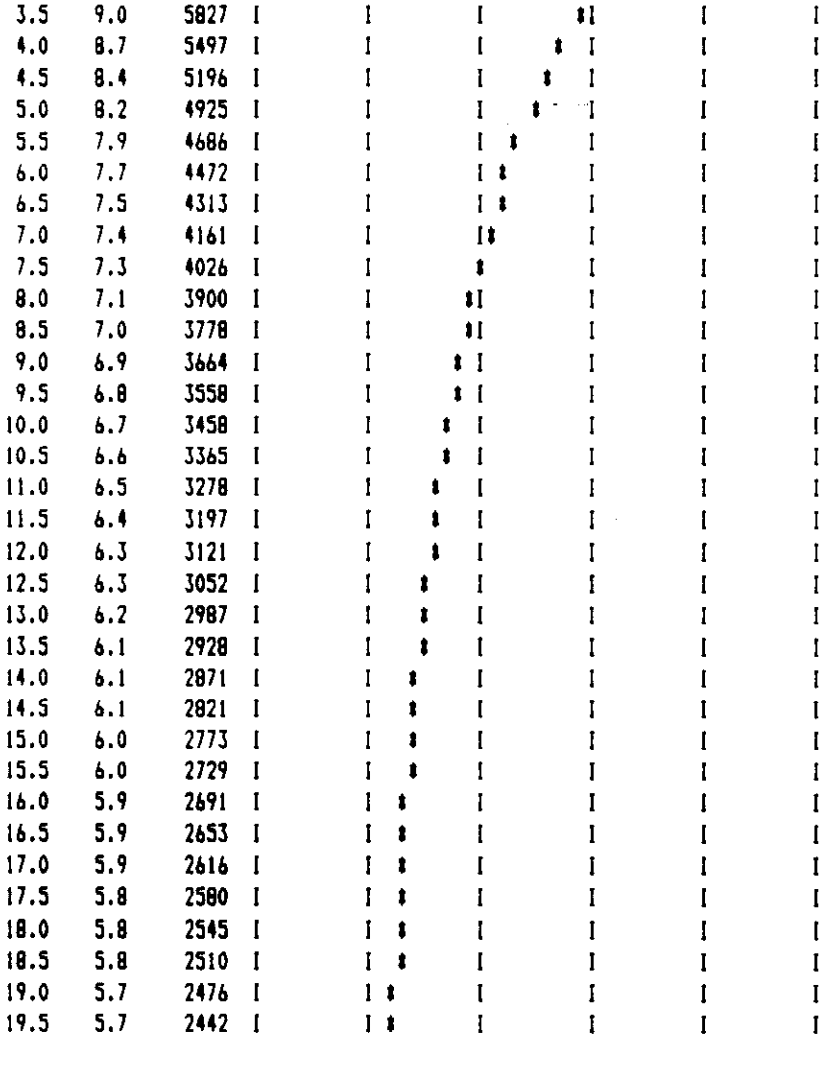
| HR | STAGE | FLOW |
|---|---|---|
| .0 | 6.4 | 1900 |
| .5 | 13.9 | 8866 |
| 1.0 | 13.7 | 8100 |
| 1.5 | 13.2 | 7437 |
| 2.0 | 12.7 | 6900 |
| 2.5 | 12.3 | 6439 |
| 3.0 | 11.9 | 6031 |
| 3.5 | 11.6 | 5702 |
| 4.0 | 11.3 | 5382 |
| 4.5 | 11.0 | 5092 |
| 5.0 | 10.7 | 4832 |
| 5.5 | 10.4 | 4603 |
| 6.0 | 10.1 | 4407 |
| 6.5 | 10.0 | 4256 |
| 7.0 | 9.8 | 4106 |
| 7.5 | 9.6 | 3976 |
| 8.0 | 9.4 | 3852 |
| 8.5 | 9.3 | 3734 |
| 9.0 | 9.1 | 3621 |
| 9.5 | 9.0 | 3517 |
| 10.0 | 8.8 | 3420 |
| 10.5 | 8.7 | 3328 |
| 11.0 | 8.6 | 3245 |
| 11.5 | 8.5 | 3164 |
| 12.0 | 8.4 | 3093 |
| 12.5 | 8.3 | 3023 |
| 13.0 | 8.2 | 2961 |
| 13.5 | 8.1 | 2903 |
| 14.0 | 8.0 | 2848 |
| 14.5 | 7.9 | 2800 |
| 15.0 | 7.8 | 2752 |
| 15.5 | 7.8 | 2712 |
| 16.0 | 7.7 | 2674 |
| 16.5 | 7.7 | 2635 |
| 17.0 | 7.6 | 2599 |
| 17.5 | 7.5 | 2564 |
| 18.0 | 7.5 | 2528 |
| 18.5 | 7.4 | 2494 |
| 19.0 | 7.4 | 2460 |
| 19.5 | 7.3 | 2426 |



