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NATIONAL DAM SAFETY PROGRAM. WAVERLY LOWER RESERVOIR DAM (NY623--ETC(U)

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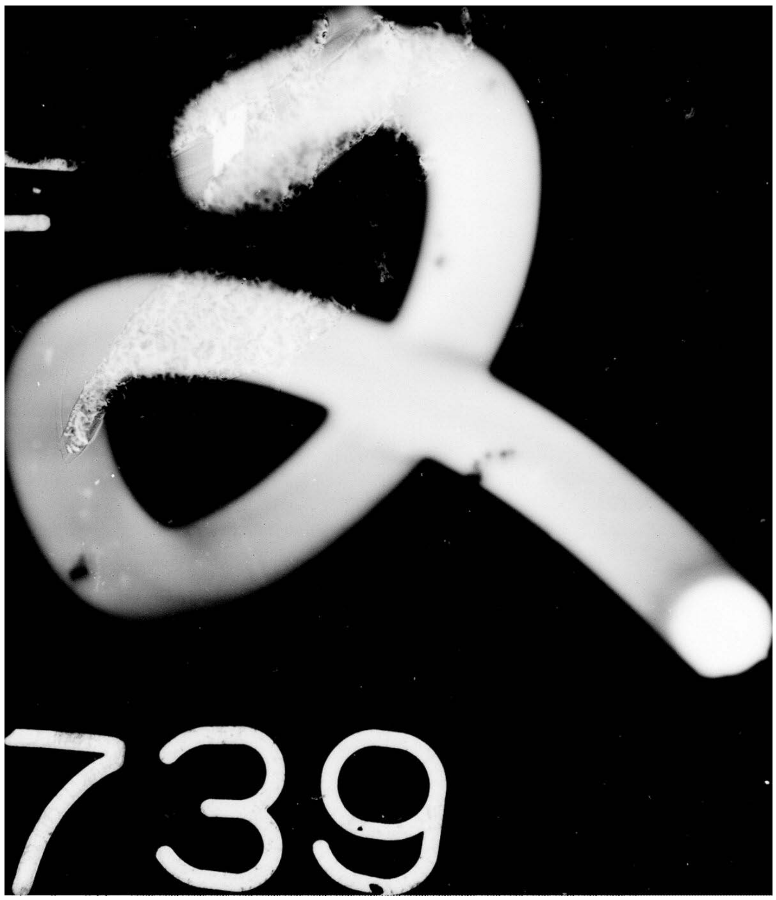
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CHEMUNG RIVER BASIN
WAVERLY LOWER RESERVOIR DAM
TIOGA COUNTY, NEW YORK
INVENTORY NUMBER NY 623

PHASE 1
INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

APPROVED FOR PUBLIC RELEASE;
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CONTRACT NO. DACW-51-78-C-0025

Prepared by

L. ROBERT KIMBALL and ASSOCIATES
615 W. Highland Ave. Ebensburg, Pa.

Prepared For

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
NEW YORK, NEW YORK

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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7. AUTHOR(s) (10) R. Jeffrey Kimball P.E.		8. CONTRACT OR GRANT NUMBER(s) (15) DACW 51-78-C-0025
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Dam Safety
National Dam Safety Program
Visual Inspection
Hydrology, Structural Stability
Waverly Lower Reservoir Dam
Tioga County
Dry Brook

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

This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization.
Waverly Lower Reservoir Dam was judged to be safe, although a boring program, hydrologic analysis, and a stability analysis were recommended.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

LEVEL II

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CHEMUNG RIVER BASIN
WAVERLY LOWER RESERVOIR DAM
TIOGA COUNTY, NEW YORK
INVENTORY NUMBER NY 623

PHASE 1
INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
NEW YORK, NEW YORK

Table of Contents

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Waverly Lower Reservoir Dam

State Located: New York

County Located: Tioga

Stream: Dry Brook of Chemung River

Date of Inspection: June 13, 1978

ASSESSMENT

The inspection and evaluation of the Waverly Lower Reservoir did not reveal any problems which require immediate emergency action.

Immediate follow up action is recommended to either evaluate embankment stability and make necessary modifications or render the reservoir and dam safe by lowering the water level and taking the impoundment out of service. This action should be initiated and hopefully completed this year. As noted in this report the village is currently considering taking the reservoir out of service as a result of new storage tank construction.

The hydrologic analysis indicated that the spillway is capable of passing the SPF with 0.3 feet of freeboard remaining. The dam will be overtopped during the PMF. The owner should consider making modifications to increase spillway capacity if the reservoir is to remain in service.

No signs of instability were noted on the embankment and the spillway can pass the SPF. Therefore, emergency actions are not warranted. The structure does not warrant an unsafe label as defined in the C.O.E. guidelines. However, the structure is a high hazard potential dam which should receive immediate followup consideration.

The immediate followup action is recommended as no information is available on the nearly 100 year old dam. Two borings were drilled into the dam in 1974. Monitors installed in these borings indicate a water level approximately 20' below the top of dam. The downstream slope is relatively steep (1.5:1) and its condition obscured by rock and small brush. Seepage was noted at the toe, apparently through the left abutment rock, and at the base of one of the pipes in the metering house possibly seeping along the pipe through the embankment.

Routine maintenance is required for the embankment including clearing of small trees and brush. The spillway weir will also require maintenance including removal of trees and brush and repairs to the overflow weir.

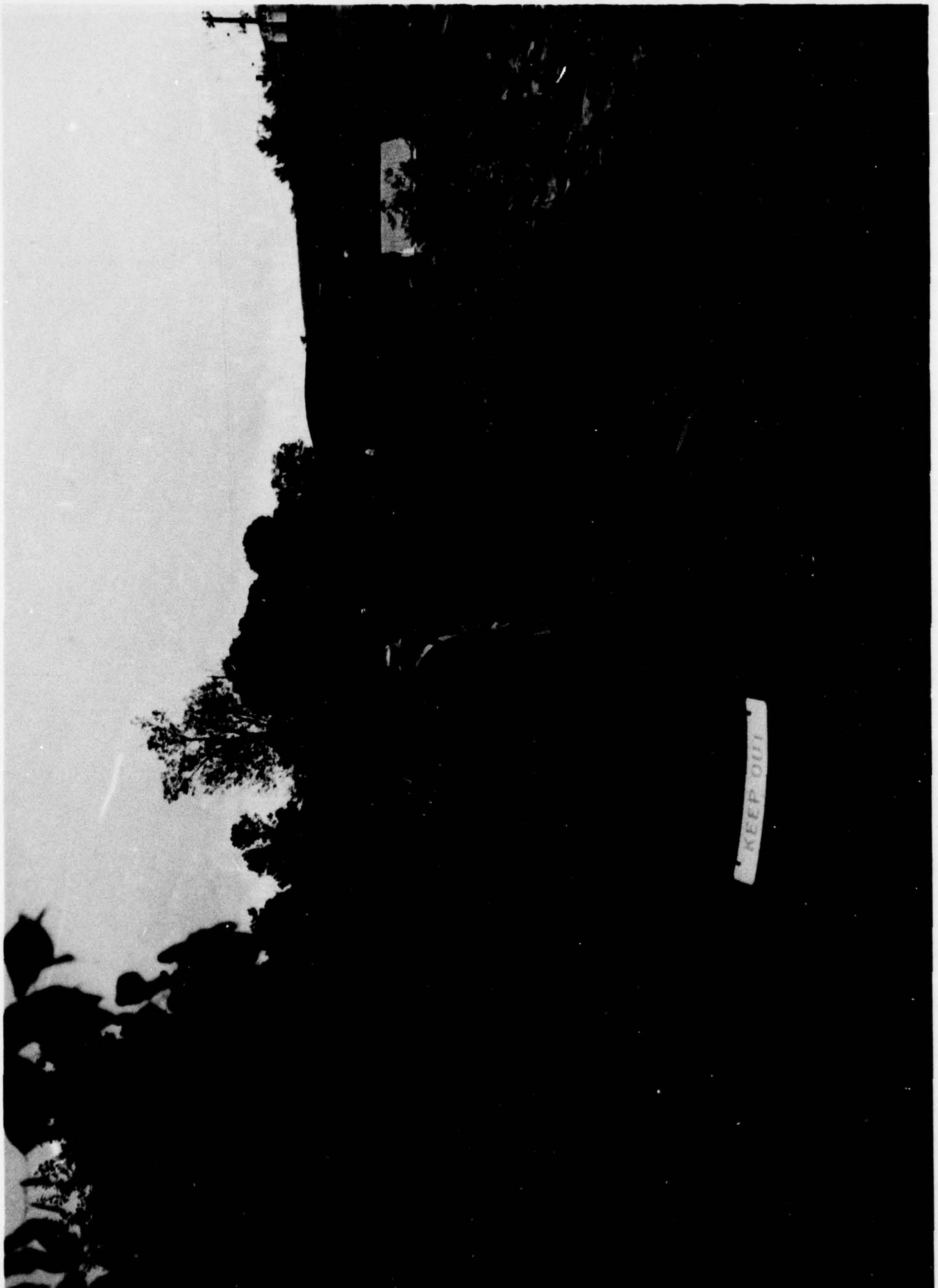
Approved by: R. Jeffrey Kimball

R. Jeffrey Kimball, P.E.
L. ROBERT KIMBALL & ASSOCIATES
Registration No. 26275E

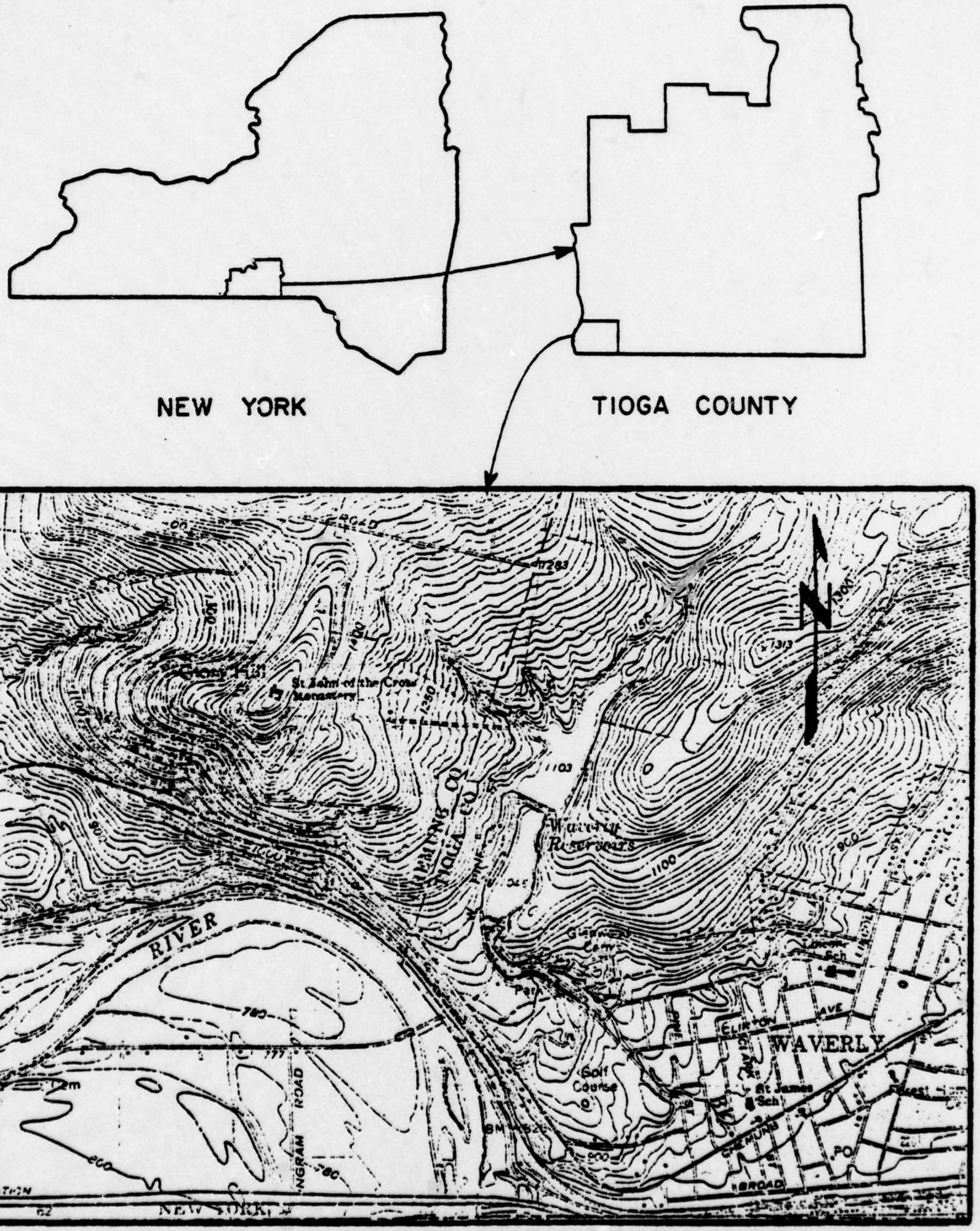
Approved by: Clark H. Benn

CLARK H. BENN
Colonel, Corps of Engineers
District Engineer

Date: 29 Aug 78



OVERVIEW FROM LEFT ABUTMENT



Portion of Waverly, New York 7.5 minute U.S.G.S. quadrangle

WAVERLY LOWER RESERVOIR DAM

SITE LOCATION MAP

SCALE : 1" = 2000'

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
WAVERLY LOWER RESERVOIR DAM ID #623

SECTION I: PROJECT INFORMATION

1.1 General:

a. Authority: Authority is provided by the National Dam Inspection Act Public Law 92-367.
Contract Number: DACW51-78-C-0025

b. Purpose of Project: Evaluation of non-Federal dams to identify dams which are a threat to life and property.

1.2 Description of Project:

a. Description of Dam and Appurtenances: The Waverly Lower Reservoir Dam is an earthfill embankment with a masonry core wall in the upstream portion. The downstream slope is 1.5:1. The upstream slope 2:1. The dam is 54 feet high with 3.2 feet of freeboard between the spillway weir and the lowest point on the top of the dam.

The spillway is a side channel structure. An 82 foot concrete weir forms the spillway which discharges to the side channel, also the exit channel for the upstream Waverly Upper Reservoir Dam Spillway.

Upstream of the subject dam is the Waverly Upper Reservoir which was studied and modified by the Baltimore District Corps of Engineers in 1973-1974. The modifications consisted of lowering the water level and excavating a spillway on the right abutment to lower the normal pool approximately 25 feet. The corps involvement was prompted by slope movement (upstream and downstream).

Two twelve inch C.I. pipes are located in the embankment, one a water supply line, the other a drain pipe.

The dam was constructed in 1880. The upstream dam in 1918. Both dams are a part of the village water supply, however, they are being phased out by new wells and storage tanks.

b. Location: The dam is located 2,000 feet northwest of the Waverly Village on the Waverly Village limits. The location can be found on the Waverly New York - Pennsylvania 7.5 minute series U.S.G.S. quadrangle (see site location map).

c. Size Classification: The dam is an intermediate size structure.

d. Hazard Classification: The Waverly Lower Reservoir is a high hazard potential structure.

e. Ownership: The dam is owned by the village of Waverly.

f. Purpose of Dam: The dam is presently used for water supply. The dam may be phased out of service by 1979.

g. Design and Construction History: The dam was constructed in 1880. No design or construction data was available.

h. Normal Operation Procedures: The reservoir is used for water supply and well water storage.

Occasional maintenance is performed by the village. Maintenance has been lax in the recent past as considerable vegetation has established on both slopes and the reservoir rim.

1.3 Pertinent Data:

a. Drainage Area: The drainage area above the two dams is approximately 2 square miles. The drainage area is primarily wooded and agricultural land with minimal development.

b. Discharge at Damsite:

Maximum known flood at damsite: No records, apparently Hurricane Agnes, 1972.

Spillway capacity at maximum design pool elevation: Unknown design pool

Gated spillway capacity at pool elevation: None

Ungated spillway capacity at maximum pool elevation: 1640 cfs

c. Elevation: (feet above MSL - based on assumed elevation on overflow weir from U.S.G.S. quadrangle).

Top of Dam: 1,049.2' (low point on dam)

Maximum Pool Design Surcharge: Unknown

Spillway Crest: 1,046.0 (assumed)

Stream bed at centerline of dam: approximately 990.0'

Maximum Tailwater: None

d. Reservoir:

Length of normal pool: 1,500 feet

Length of maximum pool: 1,600 feet

e. Storage: (acre-feet)

Normal pool: 300 (approximatley)

Design Surcharge: Unknown

Top of Dam: 360

f. Reservoir Surface: (acres)

Top of Dam: 20.5

Normal Pool: 17.8

g. Dam:

Type: Earthfill

Length: 310 feet

Height: 54 feet

Top Width: 8 feet

Side slopes: Upstream 2:1
Downstream 1.5:1

Zoning: Homogeneous

Impervious Core: Masonry Wall

Cutoff: Unknown

Grout Curtain: None

h. Diversion and Regulating Tunnel:

Type: Two 12" C.I. pipes

Length: 200' approximately

Closure: Drain pipe downstream at chlorination house, water supply line - Upstream staged gates and downstream in chlorination house.

i. Spillway:

Type: Side channel spillway with concrete weir overflow

Length: 82 feet

Crest Elevation: 1,046 feet

Gates: None

Upstream Channel: Channel entire length of right bank of reservoir, exit channel from upper reservoir.
Downstream Channel: Side channel which discharges to waterfall in abutment rock.

Side channel width: 18 feet (bottom)

Side Channel control elevation: 1,039.0'

j. Regulating Outlets: Water supply and drain line.

SECTION 2: ENGINEERING DATA

2.1 Design: No design data was available for review except for one typical section.

2.2 Construction: No data was available on the construction of the dam. The dam was reportedly constructed in 1880.

2.3 Operation: No engineering data is available on the operation of the dam or appurtenant structures.

2.4 Evaluation: Little or no data is available to adaquately evaluate the structure.

RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	4834.	3706.	1290.	653.	1.98
ROUTED TO	2	4762.	3680.	1251.	632.	1.98
ROUTED TO	3	4756.	3677.	1226.	618.	1.98

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******************************
HEC-1 VERSION DATED JAN 1973
UPDATED AUG 74
CHANGE NO. 01
******************************

                              WAVERLY UPPER RESERVOIR DAM
                        RESERVOIR AT TOP OF FLOOD CONTROL POOL
                                       TEST SPF

                                   JOB SPECIFICATION
                 NQ    NHR   NMIN   IDAY    IHR   IMIN  METRC   IPLT   IPRT  NSTAN
                 43      0     30      0      0      0      0      2      0      0
                                    JOPER    NWT
                                        3      0


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                              SUB-AREA RUNOFF COMPUTATION
                 ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME
                     1       0       0       0       0       0       0

                                    HYDROGRAPH DATA
        IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
           -1     -1    1.98     0.0    1.98    1.00     0.0       0       0       0

                                   INPUT HYDROGRAPH
       6.        29.        77.       152.       254.       372.       502.       665.       874.      1098.
    1298.      1435.      1481.      1422.      1293.      1141.       978.       821.       681.       564.
     467.       388.       322.       267.       200.       183.       152.       128.       104.        86.
      72.        59.        49.        37.        29.        25.        21.        15.        11.         5.
       4.         2.         1.

                      PEAK    6-HOUR   24-HOUR   72-HOUR    TOTAL VOLUME
             CFS     1481.     1099.      413.      413.          17770.
          INCHES                5.16      6.96      6.96            6.96
           AC-FT                545.      735.      735.            735.
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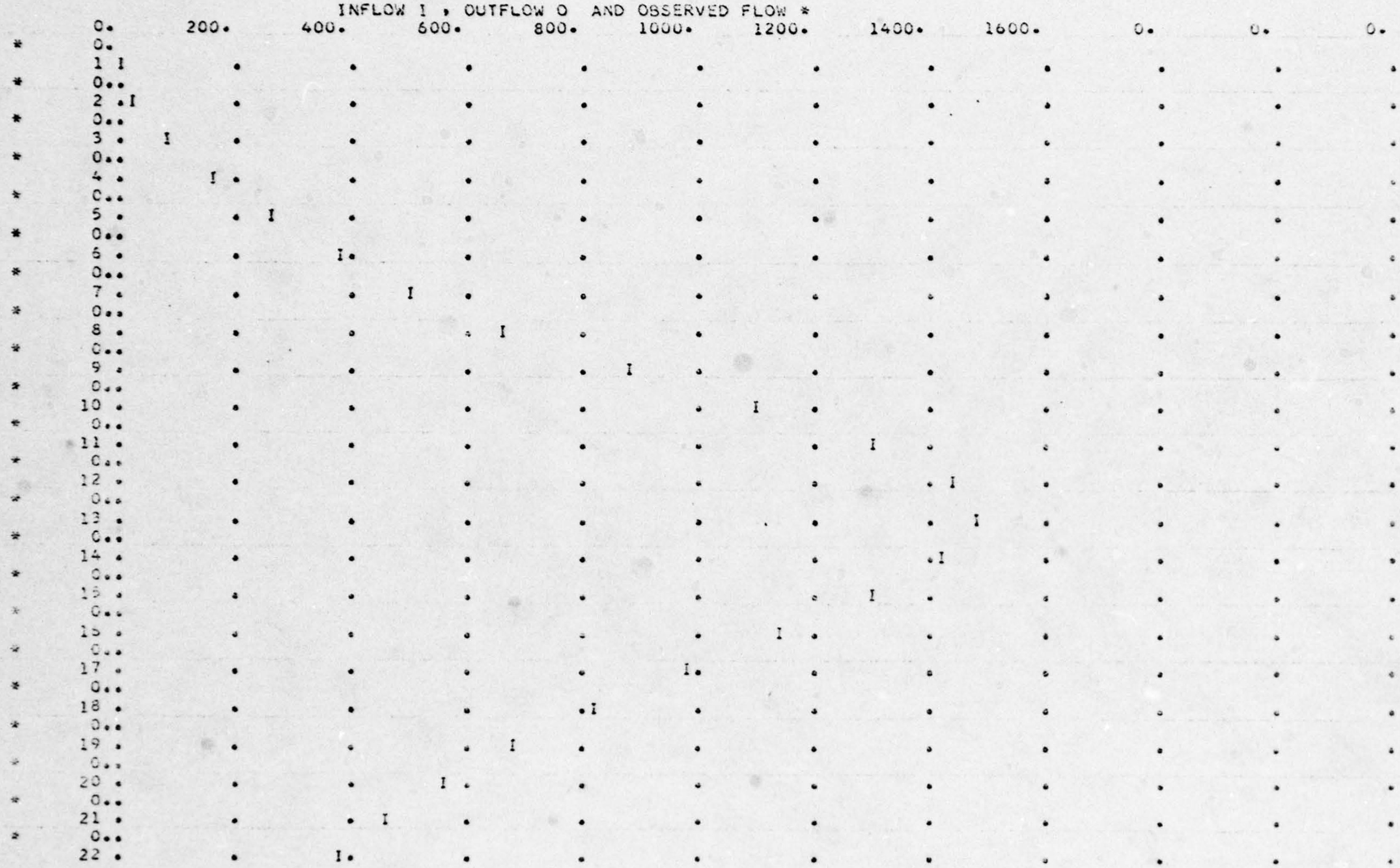
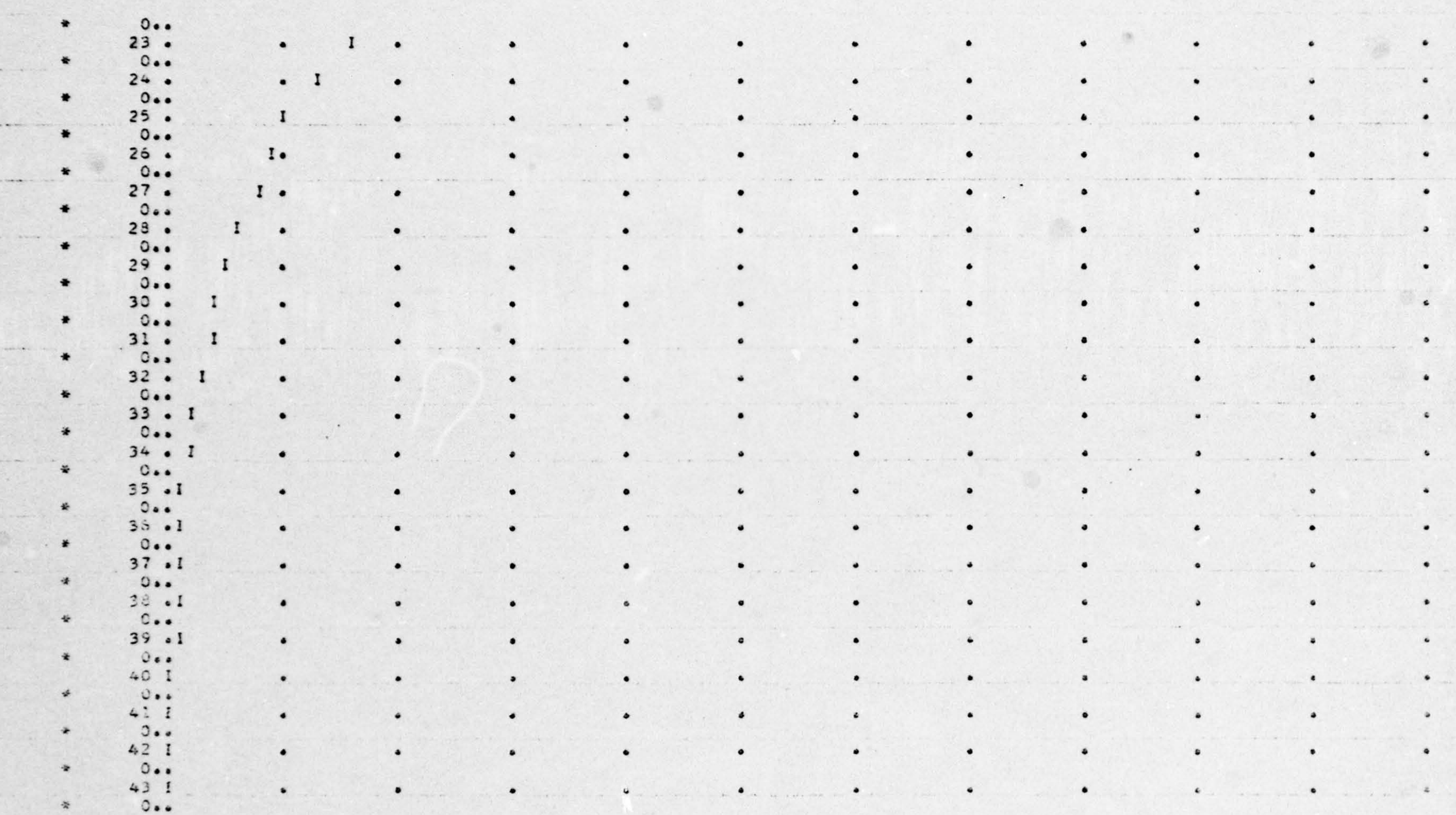
OVF

STATION 1

INFLOW I , OUTFLOW O AND OBSERVED FLOW *





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HYDROGRAPH ROUTING

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

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.	27.	115.	215.	327.	518.	564.	587.	611.	636.
OUTFLOW	0.	147.	1749.	5399.	11542.	26262.	30527.	32805.	35180.	39334.

TIME	EOP STOR	AVG IN	EOP OUT
1	1.	6.	6.
2	2.	18.	8.
3	3.	53.	17.
4	7.	115.	37.
5	13.	203.	71.
6	22.	313.	120.
7	32.	437.	246.
8	43.	584.	431.
9	53.	770.	616.
10	64.	986.	818.
11	75.	1198.	1026.
12	86.	1367.	1212.
13	93.	1458.	1346.
14	96.	1452.	1404.
15	95.	1358.	1379.
16	90.	1217.	1290.
17	83.	1060.	1164.
18	75.	900.	1019.
19	67.	751.	873.
20	59.	623.	736.
21	53.	516.	615.
22	47.	428.	513.
23	42.	355.	426.
24	38.	295.	354.
25	35.	234.	288.
26	32.	192.	235.
27	30.	168.	198.
28	28.	140.	166.
29	26.	116.	144.
30	25.	95.	134.

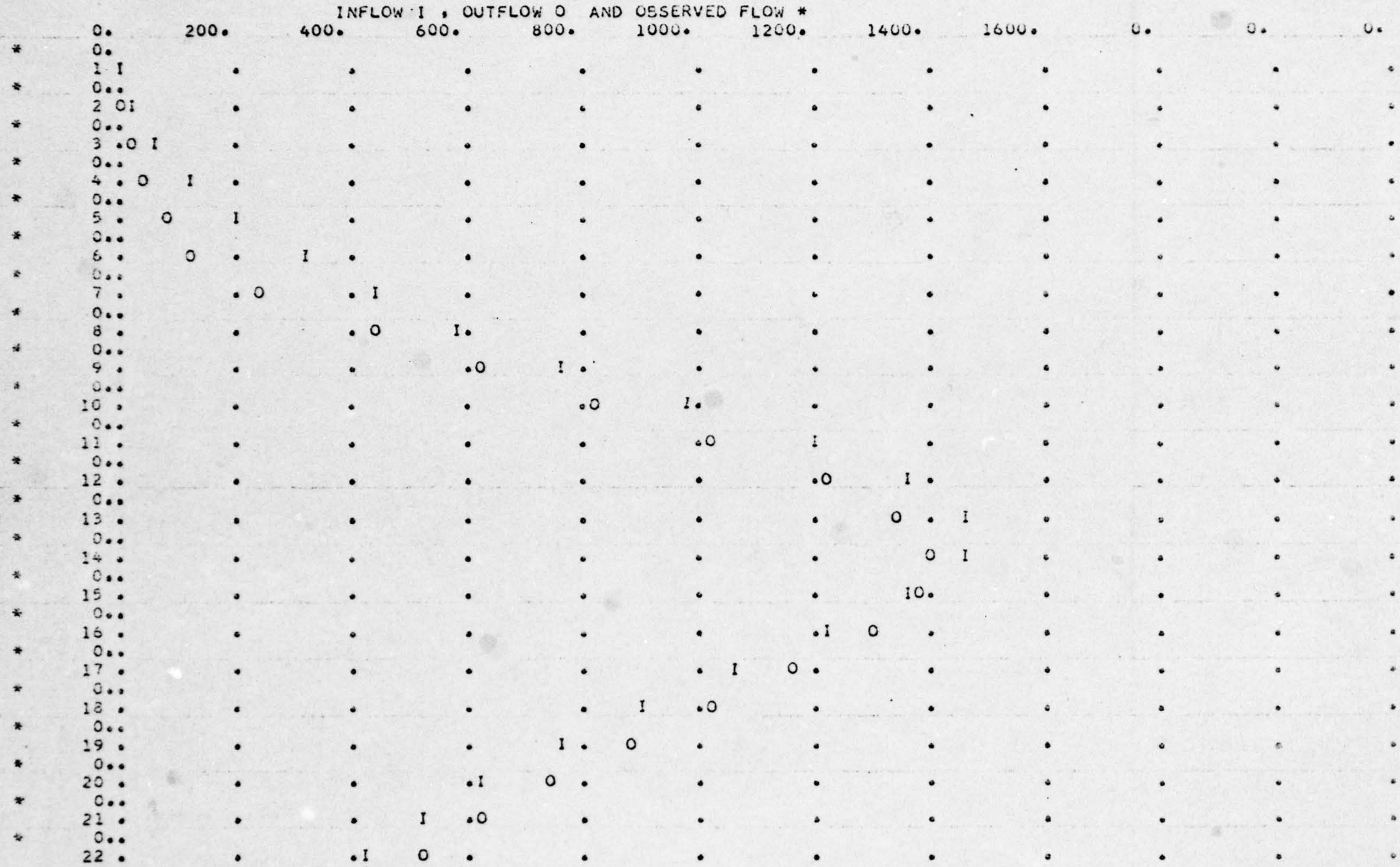
31	23.	79.	123.
32	20.	66.	111.
33	18.	54.	100.
34	16.	43.	88.
35	14.	33.	77.
36	12.	27.	67.
37	11.	23.	58.
38	9.	18.	50.
39	8.	13.	42.
40	7.	8.	36.
41	5.	5.	29.
42	4.	3.	24.
43	4.	2.	19.
SUM			17720.