DISCHARGE HYDROGRAPH FOR SUNCOOK RIVER WATERS ... STATION NUMBER 21
BELOW CRYSTAL LAKE DAM AT MILE .80

GAGE ZERO = 593.50 MAX ELEVATION REACHED BY FLOOD WAVE = 604.17
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 10.67 AT TIME = .900 HOURS
MAX FLOW = 8375 AT TIME = .900 HOURS

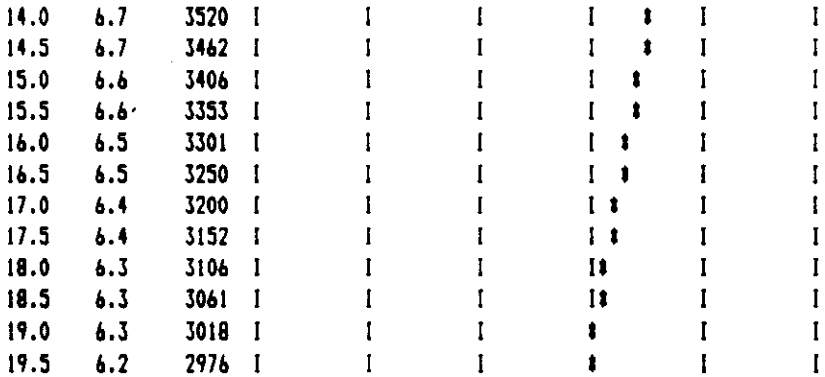
| HR | STAGE | FLOW |
|---|---|---|
| .0 | 5.1 | 2007 |
| .5 | 8.2 | 5103 |
| 1.0 | 10.6 | 8322 |
| 1.5 | 10.3 | 7697 |
| 2.0 | 9.9 | 7101 |
| 2.5 | 9.6 | 6610 |
| 3.0 | 9.2 | 6180 |
| 3.5 | 9.0 | 5827 |
| 4.0 | 8.7 | 5497 |
| 4.5 | 8.4 | 5196 |
| 5.0 | 8.2 | 4925 |
| 5.5 | 7.9 | 4686 |
| 6.0 | 7.7 | 4472 |
| 6.5 | 7.5 | 4313 |
| 7.0 | 7.4 | 4161 |
| 7.5 | 7.3 | 4026 |
| 8.0 | 7.1 | 3900 |
| 8.5 | 7.0 | 3778 |
| 9.0 | 6.9 | 3664 |
| 9.5 | 6.8 | 3558 |
| 10.0 | 6.7 | 3458 |
| 10.5 | 6.6 | 3365 |
| 11.0 | 6.5 | 3278 |
| 11.5 | 6.4 | 3197 |
| 12.0 | 6.3 | 3121 |
| 12.5 | 6.3 | 3052 |
| 13.0 | 6.2 | 2987 |
| 13.5 | 6.1 | 2928 |
| 14.0 | 6.1 | 2871 |
| 14.5 | 6.1 | 2821 |
| 15.0 | 6.0 | 2773 |
| 15.5 | 6.0 | 2729 |
| 16.0 | 5.9 | 2691 |
| 16.5 | 5.9 | 2653 |
| 17.0 | 5.9 | 2616 |
| 17.5 | 5.8 | 2580 |
| 18.0 | 5.8 | 2545 |
| 18.5 | 5.8 | 2510 |
| 19.0 | 5.7 | 2476 |
| 19.5 | 5.7 | 2442 |