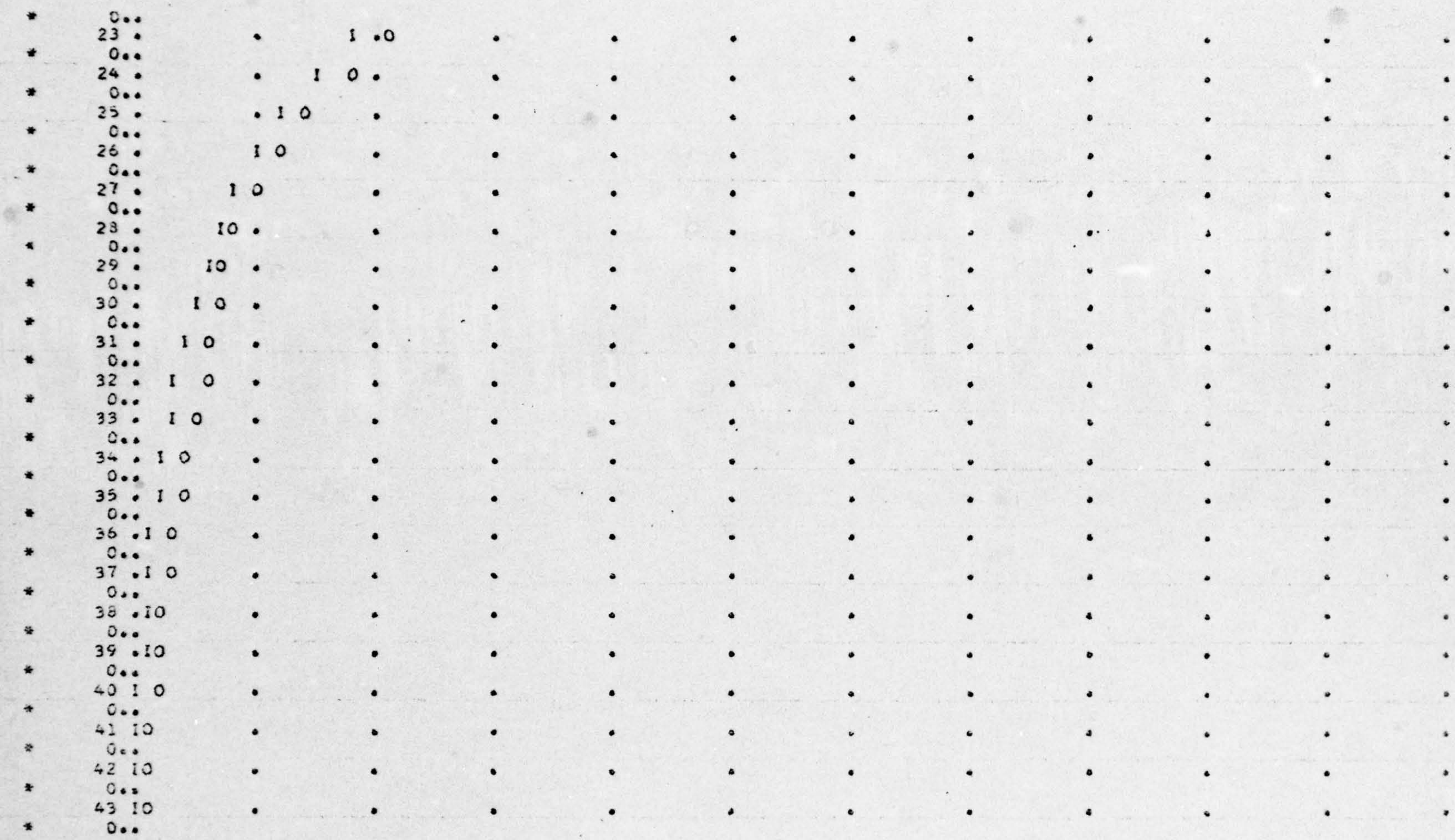
	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1404.	1074.	412.	412.	17720.
INCHES		5.04	6.94	6.94	6.94
AC-FT		533.	733.	733.	733.

OVF

STATION 2

INFLOW I , OUTFLOW O AND OBSERVED FLOW *





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31	11.	129.	139.
32	10.	117.	126.
33	10.	106.	114.
34	9.	94.	102.
35	8.	83.	94.
36	8.	72.	86.
37	7.	63.	77.
38	6.	54.	68.
39	5.	46.	60.
40	5.	39.	52.
41	4.	32.	45.
42	3.	27.	38.
43	3.	22.	32.
SUM			17670.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1386.	1065.	411.	411.	17670.
INCHES		5.00	6.92	6.92	6.92
AC-FT		528.	731.	731.	731.

OVN

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HYDROGRAPH ROUTING

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

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.	9.	18.	28.	37.	47.	57.	61.	67.	78.
OUTFLOW	0.	101.	287.	527.	812.	1134.	1491.	1643.	2022.	2917.

TIME	EOP STOR	AVG IN	EOP OUT
1	1.	6.	6.
2	1.	7.	6.
3	1.	13.	9.
4	1.	27.	16.
5	3.	54.	30.
6	5.	95.	55.
7	9.	183.	104.
8	16.	339.	244.
9	24.	523.	425.
10	31.	717.	636.
11	39.	922.	863.
12	45.	1119.	1067.
13	50.	1279.	1243.
14	53.	1376.	1355.
15	54.	1391.	1386.
16	53.	1334.	1342.
17	50.	1227.	1245.
18	46.	1092.	1116.
19	42.	946.	980.
20	38.	804.	840.
21	34.	676.	710.
22	30.	564.	594.
23	27.	470.	501.
24	24.	390.	428.
25	21.	321.	357.
26	18.	262.	294.
27	16.	217.	247.
28	14.	182.	208.
29	13.	155.	177.
30	12.	139.	154.

SECTION 3: VISUAL INSPECTION

3.1 Findings:

a. General: The Waverly Lower Reservoir was inspected by L. Robert Kimball and Associates personnel and present and past employees of Waverly Village on June 13, 1978. A brief inspection of the Waverly Upper Reservoir was also conducted.

b. Dam: Considerable vegetation was noted on both slopes making thorough inspection difficult. The vegetation was relatively young, small trees and brush.

The upstream slope is relatively steep and the crest narrow. No slumping, bulging or cracking was observed however, the vegetation and rock on the downstream slope may have concealed minor movement. Minor seepage was noted at the downstream toe apparently through the abutment rock which is closely beeded.

c. Appurtenant Structures: The emergency spillway weir was covered with young vegetative growth. The weir shows signs of considerable horizontal displacement and partial deterioration.

The spillway side channel is in relative good condition with water flowing during the inspection. The channel conveys normal runoff from the valley and discharges from the upper dam. The channel is partly vegetated. The bridge over the channel at the lower dam may present a partial obstruction to channel flow.

The two cast iron pipes are not important as spillway structures. Seepage was noted in the chlorination house around the water supply line. A build up of iron precipitate was noted as a result of the seepage. The seepage quantity is estimated at greater than 5 gallons per minute. The control valves are old but apparently operable. There are two sets of valves for each pipe line.

d. Reservoir Area: The immediate reservoir rim is partially vegetated but apparently stable. The upstream dam shows signs of instability as discussed in the Corps report of 1974.

e. Downstream Channel: The downstream channel is formed by a relatively narrow valley with steep hillsides. A village park is located immediately downstream. The channel widens at the Waverly Village limits 2,000' downstream.

3.2 Evaluation: The visual inspection did not reveal any signs of instability on the embankment. Vegetation and rock cover made inspection difficult.

Both the embankment and the spillway are in need of maintenance.

The steep slope and seepage in the chlorination house appear to require further investigation.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures: No defined operational plan is in use. Outlet works are regulated as water is needed for the water system. The blow off line is used approximately once a month. Water is pumped from wells to the reservoir for storage periodically.

4.2 Maintenance of Dam: Maintenance of the dam and embankment is lacking.

4.3 Maintenance of Operating Facilities: Maintenance of filtration plant and water system is apparently performed as needed.

4.4 Description of Any Warning System is Effect: None

4.5 Evaluation: Little maintenance is performed on the dam and appurtenant structures. This lack of maintenance may eventually affect the safety of the structure.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Hydrologic Evaluation of Features:

a. Design Data: No design data is available on the spillway and side channel.

b. Experience Record: As most runoff has been controlled by the upstream dam and side channel no significant discharges over the lower spillway dam have been noted.

From 1954 to 1964 water level and rainfall records were kept by the reservoir caretaker on an informal basis.

c. Visual Observations: At the time of the inspection no water was flowing over the spillway weir. Approximately 2 inches of water was flowing in the side channel.

Signs of deterioration and movement were noted on the spillway weir. Considerable young vegetation is developing along the spillway weir.

The bridge over the side channel appeared to present a minor flow obstruction and possible debris trap.

d. Overtopping Analysis: Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and subsequent routing of the PMF through the reservoir system. The PMF is that hypothetical flow induced by the most critical combination of precipitation, minimum infiltration losses, and concentration of run-off at a specific location, that is considered reasonably possible for a particular drainage area.

The drainage area contributing to Waverly Lower Reservoir is approximately 2.0 square miles. To develop the basic hydrologic working tool, the unit hydrograph, Snyder Coefficients were used. After discussions with the Corps of Engineers personnel assumed parameters of Cp=0.60 and Ct=2.0 were used, a value of Tp equal to 2.68 hours was calculated considering watershed size and shape.

Using hydrometeorological Report No. 33, the PMP index rainfall was determined to be 21.5 inches for a 24 hour duration, 200 square mile basin. The percentages of the index rainfall applied to other durations were interpolated from the plot of drainage area versus percent of 24 hour, 200 square mile. The computed PMF flow was 4834 cfs. After routing the PMF through the impounded storage, the peak flow was reduced to 4756 cfs. A plot of the PMF inflow and outflow hydrographs is included in Appendix B.

The ability of the Waverly Lower Reservoir to discharge the standard project flood (SPF) was also evaluated. The inflow hydrograph for the standard project flood with a peak flow of 1481 cfs was calculated from the unit hydrograph. Routing through the impounded storage reduced the flow to 1386 cfs. The SPF outflow is indicative of a pool elevation of 1048.9 feet above MSL leaving 0.3 feet of freeboard remaining

The PMF outflow is equavalent of 1.9 feet over the dam (5.1 feet above spillway crest).

To allow inflow and outflow hydrographs to be developed and routed several assumptions were made.

1. The water level in both reservoirs was assumed to be at spillway level at the start of the flood routing.
2. The side channel from the upper reservoir was assumed to fail and all water would flow into the lower reservoir.
3. Flow over the top of the entire dam length was added to evaluate overtopping.

SUMMARY OF HYDROLOGIC ANLAYSIS
WAVERLY LOWER DAM

Elevation Top of Dam = 1049.2

Elevation Crest of Spillway = 1046.0

PMF ROUTING

PMF Peak: 4834 cfs

PMF After Routing through Reservoir: 4756 cfs

Elevation of Routed PMF Corresponding to 4756 cfs - 1051.1 feet above MSL

Dam Overtopped: 1.9 feet

Spillway Surcharge: 5.1 feet

SPF ROUTING

SPF Peak: 1481 cfs

SPF After Routing Through Reservoir: 1386 cfs

Elevation of Routed SPF Corresponding to 1386 cfs - 1048.9 feet above MSL

Freeboard Remaining: 0.3 feet

Spillway Surcharge: 2.9 feet

5.2 Hydraulic Evaluation of Flood Wave: For the dam break analysis the flood wave for both total and partial failures was computed to a distance of 5,800 feet downstream of the dam. Waverly Lower Dam is an earthfill embankment founded on rock at the abutment with a masonry core wall in the upstream portion making partial failure most likely of the two cases.

The town of Waverly Village is located 2,000 feet southwest of the dam. For both total and partial failure, the southwestern portion of the town was inundated by an average of 5 feet of water for total failure and 4 feet for partial failure.

Calculated water depths and flood wave maps for the downstream channel reach are shown in Appendix B.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability:

a. Visual Observations: Based on our visual inspection it is believed that the stability of the embankment will not meet current criteria because of the excessively steep downstream slope.

b. Design and Construction Data: No data is available

c. Operating Records: None available

d. Post-construction Changes: No information available

e. Seismic Stability: The dam is located in seismic zone 1 and should not present any problems if static conditions are satisfactory.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment:

a. Safety: While no signs of instability were noted on the embankment the steep slopes yield the potential for slope failure under adverse conditions. At present no emergency actions are deemed necessary. Continued evaluation and eventual remedial modifications should be implemented in the immediate future.

b. Adequacy of Information: The information available is inadequate for complete anaylsis of the dam. The validity of the limited available information is questionable.

c. Urgency: Emergency action is not deemed necessary. However, followup studies and remedial modifications are recommended and should be initiated this year.

d. Necessity for Additional Work: As outlined above follow up analysis and modificaitons are necessary.

7.2 Recommendations:

a. Alternatives:

1. Abandon the reservoir as a water supply and make remedial modifications to render the reservoir and dam incapable of presenting a hazard.

2. Conduct a detailed evaluation of structural stability and design of any necessary modifications to allow continued use of the reservoir in an assured safe manner.

b. Other:

1. Implement a routine, regular, surveillance, program of the dam at close intervals.

2. Clear present vegetation from the embankment and spillway.

3. Evaluate the source and potential danger of seepage along the drain pipes.

4. If the reservoir is to remain in service, repairs should be made to the spillway. Construction of additional spillway capacity should also be considered.

APPENDIX A

GEOLOGY

Waverly Reservoir and Dam

The bedrock of this area is composed primarily of interbedded gray shales and siltstones of the upper Devonian Series. Locally these shales and siltstones are part of the Gardeau Formation which is a sub-division of the West Falls Group. Because of their shallow marine water origin which was relatively stable during the deposition of these sediments, an abundant and wide diversity of well preserved fossils can be found through this section of rocks.

Structurally or technically the bedrock was slightly folded during the Alleghanian Orogeny of the Carboniferous Period. These folds extend generally eastward and usually have amplitutes of less than 5°. The Waverly Dam is located on the common limb between the Willsboro Anticline, which follows the New York, Pennsylvania border and the Nichols Syncline to the north of the reservoir. The area today is very stable.

The valley in which the Waverly Dam is located was probably formed by glaciers of the Pleistocene Epoch. During the retreat of the glacial sheets deposits of clays, silts, sands and gravels were blanketed over the valley. In most areas these deposits are relatively thin and should not affect the performance of the dam.

APPENDIX B

HYDROLOGIC COMPUTATIONS

WAVERLY RESERVOIRS

PRECIPITATION

WATERSHED LOCATED AT 42° 1' LATITUDE AND 76° 33' LONGITUDE. RAINFALL INTENSITIES ARE AS FOLLOWS.

FROM HYDROMETEOROLOGICAL REPORT NO. 33, PROBABLE MAXIMUM INDEX PRECIPITATION = 21.5" (FOR 200 SQ. MILE - 24 HR.)

FROM EM 1110-2-1411 STANDARD PROJECT INDEX PRECIPITATION = 11.3" (FOR 2.1 SQ. MILE - 24 HR.)

DRAINAGE AREA

FROM WAVERLY QUADRANGLE

TOTAL AREA = 2.1 SQ. MILES (1.98 SQ.MI. FOR UPPER DAM)
(0.12 SQ.MI. FOR LOWER DAM)

SNYDER COEFFICIENTS

SNYDER'S LAG: $t_{pR} = C_t(.955)(L \times L_{ca})^{.3} + .25\, t_R$

$C_t = 2$, $L = 2.2$ MILES, $L_{ca} = 1.02$ MILES, $t_R = 1$ HR.

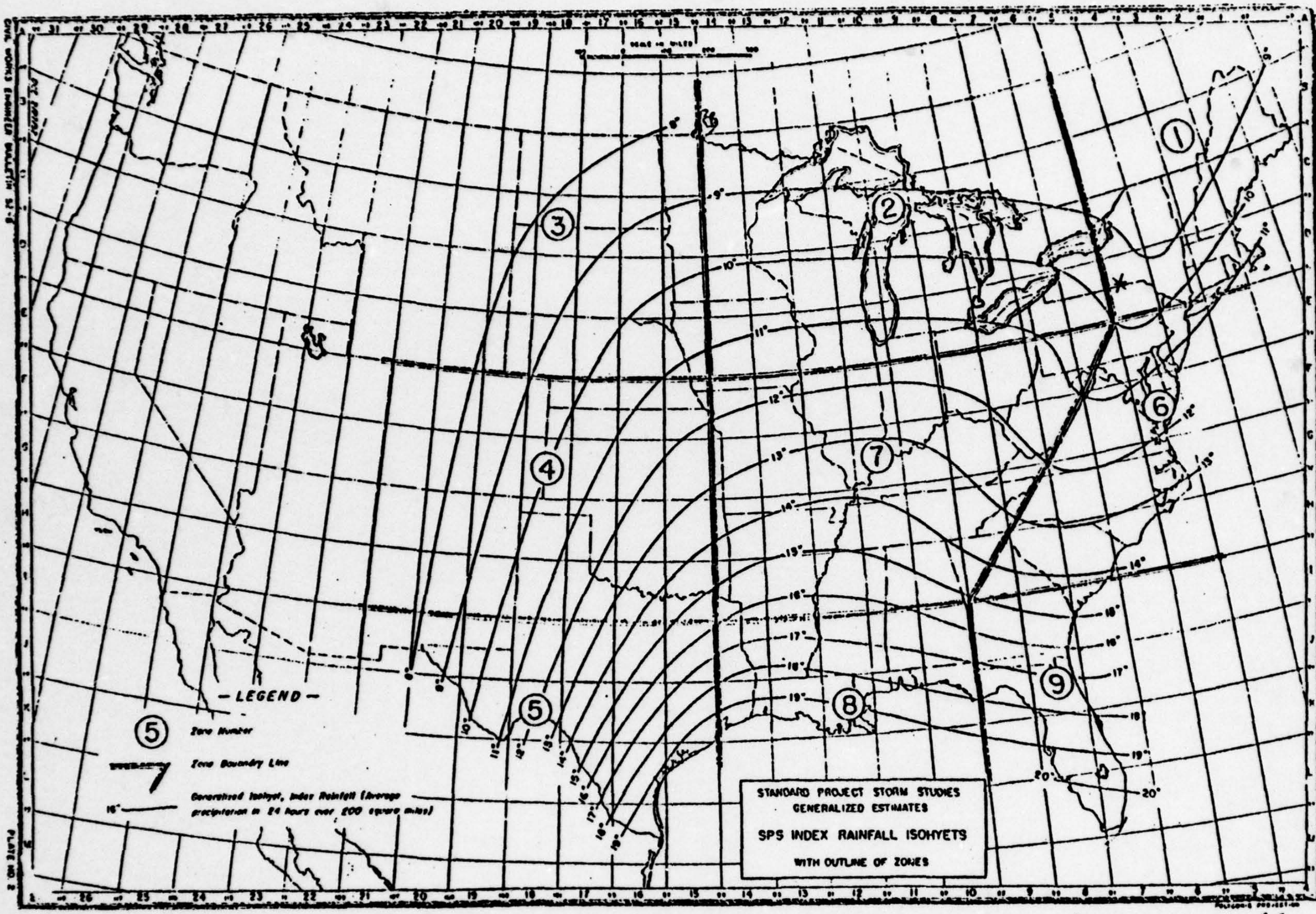
$t_{pR} = 2.68$ HR.

UNIT HYDROGRAPH PEAK DISCHARGE:

$$Q_{pR} = \frac{640\, C_p\, A}{t_{pR}}$$

$C_p = 0.6$ $A = 1.98$ SQ.MI.

$Q_{pR} = 284$ CFS.



Standard project rainfall for 24 hr period over a 200 sq. mi. area

WAVERLY UPPER RESERVOIR DAM

ELEVATION-DISCHARGE RELATIONSHIP

	ELEV. (FT.)	H (FT.)	TOTAL DISCHARGE Q (CFS)
	1070	0	0
	1072	2	147
	1074	4	463
	1076	6	1011
	1078	8	1749
	1080	10	2714
	1082	12	3926
	1084	14	5399
	1086	16	7150
	1088	18	9193
	1090	20	11542
	1092	22	14212
	1094	24	17215
	1096	26	20664
	1098	28	24271
	1099	29	26262
	1100	30	28347
	1101	31	30527
	1102	32	32805
TOP OF DAM	1103	33	35180
	1104	34	39334
	1105	35	44982
	1106	36	51637
	1107	37	59128
	1108	38	67356
	1109	39	76255
	1110	40	85777

INCLUDES DISCHARGE OVER DAM
$Q = CLH^{1.5}$
$C = 2.8$, $L = 600'$

$$Q = 4.03\,C\,h_v^{1/2}(H - h_v)[B + Z(H - h_v)]$$

WHERE

$$h_v = \frac{3(2ZH + B) - (16Z^2H^2 + 16ZBH + 9B^2)^{1/2}}{10Z}$$

L. ROBERT KIMBALL
Consulting Engineers

SUBJECT N.Y. DAM INSP. BY DSG DATE 7/5/78
SHEET NO. ____ OF ____
JOB NO. ____

WAVERLY UPPER RESERVOIR DAM

ELEVATION - STORAGE RELATIONSHIP

	ELEV. (FT)	SURFACE AREA (ACRES)	Δ ELEV. (FT)	TOTAL STORAGE (AC FT)	TOTAL DISCHARGE Q (CFS)
	1070	13		0	0
	1072	14	2	27	147
	1074	14	2	55	483
	1076	15	2	84	1011
	1078	16	2	115	1749
	1080	16	2	147	2714
	1082	17	2	180	3926
	1084	18	2	215	5399
	1086	18	2	251	7150
	1088	19	2	288	9193
	1090	20	2	327	11542
	1092	20	2	367	14212
	1094	21	2	408	17215
	1096	22	2	451	20564
	1098	22	2	495	24271
	1099	23	1	518	26262
	1100	23	1	540	28347
	1101	23	1	564	30527
	1102	24	1	587	32805
TOP OF DAM	1103	24	1	611	35180
	1104	25	1	636	39334
	1105	27	1	662	44982
	1106	28	1	689	51637
	1107	30	1	718	59128
	1108	31	1	748	67356
	1109	32	1	780	76255
	1110	34	1	813	85777

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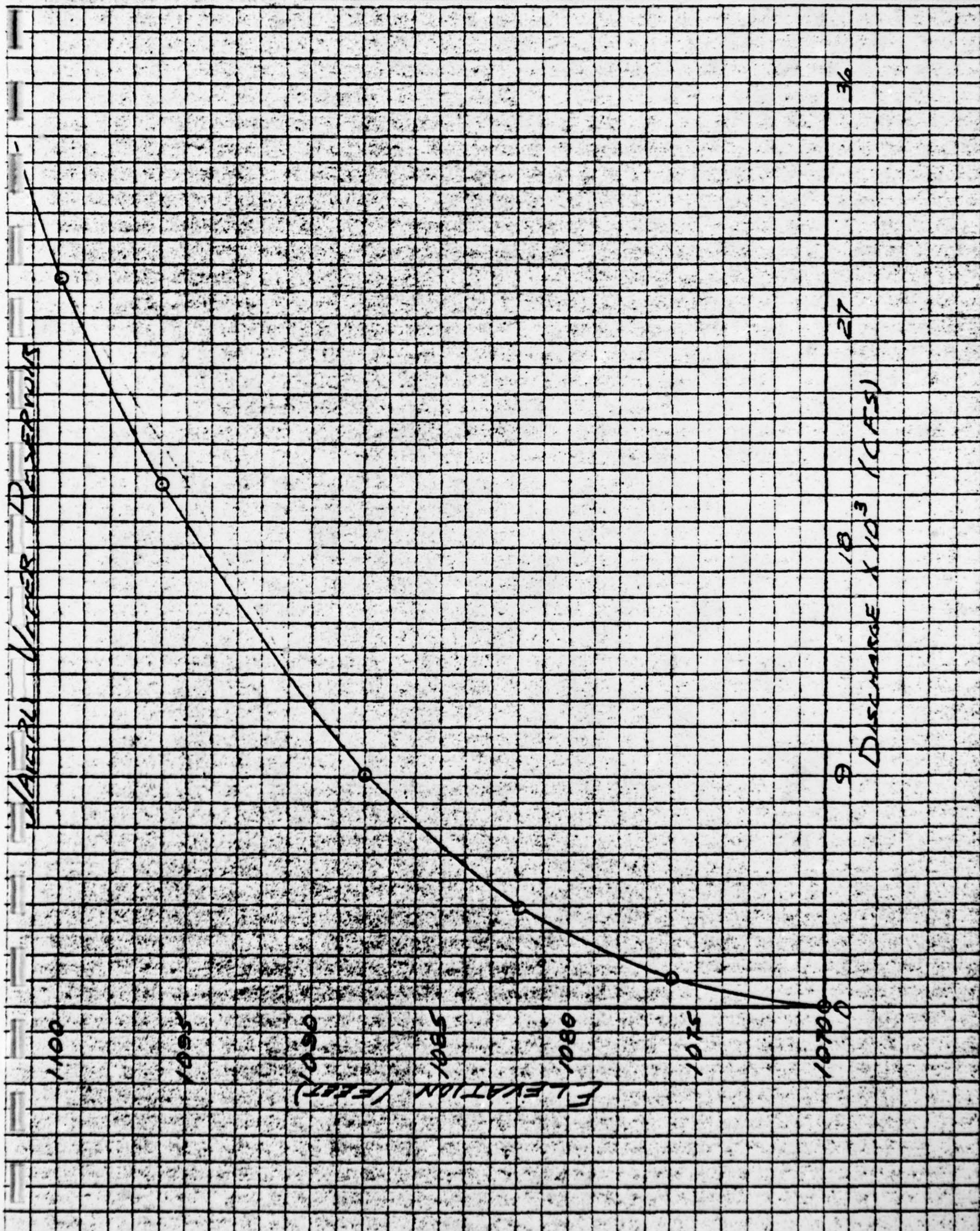
SUBJECT__________ BY__________ DATE__________

SHEET NO__________ OF__________

JOB NO.__________



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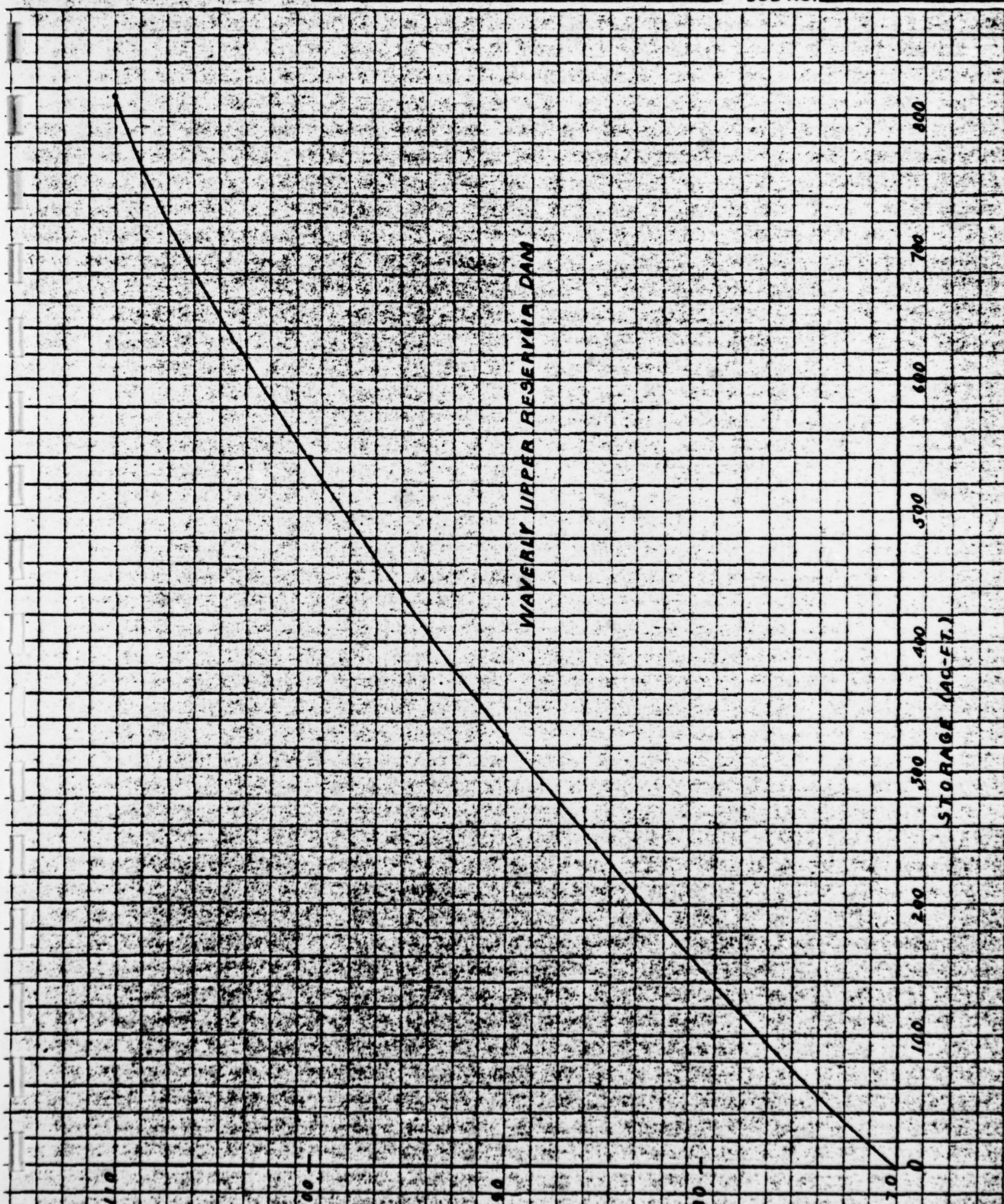
JOB NO.____



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SHEET NO. ____ OF ____
JOB NO. ____

Waverly Lower Reservoir Dam

Elevation – Discharge Relationship

	ELEV. (FT.)	SIDE SPILLWAY H (FT.)	SIDE SPILLWAY C	SIDE SPILLWAY Q (CFS)	OVERTOP SECTION H (FT.)	OVERTOP SECTION C	OVERTOP SECTION Q (CFS)	TOTAL DISCHARGE Q (CFS)
	1046.0	0		0	–	–	–	0
	1046.5	0.5		101	–	–	–	101
	1047.0	1.0		287	–	–	–	287
	1047.5	1.5		527	–	–	–	527
	1048.0	2.0		812	–	–	–	812
	1048.5	2.5	C = 3.5	1134	–	–	–	1134
	1049.0	3.0		1491	–	–	–	1491
TOP OF DAM	1049.2	3.2		1643	0	2.8	0	1643
	1049.5	3.5		1879	.3	2.8	143	2022
	1050.0	4.0		2296	.8	2.8	621	2917

WAVERLY LOWER RESERVOIR DAM

ELEVATION - STORAGE RELATIONSHIP

	ELEV. (FT.)	SURFACE AREA (ACRES)	Δ ELEV. (FT.)	TOTAL STORAGE (AC.FT.)	TOTAL DISCHARGE Q (CFS)
	1046.0	17.8		0	0
			.5		
	1046.5	18.2		9	101
			.5		
	1047.0	18.6		18	287
			.5		
	1047.5	19.0		28	527
			.5		
	1048.0	19.4		37	812
			.5		
	1048.5	19.9		47	1134
			.5		
	1049.0	20.3		57	1491
			.2		
TOP OF DAM	1049.2	20.5		61	1643
			.3		
	1049.5	20.7		67	2022
			.5		
	1050.0	21.1		78	2917

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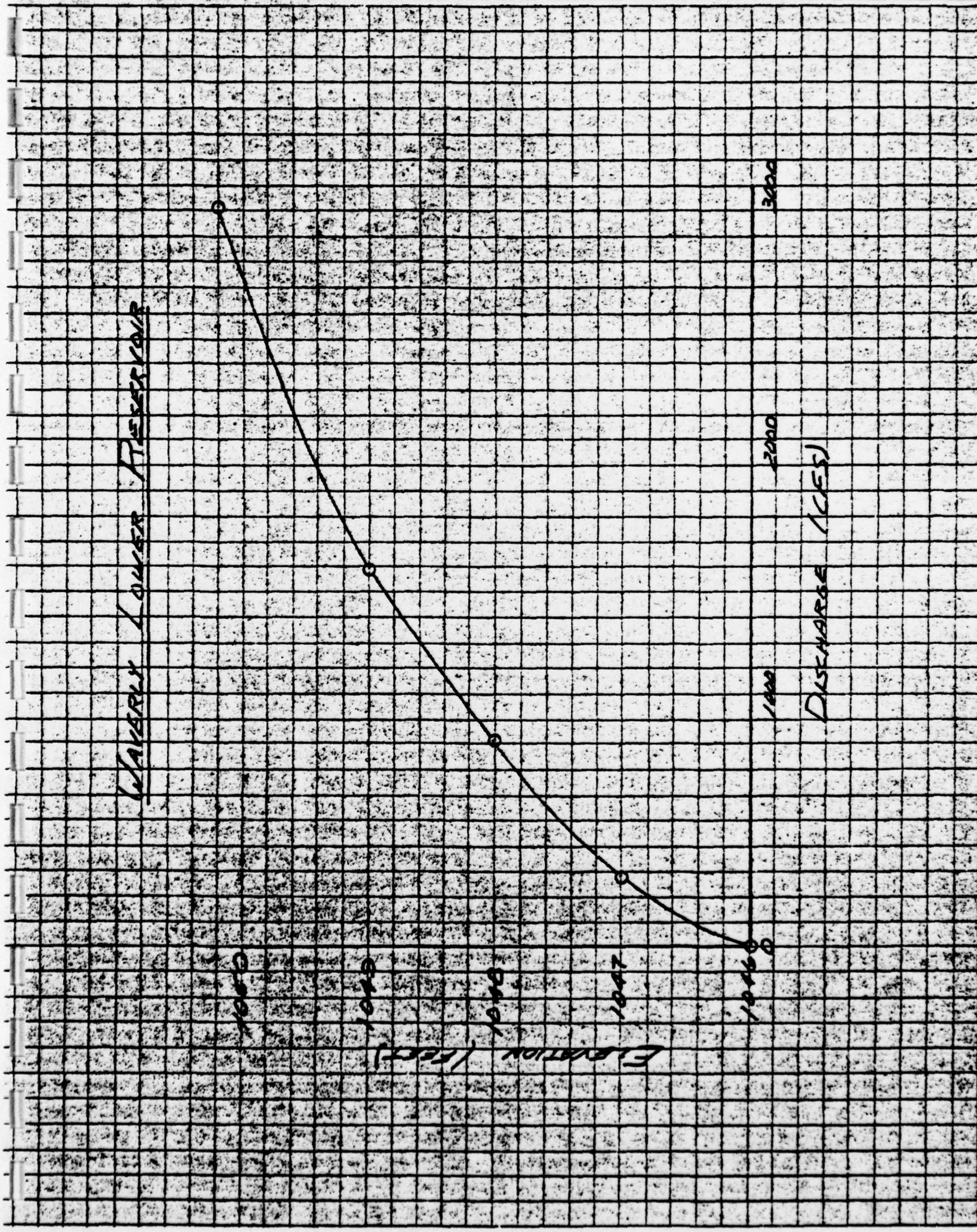
SUBJECT ______________________________ BY __________ DATE __________
SHEET NO. ______ OF ______
JOB NO. __________



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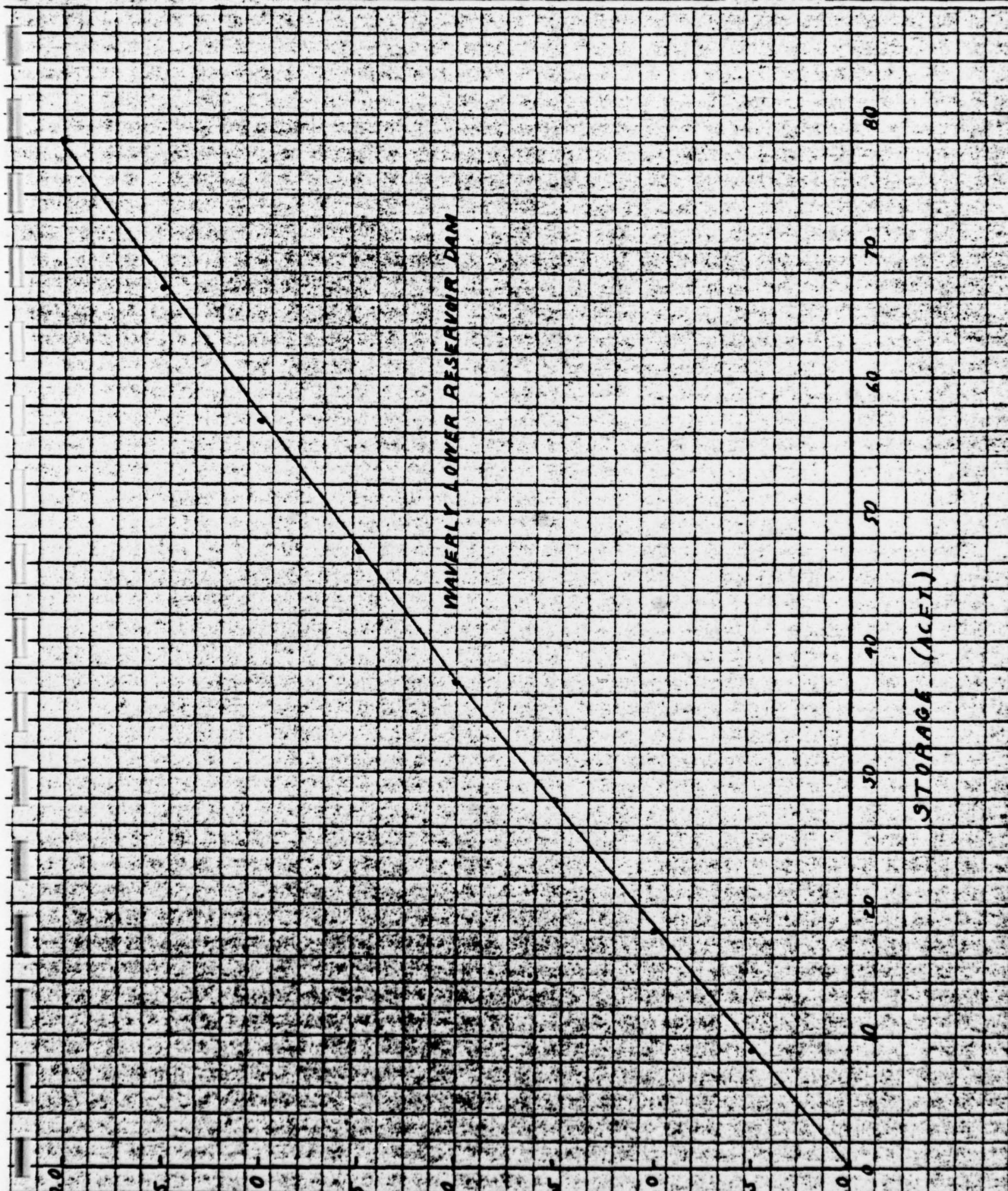
SUBJECT NEW YORK DAM INSP

BY DSG DATE 7/6/78

SHEET NO. ____ OF ____

JOB NO. ____



WAVERLY LOWER RESERVOIR

HYDRAULIC EVALUATION OF FLOOD WAVE

STORAGE CAPACITY $V_o = 61$ A.F. @ TOP OF DAM

$$Q_{max} = \frac{8}{27} \sqrt{g}\, K\, W_b D_b^{3/2}$$

$$K = \frac{W_d}{W_b} \cdot \frac{Y_o}{D_b} \qquad T_s = L\, t_s, \quad t_s = \frac{\Delta S}{\Delta Q}$$

$$S_i = \frac{12 V_o}{Q_{max}}$$

$$\frac{Att.\ Q_{max}}{Q_{max}} = \frac{0.9 S_i}{S_i + T_s}$$

A) FULL BREACH

$W_b = W_d = 310'$

$D_b = Y_o = 30'$

$Q_{max} = 85,600$ CFS

REACH 1 $L = 1800'$ @ GLENWOOD CEM — DISTANCE FROM DAM 1800'

$D_x = 19'$ $W = 385'$ $D_{ave} = 23'$

WATER SURFACE ELEV. 964'

$Q_{max} = 33,600$ CFS

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Consulting Engineers

SUBJECT ____ BY JPT DATE 7/21
SHEET NO. ____ OF ____
JOB NO. ____

WAVERLY LOWER RESERVOIR

REACH 2 L = 3000' 4800'
@ CHEMUNG ST.

D_{DS} = 5' W = 1500' D_{AVE} = 9.6

WATER SURFACE ELEV 860'

Q_{MAX} = 28200 CFS

REACH 3 L = 1000' 5800'
@ ERIE RR TRACKS

D_{DS} = 4' W = 1700' D_{AVE} = 4.3'

WATER SURFACE ELEV. 844'

Q_{MAX} = 22,800 CFS

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Consulting Engineers

SUBJECT ____ BY ____ DATE ____
SHEET NO ____ OF ____
JOB NO. ____

WAVERLY LOWER RESERVOIR

B) PARTIAL BREACH

W_b = 100' (CENTER SECTION)

$D_b = Y_o$ = 30'

Q_{max} = 27620 CFS

				DISTANCE FROM DAM
REACH 1	l = 1800'	@ GLENWOOD CEM.		1800'

D_{DS} = 11' W = 350' D_{AVE} = 17.3'

WATER SURFACE ELEV. 956'

Q_{MAX} = 21,500 CFS

REACH 2 l = 3000' @ ERIE RR TRACKS — 4800'

D_{DS} = 4' W = 1200' D_{AVE} = 6.3'

WATER SURFACE ELEV. 859'

Q_{MAX} = 16,100 CFS

REACH 3 l = 1000' — 5800'

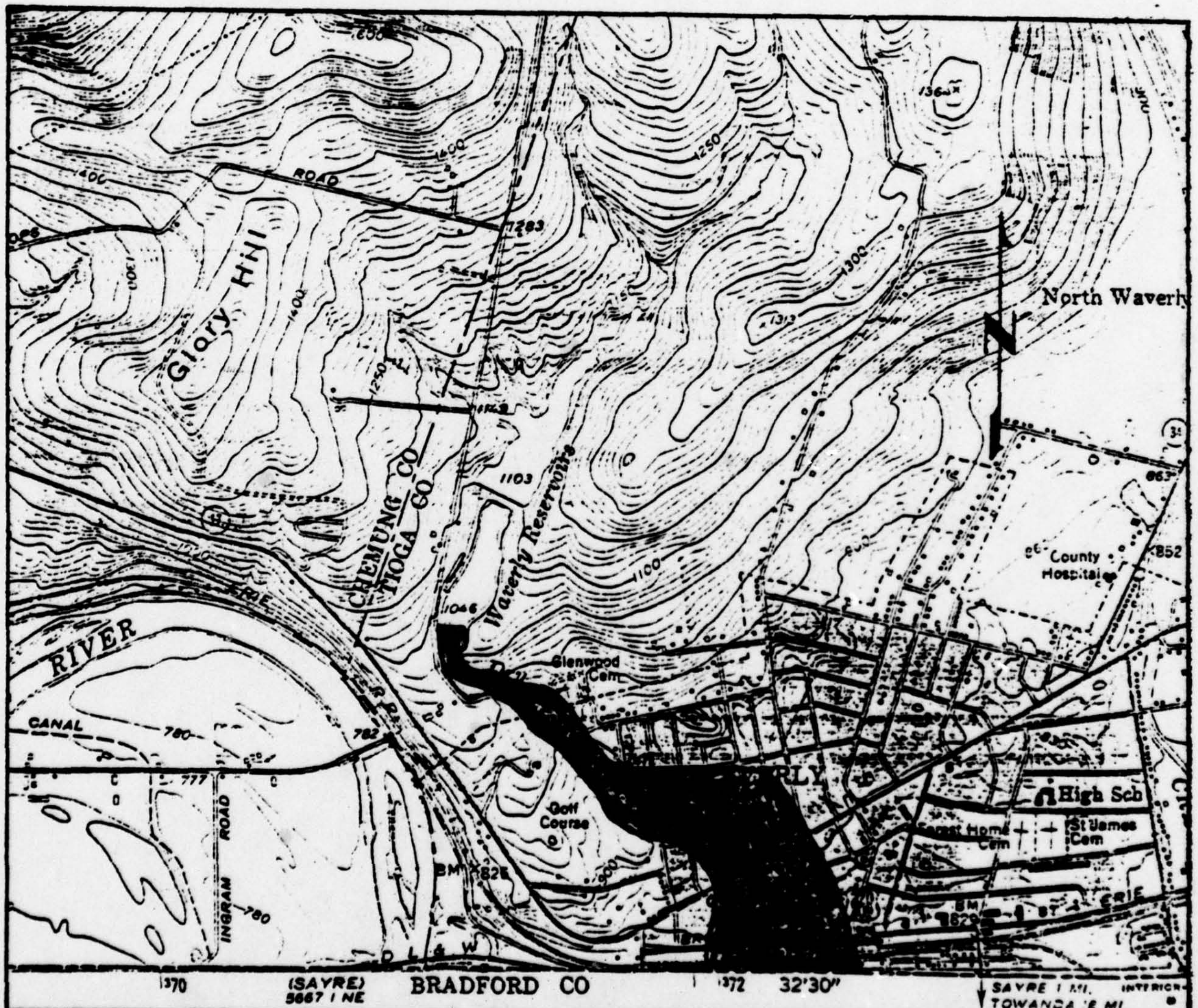
D_{DS} = 3' W = 1500' D_{AVE} = 3.3'

WATER SURFACE ELEV = 843'

Q_{MAX} = 13,100 CFS

WAVERLY LOWER RESERVOIR DAM

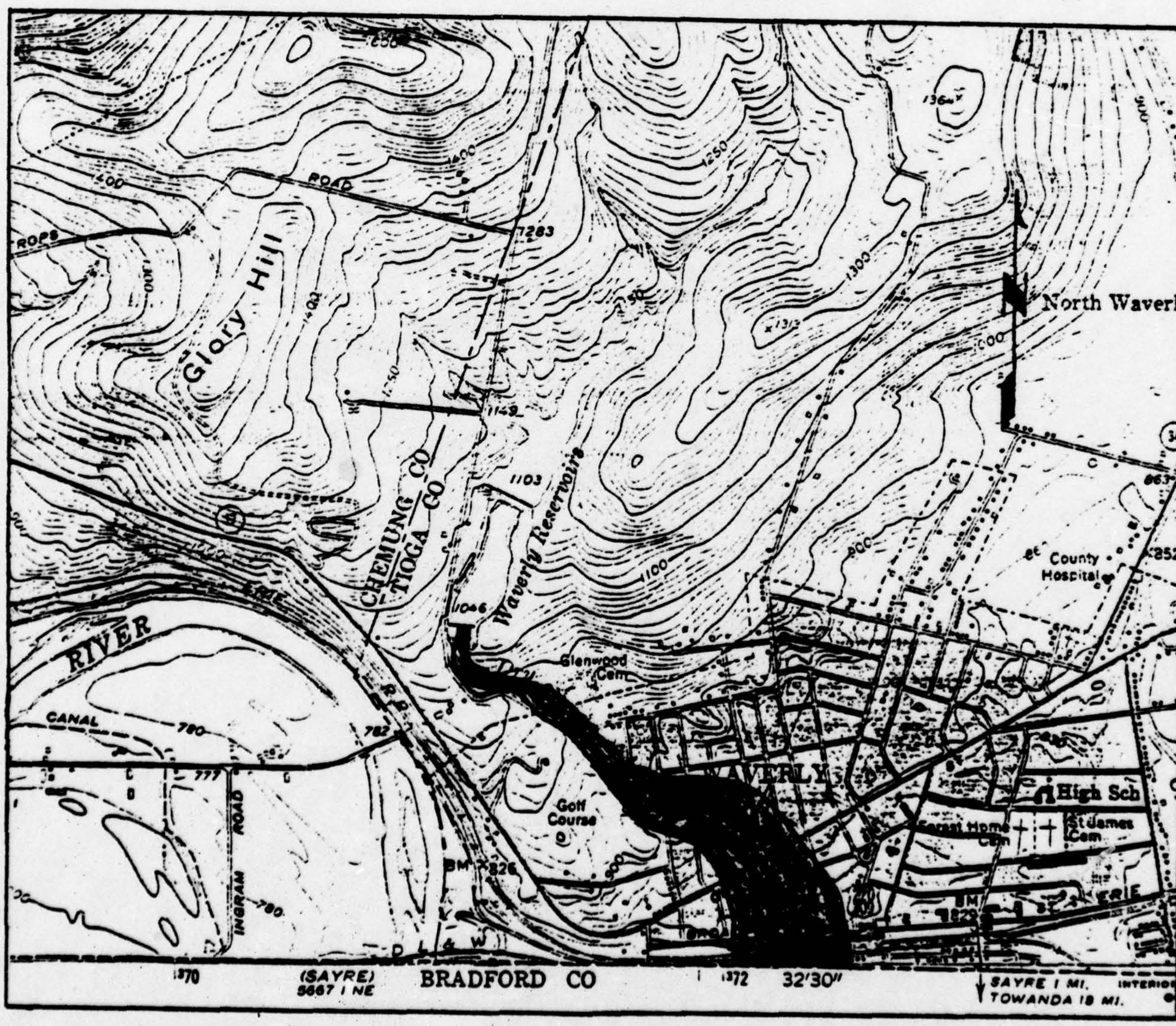
FULL BREACH



SCALE: 1" = 2000'

WAVERLY LOWER RESERVOIR DAM

PARTIAL BREACH



SCALE: 1" = 2000'

WAVERLY UPPER RESERVOIR

30-MINUTE UNIT HYDROGRAPH

TIME (HOURS)	INFLOW (CFS)
0 - 0.5	20
0.5 - 1.0	73
1.0 - 1.5	144
1.5 - 2.0	216
2.0 - 2.5	267
2.5 - 3.0	286
3.0 - 3.5	263
3.5 - 4.0	220
4.0 - 4.5	183
4.5 - 5.0	151
5.0 - 5.5	125
5.5 - 6.0	104
6.0 - 6.5	86
6.5 - 7.0	71
7.0 - 7.5	59
7.5 - 8.0	49
8.0 - 8.5	41
8.5 - 9.0	34
9.0 - 9.5	28
9.5 - 10.0	23
10.0 - 10.5	19
10.5 - 11.0	16
11.0 - 11.5	13
11.5 - 12.0	11
12.0 - 12.5	9
12.5 - 13.0	8
13.0 - 13.5	[illegible]
13.5 - 14.0	6
14.0 - 14.5	4
14.5 - 15.0	4
15.0 - 15.5	3
15.5 - 16.0	2

USE U.G. METHOD FOR MAXIMUM 6-HOUR DURATION OF 48-HOUR SPILLWAY DESIGN STORM. FOR REMAINING 42 HOURS ASSUME INST. RUNOFF USING 6-HOUR RAINFALL DURATIONS.

FOR 1.98 SQ. MILES OR 1267 ACRES:

$$1'' \text{ IN } 6 \text{ HR.} = \frac{1267}{12}(.504)(4) = \underline{213 \text{ CFS}}$$ UNIFORM FLOW FOR THAT 6-HR. DURATION

WAVERLY UPPER RESERVOIR

FROM EM 1110-2-1411 STANDARD PROJECT INDEX PRECIPITATION = 9.5" (FOR 24-HOUR - 200 SQ. MILES)

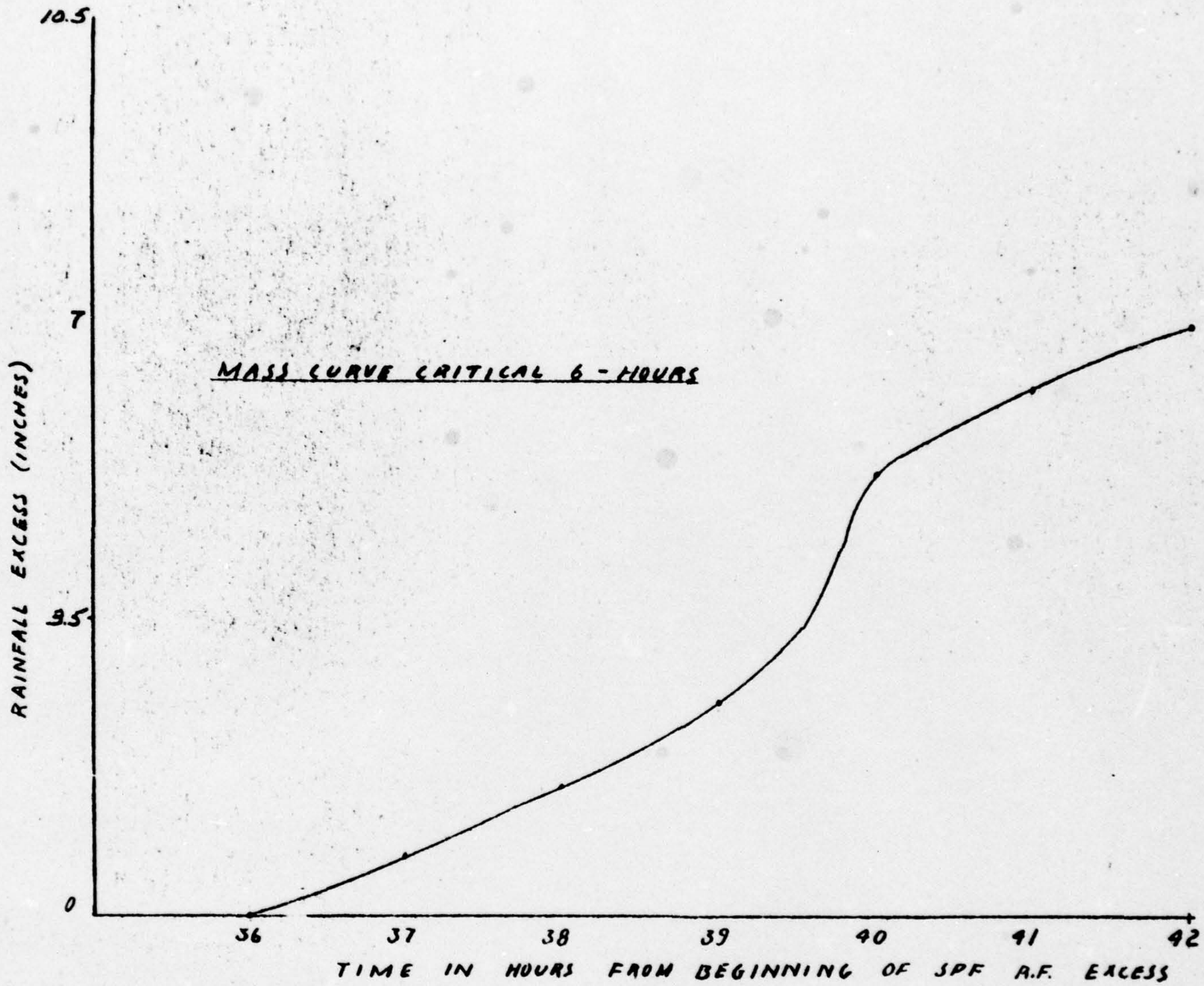
DURATION (HOURS)	PERCENT	R.F. DEPTH	REDUCTION (20%)	INCR RF	ORDER
0-6	100	9.5	7.6	7.6	1
6-12	111	10.5	8.4	0.8	3
12-24	118	11.2	9.0	0.6	4
24-48	132	12.5	10.0	1.0	2

HOURLY RAINFALL DISTRIBUTION AND INFILTRATION LOSSES

TIME (HOURS)		R.F. DISTR. (4-2-1-3)		INITIAL LOSS	INFILT. LOSSES	R.F. EXCESS	RUNOFF (CFS) (x213)
0-6		0.15	0.6"	0.15		0	0
6-12		0.15			0.6	0	0
12-18		0.15			0.6	0	0
18-24		0.15			0.6	0	0
24-30		0.32			0.6	0	0
30-36		1.0			0.6	.4	85
36-37	7.6"	0.76 (10%)			0.1	TO BE DETERMINED BY 30-MIN. R.F.E. DISTRIBUTION AND U.G. CALCULATION	
37-38		0.91 (12%)			0.1		
38-39		1.14 (15%)			0.1		
39-40		2.89 (38%)			0.1		
40-41		1.06 (14%)			0.1		
41-42		0.84 (11%)			0.1		
42-48		0.48			0.6	0	0

MASS CURVE OF MAXIMUM 6-HOURS

TIME (HOURS)	R.F. INCR	R.F. EXCESS	R.F.E. (ACCUM)
36-37	0.76	0.66	0.66
37-38	0.91	0.81	1.47
38-39	1.14	1.04	2.51
39-40	2.89	2.79	5.30
40-41	1.06	0.96	6.26
41-42	0.84	0.74	7.00


MASS CURVE CRITICAL 6 - HOURS
RAINFALL EXCESS (INCHES)
10.5
7
3.5
0
36
37
38
39
40
41
42
TIME IN HOURS FROM BEGINNING OF SPF A.F. EXCESS

WAVERLY UPPER RESERVOIR

TIME (HOURS)	RAINFALL EXCESS (MASS CURVE)	30-MIN. INCR.	30-MIN U.G.	HYDRO-GRAPH BY U.G. METHOD		INST. R.O. ASSUMED	TOTAL S.D. FLOOD	
0-6						0	0	
6-12			20			0	0	
12-18			73			0	0	
18-24			149			0	0	
24-30			216			0	0	
30-36			267			85	85	
	0.29	0.29	285	6			6	
37	0.66	0.37	263	29			29	
	1.05	0.39	220	77			77	
38	1.47	0.42	183	152			152	
	1.95	0.48	151	254			254	
39	2.51	0.56	125	372			372	
	3.28	0.77	104	502			502	
40	5.30	2.02	86	665			665	
	5.81	0.51	71	874			874	
41	6.26	0.45	59	1098			1098	
	6.66	0.40	49	1298			1298	
42	7.00	0.34	41	1435			1435	
			34	*1481			*1481	
			28	1422			1422	
			23	1293			1293	
			19	1141			1141	
			16	978			978	
			13	821			821	
			11	681			681	
			9	564			564	
			8	467			467	
			6	388			388	
			5	322			322	
			4	267			267	
			4	200			200	
			3	183			183	
			2	152			152	
				128			128	
				104			104	
				86			86	
				72			72	
				59			59	
				49	CONT.		49	CONT
				37	11		37	11
				29	5		29	5
				25	4		25	4

```
******************************
HEC-1 VERSION DATED JAN 1973
UPDATED AUG 74
CHANGE NO. 01
******************************

                         WAVERLY UPPER RESERVOIR DAM
                    RESERVOIR AT TOP OF FLOOD CONTROL POOL
                                  TEST PMP

                              JOB SPECIFICATION
          NQ    NHR   NMIN   IDAY    IHR   IMIN METRC  IPLT  IPRT NSTAN
          60      0     30      0      0      0     0     2     0     0
                              JOPER      NWT
                                  3        0

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

                        SUB-AREA RUNOFF COMPUTATION
           ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME
               1       0       0       0       0       0       0

                              HYDROGRAPH DATA
   IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
       1       1    1.98     0.0    1.98    1.00     0.0       0       0       0

                                PRECIP DATA
           SPFE     PMS      R6     R12     R24     R48     R72     R96
            0.0   21.50  110.00  122.00  134.00  144.00     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    1.50    0.10     0.0     0.0

                           UNIT HYDROGRAPH DATA
                      TP   2.68     CP 0.60     NTA   0

                               RECESSION DATA
                 STRTO    2.00    QRCSN   -0.25    RTIOR  3.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC  6.22 AND R  5.34 INTERVALS

      UNIT HYDROGRAPH 32 END-OF-PERIOD ORDINATES, LAG    2.71 HOURS, CP  0.60  VOL  1.00
      20.      73.     144.     216.     267.     285.     263.     220.     183.     151.
     125.     104.      86.      71.      59.      49.      41.      34.      28.      23.
      19.      16.      13.      11.       9.       8.       6.       5.       4.       4.
       3.       2.

                              END-OF-PERIOD FLOW
```

TIME	RAIN	EXCS	COMP Q
1	0.01	0.00	2.
2	0.01	0.00	2.
3	0.01	0.00	1.
4	0.01	0.00	1.
5	0.01	0.00	1.
6	0.01	0.00	1.
7	0.01	0.00	1.
8	0.01	0.00	1.
9	0.01	0.00	1.
10	0.01	0.00	1.
11	0.01	0.00	1.
12	0.01	0.00	1.
13	0.02	0.00	0.
14	0.02	0.00	0.
15	0.02	0.00	0.
16	0.02	0.00	0.
17	0.02	0.00	0.
18	0.02	0.00	0.
19	0.02	0.00	0.
20	0.02	0.00	0.
21	0.02	0.00	0.
22	0.02	0.00	0.
23	0.02	0.00	0.
24	0.02	0.00	0.
25	0.09	0.00	0.
26	0.09	0.00	0.
27	0.11	0.00	0.
28	0.11	0.00	0.
29	0.13	0.00	0.
30	0.13	0.00	0.
31	0.34	0.00	0.
32	0.34	0.08	2.
33	0.12	0.07	7.
34	0.12	0.07	18.
35	0.10	0.05	34.
36	0.10	0.05	52.
37	0.01	0.00	68.
38	0.01	0.00	78.
39	0.01	0.00	81.
40	0.01	0.00	76.
41	0.01	0.00	67.
42	0.01	0.00	57.
43	0.01	0.00	48.
44	0.01	0.00	39.
45	0.01	0.00	33.
46	0.01	0.00	27.
47	0.01	0.00	22.
48	0.01	0.00	19.
49	0.09	0.04	17.