DISCHARGE HYDROGRAPH FOR SUNCOOK RIVER WATERS ... STATION NUMBER 141
BELOW CRYSTAL LAKE DAM AT MILE 3.80

GAGE ZERO = 551.50 MAX ELEVATION REACHED BY FLOOD WAVE = 558.37
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 6.87 AT TIME = 10.233 HOURS
MAX FLOW = 4374 AT TIME = 6.138 HOURS

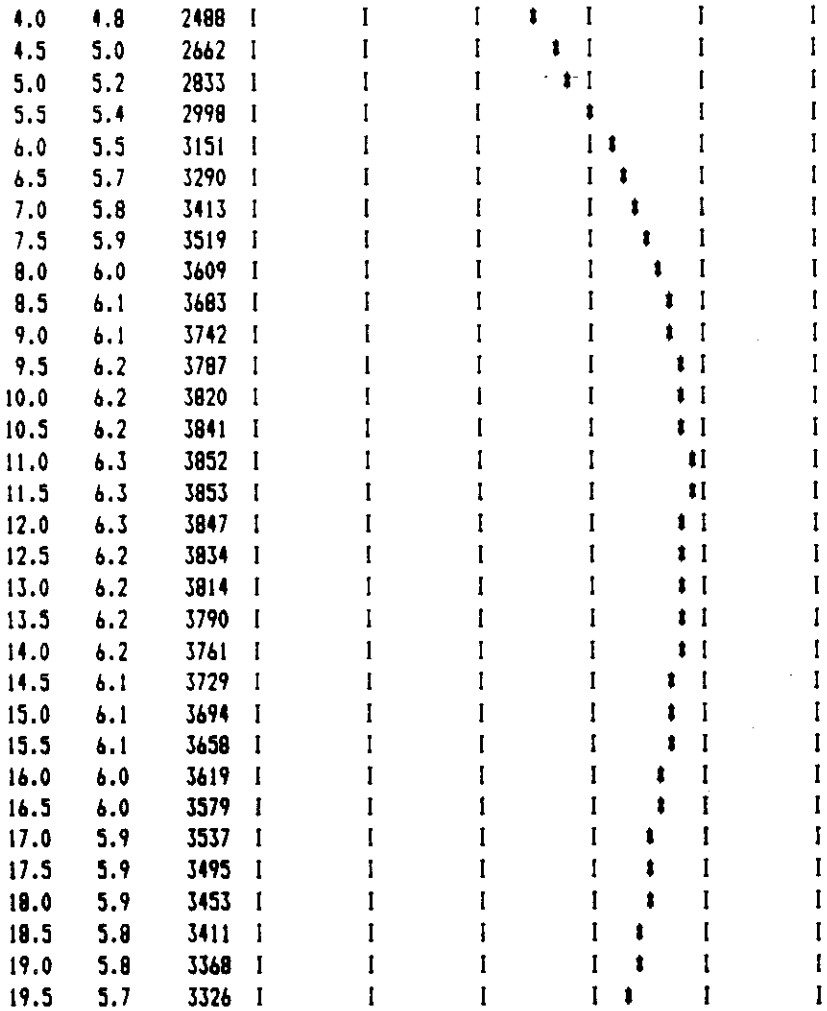
| HR | STAGE | FLOW |
|---|---|---|
| .0 | 4.4 | 1900 |
| .5 | 4.5 | 1900 |
| 1.0 | 4.5 | 1900 |
| 1.5 | 4.8 | 2192 |
| 2.0 | 5.2 | 2765 |
| 2.5 | 5.5 | 3209 |
| 3.0 | 5.7 | 3559 |
| 3.5 | 5.9 | 3830 |
| 4.0 | 6.0 | 4035 |
| 4.5 | 6.2 | 4184 |
| 5.0 | 6.3 | 4286 |
| 5.5 | 6.4 | 4346 |
| 6.0 | 6.5 | 4373 |
| 6.5 | 6.6 | 4369 |
| 7.0 | 6.7 | 4346 |
| 7.5 | 6.7 | 4311 |
| 8.0 | 6.8 | 4266 |
| 8.5 | 6.8 | 4214 |
| 9.0 | 6.8 | 4157 |
| 9.5 | 6.9 | 4096 |
| 10.0 | 6.9 | 4032 |
| 10.5 | 6.9 | 3966 |
| 11.0 | 6.9 | 3900 |
| 11.5 | 6.8 | 3834 |
| 12.0 | 6.8 | 3769 |
| 12.5 | 6.8 | 3704 |
| 13.0 | 6.8 | 3641 |
| 13.5 | 6.7 | 3580 |
| 14.0 | 6.7 | 3520 |
| 14.5 | 6.7 | 3462 |
| 15.0 | 6.6 | 3406 |
| 15.5 | 6.6 | 3353 |
| 16.0 | 6.5 | 3301 |
| 16.5 | 6.5 | 3250 |
| 17.0 | 6.4 | 3200 |
| 17.5 | 6.4 | 3152 |
| 18.0 | 6.3 | 3106 |
| 18.5 | 6.3 | 3061 |
| 19.0 | 6.3 | 3018 |
| 19.5 | 6.2 | 2976 |



DISCHARGE HYDROGRAPH FOR SUNCOOK RIVER WATERS ... STATION NUMBER 173
BELOW CRYSTAL LAKE DAM AT MILE 5.20

GAGE ZERO = 551.00 MAX ELEVATION REACHED BY FLOOD WAVE = 557.26
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 6.26 AT TIME = 11.335 HOURS
MAX FLOW = 3854 AT TIME = 11.335 HOURS

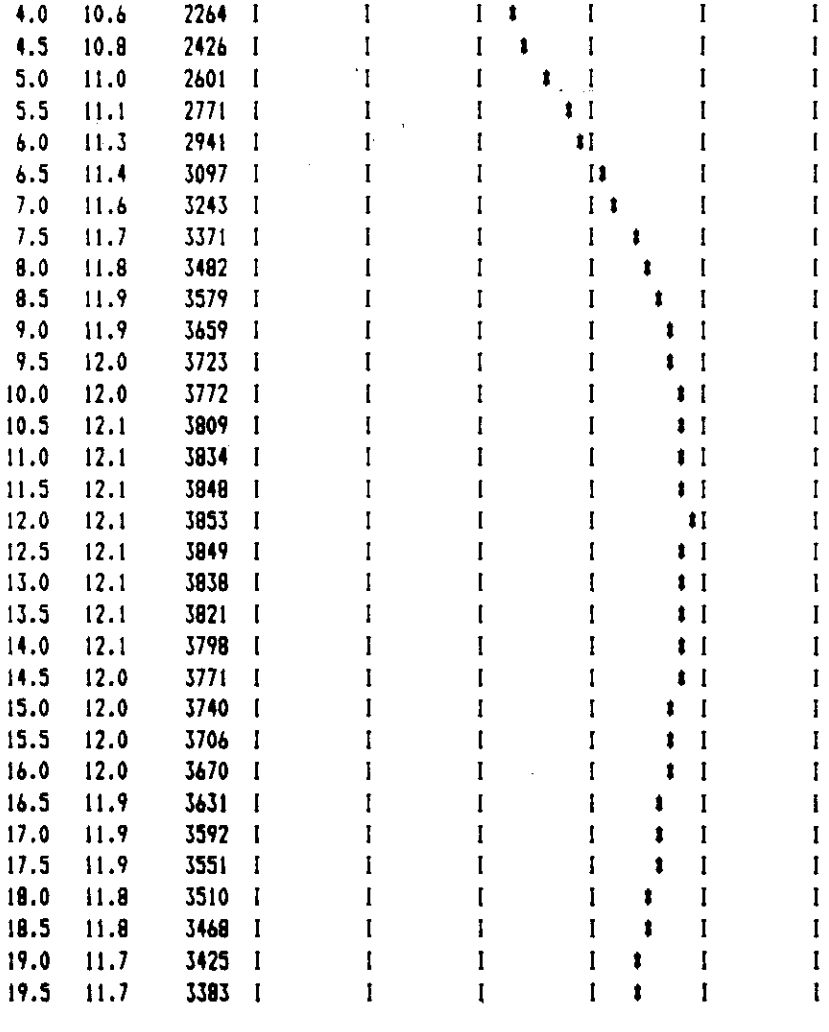
| HR | STAGE | FLOW |
|---|---|---|
| .0 | 4.1 | 1900 |
| .5 | 4.1 | 1900 |
| 1.0 | 4.1 | 1900 |
| 1.5 | 4.1 | 1900 |
| 2.0 | 4.1 | 1925 |
| 2.5 | 4.2 | 2028 |
| 3.0 | 4.4 | 2163 |
| 3.5 | 4.6 | 2319 |
| 4.0 | 4.8 | 2488 |
| 4.5 | 5.0 | 2662 |
| 5.0 | 5.2 | 2833 |
| 5.5 | 5.4 | 2998 |
| 6.0 | 5.5 | 3151 |
| 6.5 | 5.7 | 3290 |
| 7.0 | 5.8 | 3413 |
| 7.5 | 5.9 | 3519 |
| 8.0 | 6.0 | 3609 |
| 8.5 | 6.1 | 3683 |
| 9.0 | 6.1 | 3742 |
| 9.5 | 6.2 | 3787 |
| 10.0 | 6.2 | 3820 |
| 10.5 | 6.2 | 3841 |
| 11.0 | 6.3 | 3852 |
| 11.5 | 6.3 | 3853 |
| 12.0 | 6.3 | 3847 |
| 12.5 | 6.2 | 3834 |
| 13.0 | 6.2 | 3814 |
| 13.5 | 6.2 | 3790 |
| 14.0 | 6.2 | 3761 |
| 14.5 | 6.1 | 3729 |
| 15.0 | 6.1 | 3694 |
| 15.5 | 6.1 | 3658 |
| 16.0 | 6.0 | 3619 |
| 16.5 | 6.0 | 3579 |
| 17.0 | 5.9 | 3537 |
| 17.5 | 5.9 | 3495 |
| 18.0 | 5.9 | 3453 |
| 18.5 | 5.8 | 3411 |
| 19.0 | 5.8 | 3368 |
| 19.5 | 5.7 | 3326 |