50	0.09	0.04	16.
51	0.09	0.04	19.
52	0.09	0.04	25.
53	0.09	0.04	33.
54	0.09	0.04	42.
55	0.09	0.04	51.
56	0.09	0.04	58.
57	0.09	0.04	64.
58	0.09	0.04	68.
59	0.09	0.04	72.
60	0.09	0.04	76.
61	0.21	0.16	81.
62	0.21	0.16	93.
63	0.21	0.16	113.
64	0.21	0.16	143.
65	0.21	0.16	178.
66	0.21	0.16	216.
67	0.21	0.16	251.
68	0.21	0.16	280.
69	0.21	0.16	304.
70	0.21	0.16	324.
71	0.21	0.16	341.
72	0.21	0.16	355.
73	1.18	1.13	385.
74	1.18	1.13	465.
75	1.42	1.37	617.
76	1.42	1.37	849.
77	1.77	1.72	1154.
78	1.77	1.72	1511.
79	4.49	4.44	1938.
80	4.49	4.44	2496.
81	1.66	1.61	3167.
82	1.66	1.61	3848.
83	1.30	1.25	4418.
84	1.30	1.25	4771.
85	0.13	0.08	4834.
86	0.13	0.08	4610.
87	0.13	0.08	4220.
88	0.13	0.08	3754.
89	0.13	0.08	3256.
90	0.13	0.08	2767.
91	0.13	0.08	2331.
92	0.13	0.08	1966.
93	0.13	0.08	1664.
94	0.13	0.08	1414.
95	0.13	0.08	1207.
96	0.13	0.08	1081.
SUM	31.06	26.72	62685.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4834.	3706.	1290.	653.	62690.
INCHES		17.41	24.25	24.54	24.54
AC-FT		1839.	2561.	2592.	2592.

```
*OVF*
                                        STATION     1

                          INFLOW I , OUTFLOW O  AND OBSERVED FLOW *
            0.     1000.     2000.     3000.     4000.     5000.     0.     0.     0.     0.     0.     0.
      *     0.
                                                                                PRECIP L  AND EXC
      ESS X
            0.     0.        0.        0.        0.        0.        0.     0.     0.     6.     4.     2.
      ESS X 0.
           1 I
      ESS X 0.L
           2 I
      ESS X 0.L
           3 I
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           4 I
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           5 I
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      ESS X 0.L
          13 I
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          14 I
      ESS X 0.L
          15 I
      ESS X 0.L
          16 I
      ESS X 0.L
          17 I
      ESS X 0.L
          18 I
      ESS X 0.L
          19 I
      ESS X 0.L
          20 I
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ESS X  0.L
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ESS X  0.L
   22 I    .    .    .    .    .    .    .    .    .    .    .
ESS X  0.L
   23 I    .    .    .    .    .    .    .    .    .    .    .
ESS X  0.L
   24 I    .    .    .    .    .    .    .    .    .    .    .
ESS X  0.L
   25 I    .    .    .    .    .    .    .    .    .    .    .
ESS X  0.L
   26 I    .    .    .    .    .    .    .    .    .    .    .
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   27 I    .    .    .    .    .    .    .    .    .    .    .
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   29 I    .    .    .    .    .    .    .    .    .    .    .
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      66 . I       .         .         .         .         .         .         .         .         .         .         .
ESS X  LLX
      67 .  I      .         .         .         .         .         .         .         .         .         .         .
ESS X  LLX
      68 .  I      .         .         .         .         .         .         .         .         .         .         .
ESS X  LLX
      69 .  I      .         .         .         .         .         .         .         .         .         .         .
ESS X  LLX
      70 .  I      .         .         .         .         .         .         .         .         .         .         .
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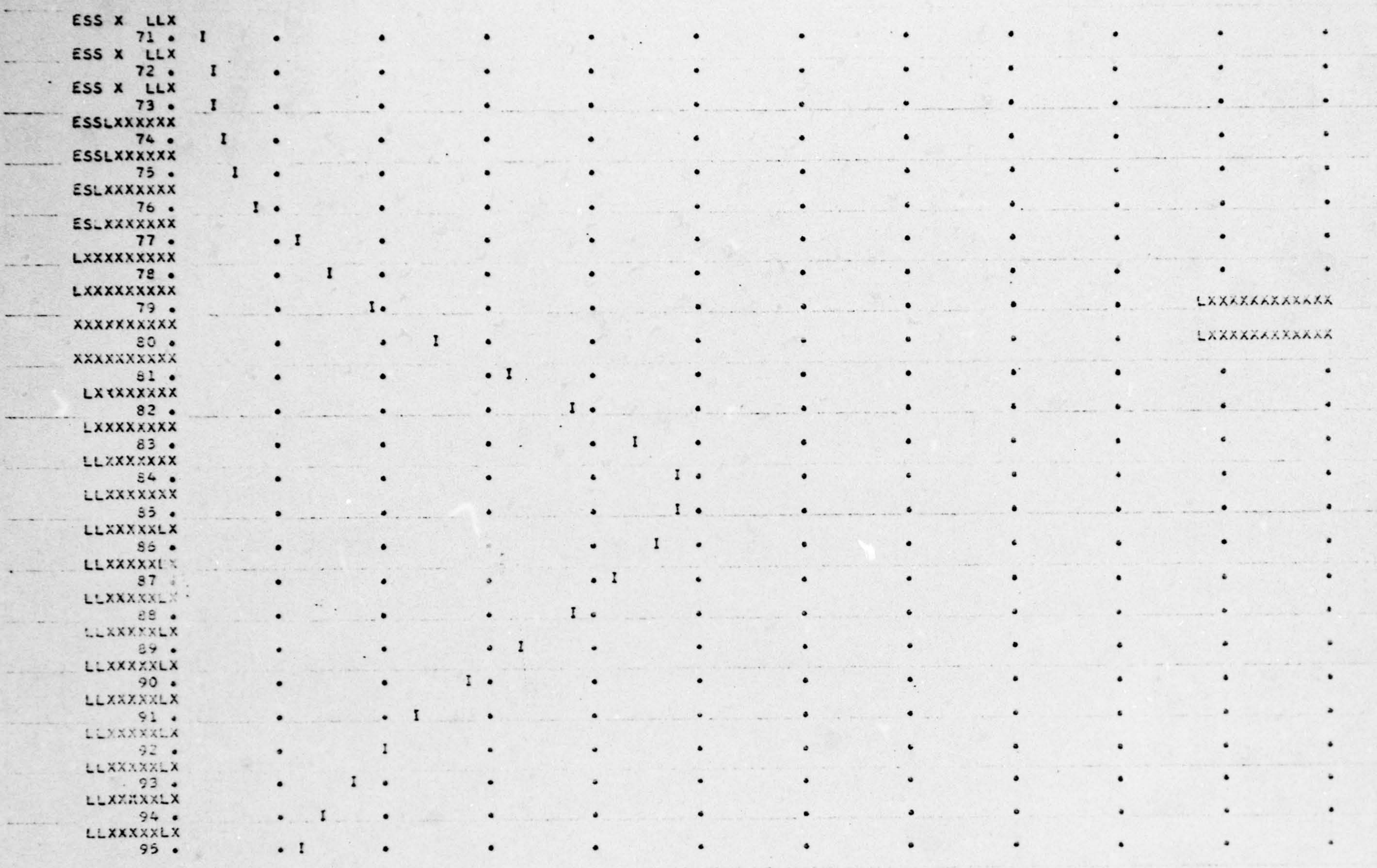
ESS X LLX
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ESS X LLX
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OVN

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HYDROGRAPH ROUTING

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

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.	27.	115.	215.	327.	518.	564.	587.	611.	636.
OUTFLOW	0.	147.	1749.	5399.	11542.	26262.	30527.	32805.	35180.	39334.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	2.	2.
2	0.	2.	2.
3	0.	2.	2.
4	0.	1.	2.
5	0.	1.	2.
6	0.	1.	1.
7	0.	1.	1.
8	0.	1.	1.
9	0.	1.	1.
10	0.	1.	1.
11	0.	1.	1.
12	0.	1.	1.
13	0.	1.	1.
14	0.	0.	1.
15	0.	0.	1.
16	0.	0.	1.
17	0.	0.	1.
18	0.	0.	1.
19	0.	0.	0.
20	0.	0.	0.
21	0.	0.	0.
22	0.	0.	0.
23	0.	0.	0.
24	0.	0.	0.
25	0.	0.	0.
26	0.	0.	0.
27	0.	0.	0.
28	0.	0.	0.
29	0.	0.	0.
30	0.	0.	0.

31	0.	0.	0.
32	0.	1.	0.
33	0.	4.	1.
34	1.	13.	3.
35	1.	26.	8.
36	3.	43.	15.
37	4.	60.	24.
38	6.	73.	34.
39	8.	79.	43.
40	9.	78.	50.
41	10.	72.	55.
42	10.	62.	56.
43	10.	52.	55.
44	10.	43.	53.
45	9.	36.	50.
46	8.	30.	46.
47	8.	25.	41.
48	7.	21.	37.
49	6.	18.	33.
50	6.	17.	30.
51	5.	18.	28.
52	5.	22.	26.
53	5.	29.	27.
54	5.	38.	29.
55	6.	46.	33.
56	7.	54.	37.
57	8.	61.	42.
58	9.	66.	47.
59	9.	70.	51.
60	10.	74.	56.
61	11.	78.	61.
62	12.	87.	66.
63	13.	103.	73.
64	16.	128.	84.
65	18.	160.	100.
66	22.	197.	119.
67	26.	233.	142.
68	30.	265.	202.
69	33.	292.	251.
70	35.	314.	286.
71	36.	332.	311.
72	37.	348.	331.
73	38.	370.	352.
74	40.	425.	392.
75	45.	541.	474.
76	53.	733.	616.
77	64.	1002.	827.
78	80.	1333.	1103.
79	98.	1724.	1443.
80	120.	2217.	1933.

81	141.	2831.	2705.
82	160.	3507.	3395.
83	177.	4133.	4029.
84	191.	4594.	4515.
85	198.	4803.	4762.
86	197.	4722.	4728.
87	189.	4415.	4459.
88	178.	3987.	4053.
89	165.	3505.	3582.
90	152.	3012.	3092.
91	139.	2549.	2625.
92	128.	2148.	2215.
93	118.	1815.	1871.
94	109.	1539.	1645.
95	99.	1310.	1462.
96	90.	1144.	1288.
SUM			60631.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4762.	3680.	1251.	632.	60631.
INCHES		17.29	23.50	23.74	23.74
AC-FT		1826.	2482.	2507.	2507.

OVF

STATION 2

INFLOW I , OUTFLOW O AND OBSERVED FLOW *

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      0.     1000.     2000.     3000.     4000.     5000.      0.        0.        0.        0.        0.        0.
      0.
      1 I          .         .         .         .         .         .         .         .         .         .         .
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      2 I          .         .         .         .         .         .         .         .         .         .         .
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      4 I          .         .         .         .         .         .         .         .         .         .         .
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      5 I          .         .         .         .         .         .         .         .         .         .         .
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      6 I          .         .         .         .         .         .         .         .         .         .         .
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      7 I          .         .         .         .         .         .         .         .         .         .         .
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      8 I          .         .         .         .         .         .         .         .         .         .         .
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      9 I          .         .         .         .         .         .         .         .         .         .         .
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     10 I          .         .         .         .         .         .         .         .         .         .         .
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     11 I          .         .         .         .         .         .         .         .         .         .         .
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     12 I          .         .         .         .         .         .         .         .         .         .         .
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     13 I          .         .         .         .         .         .         .         .         .         .         .
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     14 I          .         .         .         .         .         .         .         .         .         .         .
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     15 I          .         .         .         .         .         .         .         .         .         .         .
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     19 I          .         .         .         .         .         .         .         .         .         .         .
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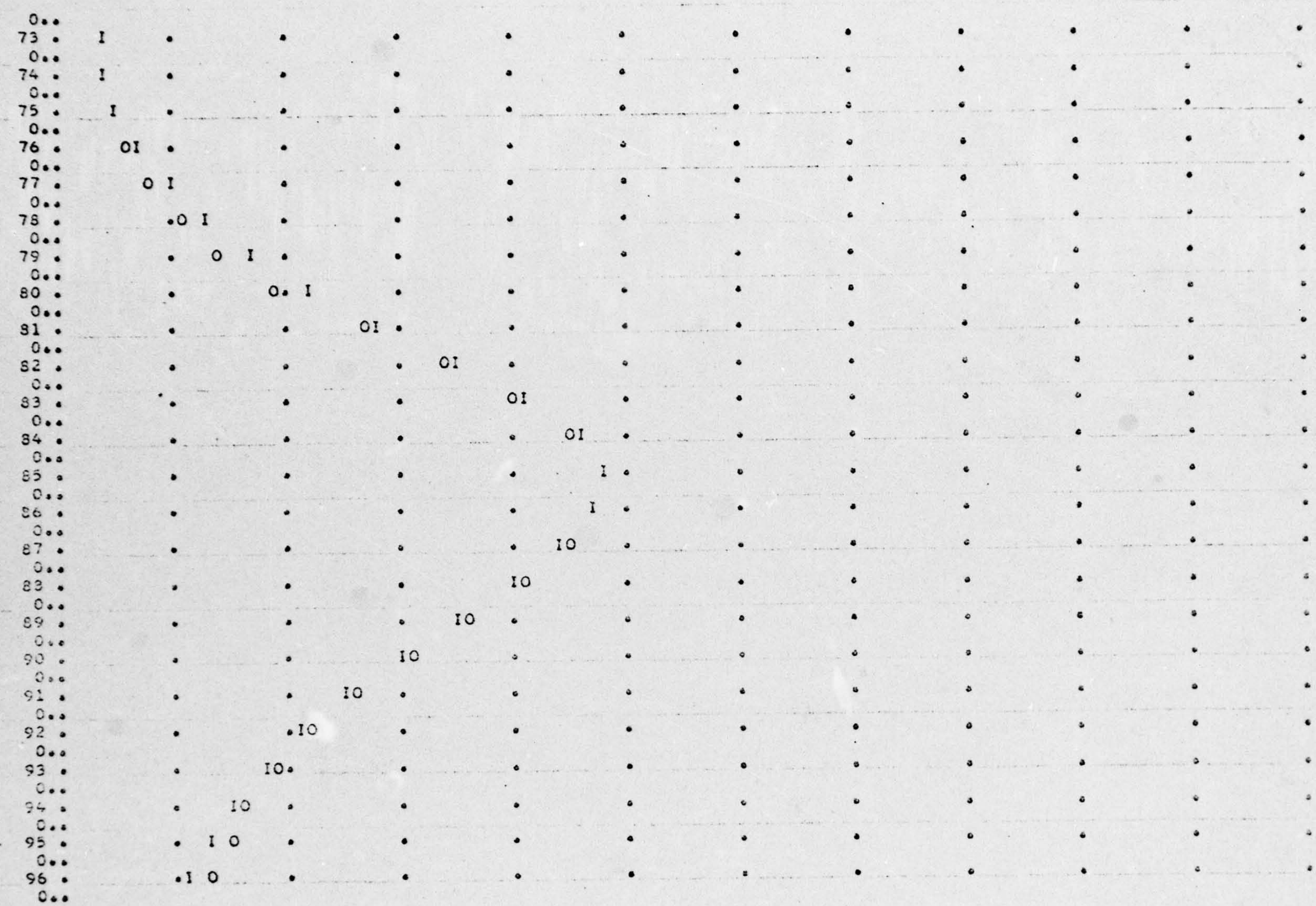

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OVN

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HYDROGRAPH ROUTING

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

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.	9.	18.	28.	37.	47.	57.	61.	67.	78.
OUTFLOW	0.	101.	287.	527.	812.	1134.	1491.	1643.	2022.	2917.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	2.	2.
2	0.	2.	2.
3	0.	2.	2.
4	0.	2.	2.
5	0.	2.	2.
6	0.	2.	2.
7	0.	1.	2.
8	0.	1.	1.
9	0.	1.	1.
10	0.	1.	1.
11	0.	1.	1.
12	0.	1.	1.
13	0.	1.	1.
14	0.	1.	1.
15	0.	1.	1.
16	0.	1.	1.
17	0.	1.	1.
18	0.	1.	1.
19	0.	0.	1.
20	0.	0.	1.
21	0.	0.	0.
22	0.	0.	0.
23	0.	0.	0.
24	0.	0.	0.
25	0.	0.	0.
26	0.	0.	0.
27	0.	0.	0.
28	0.	0.	0.
29	0.	0.	0.
30	0.	0.	0.

31	0.	0.	0.
32	0.	0.	0.
33	0.	1.	0.
34	0.	2.	1.
35	0.	6.	3.
36	1.	12.	6.
37	1.	20.	11.
38	2.	29.	18.
39	2.	39.	26.
40	3.	47.	34.
41	4.	53.	41.
42	4.	55.	46.
43	4.	56.	50.
44	5.	54.	52.
45	5.	51.	51.
46	4.	48.	50.
47	4.	44.	48.
48	4.	39.	44.
49	4.	35.	41.
50	3.	32.	38.
51	3.	29.	34.
52	3.	27.	32.
53	3.	27.	30.
54	3.	28.	29.
55	3.	31.	30.
56	3.	35.	32.
57	3.	39.	35.
58	3.	44.	38.
59	4.	49.	42.
60	4.	54.	47.
61	5.	58.	51.
62	5.	63.	56.
63	5.	70.	61.
64	6.	79.	68.
65	7.	92.	77.
66	8.	110.	89.
67	9.	131.	107.
68	11.	172.	146.
69	14.	226.	194.
70	16.	268.	239.
71	17.	298.	274.
72	19.	321.	304.
73	20.	342.	329.
74	21.	372.	358.
75	23.	433.	408.
76	27.	545.	498.
77	32.	721.	669.
78	40.	965.	904.
79	49.	1273.	1203.
80	60.	1688.	1619.

81	72.	2319.	2446.
82	82.	3050.	3204.
83	89.	3712.	3841.
84	96.	4272.	4382.
85	100.	4639.	4704.
86	101.	4745.	4756.
87	98.	4593.	4552.
88	94.	4256.	4181.
89	88.	3818.	3725.
90	82.	3337.	3238.
91	76.	2858.	2762.
92	71.	2420.	2333.
93	66.	2043.	1975.
94	62.	1758.	1729.
95	59.	1554.	1555.
96	54.	1375.	1400.
SUM			59373.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4756.	3677.	1226.	618.	59373.
INCHES		17.28	23.05	23.25	23.25
AC-FT		1824.	2434.	2455.	2455.

OVF

STATION 3

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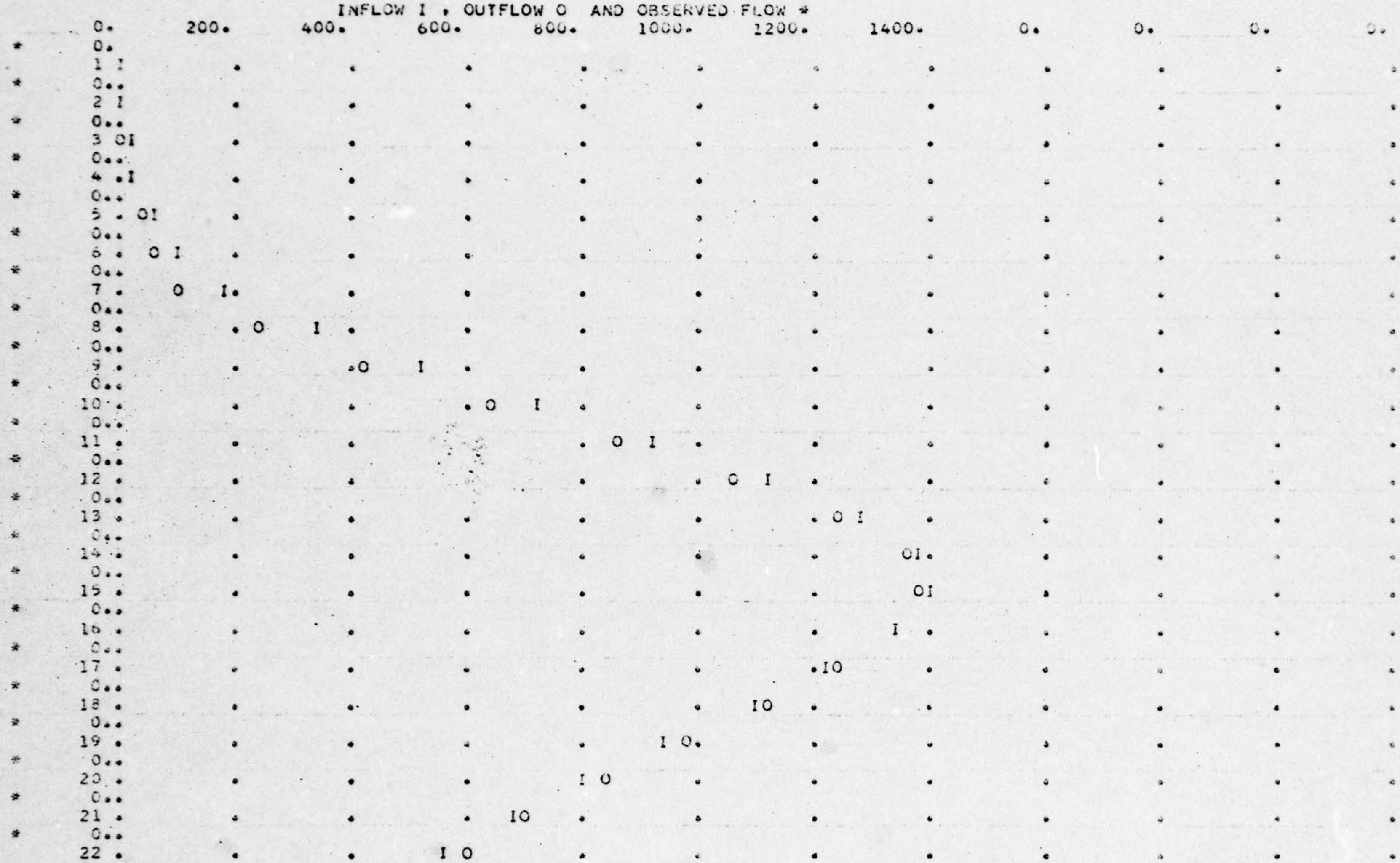
OVF

STATION 3

INFLOW I , OUTFLOW O AND OBSERVED FLOW *



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*      0..
      43 .IO      .        .      .        .        .        .        .        .        .        .        .
*      0..
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RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	1481.	1099.	413.	413.	1.98
ROUTED TO	2	1404.	1074.	412.	412.	1.98
ROUTED TO	3	1386.	1065.	411.	411.	1.98

APPENDIX C

PHOTOGRAPHS

Photograph Index

1. View of crest from left abutment looking toward spillway.

2. & 3. Upstream face.

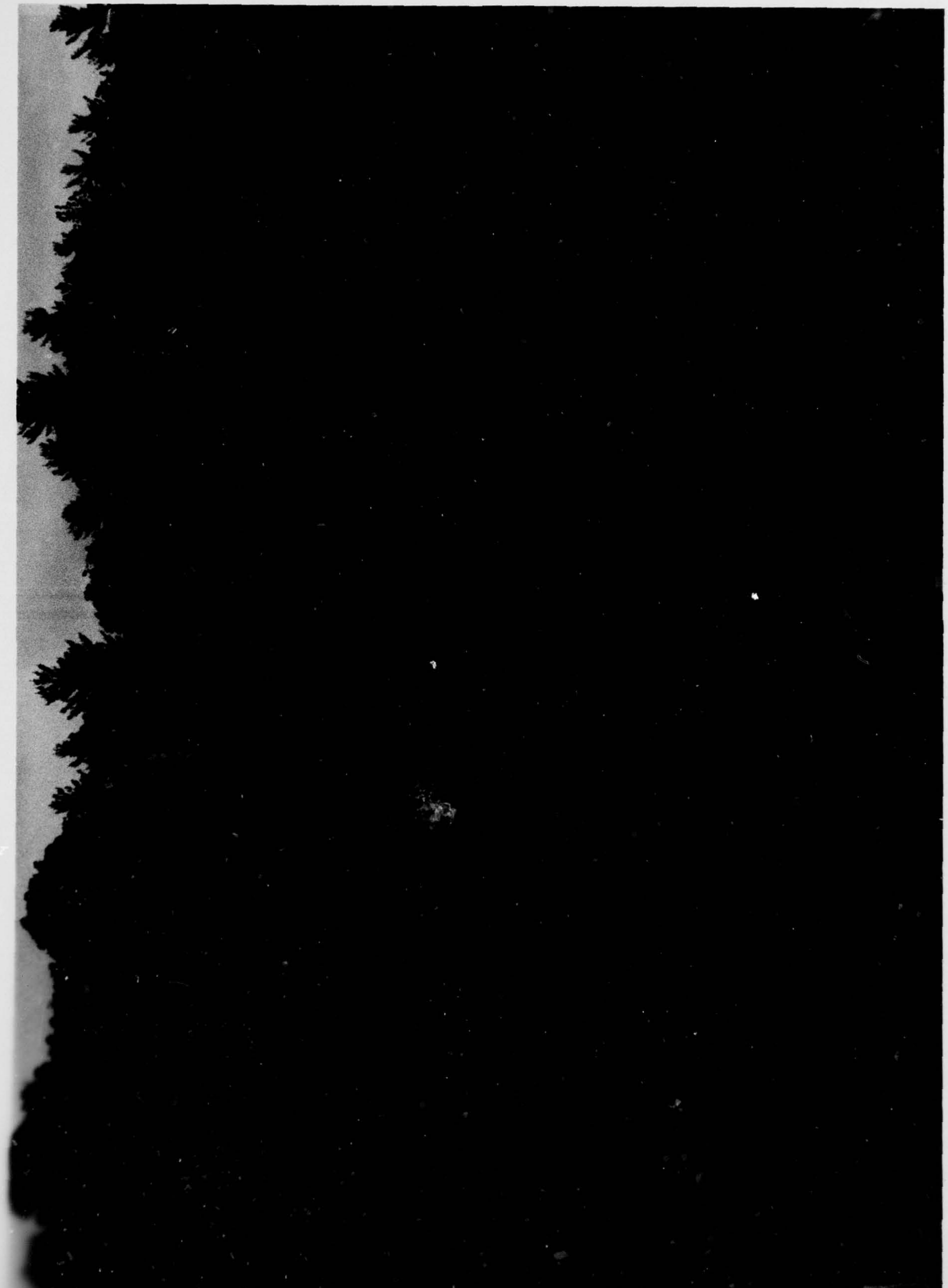
4. Downstream slope, note valve house.

5. Emergency spillway crest weir in foreground.

6. Seepage around pipe inside valve house.

7. View of downstream slope of Upper Waverly Dam from crest of Lower Waverly Dam.

PLATE 1



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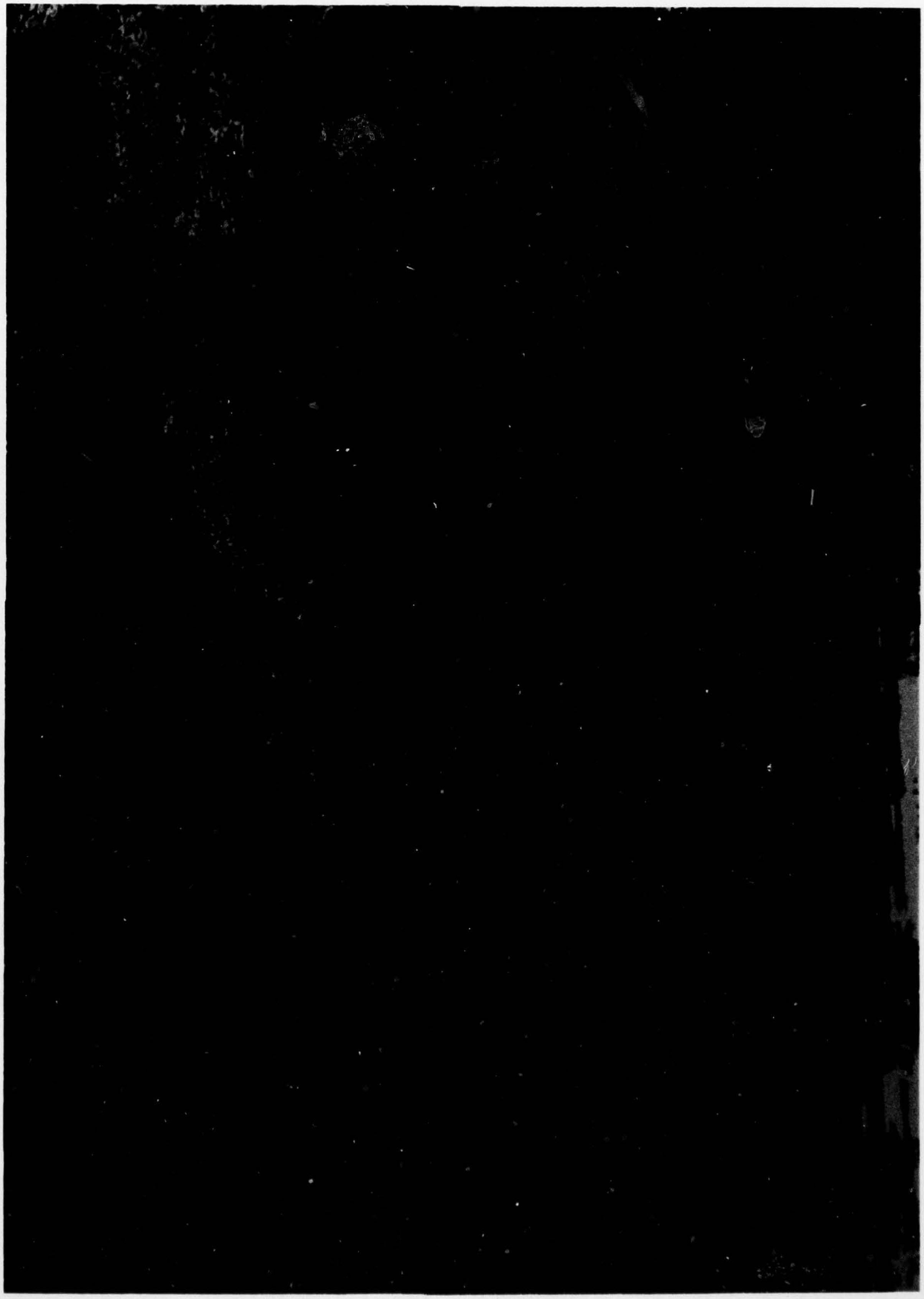

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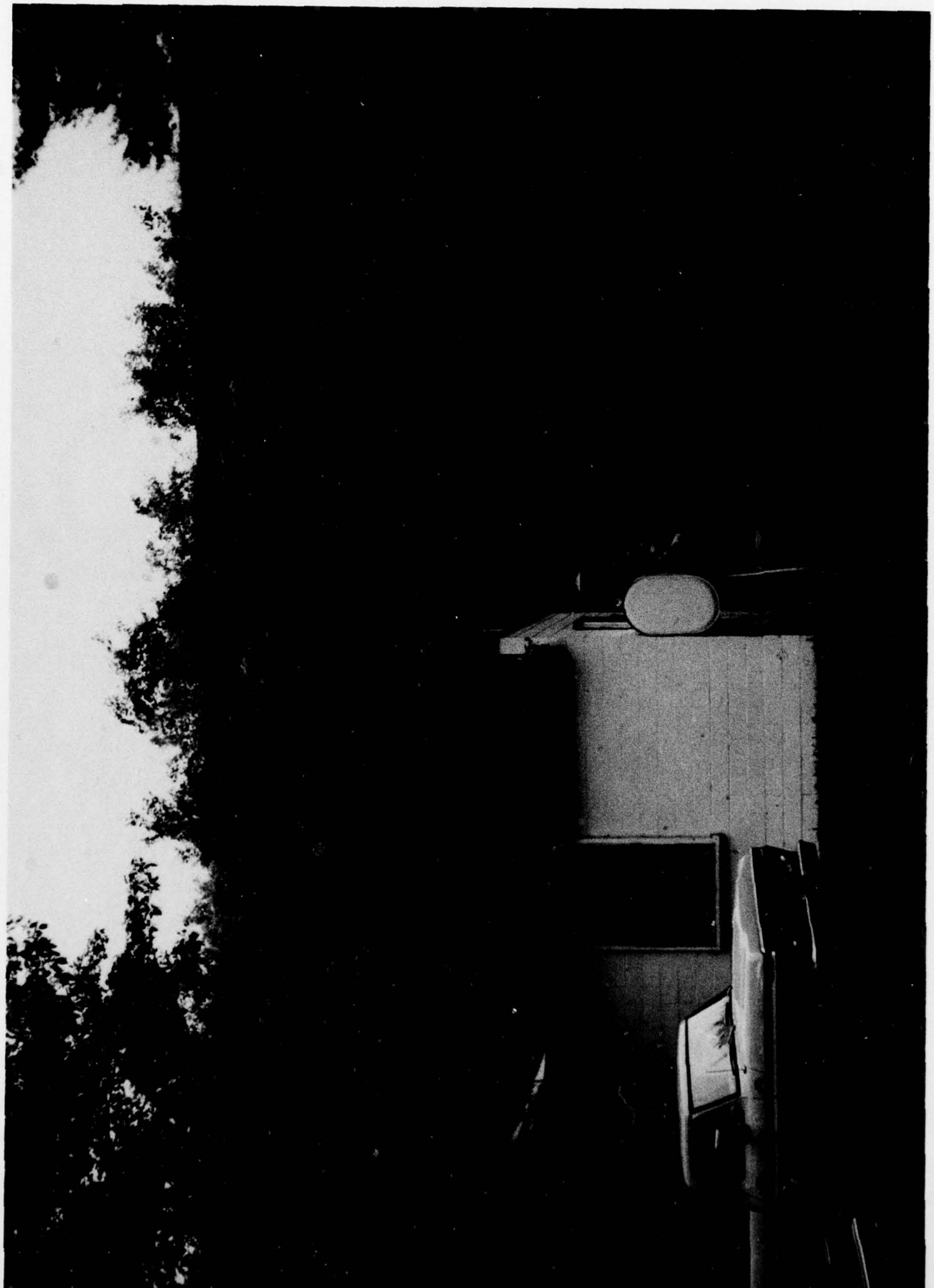

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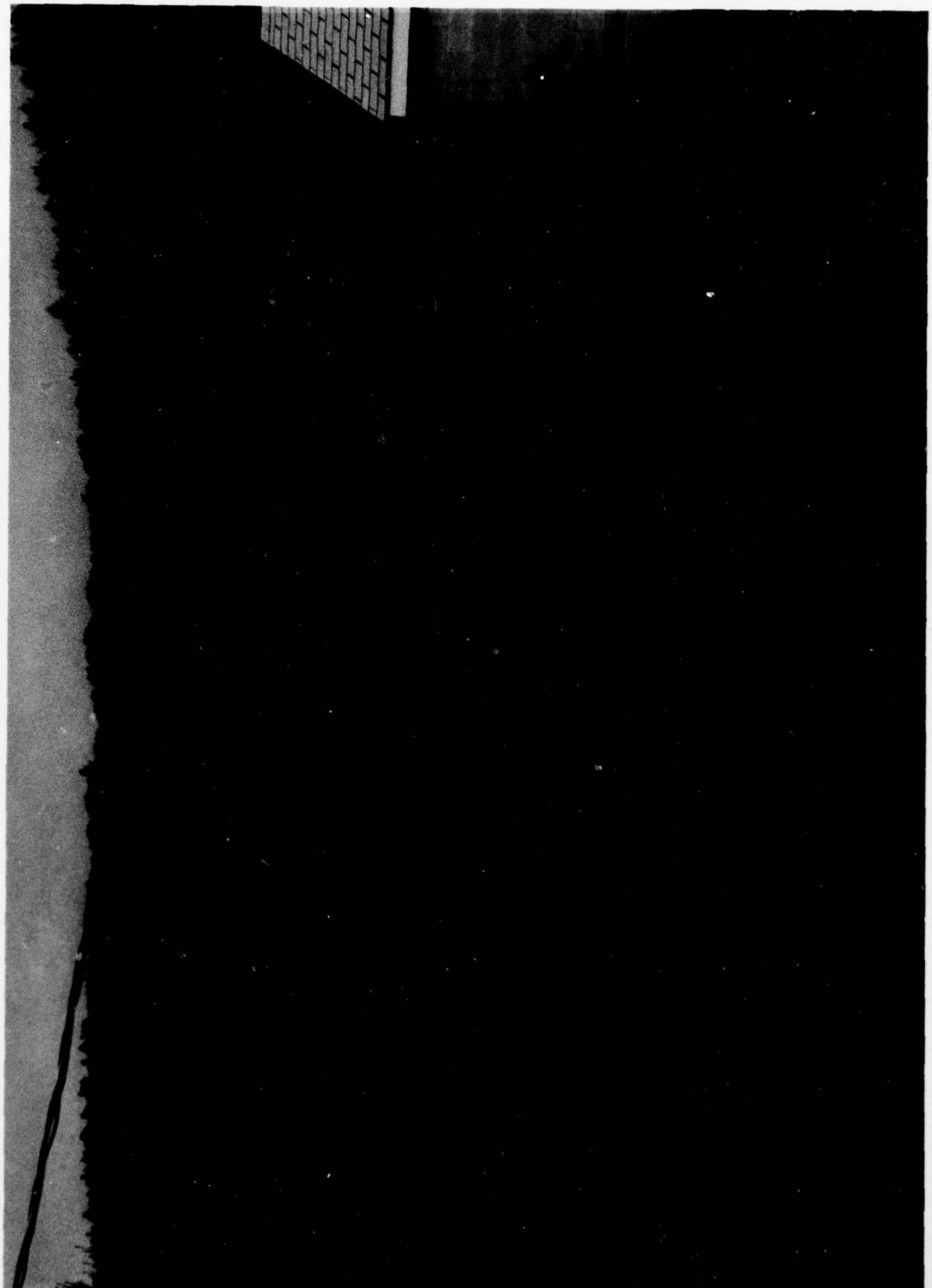

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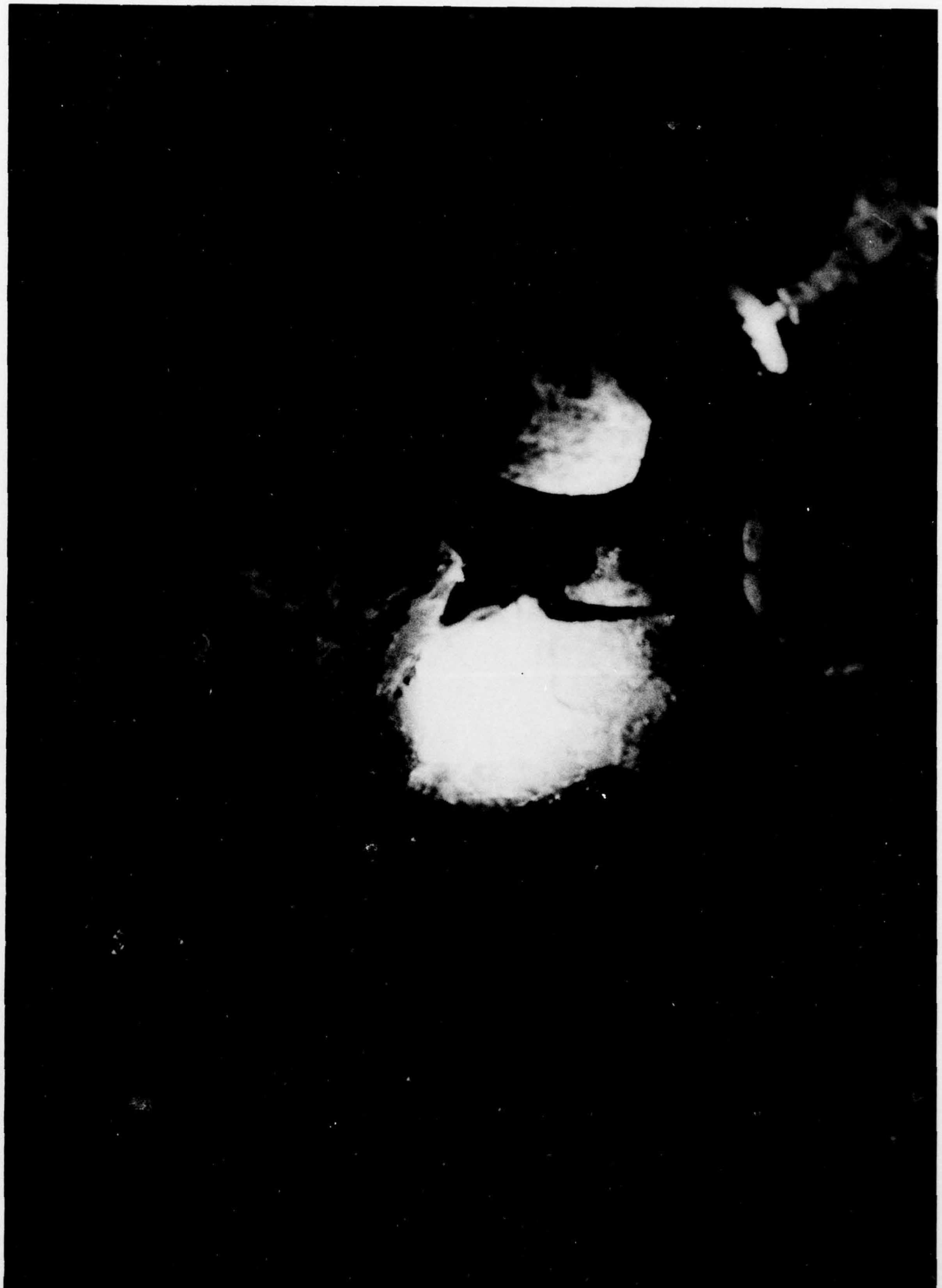

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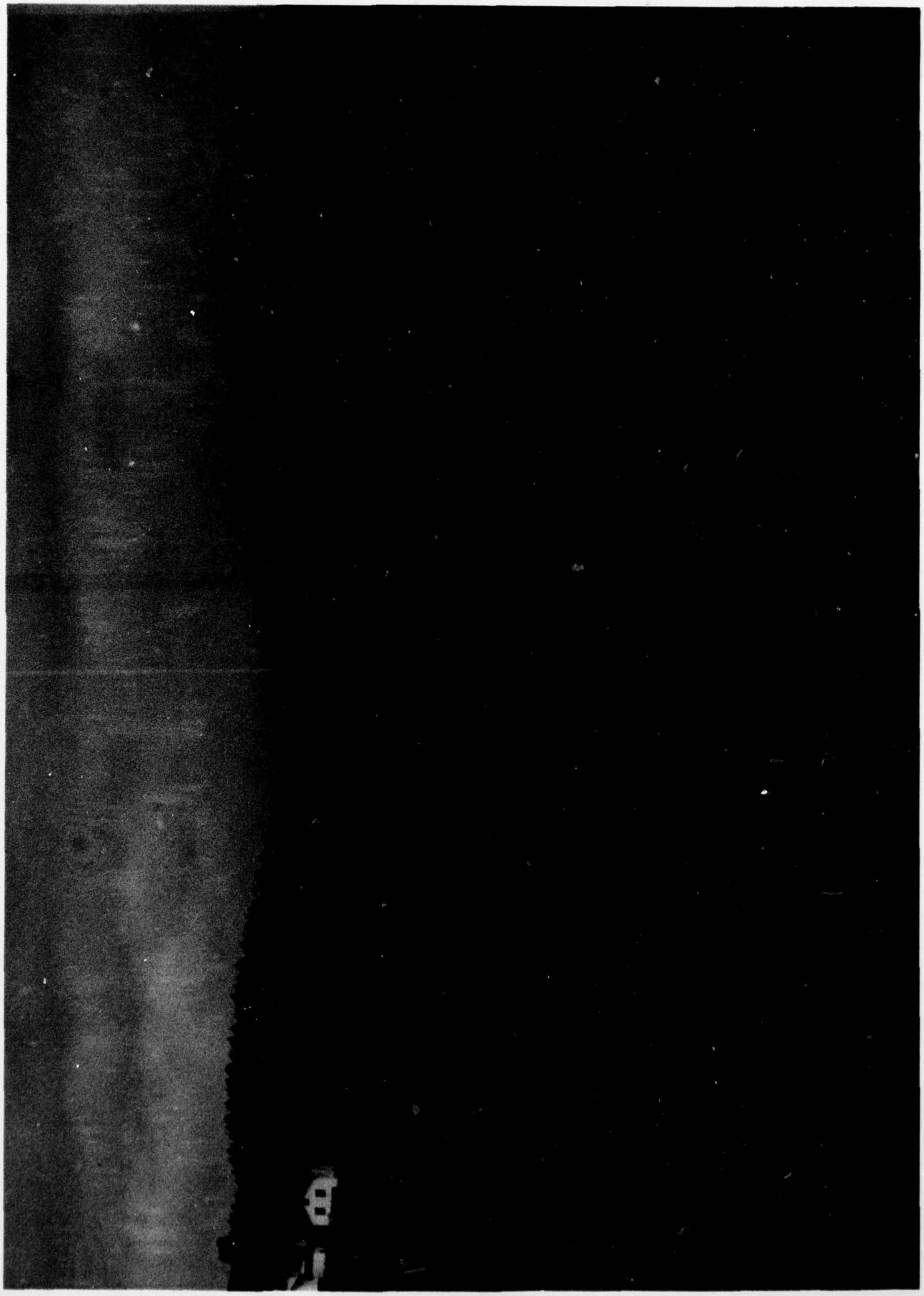

PLATE 7

APPENDIX D

PERTINENT CORRESPONDENCE AND REPORTS

Leary 4/24

VILLAGE Of WAVERLY Waverly, New York 14892

NIEL F. LEARY
MAYOR

RRIS GRESSEL
CLERK

WALTER MANDEVILLE
TREASURER

WILLIAM M. DONNELLY
ATTORNEY

April 10, 1973.

Elmer Lohman, President
Board of Water Commissioners
Waverly Street
Waverly, New York

Dear Bud:

This morning I received a call from Stanford Zeccolo, one of the two persons from the Dams Division of the Conservation Department, with whom we visited last week. Mr. Zeccolo stated that he had written a letter to the Mayor, outlining his recommendations based on the inspection. Unfortunately, his Secretary had directed the letter to Wilson Chadderdon, rather than to Daniel Leary, for which he apologized.

After returning to Albany, Mr. Zeccolo reviewed the department file on the Waverly impounding dams. He discovered that drawings made on 8/1/16 and 8/27/20 indicated a 14" blow-off main under the upper impounding dam. This main is controlled by a valve on the down-stream portion of the dam, which Mr. Zeccolo thought would be operable. He felt that this would serve as an answer to the immediate emergency problem, if operable, for the reason that it is a larger main and is situate at such a point that it is capable of draining a large portion of the water behind the upper impounding dam.

Mr. Zeccolo also stated that if the crest level behind the upper impounding dam could be lowered 15 feet, and he opined that it could, with the use of this main, and the emergency situation could be well controlled.

I checked with Lester Marshall after the call from Mr. Zeccolo. Mr. Marshall was familiar with the 14" main and said that he had used it on numerous occasions when he was Water Superintendent, and that to the best of his knowledge it was still operable. He offered to assist the Water Department in becoming acquainted with using it. Mr. Marshall also stated that the outflow from the 14" main could be shunted into the lower reservoir, or around it, into the causeway leading around the lower reservoir. He stated that this was the original blow-off main for the upper impounding dam, built many years before the 8" main which was constructed only when the level of the upper dam was raised.

Mr. Zeccolo also reported that he had reviewed the Parson firm's recommendations. With one exception he felt that the proposal was sound and that the Village needed all of the basic information. He did feel that the Nussbaummer firm must have acquired all of the needed hydrological information in connection with the design of the filtration plant and that taking it again might be a duplication. He did feel that the topography maps and the soundings would be most important as it is his thought that an attempt should be made to correlate the upper impounding dam with the new filtration plant. His thinking is that with the construction of the filtration plant, there should be little need for a large settling reservoir, and that the conclusion of the engineers might be that the upper impounding dam be reduced in height.

Subject to receiving the written report of Mr. Zeccolo, it would be my suggestion that immediate steps be taken to put in operation the 14" blow-off valve, which should appreciably reduce the crest level behind the upper impounding dam.

Very truly yours

William M. Donnelly

WILLIAM M. DONNELLY
Village Attorney

WMD/r

MAYOR
4/24

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MARYLAND 21203

NABEN-R

24 January 1974

Honorable Daniel F. Leary
Mayor of Waverly
P. O. Box 149
Waverly, New York 14892

Dear Mayor Leary:

This letter confirms and supplements the information provided at our meeting held in the Village Hall on 4 January 1974.

The new low level spillway in the right abutment of the upper Waverly dam is designed for a flow of 1,000 cubic feet per second. The crest of the spillway is at elevation 965 (project datum used on the Baker survey, 8/31/73). The water surface in the reservoir would be at about elevation 971 with 1,000 cubic feet per second flowing over the spillway. The volume of reservoir storage between elevation 965 and elevation 971 is about 35 acre feet. If the reservoir is operated to maintain a normal pool at elevation 955, an additional 40 acre feet, equal to 0.37 inch of runoff from the 2.0 square mile watershed, will be available for flood storage. The storage capacity below elevation 955 is about 15 acre feet.

Outflow greater than 1,000 cubic feet per second is expected at average intervals of about 100 years.

Sincerely yours,

Robert S. McGarry

ROBERT S. McGARRY
Colonel, Corps of Engineers
District Engineer

From MAYOR 4/24

M E M O R A N D U M
re
VILLAGE OF WAVERLY Impounding Dams.

On March 27, 1973, Mayor Leary and Village Attorney William M. Donnelly, attended a meeting with the Construction Grants Division of the New York State Department of Environmental Conservation, at 50 Wolf Road, in Albany, New York. County Legislator, Leon Thomas, of the Fifth Legislative District of the Connty of Tioga, also attended the meeting.

After the meeting with the Construction Grant Division, Mayor Leary and Village Attorney Donnelly were introduced to Louis M. Concra, Jr., Chief of the Bureau of General Engineering of the New York State Department of Environmental Conservation. Mr. Concra's office is at 50 Wolf Road, Albany, New York, 12201, and his telephone number is Area Code 518 (457-7448).

Mr. Concra was involved in an examination before trial being conducted by J. Edward Murray, Asst. Attorney General, withwhom Mayor Leary and Village Attorney Donnelly were acquainted. A Discussion of the Waverly Impounding Dams followed:

Mr. Concra stated that his office was making an inspection of every dam in the State, pursuant to legislation which was adopted several years ago, and were proceeding from East to West across the State. They had not as yet reached Tioga County. Mr. Concra, when advised that the Board of Trustees and the Board of Water Commissioners were contemplating a dam study, suggested that his Department make a study of the impounding dams, as they would be reached shortly, possibly late this summer and at the latest, by next Spring, in any event.