DISCHARGE HYDROGRAPH FOR SUNCOOK RIVER WATERS ... STATION NUMBER 190
BELOW CRYSTAL LAKE DAM AT MILE 6.90

GAGE ZERO = 502.00 MAX ELEVATION REACHED BY FLOOD WAVE = 514.11
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 12.11 AT TIME = 12.018 HOURS
MAX FLOW = 3853 AT TIME = 12.018 HOURS

| HR | STAGE | FLOW |
|---|---|---|
| .0 | 10.2 | 1900 |
| .5 | 10.2 | 1909 |
| 1.0 | 10.2 | 1909 |
| 1.5 | 10.2 | 1909 |
| 2.0 | 10.2 | 1909 |
| 2.5 | 10.2 | 1913 |
| 3.0 | 10.3 | 1991 |
| 3.5 | 10.5 | 2103 |
| 4.0 | 10.6 | 2264 |
| 4.5 | 10.8 | 2426 |
| 5.0 | 11.0 | 2601 |
| 5.5 | 11.1 | 2771 |
| 6.0 | 11.3 | 2941 |
| 6.5 | 11.4 | 3097 |
| 7.0 | 11.6 | 3243 |
| 7.5 | 11.7 | 3371 |
| 8.0 | 11.8 | 3482 |
| 8.5 | 11.9 | 3579 |
| 9.0 | 11.9 | 3659 |
| 9.5 | 12.0 | 3723 |
| 10.0 | 12.0 | 3772 |
| 10.5 | 12.1 | 3809 |
| 11.0 | 12.1 | 3834 |
| 11.5 | 12.1 | 3848 |
| 12.0 | 12.1 | 3853 |
| 12.5 | 12.1 | 3849 |
| 13.0 | 12.1 | 3838 |
| 13.5 | 12.1 | 3821 |
| 14.0 | 12.1 | 3798 |
| 14.5 | 12.0 | 3771 |
| 15.0 | 12.0 | 3740 |
| 15.5 | 12.0 | 3706 |
| 16.0 | 12.0 | 3670 |
| 16.5 | 11.9 | 3631 |
| 17.0 | 11.9 | 3592 |
| 17.5 | 11.9 | 3551 |
| 18.0 | 11.8 | 3510 |
| 18.5 | 11.8 | 3468 |
| 19.0 | 11.7 | 3425 |
| 19.5 | 11.7 | 3383 |