On Thursday, April 5th., Mr. Concra visited Waverly and inspected the impounding dams with another inspector from his office. Later Mr. Concra and his associate met with Mayor Leary and Village Attorney Donnelly, and Elmer Lohman, Chairman of the Water Boaord, and Supt. of Public Works, William Connor. The findings were set forth as follows:

The upper impounding dam was stated to be a Class C. safety hazard, which is the most serious hazard rating made by the office of which Mr. Concra is Bureau Chief. The impounded waters were found to be flowing out the emergency spillway. Apparent fissures were found in the top of the earthen dam enbankment. Bulging was found on the downstream face of the earthen dam with areas of slippage above the bulging area. It was suggested that constant surveillance be kept on the upper dam, particularly during the Spring period and during periods of heavy rain. The Bureau will make an immediate report, in writing, suggesting that the crest level behind the upper impounding dam be lowered to conform to the amount of the lowering of the crest level to be stated in the Bureau's letter. The 8" run-off main at the upper dam was found to be totally inadequate for the purpose of lowering the crest level. Unofficially, it was suggested that immediate steps be taken to install a syphon at the site of the upper dam as an emergency method of reducing the crest level. Both parties agreed that over-topping of the upper dam would cause catastrophic damage, both to property and life down-stream of the dam site. The impression created was that the condition of the upper dam was such that emergency steps be taken immediately to lower the crest level and to keep it lowered.

Mr. Concra took the specifications set forth in Task Order #1, which constitutes the proposed engineering work to be done by the Parsons Engineering firm, and promised to review them immediately and report back to the Village. He suggested that he would be glad to work with the Village, or with the Consultant for the Village, in any manner which might be helpful.

Mr. Concra and his associate did not seem concerned about the lower dam. They noted some seepage, but stated that this was always the case with earthen dams. They would suggest some maintenance problems, including a number of woodchuck holes. They suggested that this problem be taken care of immediately.

The Bureau will make a written report to the Village, undoubtedly mandating an immediate lowering of the crest level behind the upper dam, with the number of feet to be stated in the letter, after certain engineering are made.

WMD.

NABEN-F 14 December 1973

Report of Inspection
Water Supply Dams
Waverly, N.Y.

Purpose: At the request of the Village of Waverly, through the Regional Director of the Federal Disaster Assistance Administration, an inspection of the subject dams was made to evaluate a potential hazard caused by reported movement of the upstream slope of the upper water supply dam.

Date of Inspection: 10-11 December 1973

Principal Contacts:

- Mr. Daniel Leary - Mayor, Village of Waverly
- Mr. Harry Woodburn - President, Village of Waverly Water Commission
- Mr. E. H. Lohman - Village of Waverly Water Commission
- Mr. William Connor - Superintendent of Public Works, Waverly, N.Y.
- Mr. G. E. Lloyd - Parsons, Brinckerhoff, Quade and Douglas, Inc., Consulting Firm

Narrative: Waverly, N.Y. is a small town of approximately 5500 population and is located on Route 17, 20 miles east of Elmira and 40 miles west of Binghamton, N.Y.

The two water supply dams are located about one mile northwest of the Village of Waverly on Dry Brook Creek. The upper impoundment is used for sedimentation while the lower impoundment is used for direct water supply. Downstream of the dams, Dry Brook Creek flows through the westerly 1/3 of the village and has very limited channel capacity. The drainage area for the impoundments is about two square miles. A consulting firm, Parsons, Brinckerhoff, Quade and Douglas, was retained to study the hydraulics and hydrology of a proposed filtration plant just downstream of the lower dam. Both dams were built or raised in 1918. Virtually no as-built data exists.

Lower Dam: The lower dam has a height of 54 feet, is about 310 feet long and the normal pool level creates a hydraulic head of 47 feet. The embankment is founded on rock, has a central contrete core wall, upstream and downstream slopes that vary between 1 vertical and $1\frac{1}{4}$ horizontal to 1 vertical to $1\frac{1}{2}$ horizontal. The crest width is about 8 feet and shows signs of about 6-8 inches of settlement at the maximum section. The dam was built in 1918 and no record drawings exist. A side channel spillway having a length of about 100 feet is located on the right abutment.

Reservoir control is obtained by controlled discharges from the upper dam, water supply discharges, and the spillway. Virtually no drawdown capability exists.

The only visable signs of distress are the settlement at the top of dam and about 25 gpm of seepage exiting from the embankment into the Valve house located at the downstream toe at the base of the right abutment.

Upper Dam: The upper dam has a height of 70 feet, a top width of 10 feet, a length of about 700 feet, and the normal pool creates a hydraulic head of about 65 feet. Records from 1918 indicate that the original dam was about 36 feet high and was raised to its present height by upstream construction. There are virtually no design or construction records for the embankment. One sketch shows a short concrete core wall in the upstream third of the embankment. Both upstream and downstream slopes vary from 1 vertical on $1\frac{1}{4}$ horizontal to 1 vertical on $1\frac{1}{2}$ horicontal. The downstream slope has about 6 feet of tail water created by the lower reservoir.

Reservoir control was previously obtained by a spillway located on the right abutment at elevation 993.5 feet. Top of dam is at elevation 1000±. The discharge through a 6-inch and a 14-inch pipe located in the embankment provides little or no control. An emergency spillway, also located on the right abutment is 2 feet higher than the normal crest. Tropical Storm Agnes caused high reservoir stages and flow through the emergency spillway. Since Agnes, several signs of distress were observed by the owners, namely settlement of the upstream portion of the top of dam accompanied by cracks and fissures. In April the State of New York advised owners to lower the reservoir 15 feet below normal pool to elevation 979 as a precautionary measure. The Village consulted their A/E, who recommended monumentation, exploration and observation wells. and that the pool be maintained at the lower level. The A/E also started to evaluate the drawdown system.

Prior to this, no formal inspection had been conducted, the pool has never been lowered to inspect the 14-inch outlet pipe or the upstream slope. No instrumentation or monumentation had been installed.

At the time of the inspection the embankment was in a gradual state of failure with, a slide over the entire length in the upstream slope, which probably resulted from a sudden drawdown condition after Agnes. The maximum downward movement of the top of the upstream slope is about 4 feet. The entire top of dam is cracked and fissured, the maximum crack being about 10 inches wide. A slide over at least 2/3 of the length of dam is occurring in the downstream direction about midway up the slope. This is a result of the long term steady seepage condition.

Although tail water at elevation 935± prevented observation for seepage at the downstream toe, seepage was observed exiting from the base of the slope on the right abutment and along the concrete spillway retaining wall.

AD-A068 739 KIMBALL (L ROBERT) AND ASSOCIATES EBENSBURG PA F/G 13/2
NATIONAL DAM SAFETY PROGRAM. WAVERLY LOWER RESERVOIR DAM (NY623--ETC(U)
AUG 78 R J KIMBALL DACW51-78-C-0025

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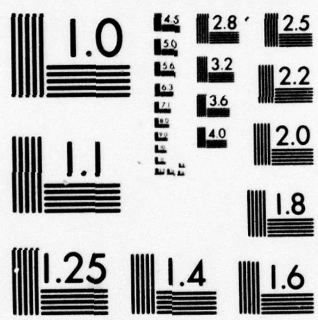


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Temporary monuments along the top of the dam were installed by the owners in October 1973; however, four sets of readings showed no major signs of movement. Prior to Agnes, the top of dam was reported to be level. A 1.5 inch rainfall in the period of 8-9 December caused an 8-foot rise in the pool with both the 6-inch and 14-inch discharge lines opened fully. Preliminary analysis indicates that a rainfall of about 2.7 inches in three hours, which is approximately a twenty-five year storm, could be contained to the spillway crest with the prior pool elevation at 979 as recommended by New York State. Peak discharge for a twenty-five year stowm would be of a magnitude between 500 and 1000 cubic feet per second and could not be controlled by the available outlet pipes and possible portable pumps.

Photographs are available at the Baltimore District office.

Conclusions:

1. The lower dam is not considered safe by current design criteria, but does not present an immediate hazard as does the upper dam.

2. The upper dam is in a state of gradual failure with a downstream slide caused by long term steady seepage and an upstream slide resulting from a sudden drawdown during Agnes in June 1972. The downstream condition was probably aggravated at this time.

Recommendations:

1. Immediate action should be taken to lower the upper reservoir at a controlled rate from its present level at elevation 979 to at least elevation 955. This should be accomplished by opening all discharge pipes, operation of portable pumps and if necessary, the excavation of a diversion ditch on the right abutment to control the inflow of surface runoff. During this period of drawdown the embankment should be kept under constant surveillance by a competent Soils Engineer.

2. The upper reservoir should be maintained at this lower level as long as the embankment remains in its present condtion. This can be accomplished by providing a lower spillway, if required.

3. The A/E, Parsons, Brinckerhoff, Quade and Douglas, Inc., should conduct a study to determine the extent of permanent remedial measures that will be required to restore the embankment to a safe condtion and meet the needs of the village.

ARTHUR H. WALZ
Actg Chief, Dams & Levees Section

J. HEMLER
Asst. Chief, Project Planning Branch

J. LESNIK
Hydraulic Engineer

From MAYOR
4/22

VILLAGE Of WAVERLY Waverly, New York 14892

DANIEL F. LEARY
MAYOR

DORRIS GRESSEL
CLERK

WALTER MANDEVILLE
TREASURER

WILLIAM M. DONNELLY
ATTORNEY

RELEASE - DECEMBER 11, 1973

Since Hurricane Agnes in June of 1972, substantial investigation has been made concerning the safety of the two impounding dams which are one of the sources of the Waverly water supply. For the past year, the Consulting Engineering Firm of Parsons, Brinckerhoff, Quade & Douglas, Inc., have been conducting an investigation of the dams in an effort to determine the question of their safety. During that period, several inspections have been made of the dams by engineers of the New York State Department of Environmental Control. Recently, through the efforts of Congressman Howard W. Robison and Leon Thomas, our County Legislator, the U.S. Corp of Engineers have made on-site inspections. Today, I met, along with other Village officials, with representatives of the Corp of Engineers and a representative of our engineering firm. The information elicited indicates that the problem may be considerably more serious than had earlier been thought.

We are told that there has been subsidence in the down-stream face of the upper dam, probably of some time duration, and further subsidence on the up-stream face of the upper dam which can be attributed to the effects of Hurricane Agnes. The level of the parapet on the upper dam has subsided about four feet since Hurricane Agnes. We do not feel that there is any immediate danger of a breach and in this conclusion, our advisors concur. However, because of the

RELEASE - DECEMBER 11, 1973

nature of what has taken place at the site of the impounding dams in the hills above the Village, we are taking the following steps as precautionary measures:

1. In accordance with the suggestions of the Corp of Engineers and our engineering consultant, we are lowering the pool behind the upper impounding dam to as low a level as possible. This must be done slowly in accordance with the engineering advice given to us, and with the reduction being in the neighborhood of not more than four inches a day, to prevent further deterioration in the upper dam.

2. We are taking steps to commence immediately core drilling at the upper dam site to determine the stability of the material in the interior of the upper dam, and on an emergency basis so as to dispense with competitive bidding.

3. We are preparing an emergency evacuation plan for use in the unlikely event that a serious problem might arise which would endanger the lives and property of people residing downward from the dam sites. Representatives of the adjoining Borough of South Waverly will be asked to participate in the working out of such plan.

Release of this statement should not be a cause for alarm to residents of our community. It is simply a statement designed to define the problem and alert the citizenry to the steps being taken as a precaution. There will be certain observable activity in the dam area within the next month and it is hoped that this statement will clarify the reasons and prevent undue alarm.

OFFICE OF ENVIRONMENTAL ANALYSIS

MEMORANDUM

Vic Glider

S. J. Zeccolo

CT: Waverly Dams

December 17, 1973

On April 5, 1973, myself and another Department engineer inspected these dams at the request of the Village of Waverly.

During the time of the Agnes floods, the water's level rose to unprecedented levels and soaked portions of the embankment which had not been previously so exposed. This condition plus a sudden drawdown has resulted in a sloughing of the earthen embankment in both directions. It was stated that cracks along the crest of the dam appeared after Hurricane Agnes. A result of this inspection was an order from us to lower the water level 15 feet below normal pool elevation, and to maintain that level until completion of an engineering study. Sect 71-1719 & Sect 71-0301 Summary Citation Summary Abatement

The Village then asked me to review the engineering proposal for a dam investigation presented by Parsons-Brinkerhoff. On April 16, I sent a letter outlining my comments. One of my comments was that Parsons-Brinkerhoff should coordinate their study with Nausbaummer & Clark (the filtration plant's designer) to determine whether or not the upper reservoir should be permanently lowered or eliminated.

The Village was very concerned over the fact that they were contemplating a new water filtration plant, and now faced with an expensive dam repair, they would be unable to do both projects.

During the State's "Federal Dam Inventory", the Army Corps of Engineers was notified of the situation and that a serious downstream hazard existed. The Corps has recently inspected the upper dam and deemed it necessary to implement emergency action. On Friday, December 14, I was directed by the Department to act as liaison at a meeting between the Army Corps of Engineers - Baltimore District, the Village of Waverly, Department of Environmental Conservation and Department of Transportation. At this meeting, Colonel McGarry stated that this was a serious situation and that emergency action was deemed necessary by the Corps of Engineers. Department of Environmental Conservation, Parsons-Brinkerhoff and the Department of Transportation Soils Engineers feel that the situation is serious, but as long as the water levels are kept down, there is no crisis.

A complete list of attendance is attached. Not shown on this list were several people from the news media. The U. S. Corps of Engineers Public Affairs man invited the press.

If the Corps of Engineers wishes to call this an emergency and bare the costs for remedial action, the Village has no objection and neither should the Department. Colonel McGarry asked me if the State of New York could assist the Village in any way. I advised him that I was not authorized to speak for the entire State, but that the Department of Environmental Conservation was unable to render any financial or construction assistance. The D.O.T. representative informed Colonel McGarry that there was a possibility of obtaining equipment from their Region 6. However, such an order would have to be received from higher D.O.T. officials. Colonel McGarry said he would send an official request to the Governor's office. This procedure is necessary for him to exhaust all other available assistance before committing federal funds in an emergency. As long as N. Y. S. cannot assist the Village, the Corps will step-in using emergency funds. Colonel McGarry expressed a desire to do this project without proceeding to formal Federal contracts by procuring trucks, equipment and labor from the Village or the State.

The emergency procedure as outlined by Major Johnson was to:

1. Drawdown the reservoir by pumping.

2. Construct a diversion ditch to eliminate inflow.

3. Conduct core borings and analyze them.

4. Design a new principal spillway.

5. Construct the new spillway.

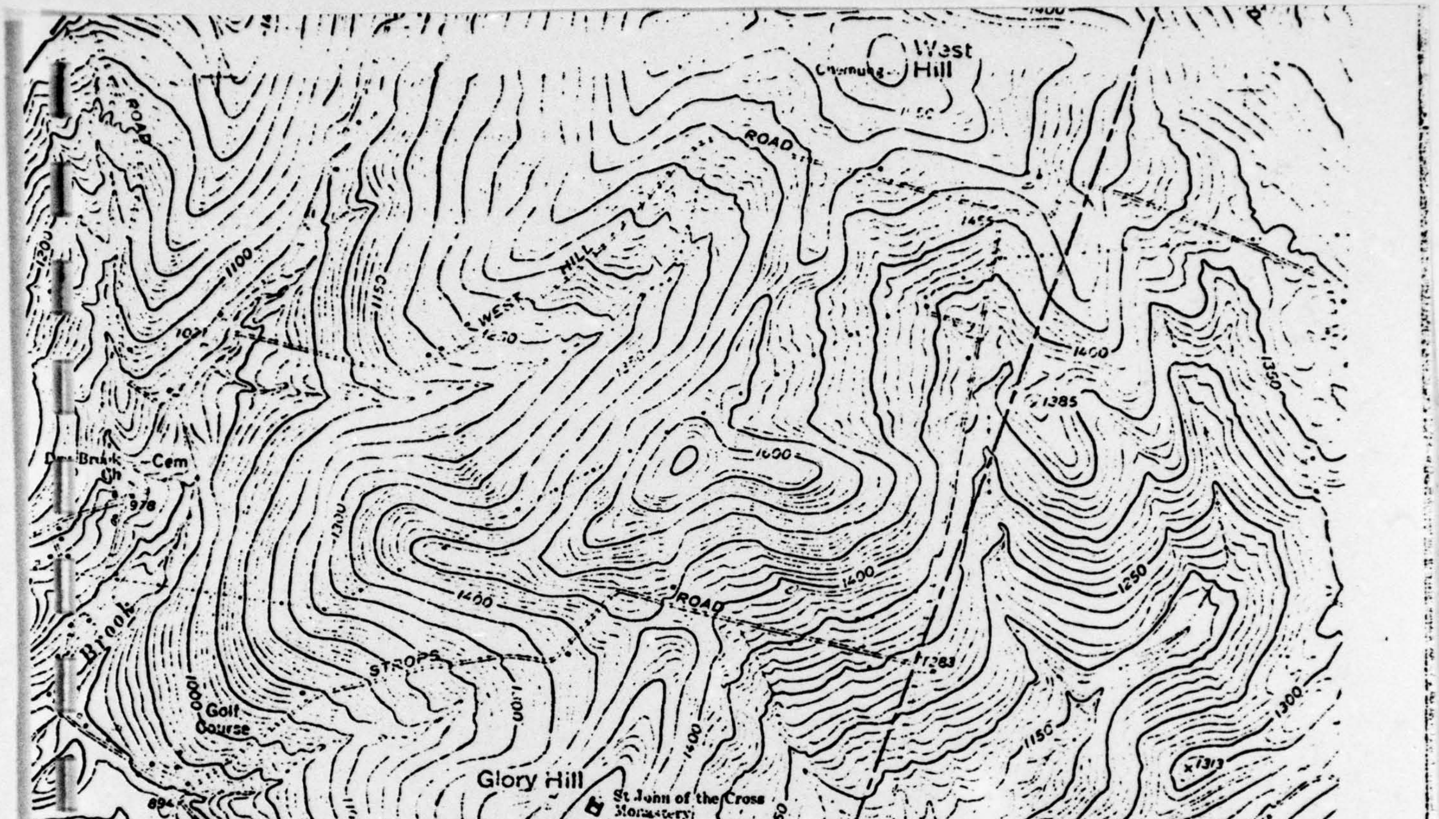
I agreed with their logic except for the necessity of the diversion ditch. Levels can be controlled by pumping during periods of low inflow without resorting to a diversion ditch. The Corps will determine whether or not to ditch depending on the pumping capability.

The Village welcomes this assistance and will cooperate in any way they can with the Corps. The Department should welcome this Federal assistance. If the Army Corps of Engineers wishes to repair or reconstruct unsafe dams with high hazards, they would provide a great service to the State.

SJZ:cs

Encl.

cc: Terry Curran



SCALE 1:24000

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

MAGNETIC NORTH
... OF SHEET

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON, D. C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

List of Persons in Attendance
Town of Waverly

Dam Discussion 12/14/73

Stanford Zeccolo	Sr. Hydraulic Eng D.E.C.
Joe Hemler	Corps of Engr.
Michael A. Kolessar	Corps of Engrs
Austars R. Schnore	NYS-Dept. of Transportation - Soil Mech. Bureau
Bernard E. Butler	" " " " "
STANLEY R. JOHNSON	SUSQUEHANNA AREA OFC, BALTO DIST, COE
LEON THOMAS	TIOGA COUNTY LEGISLATURE
COL ROBERT McGARRY	BALTIMORE DISTRICT ENGR, COE
Dick Whitaker	" " PAO
J. C. Viselli	Water Comm.
J.C. Bonesch	NYS D.O.T Region 6
Walt. Robbins	- Tioga Co. Civil Defense Director
M.C. Fucci	N.Y.S D.O.T Region 6
CPT C S Joyne	1/108th Inf NYARNG
Don L. Long	mayor of Waverly
Col Robert S McGarry	District Engineer Baltimore District Corps of Engineers.
Henry J. Wardleum	- Pres. - Bd. of Water Commission.
R. B. Gillan	DEC - CONSERVATION OFFICER
Lt. Joseph T. Lynch	DEC - Division of Law Enforcement
Bill Donnelly	Village attorney

Waverly

PARSONS, BRINCKERHOFF, QUADE & DOUGLAS, INC
111 JOHN STREET, NEW YORK, N.Y. 10038 TELEPHONE (212) 233-6300
CABLE: PARKLAP NEW YORK • TELEX WU 1-2403 • RCA 232 117
ENGINEERS

October 31, 1973

Mr. Stanford Zeccolo
Department of Environmental Conservation
50 Wolf Road
Albany, New York 12205

Dear Mr. Zeccolo:

We are in the process of studying the water supply dams in the Village of Waverly, New York, and we understand that some data is available in the New York State archives.

Please send us information on Registered Dams numbered 10 and 10A, in the Chemung River Watershed, as we discussed during our telephone conversation of October 31, 1973.

Thank you for your assistance in this matter, we remain

Very truly yours,

PARSONS, BRINCKERHOFF, QUADE & DOUGLAS, INC.

G. R. Lloyd

GRL:ml

Xerox copies of 1916 reports sent to above 11/2/73

150

FILE

September 7, 1915.

Waverly Water Company,

Waverly, N. Y.

Gentlemen:-

Our Inspector, Mr. McKim, reports that the embankment for your new reservoir dam (#10/A Upper Chemung Watershed) is not being rolled at all, as called for by the specifications. It is impossible to do this work satisfactorily unless same is rolled. This work should be done in accordance with the specifications.

Very truly yours,

GEO. D. PRATT, Commissioner,

By A.H.P.

Division Engineer.

McK/C.

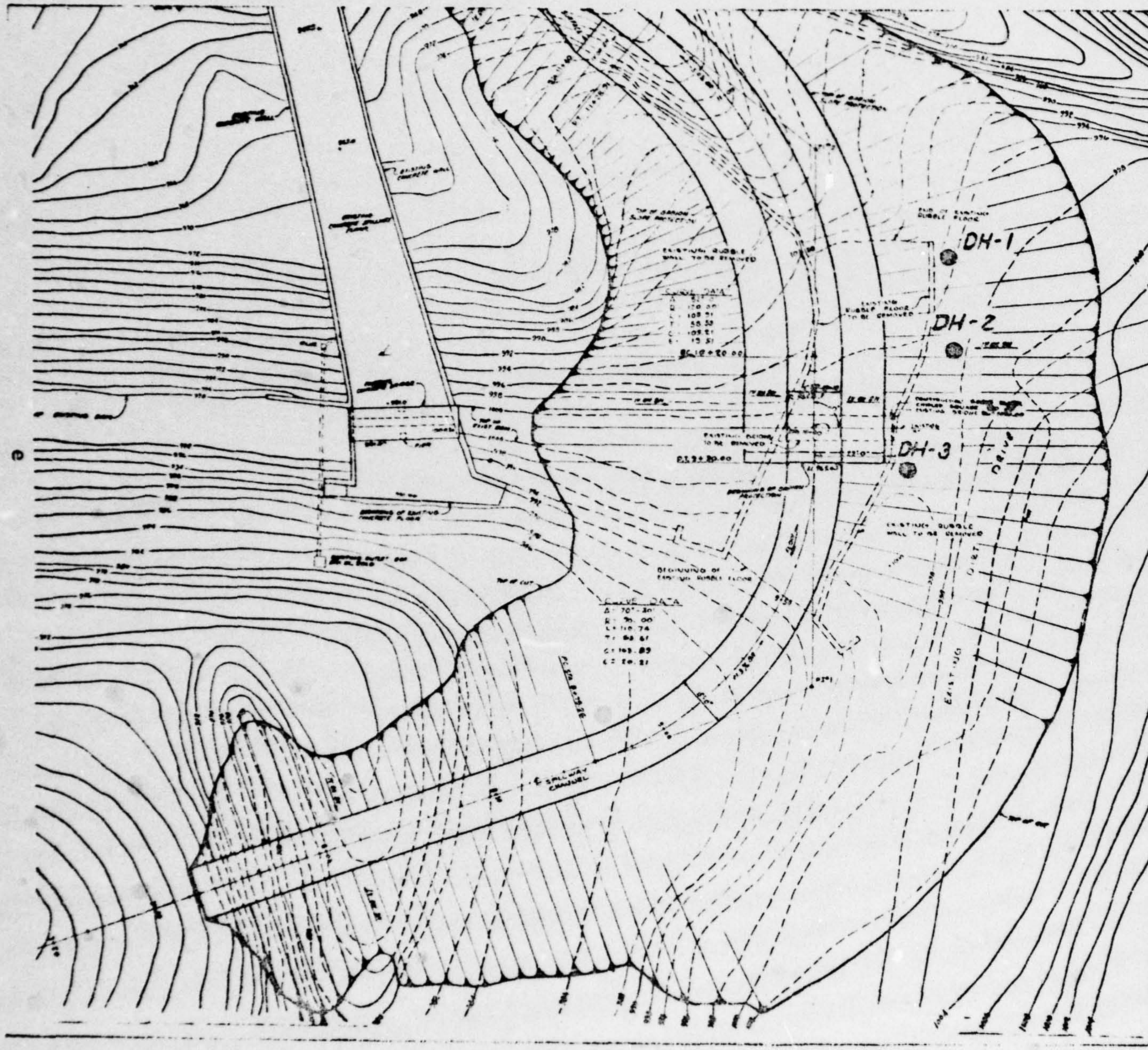
36

WAVERLY, NEW YORK

AFTER ACTION REPORT

U.S. ARMY ENGINEER DISTRICT BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

APRIL 1974



VILLAGE OF WAVERLY
NEW YORK
EMERGENCY SPILLWAY

PLAN OF EXPLORATION

FOREWORD

Following requests from the village of Waverly, New York State Officials, and the Federal Disaster Assistance Administration, the U. S. Army Corps of Engineers responded and inspected the village's two water supply dams.

The inspection disclosed that one of the dams was in a gradual state of failure and presented a serious threat to life and property in the village as well as in the neighboring community of South Waverly, Pennsylvania.

This report documents the emergency operations undertaken by the Baltimore District under the provisions of ER 500-1-1. The emergency actions undertaken were the lowering of pool behind the dam to a safe elevation and the construction of a low-level spillway to prevent impoundment of water behind the dam.

AFTER ACTION REPORT

WAVERLY, NEW YORK

14 December 1973

1.1 Authority. This report on the activities of the U. S. Army Engineer District, Baltimore, in Waverly, New York, surrounding the potential failure of an earthen dam is prepared in accordance with instruction contained in ER 500-1-1.

1.2 Purpose. This report summarizes activities undertaken with the statutory authority granted the Corps of Engineers in PL 84-99 and is intended to describe the emergency operations carried out by the Baltimore District.

1.3 Location. The village of Waverly, New York, is a town of approximately 5,500 population located along the southern tier expressway (Route 17), 20 miles east of Elmira, New York, and 40 miles west of Binghamton, New York. The village was incorporated in 1854. Dry Brook, a tributary stream of the Chemung River which flows through the village, has two water impoundment dams about 1-1/2 miles upstream of the center of the village. Although the purpose of these dams is for water supply, there are some inherent flood control benefits.

1.4 History. In the days of colonial settlement, cities and villages were founded along navigable waterways since boats were the primary vehicle for transportation and commerce. By the mid 1800's railroads began linking cities and opening areas to development that were not necessarily near a waterway. New cities and villages appeared almost overnight along these railroad rights-of-way. Many of the buildings constructed were of lumber, since it was the most plentiful building material. The fact that many of these towns were remote from large quantities of water resulted in almost invariable losses to fire of whole blocks, ravaged because there was not enough water to bring the flames under control.

Commercial wooden buildings sprang up on both sides of Waverly's Broad Street situated as it was adjacent to the newly constructed Erie Railroad. This railroad was a link between New York City, Lake Erie, and the West.

As the village expanded it was soon beset by a succession of disastrous fires. In the spring of 1855, Waverly's first great fire destroyed seventeen stores. Shortly thereafter, the first village fire company was organized and a hand engine purchased. Cisterns were dug and bricked in for the purpose of providing water supply for fire fighting. Remains of several cisterns were unearthed in the 1960's when Broad Street was resurfaced. In 1871, a second disastrous fire destroyed sixteen buildings and twenty-five businesses. The cisterns source of water supply proved inadequate.

Continued rapid growth of the town led insurance companies to threaten to cancel fire policies. Village Trustees studied the problem and retained a civil engineer to study the possibility of impounding the head waters of Dry Brook to provide a source for a water system. The cost of $129,000 proved prohibitive to the village government. The suggestion of a well at the foot of Spanish Hill with the water to be pumped to storage tanks was also rejected as being too costly.

The impetus for the beginning of the Waverly Water System ultimately came from private sources in 1880 when the Waverly Water Company was organized. The voters of the village ratified a contract which provided for payment to the Company of an annual sum of $1,600.00 for furnishing eighteen Broad Street meters with water, with additional hydrants to be furnished with water at $75.00 per year per hydrant. The Waverly Water Company, a privately owned stock company, was given the necessary village franchise and commenced, in 1880, the construction of impounding dams at the headwater of Dry Brook north and west of the village. What is now called the lower reservoir was constructed during that year and retains approximately its original form. This was to be the primary storage reservoir. At the same time a smaller reservoir, with an impounding dam fifteen feet in height, was constructed north of the primary reservoir. A 14-inch outlet pipe was included to feed the lower reservoir. The purpose of the smaller reservoir was probably two-fold--to impound the waters of Dry Brook while construction was underway on the primary storage reservoir below, and secondly to act as a sedimentation basin for run-off waters from Dry Brook before it was fed into the lower reservoir. At the same time, a run-off spillway was built leading from the west side of the upper dam, around the lower reservoir, and into the upper Waverly Glen at the present side of the Glen waterfall. Though need for fire protection provided the immediate impetus for construction of the Waverly impounding dam, the newly organized company moved immediately into a program of providing water for household patrons in the rapidly expanding residential areas of the village. Mains were laid in numerous newly developed streets, and the Waverly Water Company became an active force in the rapid development of the village.

In 1906 the Board of Trustees of the village submitted to the voters the question of whether the village should acquire the existing private system of Water Works of the Waverly Water Company, including its mains, lands, easements, rights-of-way and property for a sum not to exceed $125,000.00. The proposition was noted in the affirmative. There followed a period of five years of extended and bitter litigation in the Supreme Court of the State of New York involving the acquisition of the water works by the village through condemnation proceedings. The Water Company contested the acquisition on numerous grounds, but by 1912 litigation was concluded and the Waverly Water System, including the impounding dam, became the property of the village of Waverly and a municipal utility. Bonds were authorized and issued to finance the purchase and improvements and a separate Board of Water Commissioners was created that year to operate and manage the new municipal water system.

In the following years, and up to 1918, the upper impounding dam was improved and its capacity enlarged. Additional watershed lands were purchased. The upper dam was raised an additional thirty feet above the original fifteen feet, and adjustments were made to the diversion spillway to make it compatible with the raised height of the upper dam.

By 1920 the Waverly Water System had for the most part taken its present form. Village-owned lands in the impounding area consist of approximately five hundred acres. The entire watershed consists of approximately two square miles of land. The capacity of the lower impounding reservoir is approximately 90 million gallons and that of the upper reservoir approximately 130 million gallons. Extensive reforestation and plantings on the slopes adjoining both reservoirs control erosion and add to the water retention capacity of the watershed.

From 1920 to 1970 the dam existed essentially in its present form, being maintained by the village public works department. A number of independent events in the past several years brought attention to dams in general, and the Waverly Water System in particular.

In early 1970, the village began to assess its water supply from a quality standpoint, and this, in turn, led to an evaluation of the structural soundness of the dams. Concurrently, in 1970, the Buffalo Creek Disaster occurred in West Virginia. This disaster, in which a series of mine company dams broke and flooded a narrow valley, resulted in passage on 8 August 1972 of the Dam Safety Act, PL 92-367. The objectives of the Act are to inventory all dams meeting a specified criteria in the United States and to develop recommendations for a comprehensive National Dam Safety Program. This enormous task was delegated to the Department of the Army, Office of the Chief of Engineers, Army Corps of Engineers. The responsibility for the State of New York under this program was assigned to the New York District Engineer who entered into a contract with the New York State Department of Environmental Conservation (DEC) to perform the inventory and submit, prior to 1 April 1974, a report on applicable New York State dams.

In June 1972 the effects of tropical storm Agnes were felt in and around the Waverly area and extensive damages resulted to the village, and as was later realized, to the dams.

Following Agnes, village officials kept a watchful eye on the dams; and sometime later when settling was noticed, they requested the New York State DEC to inspect the dams as soon as possible.

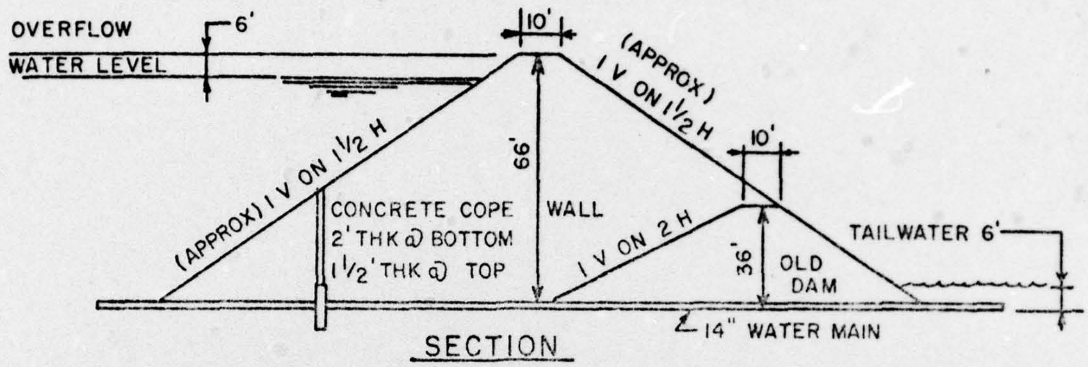
Officials from the DEC visited the damsite on 4 April 1973 and, noting some deficiencies, verbally ordered the water level of the upper impoundment lowered 15 feet from its normal pool elevation. The authority for New York State Officials to act in such emergencies is contained in the New York State Environmental Conservation Law, Section 15-0507 (Inspection of Dams) and Section 71-1819 (Summary Action). DEC officials reported after their visit that "these dams constitute a greater threat than any other existing dams in the state at the present time." The village then consulted architect-engineer, Parsons, Brinckerhoff, Quade and Douglas of New York City, who recommended monumentation be established, exploration and observations wells be dug, and that the pool be maintained at the lower level. This firm was under contract with the village for other services.

Concerned over this assessment, village officials contacted numerous governmental agencies including the New York State Civil Defense and the Federal Disaster Assistance Agency (FDAA). The FDAA concluded that it had not authority to render assistance to the village, and on 14 November 1973, sent a letter (see appendix G) to the Baltimore District Corps of Engineers requesting initiation of a study concerning a potential dam failure.

The Baltimore District dispatched an inspection team to Waverly soon after the arrival of the request for the study. The resulting emergency operation was unusual in that it was undertaken to preclude occurrence of rather than recover from a disaster. As the Mayor of Waverly, New York, who had experienced the flood of 1972, said, "It seems relatively easy to get outside help after a disaster but nearly impossible to get assistance in averting a potential disaster." Upon returning to Baltimore, the inspection team filed the trip report found in appendix A.

1.5 Dam description. The upper dam has a height of 70 feet, a top width of 10 feet, a length of about 700 feet, and the normal pool creates a hydraulic head of about 66 feet. A dam report, made in 1916 by the Conservation Commission of the State of New York, indicates that the dam was originally about 36 feet high and was raised to its present height when the reservoir was enlarged. There are virtually no design or construction records for the embankment. One sketch in the 1916 report shows a short concrete core wall in the upstream third of the embankment. See the sketch marked "Section" on page 5. Both upstream and downstream slopes vary from 1 vertical on 1-1/4 horizontal to

1 vertical on 1-1/2 horizontal. The downstream slope has about 6 feet of tail water created by the lower reservoir.



Reservoir control was previously obtained by a spillway located on the right abutment at elevation 993.5 feet. Top of dam is at elevation 1000± the discharge through a 6-inch and 14-inch pipe located in the embankment provides little or no control. A second spillway, called the emergency spillway, also located on the right abutment, is 2 feet higher than the first one. Tropical storm Agnes caused high reservoir stages and flow through the emergency spillway. Since Agnes, several signs of distress have been observed by the owners, namely settlement of the top of dam accompanied by cracks and fissures.

Prior to the arrival of the Baltimore District's inspection team, no formal inspection had been conducted, the pool had never been lowered to inspect the 14-inch outlet pipe or the upstream slope, and no instrumentation and very little monumentation had been installed.

At the time of the team's inspection, the embankment was noted as being in a gradual state of failure, with a slide over its entire length in the upstream slopes which probably resulted from a sudden drawdown condition after Agnes. The maximum downward movement of the top of the upstream slope is about 4 feet. The entire top of dam is cracked and fissured, with the maximum crack being about 10 inches wide (see photo 4, page 6.) A slide over at least 2/3 of the length of dam is occuring in the downstream direction about midway up the slope resulting from a long-term steady seepage condition.

Although tail water at elevation 935± prevented observation for seepage at the downstream toe, seepage was observed exiting from the base of the slope on the right abutment and along the concrete spillway training wall. A few monuments along the top of the dam were installed by the owners in October 1973; however, four sets of readings showed no major signs of movement. Prior to Agnes, the top of dam was reported to be level. A 1.5-inch rainfall in the period of 8-9 December caused an 8-foot rise in the pool with both the 6-inch and 14-inch discharge lines opened fully. Preliminary analysis indicates that a rainfall of about 2.7 inches in three hours, which is approximately a twenty-five year storm, could be contained to the spillway crest with the prior pool elevation at 979± as recommended by New York State. Peak discharge for a twenty-five year storm would be of magnitude between 500 and 1,000 cubic feet per second and could not be controlled by the available outlet pipes even if supplemented by portable pumps.

The conclusions of the inspection that were presented to the village officials on the afternoon of December 11 in the village hall were: (1) the lower dam is not considered safe by current design criteria, but does not present an immediate hazard as does the upper dam, and (2) the upper dam is in a state of gradual failure with a downstream condition probably aggravated at this time.

In light of these observations, the following recommendations were offered:

(1) Immediate action should be taken to lower the upper reservoir at a controlled rate from its present level at elevation 979 to at least elevation 955. This should be accomplished by opening all discharge pipes, operating portable pumps and, if necessary excavating a diversion ditch on the right abutment to control the inflow of surface runoff. During this period of drawdown, the embankment should be kept under constant surveillance by a competent soils engineer.