# APPENDIX C

# BREACH FORMATION AND SIZING CALCULATION

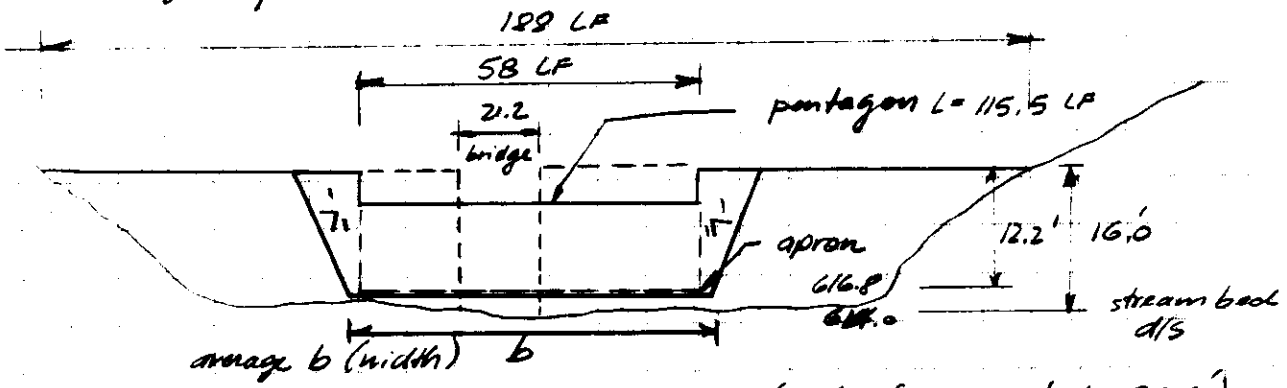
**STORCH ASSOCIATES**
**Engineers - Surveyors - Planners**
**Landscape Architects**
**Environmental Scientists**

JOB 6384 - NH Dams - Crystal Lo
SHEET NO. 1 OF
CALCULATED BY JH DATE 12-28-87
CHECKED BY DATE
SCALE Breach Sizing Gilmanton

## Breach Formation & Sizing.

Crystal Lake Dam - concrete, concrete upstream face, masonary and earthen embankment.

$L_d$ = 72.5 LF (top of dam) EL. 629.0 ($L_{dia}$ = 132 LF)
$L_s$ = 115.5 LF (spillway & pentagon) EL. 623.3 Ft ($L_{dia}$ = 56 LF)
$L_T$ = 188 LF (overall)
$h_d$ = 16 FT (12.2 Ft from apron)
invert = 616.8 Ft apron ; 614.0 d/s from bridge
Bridge op. = 21.2 LF




$h_d < b < 3h_d$ (varies from 12.2' to 36.6')

(40% L) → or $0.4 L_T$ → $188 \times .4 = 75'$

assuming spillway segment breach plus earthen portion erosion 1:1 use $\underline{b = 60}$ LF at apron elevation.

top width 60 + 24 = 84 LF

$h_d$ = 12.2 Ft.

| | | |
|---|---|---|
| Reservoir Length | 2.3 Mi | |
| Water Surface | EL 623.3 Ft | |
| Test Flood | 18,500 cfs (PMF) | inflow |
| Outflow | 11,910 cfs | EL 634.2 |

PRODUCT 204-1 NEBS Inc., Groton, Mass. 01471.