(2) The upper reservoir should be maintained at this lower level as long as the embankment remains in its present condition. This can be accomplished by providing a lower spillway.

(3) An architect-engineer should conduct a study to determine the extent of permanent remedial measures that will be required to restore the embankment to a safe condition and meet the needs of the village.

1.6 Emergency actions. On December 13, a teletype message was sent to the North Atlantic Division office with an information copy to the Office of Chief of Engineers in Washington, D. C., apprising them that the upper dam was in a state of failure and presented an immediate hazard to the village (see appendix G). It was recommended that immediate action be taken to lower the upper reservoir, to excavate a diversion ditch and to construct a low level spillway. Any delay in the drawdown operations could have resulted in failure of the upper dam which in turn would cause overtopping and failure of the lower dam and extensive flooding and loss of life in the village.

Colonel Robert S. McGarry, District Engineer, was briefed on the report at 0830 hours on 14 December 1973. He was concerned with the seriousness of the situation of the upper dam and at 0900 hours directed that key personnel be ready to leave the District office for Fort Meade, Maryland airfield by 1000 hours and that the village, New York State, and other interested officials be notified that he desired to meet with them at 1200 hours in Waverly. The purpose of the meeting was to assess the condition of the dam personally and to ascertain the capabilities of the related local governments to reduce the hazard. Prior to departure, standby pumps located in the Buffalo District were requested for Waverly.

The 14 December meeting was attended by Waverly Village officials (Mayor, President of Water Board, Village Attorney), Town Officials, County Civil Defense, New York State Department of Environmental Conservation, New York State Fish and Game Commission, New York State Department of Transportation, and members of the press.

The Mayor described the resources and revenue income for the village which showed that the village could not undertake the expense of carrying out the proposed recommendations. The New York State representative explained that the State would be unable to respond to the emergency with the necessary speed. Also, for the State to accomplish the work would require conducting a public hearing in the village, getting approval from the residents and placing a lien against the village after performing the work.

In the meeting, it was established that two main categories of work were required. First, the amount of water behind the weakened dam had to be reduced as quickly and as safely as possible. Because of the very restrictive outlet conduits, pumping operations were required to lower the pool level. Secondly, a new low-level spillway had to be excavated to maintain the pool at the lower, safe level.

At this point, the District Engineer had to make a difficult decision. Although an emergency existed, no disaster had occurred. Baltimore District had inspected the dam and had made a recommendation to local officials on remedial measures. With local and state officials indicating that they lacked the financial and physical resources to do the work in the urgent manner required, and with the dam in a state of failure, the Baltimore District committed itself to accomplish the more urgent requirements.

Public Law 84-99 earmarks a $15,000,000 fund which is "to be expended in . . . repair or restoration of any flood control work threatened . . . by flood including strengthening, raising, extending, or other modification thereof as may be necessary at the discretion of the Chief of Engineers. . .

to protect against imminent and substantial loss to life and property . . ." Division Engineers are delegated authority to approve emergency work under PL 84-99 by hired labor and government plant or rented equipment.

In his decision to proceed with emergency work by the District, the District Engineer not only considered the above mentioned provisions of PL 84-99, but also investigated Chapter 5 of ER 500-1-1, titled Operational Policies and Principles. Paragraph 52.10 states that it is policy in time of flood for District Engineers "to determine if emergency operations are to be undertaken by the Corps of Engineers to supplement local efforts and that such preventative measures will generally be of temporary nature. A declaration of a responsible authority of a political subdivision, while desirable, is not a prerequisite to furnishing emergency assistance under PL 84-99. It is the policy of the Chief of Engineers, however, that local assurances and appropriate requests will be obtained. Participation by the Corps of Engineers in emergency operations may extend to Division and District Engineer assumption of a leadership role if normally responsible local authorities are unable to cope with the situation. Such leadership is limited to operational control of emergency forces and would follow a written request from State or local authorities. These actions must be subordinate to the responsibilities and authorities of State and local officials, but the Corps' capabilities and pre-eminence in the field should be made available at a time when it is most needed. An aggressive interest in appropriate assistance to the community is desirable."

A separate paragraph, 52.60 deals with possible dam breaching. The paragraph states, "if breaching of a dam is likely unless immediate action is taken, and if such breaching would cause a flood hazard, requested flood fighting assistance may be given regardless of whether the dam is a flood control work. However, only temporary flood fighting measures will be taken. Due recognition will be given State and local responsibilities for public health and safety requirements which may require draw-down of the pool until the dam can be repaired. The Corps' activities should be terminated as soon as the immediate threat has passed."

With the above authorities in mind, the District Engineer ordered the Engineering Division to provide personnel and equipment from the Foundation and Materials Branch Exploration Section to operate pumps to draw down the reservoir. The Exploration Section began moving in several small pumps of their own. Meanwhile, Buffalo District and New York State Civil Defense were shipping pumps which would also be operated by Baltimore District personnel. Major Stanley Johnson of the Susquehanna Area Office was directed to stay on the scene until pumping operations were underway. In addition, Baltimore District assisted the village in constructing a diversion ditch which captured one of the upper reservoir tributary streams and routed it around the side of the reservoir and over the spillway. Approximately one-fourth of the drainage area was controlled by this ditch.

The second element of the solution to the emergency, after the water was pumped down, was the excavation of a new low level spillway. The District Engineer asked if New York had assets in the Department of Transportation, or some other agency, which could complete the required excavation. The New York Representative promised to explore this possibility upon his return to Albany.

A telegram was sent by the District to the Governor of the State of New York apprising him of the extremely dangerous conditions existing at Waverly (see appendix G). The immediate measures of drawing the pool down and excavating the diversion ditch were noted and a request was made for assistance of the State in constructing the low level spillway.

Before sundown that same Friday, the 14th of December, pumps were being installed by District personnel; and by the end of the next day, the Civil Defense pumps and Buffalo District pumps had arrived. The Civil Defense pumps were trailer mounted, powered by V-8 gasoline engines with a 1,500 GPM capacity. These were placed in operation and the reservoir began to be drawn down. (See photo 5, page 11.) At first a slow drawdown rate was maintained because of the fear that the saturated soil in the dam would slump if the pressure of the reservoir was removed too rapidly.

From the 14th through the 18th good progress was made. Then a series of warm and rainy days occurred and despite best efforts the level of the reservoir rose so rapidly that it endangered the pumps, and placed additional stress on the dam. On 21 December, the District Engineer received a response from the Governor of New York which stated that New York appreciated the work being done by the Corps, but " . . . in view of the long experience and expertise of the Corps of Engineers and the urgent need to quickly construct the low level spillway, I urge you to continue to move rapidly ahead with the necessary work. State forces will continue to provide assistance but do not have the capability to design and construct the spillway within the next few weeks" (see appendix G).

The alarming fluctuation in the pool level dictated that the new low-level spillway be constructed as soon as possible.

On 22 December, the District Engineer again visited Waverly. The response from the Governor, combined with the reservoir fluctuations, caused him to direct that the District's Engineering Division draw up the plans and specifications for the low-level spillway and that contractors be invited to submit proposals on the required work. By 1200 hours on 27 December, the documents were prepared, transported to Waverly, and given to two contractors. At 0900 hours on 28 December, the two proposals were opened and by 1230 hours the contract was awarded in the amount of $98,430.

The contract called for excavation of 22,000 C.Y. of earth, installation of 650 C.Y. of gabion slope protection, and turfing.

1.7 Diversion channel. Also, on 22 December, a private contractor, Charles Jones Construction Company, was hired to assist in running the pumps and the construction of the diversion channel. Men from Jones Construction assisted in pumping operations from 22 December until 2 January. From 24 December until 15 January, Jones Construction built a diversion channel which captured water from a reservoir tributary and routed it around the reservoir. This included construction of an elevated 24-inch CMP pipeline to carry diverted water over a depression and excavation of a ditch (see photo 6, page 13).

1.8 Construction phase. The notice to proceed was given on 28 December 1973 and the contractor, Triple Cities Construction Company of Binghamton, New York, undertook actions to begin work immediately. However, a New York State law prohibits heavy equipment from traveling on highways on weekends and the day before or after holidays. Since the 29th and 30th were weekend days, and the following Tuesday was New Year's Day, no equipment could move until the following Thursday, 3 January. Major Johnson called the permits division of the State Department of Transportation and described the emergency. A permit was granted and equipment arrived on the scene on 29 December.

During the period 29 December 1973 - 2 January 1974, the project was surveyed and the haul roads to the spoil area constructed. Intensive excavation at an average rate near 2,500 C.Y./day during the period 3-8 January filled the design spoil area. A second, more distant, spoil area was designated by the village and the haul road extended on 9 January. The longer haul distance reduced the daily output during the period 9-15 January to 2,000 C.Y./day. By 15 January, the excavation was nearly 90% complete and the threat of the reservoir filling and endangering the dam was passed.

During the period 16-24 January the excavation was being brought to final grade, and the rate of daily output reduced to between 400-1,500 C.Y./day.

From mid-January until 4 February several events occured which extended the planned time of the contract. In addition to inclement weather that prevented work on a number of days, the job was picketed by an operators union because of a dispute with the contractor over another job. District Labor Relations personnel investigated, and this union dispute problem was resolved after about a week.

Work in the excavation resumed full scale on 4 February with placement of the gabion slope protection. Once the contractors' crews learned the techniques of placing, filling, and connecting the baskets, the placement rate averaged 45 C.Y./day. Work on the gabion slope protection was completed on 1 March 1974. (See photo 7, page 15.)

Analysis of the provisions of PL 84-99 disclosed that seeding could not be considered as an emergency measure under the law and the seeding provision was withdrawn from the contract.

1.9 Hydrology. About the first of December 1973 hydrologic data was requested regarding the upper water supply dam. The dam's location was noted on a U.S.G.S. quadrangle sheet, the watershed was delineated, and the drainagage area determined. At this time, nothing was known of the physical characteristics of the dam.

An approximate flood frequency curve at the damsite was computed using the generalized method developed for the Agnes report by the Hydrologic Engineering Center. The 24-year flood also was determined using two alternate methods and a determination was made regarding the 25-year peak discharge. Concurrent with the frequency calculation, an effort was made to develop a very approximate storage curve for the upper dam.

During early December, additional data on the dam were obtained from the village of Waverly such as pool elevations, spillway elevations, and some miscellaneous information. A copy of a topographic survey of the dam was obtained from Baker Surveys of Columbia Crossroads, Pennsylvania. This had been prepared for the village by an architect-engineer for a previous project. From this information a more exact storage curve for the dam was developed (see appendix D).

The storage in inches of runoff from the watershed between significant pool levels, that is, normal pool and spillway crest was determined. Knowing this, an estimate of the frequency of attaining spillway crest was made. About this time, an approximate profile of the stream was developed from Geological Survey Quad Sheets.

The question was raised concerning the maximum extent of flooding that could be expected from a catastrophic failure of the upper reservoir. There was no known method, given the data at hand, to make this determination so an approximate system to answer this question was devised that showed that the flood wave would be about 11 feet above streambed as it entered the town. This was assuming that the upper reservoir failed instantaneously, filling the lower pool to 7 feet over the crest of the lower dam, which then failed instantaneously. The consequences arising from failure of the dam were that about 1/2 to 2/3 of the town of Waverly could be flooded if such an event occurred.

A flow of 1,000 c.f.s. was selected as the design discharge for the emergency spillway. The design of the low level spillway was accomplished during the period of 17-27 December 1973. This lowered spillway was designed to be 15 feet wide with 2 horizontal on 1 vertical side slopes, with the channel protected with 18" gabions, it was judged that protection of the channel by gabions would be adequate for the range of velocities to be encountered. A pool elevation of about 971'± is necessary to discharge the design flow of 1,000 c.f.s. through the new low-level spillway.

A hydraulic jump type stilling basin was provided for energy dissipation and it too was constructed of 18" gabions. On 8 January 1974, the Division office expressed concern about erosion that could possibly occur on the left bank above the stilling basin. Closer examination of this problem than was possible during the original design revealed that some erosion could possibly occur from a hydraulic jump forming on the spillway chute. A contract modification resulted in the placement of additional gabions at endangered areas to eliminate any possible damage.

A study of the capacity of the channel that bypasses the lower dam showed that this channel would be more than adequate for the 1,000 c.f.s. spillway design flood.

1.10 Funding/costs. Public Law 84-99 emergency activities are funded from the established emergency fund maintained under the appropriation flood control and coastal emergencies.

Prior to the District Engineer's first meeting in Waverly on 14 December, verification by telephone had been received from the Division office on his standing authority to obligate up to $100,000 for emergency activities pursuant to PL 84-99. Subsequent to this meeting elimination of the imminent danger was pursued under this authority.

Plans, specifications, and a detailed cost estimate were finalized on or about 27 December 1973. With the contract to be let on 28 December, additional funds had to be requested by teletype (see appendix C). Immediate additional obligational authority to $165,000 from $100,000 was received the next day.

In a letter to the Division Engineer, General Richard H. Groves on 7 February 1974 (see appendix G), the status of the work and other unforeseen costs were explained. Included in this letter was a request for additional obligational authority to $215,000 from $165,000. Subsequent approval was received.

Actual costs, which are not complete as of this date indicate additional costs for the gabions and pumping operations.

1.11 Summary. The threat of disaster from the potential failure of the water supply dams in the village of Waverly was investigated on 10 December 1973. By 28 December 1973, upon the recommendations of the inspection team, excavation had begun on the low-level spillway and the potential hazard was in the process of being eliminated. By 1 March 1974 all work had been essentially completed. In addition to the dewatering operation that was performed by Corps and local personnel, with pumps being supplied by the Corps and State Civil Defense, the basic construction contract called for the excavation of 22,000 C.Y. of earth and installation of 650 C.Y. of gabion protection. Included in the construction contract was a stilling basin constructed with gabions to dissipate the energy of the water.

1.12 Lessons learned. At an Emergency Operations seminar conducted by the North Atlantic Division on 26-28 February 1974 at Pocono Manor, Pennsylvania, Major Stanley Johnson of the Susquehanna Area Office, in a presentation, best summed up the lessons learned from the Waverly project. Major Johnson said:

"1. Authority exists for disaster prevention operations by the Corps limited only by what logically is the reduction of the emergency and not a total solution of the entire problem.

2. Local and State officials find it difficult to react, both from a resources standpoint as well as from a standpoint of overcoming the inertia of daily operations and acquiring a sense of urgency.

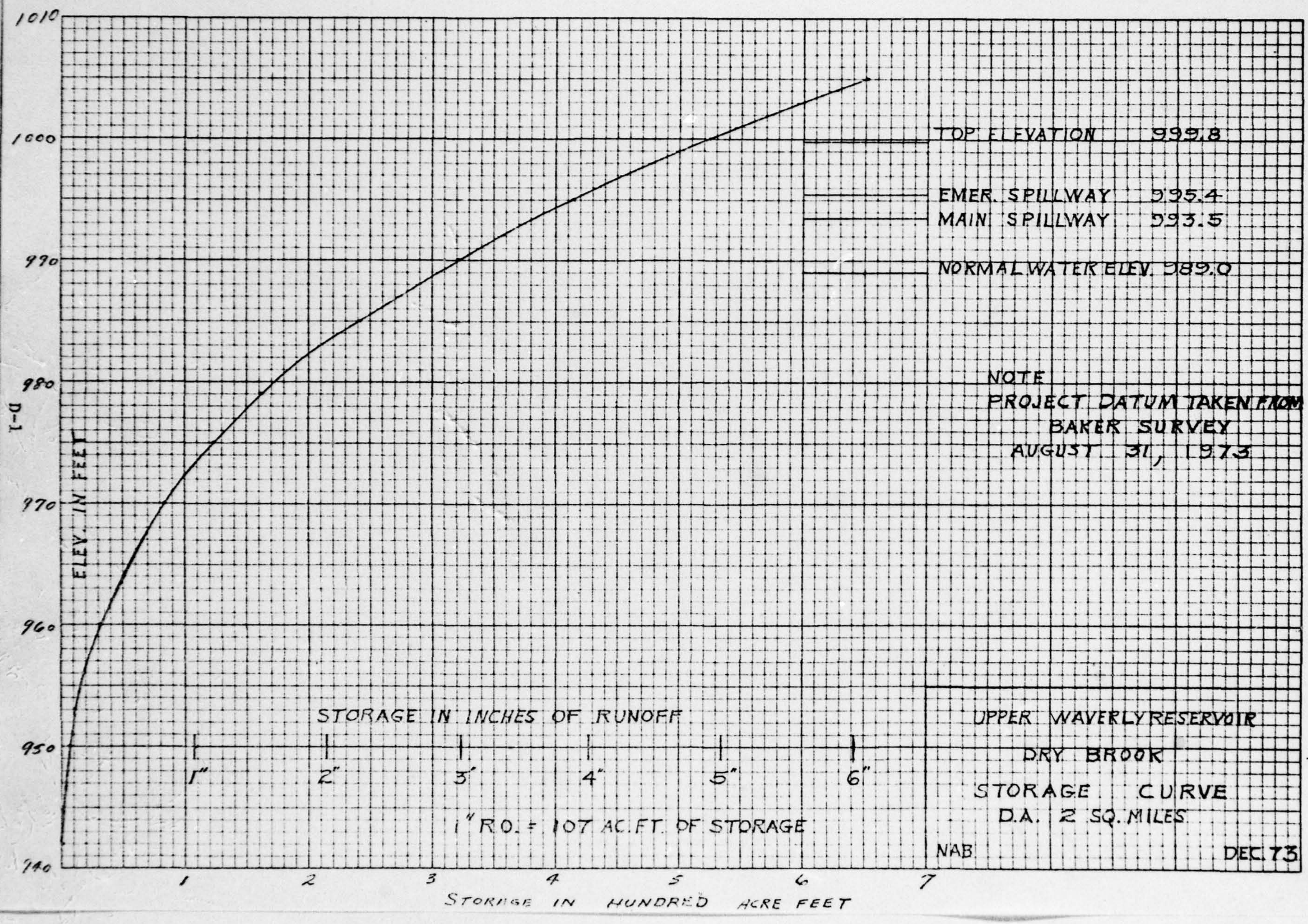
3. The townspeople are difficult to arouse to a sense of urgency in a potential situation which out-of-towners have called to their attention and are acting upon.

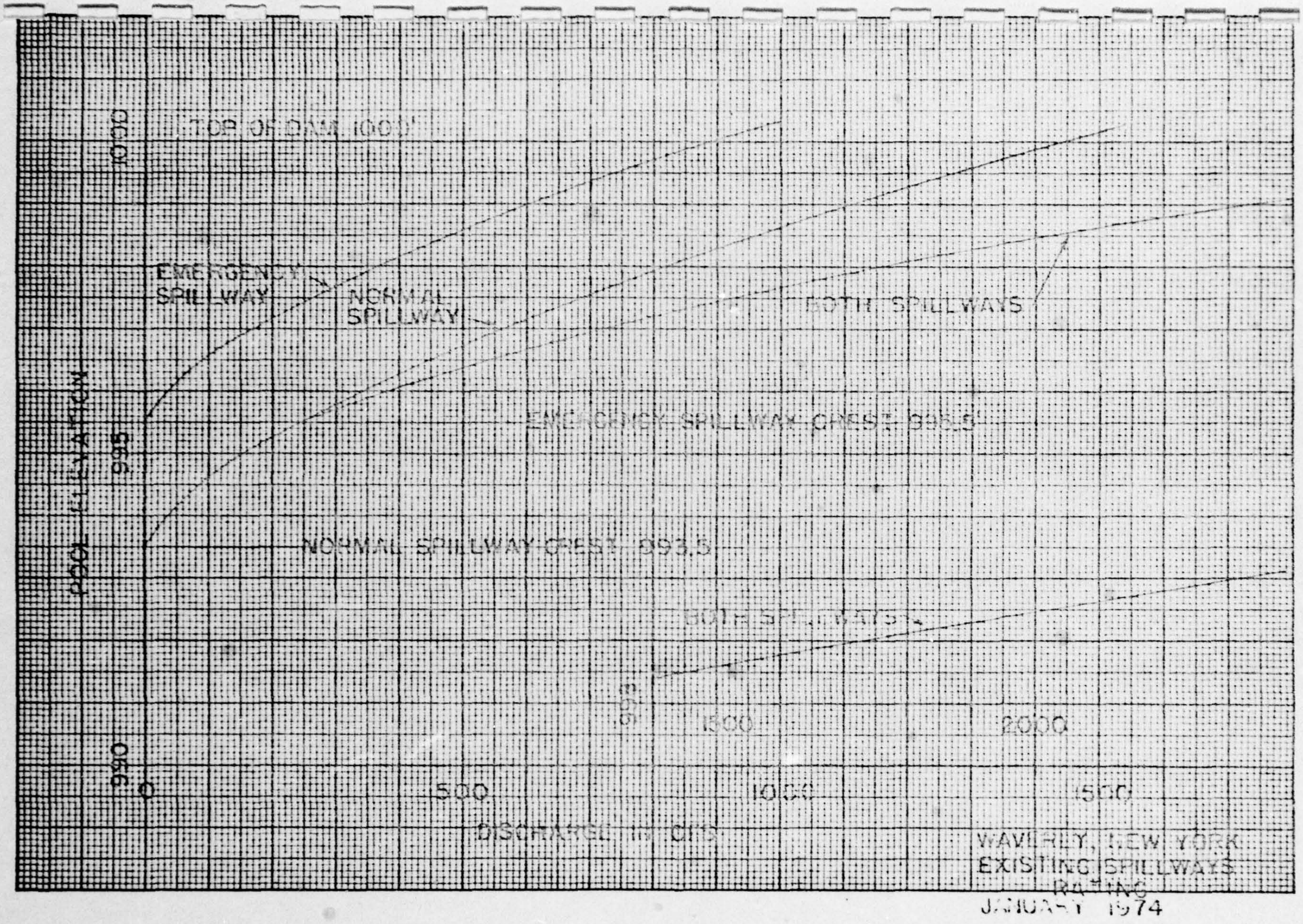
4. There is a deep-seated respect for the Corps of Engineers organization and for the authority and expertise of Corps officials.

5. When in doubt in an emergency situation, application of normal logic, common sense, and customary courtesies will be borne out by the regulations when you finally have time to read them."

HYDROLOGY-HYDRAULICS

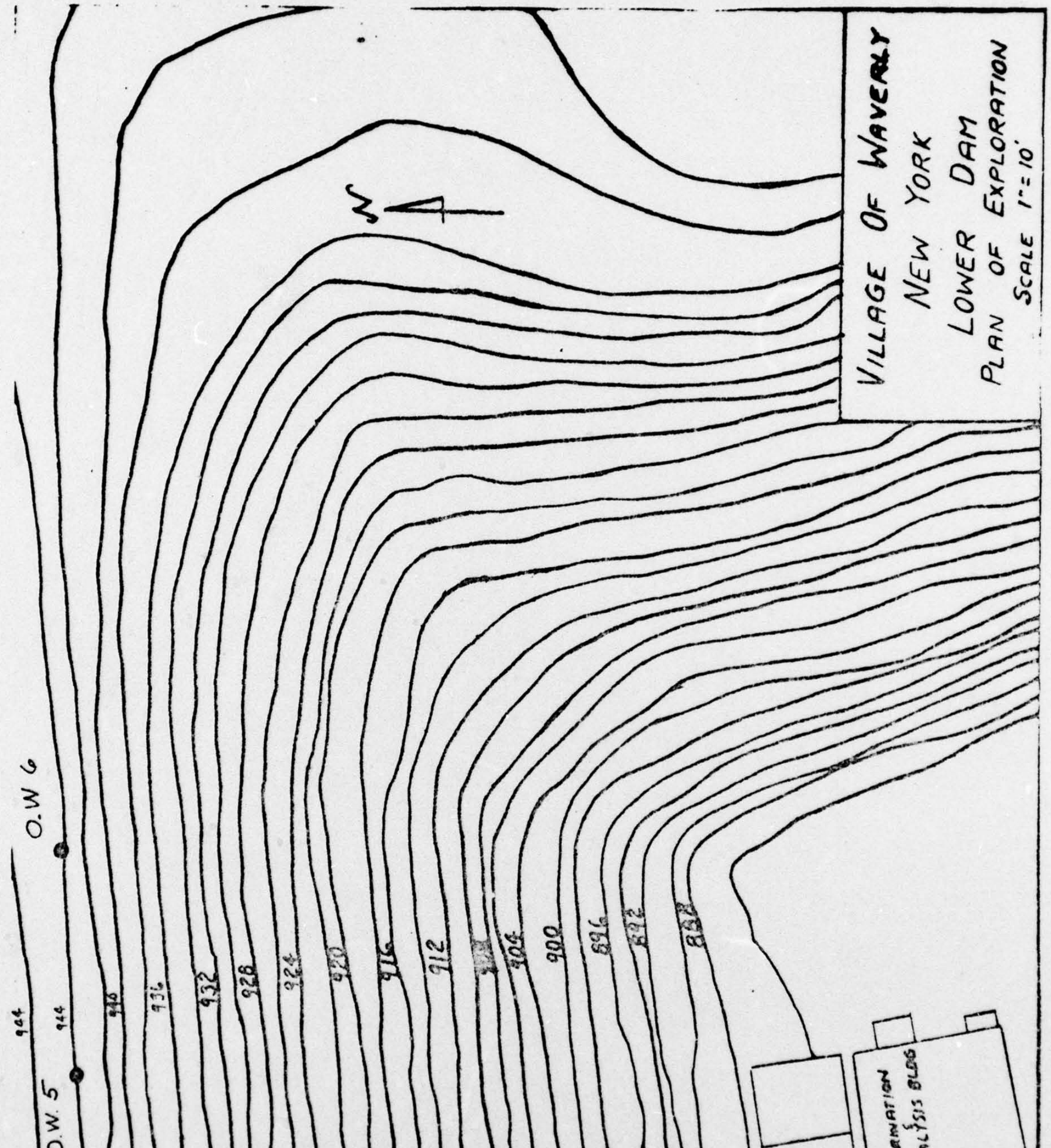
APPENDIX D


1010
1000
990
980
970
960
950
940
ELEV. IN FEET
1
2
3
4
5
6
7
STORAGE IN HUNDRED ACRE FEET
TOP ELEVATION 999.8
EMER. SPILLWAY 995.4
MAIN SPILLWAY 993.5
NORMAL WATER ELEV. 989.0
NOTE
PROJECT DATUM TAKEN FROM
BAKER SURVEY
AUGUST 31, 1973
STORAGE IN INCHES OF RUNOFF
1"
2"
3"
4"
5"
6"
1" R.O. = 107 AC.FT. OF STORAGE
UPPER WAVERLY RESERVOIR
DRY BROOK
STORAGE CURVE
D.A. 2 SQ. MILES
NAB
DEC. 73

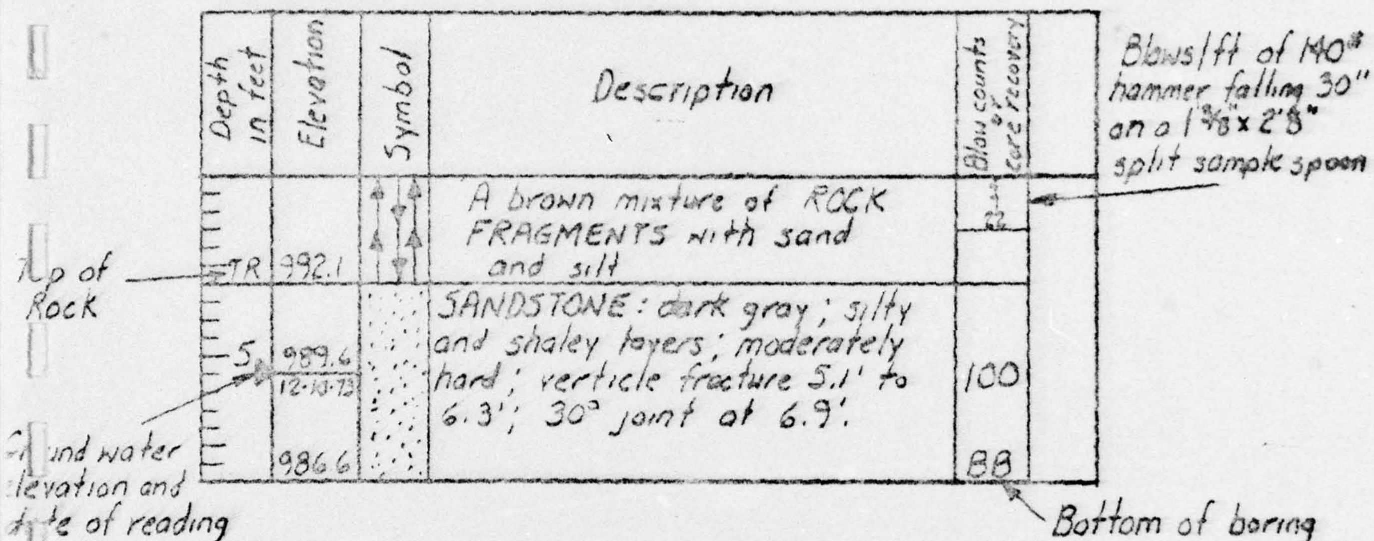

TOP OF DAM 1000'
EMERGENCY SPILLWAY
NORMAL SPILLWAY
BOTH SPILLWAYS
EMERGENCY SPILLWAY CREST 996.5
NORMAL SPILLWAY CREST 993.5
POOL ELEVATION
1000
995
990
0
500
1000
1500
2000
DISCHARGE IN CFS
WAVERLY, NEW YORK
EXISTING SPILLWAYS
RATING
JANUARY 1974

DRILLING INFORMATION

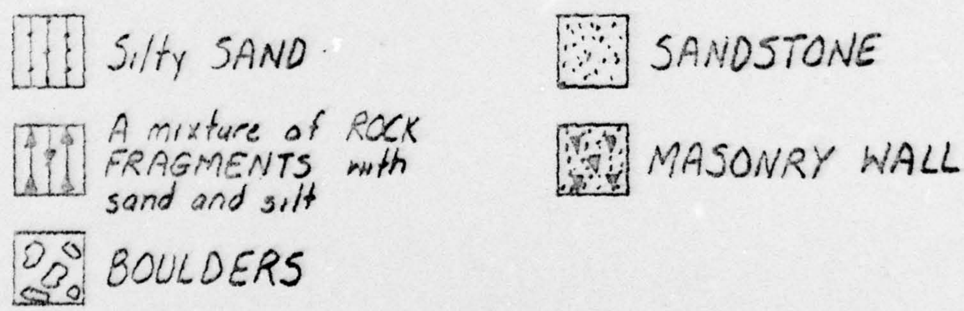
APPENDIX F


VILLAGE OF WAVERLY
NEW YORK
LOWER DAM
PLAN OF EXPLORATION
SCALE 1"=10'
O.W. 5
O.W. 6
944
944
944.5
940
936
932
928
924
920
916
912
904
900
896
892
888
VENTURI METER
CHLORINATION & ANALYSIS BLDG

LEGEND



SYMBOLS

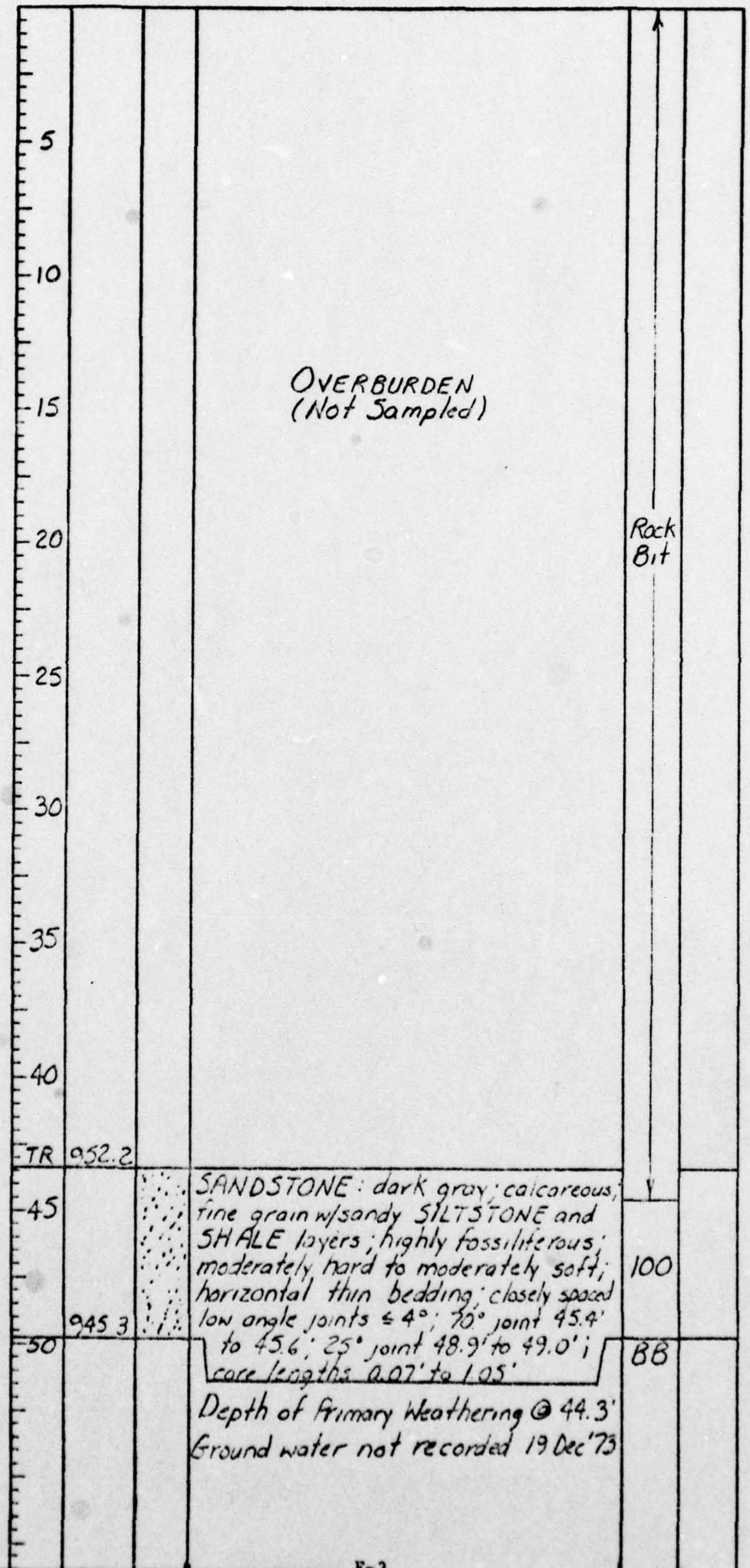


Note: Soil descriptions are field inspector's classifications

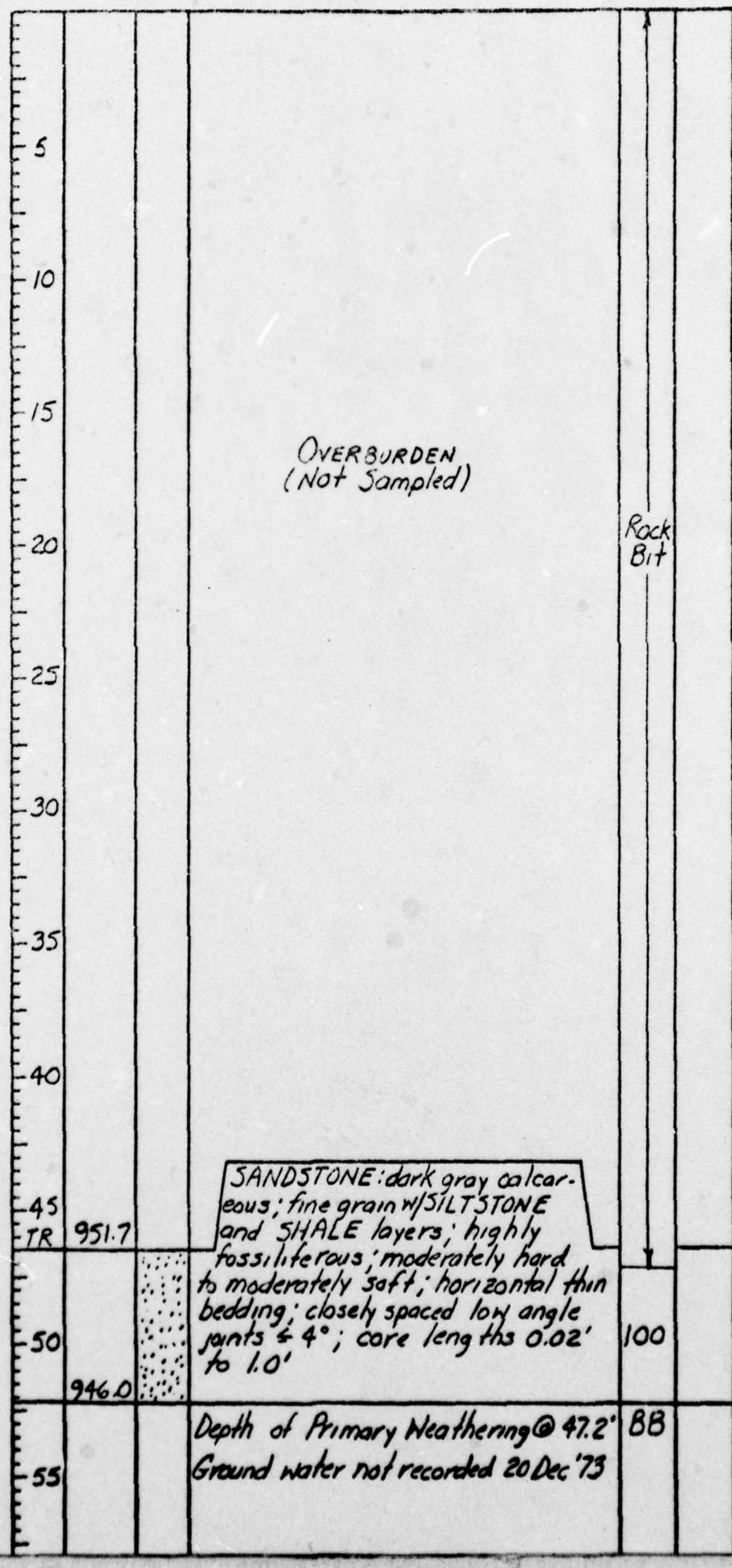
WAVERLY DAMS

DH-1

El. 995.5'



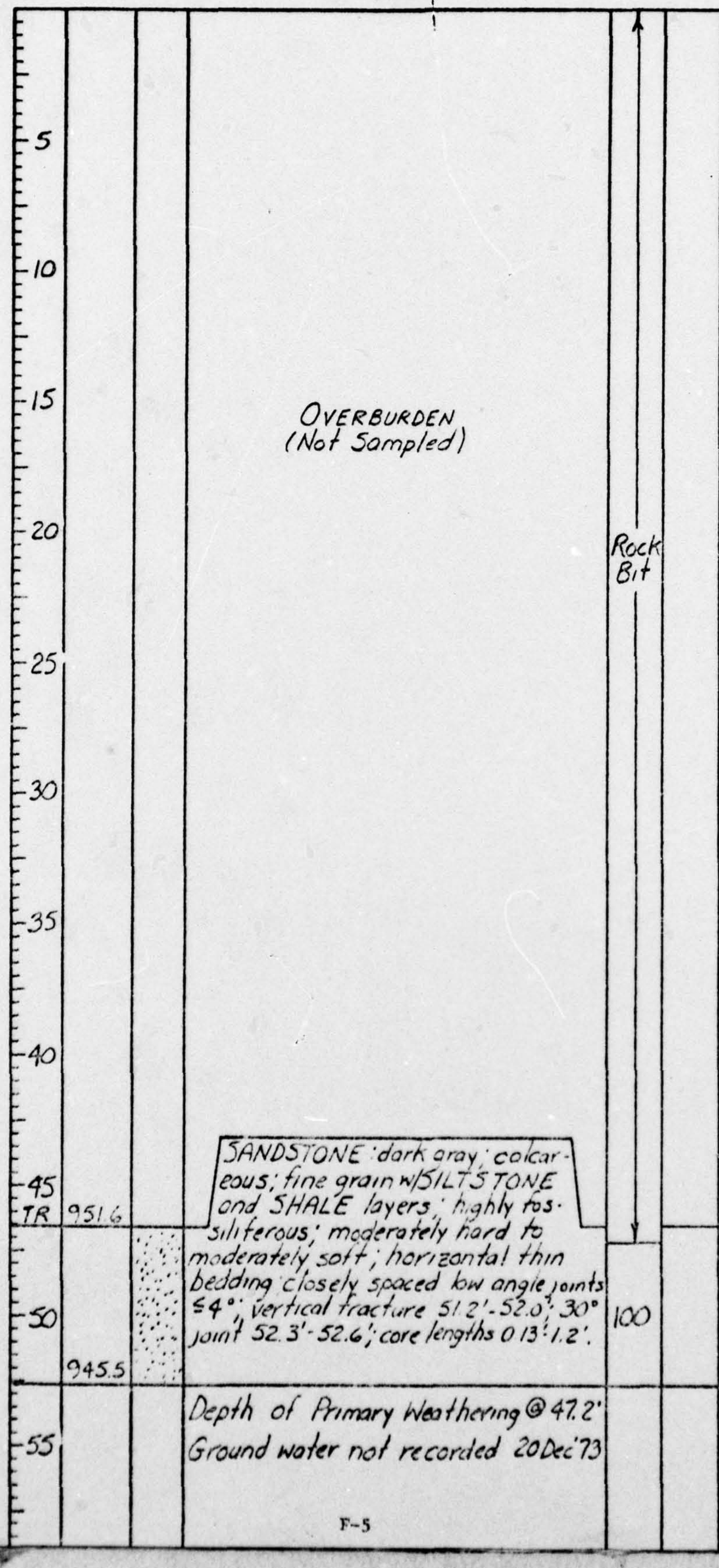
WAVERLY DAMS
DH - 2
El. 998.2'



WAVERLY DAMS

DH-3

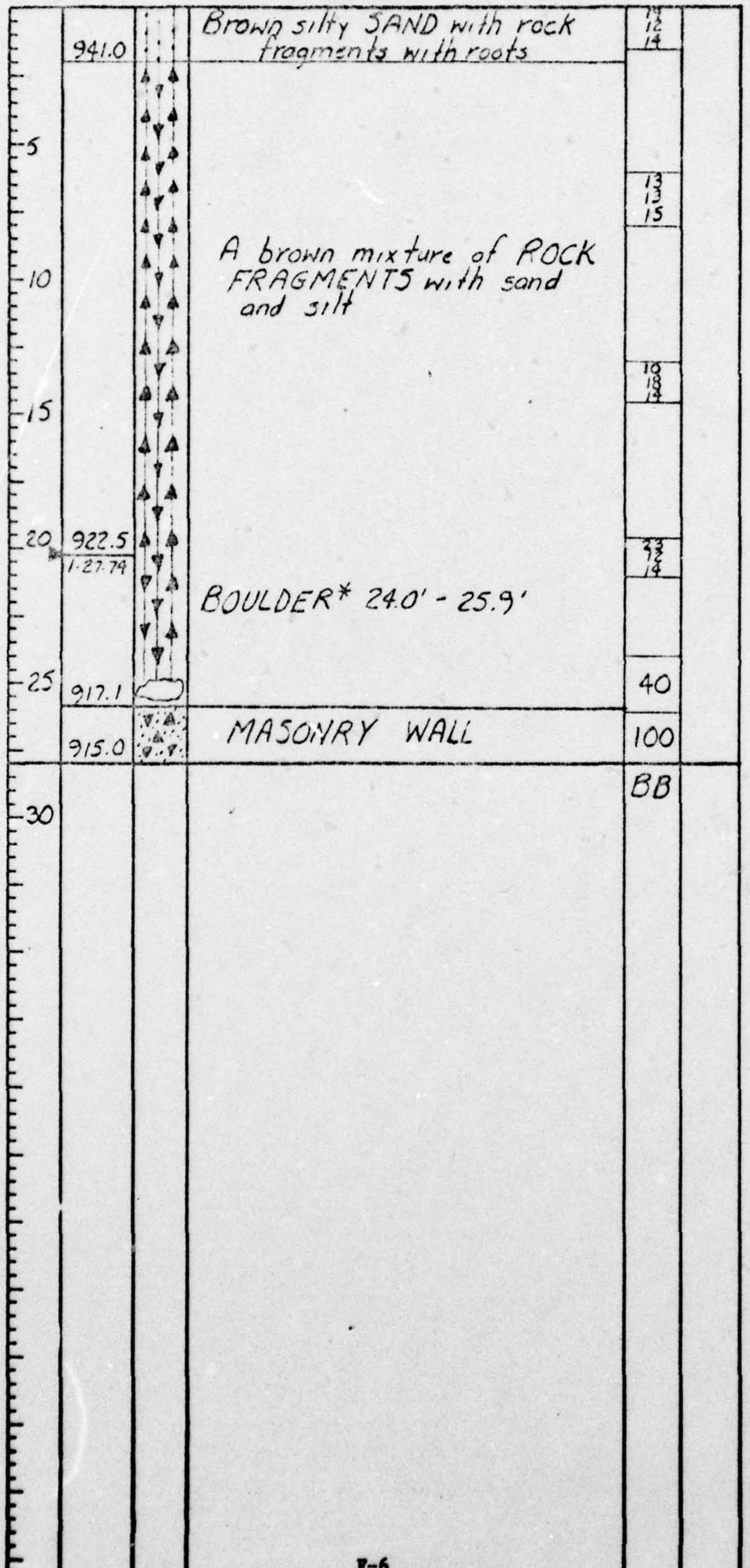
El. 998.2



WAVERLY DAMS

OW-5

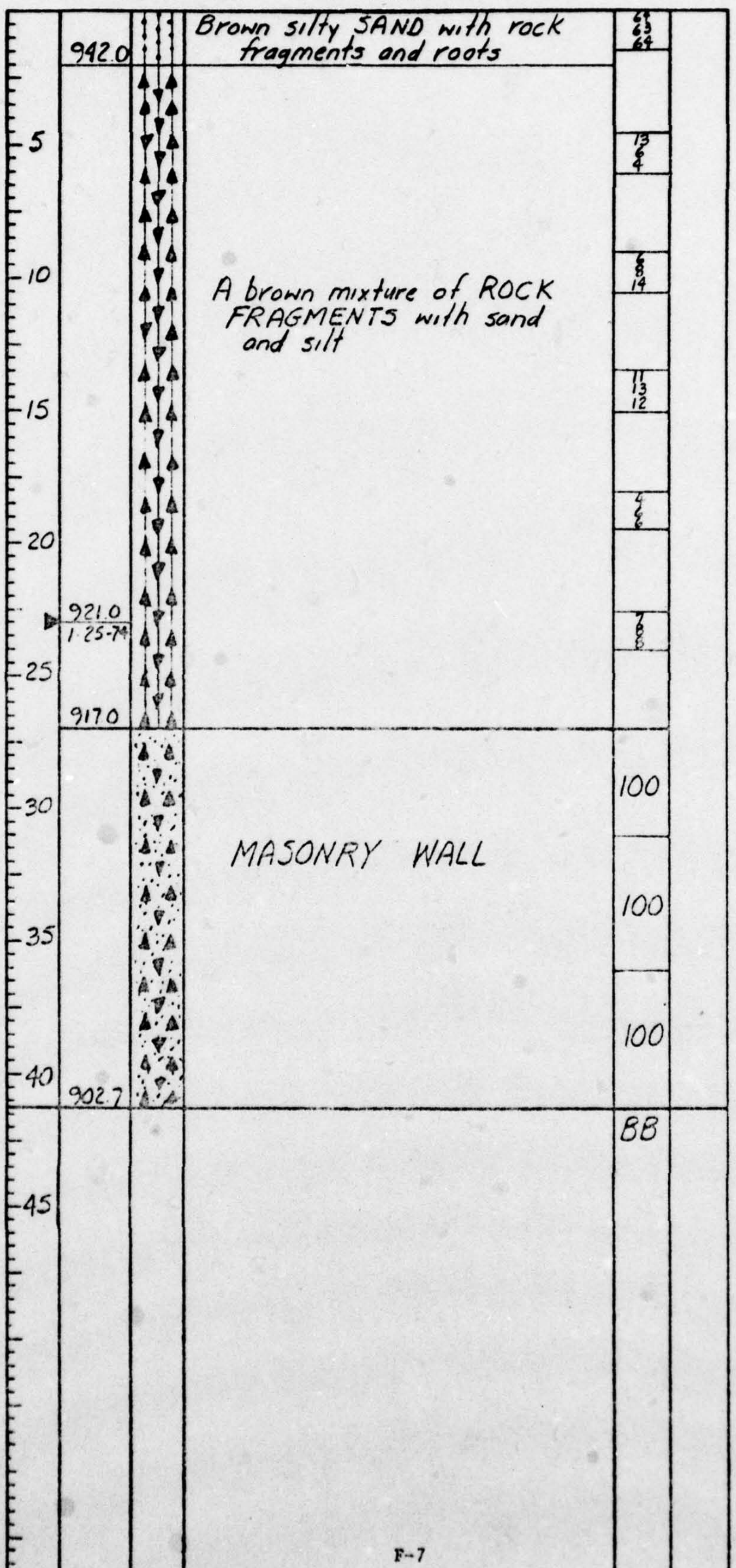
El. 943.0±

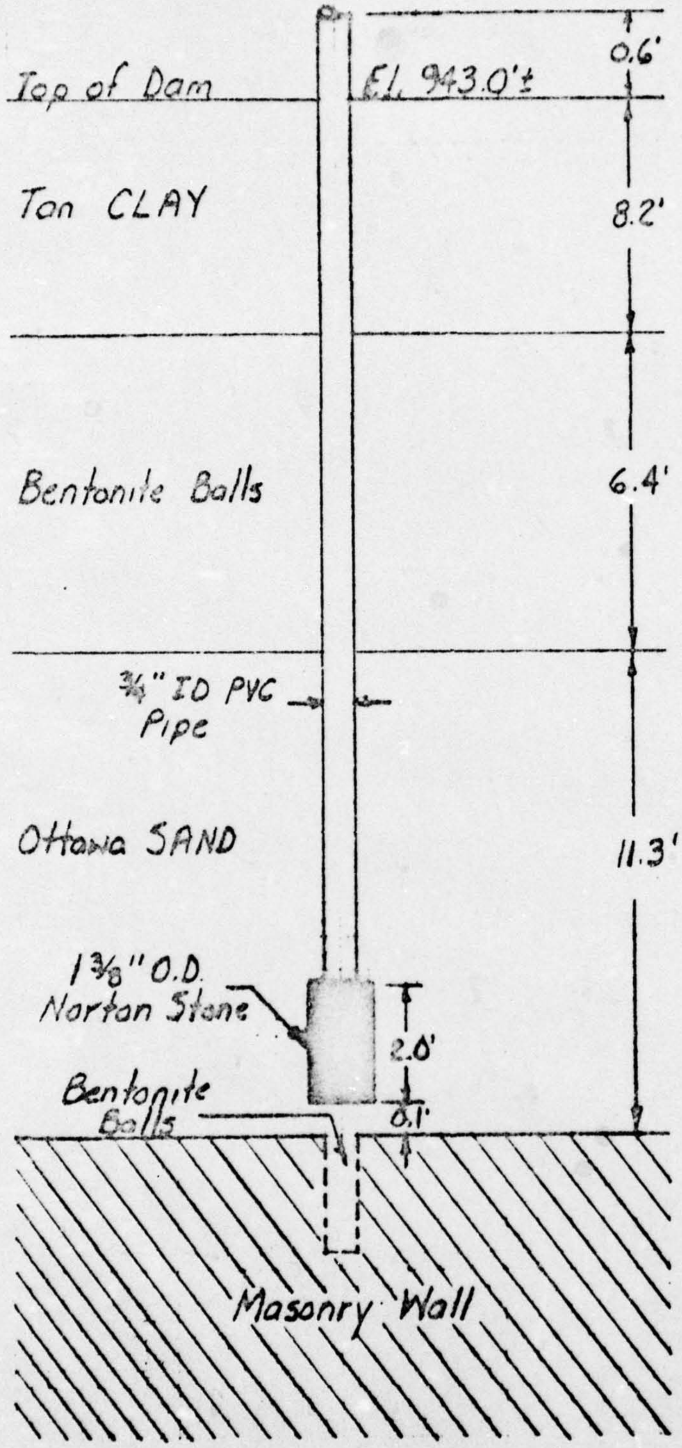


WAVERLY DAMS

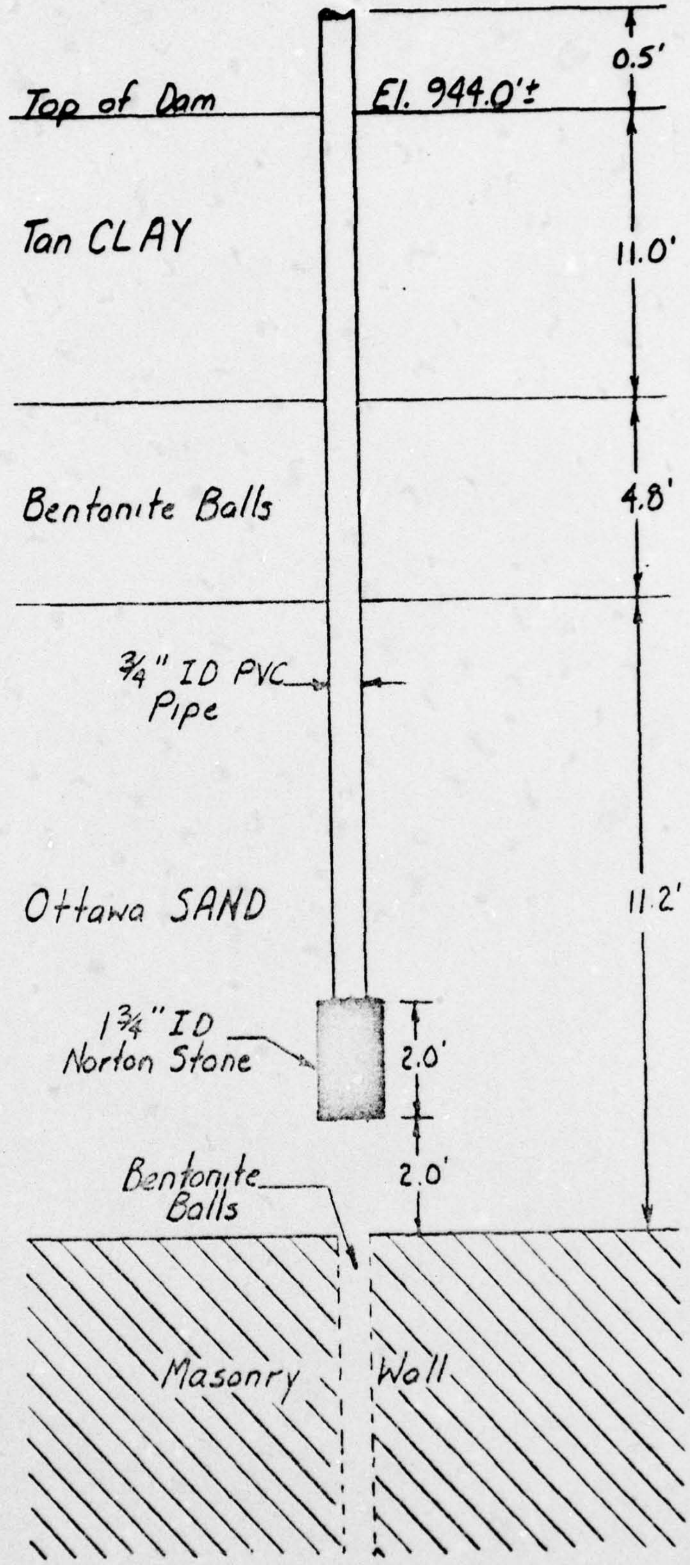
OW.- 6

El. 944.0±

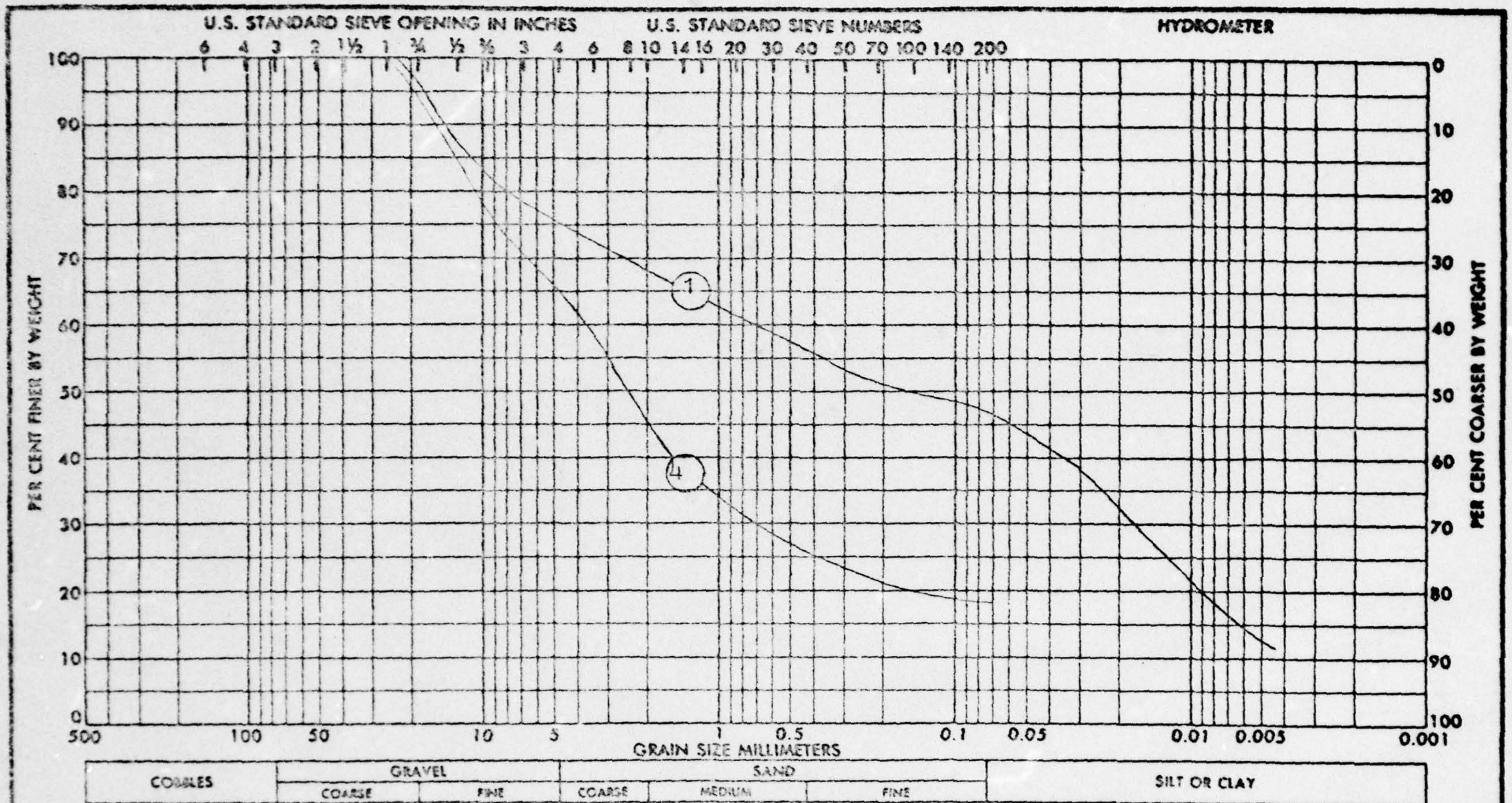




Observation Well
OW-5
Not to Scale



Observation Well
OW-6
Not to Scale



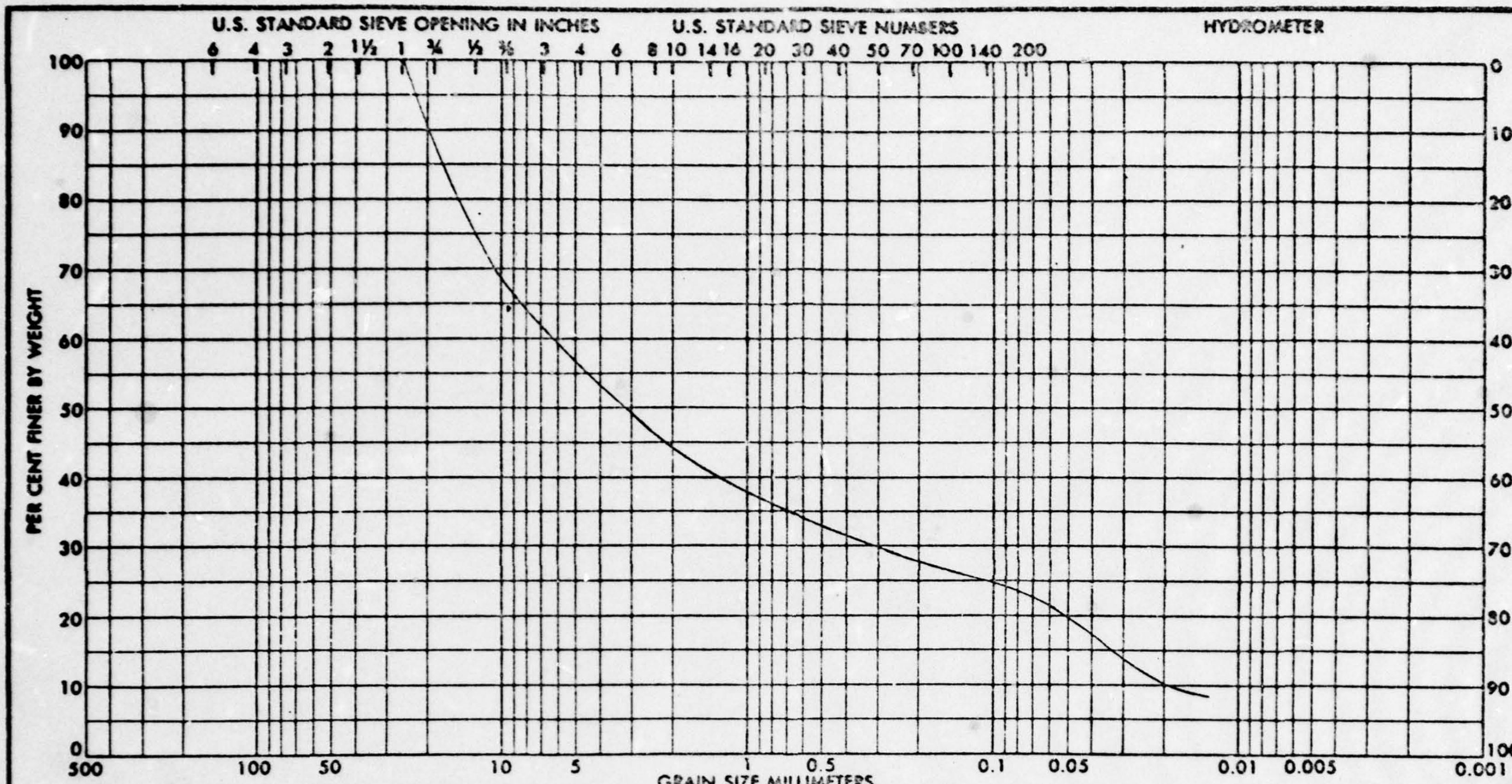
SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Jar-1	0.0 - 1.5	Gravelly silty sand (SM)	9.8			
Jar-4	13.5 - 15.0	Clayey Gravelly sand (SC)	11.8			

PROJECT Waverly, N.Y.
Lower Dam
AREA
BORING NO. OW-6
DATE 2/71

GRADATION CURVES

ENG FORM 1 MAY 63 2087 REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE 1963 OF—700-186



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Jar-4	19.5 - 21.0	Clayey Sandy Gravel (GC)	10.1			

PROJECT Waverly, N.Y.
Lower Dam
AREA
BORING NO. OW-5
DATE 2/74

GRADATION CURVES

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE 1963 OF—765-124

Waverly, NY Lower Water Supply Dam
Soil Classifications

OW-5

SAMPLE NO.	DEPTH	CLASSIFICATION
Jar-1	0.0' - 1.5'	Moist br., sandy, silty, GRAVEL w/grass and roots GM
-2	6.5' - 8.0'	Wet, brown, silty, sandy, GRAVEL GC
-3	13.0' -14.5'	Wet, brown, clayey, silty, sandy GRAVEL GC
-4	19.5' -21.0'	Wet, brown & gray, clayey, sandy GRAVEL GC

OW-6

SAMPLE NO.	DEPTH	CLASSIFICATION
Jar-1	0.0' - 1.5'	Moist, gray and br., bilty, sandy, GRAVEL with small roots GM
-3	9.0' -10.5'	Wet, gray and brown, clayey, sandy, GRAVEL GC
-4	13.5'-15.0'	Wet, gray & br., silty, clayey, sandy, GRAVEL GC
-5	18.0' -19.5'	Wet, gray & brown, silty, clayey, sandy, GRAVEL GC
-6	22.5' -24.0'	Wet, grey & brown, silty, clayey, sandy, GRAVEL GC
Jar-2	4.5' - 6.0'	Very moist, gray & brown, clayey, sandy, GRAVEL GC

NOTE: Gravel is soft angular rock fragments.

CORRESPONDENCE

APPENDIX G

COPY

700 East Water Street, Syracuse, New York 13210

RC&D - Tioga County - Village of Waverly Water Supply Reservoirs - Trip Report

October 28, 1971

Donald McArthur, AC
Binghamton, New York

As a result of your August 17, 1971 request, Bernie Ellis and I made a trip to Waverly to look at the subject proposed project measure. At the site we met DC John Rathbun, Ed Blackmer from the Binghamton Area Office, Mr. William Conner, Superintendent of Waverly Public Works Department and an employee of the Public Works Department. Our understanding of the purpose of this trip was to assess the condition and possible maintenance needed on two earth reservoir structures used by the village of Waverly for their municipal water supply. We reviewed the correspondence which was sent with your request and will attempt to gear our observations and report to some of the concerns that people have raised about these two structures.

We first investigated Dam No. 1. Apparently from the correspondence available, the primary concern for this dam has been seepage from the left abutment. Another area of concern was the general condition as far as vegetated maintenance of the structure and the adjacent sluice-way which represented the main outlet or emergency outlet for this structure. Dam #1, the downstream dam, is basically used as a holding reservoir and is a reservoir from which flow is drawn to go into the village water system.

There is a concrete channel or sluice-way in the right abutment that bypasses this dam coming down from the upper structure. This lower dam has a wall or weir lip lower than the top of the dam over which high flows can enter this sluice-way. There is at present a pump-house situated in part of this weir which causes some obstruction. Further upstream there was a lower weir or ramp spillway that has been filled in with earth to form a dike. There is at present less capacity for emergency flows out of this reservoir than apparently was originally designed into it. This would be one area of concern and one thing that should be looked into at some future date. This sluice-way itselft in the area of Dam No. 1 has a ramp or walkway built over the top of it with a small pier extending in the middle of the channel which was constructed in 1963. This offers some restriction to the channel that was not there originally. The sluice-way is heavily grown up with weeds, brush and occasional small trees which restrict it from the hydraulic standpoint rather significantly. This adjacent sluice-way is basically in good structural condition. The biggest questions would be hydraulic capacity and hydraulic condition related to maintenance.

The dam itself is covered with vegetation. However, much of this vegetation is again weeds, brush and small trees. Some small trees have been cut recently and in the past but there is fairly heavey woody vegetation, specifically on the downstream slope. Slopes of this dam appear to be 1½ to 1 downstream and 2 to 1 upstream. Some woodchuck holes also were observed along the top of the dam, and this apparently is a continuing problem, according to the local water department people. The slopes on the dam show no evidence of instability due to active seepage. Although steep, these slopes are apparently stable. This is certainly partly due to the fact that the fill has considerable amount of stone and rock in it. This would allow steeper slopes to be stable.

The downstream toe at the left abutment was examined for the reported seepage problem. At this point, bedrock is expopsed on the left abutment and this exposed bedrock continues in a bluff approximately 100 to 150 feet downstream from the toe of the dam. This rock has seepage in several planes and at several spots as it extends up and down this abutment. There is a wet spot immediately at the toe of the dam and against this rock abutment. There was no evidence that any material had been transported or was being transported from inside the dam or the abutment through this seepage area. This is an old, well established but small seep area. Much of it is probably coming down the hill through the rock. The presence of the dam when it was first installed probably also influenced the ground water seepage in general in the left abutment and redirected it to this downstream area. The water department people were questioned at some length as to the nature of the seepage here and any observable differences in seepage depending on the time of the year, and depending on the stage of the reservoir. There are unconfirmed reports of seepage occurring higher in the bank or the abutment during higher stages of water in the reservoir. The people we talked with have not witnessed this seepage and really could not confirm that they have observed any significant differences in this particular seepage area. As the high stages usually occur with spring run-off and snow melt, these conditions obviously complicate any accurate reporting of seepage in the abutment. There is no real evidence on the site that any higher seepage has occurred of any magnitude.

The upper dam, Dam #2, was then examined. This dam is actually the control for flow, since its outflow feeds the sluice-way that bypasses Dam #1. The upper dam again has 2 to 1 upstream and 1½ to 1 downstream slopes. There is a detailed plan available for this dam which the water department people have on the site. We also have a copy here in the file. The upper slope of this dam is paved with rock almost to

The top. The lower slope is in fair maintenance but still has some brush and a few small trees. The slopes again are apparently stable, and appear to have a good deal of rock in the earthfill. Examination of slopes of this dam did not reveal any significant or serious seepage.

This dam has two emergency sluice-ways in the general vicinity of the right abutment. One of the sluice-ways has concrete sides and a rock-lined bottom. This one is at the higher elevation and apparently does not run but on very rare occasions. A concrete cute type spillway is located in the rigth side of the embankment and provides the main water control since it is at the lower elevation. This concrete chute spillway is in good structural shape. There are several vertical cracks where the top slab meets the abutments or walls. These cracks are possible 3/4" wide. They should have some attention. The channel at the bottom of this chute and extending downstream towards the lower dam is in poor maintenance as far as brush, small trees and weeds. It has very bad hydraulic conditions with restricted capacity. The older sluice spillway is also in good condition. It has a walkway constructed in 1963 across it with a small pier which offers some restriction but should not be too significant.

Conclusions

Dam No. 1 - From our observations we could not discover a signficant or serious seepage problem in the left abutment of the dam. Dam slopes under present operating conditions and the present state of repair appear to be stable. The emergency weir to the sluice-way in the right abutment has been restricted. To what degree this affects emergency flow escaping from this reservoir will have to be determined. The sluice-way or emergency channel by-pass in the right abutment is severely restricted at present due to lack of maintenance on heavy vegetation. The structural quality of this sluice-way for the most part is adequate and does not need any major maintenance.

Dam No. 2 - The slopes of this structure under present operating conditions and with present maintenance appear to be stable. Both the emergency sluice-way and chute spillway are in a reasonably good state of repair and sound structurally. The concrete chute needs some minor repair of cracks to avoid further deterioration from ice action in the winter. Downstream from the dam the channel that leads towards the lower dam along the right abutment needs maintenance of vegetation to improve hydraulic capacity.

Recommendations

The most apparent recommendation is one which appeared in John Rathbun's report of August 4, 1971, and that is the village definitely needs a plan of maintenance to keep both structures and the by-pass channel or sluice-way in good repair. Another item of importance would be to determine the hydraulic capacity of both structures and sluice-way as they exist today with respect to expected storms of high frequency and high runoff. In other words determine the exact flood control capabilities of this system at present. For comparison, the flooding situation without the structures should be evaluated also. The third item would be a more thorough examination of the downstream toe area of the first dam to verify with amore certaintly the extent of any seepage problem. The fourth item would be a general investigation to determine improvements or additions that could be made to these structures to insure the stability which they have had over the years and safe operation in the future.

These recommendations should be carried out by a competant professional engineer experienced in this type of work. This is primarily a municipal water supply problem. If the consulting engineer's report showed that a substantial level of flood control is being provided, we could then probably justify some further involvement. We could give some assistance in the selection of a consulting engineer.

Donald W. Shanklin
Asst. State Conservation Engineer

cc: R. Phillips
J. Rathbun
B. Ellis
D. Plackmer

Dry Brook Falls - Waverly

PARSONS, BRINCKERHOFF, QUADE & DOUGLAS, INC
111 JOHN STREET, NEW YORK, N.Y. 10038 TELEPHONE (212) 233-6300
CABLE: PARKLAP NEW YORK • TELEX WU 1-2403 • RCA 222 117

ENGINEERS

July 7, 1972

W. M. Donnelly
Attorney At Law
328 Broad Street
Waverly, New York 14892

Gentlemen:

At the request of Attorney William M. Donnelly, Messrs. H. L. Michel, C. K. Lee and Birger Schmidt of Parsons, Brinckerhoff, Quade & Douglas, Inc. visited the Waverly, New York water supply reservoirs on June 28, 1972, to ascertain their present condition and the apparent safety of the dams. During our visit, we interviewed a number of persons, examined the available plans of the structures and inspected the structures during a three-hour site visit. In the evening, we presented our preliminary findings to the Board of Water Commissioners.

This letter summarizes our findings and recommendations. Briefly, we find that on the surface the structures do not appear to exhibit any signs of impending partial or total failure. We do, however, recommend certain additional investigations and specific maintenance or restoration work be accomplished as outlined and described below.

GENERAL DESCRIPTION OF FACILITIES

The Reservoirs

The Waverly reservoirs, which consist of two storage dams in series, are located about half a mile northeast to the Village of Waverly. The gross storage capacity of the upper reservoir is about 460 acre-ft. (or $150 X 10^6$ gallons) and that of the lower reservoir is about 275 acre-ft. (or $90 X 10^6$ gallons). The active storage is used for water supply of the Village of Waverly. Supplementary water supply is available from an active well. At full capacity the upper and lower reservoirs have surface areas of about 0.03 sq. mile and 0.02 sq. mile respectively. The distance between the dams is about 2000 feet.

The Dams

Both dams were designed with a 10-foot crest, 1-1/2 to 1 downstream slopes and 2 to 1 upstream slopes, and both have concrete cores. The quality of the earth material in the dam is not known. It is presumed to be native silty, gravelly sand, compacted manually. Approximate heights and elevations, as deduced from existing drawings, are tabulated below:

	Lower Dam	Upper Dam
Approx. height	65 ft.	62 ft.
Crest elevation	1046 (1048?)	1102.3
Pool elevation	1041 (1044.7?)	1096.3
Elevation top of concrete core	1041 (1031?)	1075.3
Approx. crest length	260 ft.	550 ft.

The lower dam was built in 1877, and the lower part of the upper dam was presumably built at the same time, to a crest elevation of 1072.3. It is not known if a concrete core wall was provided for the upper dam as part of the original construction. The upper dam was enlarged to elevation 1102.3 in 1917, and a concrete core wall was installed in the upstream slope. It was subjected to repair in 1934 because of bowing and settlements. The lower dam may have been raised 2 feet between 1913 and 1917.

The Spillway

The major hydraulic appurtenance of the upper dam is a chute type structure associated with an emergency spillway. The total hydraulic capacity of the chute spillway structure is estimated at 5,400 cfs with an effective head at El. 1099 ft. which is 3 feet below the top of the upper dam. Flow from the upper reservoir passes over the crest of the spillways near the west end of the dam, discharging downstream of the lower dam through a passway. The passway is only about 6 feet from the bank of the lower reservoir. This passway is a partially concrete and rip-rap lined channel with an estimated discharge of 3,100 cfs. No stilling basin or energy dissipator has been provided and no spillway exists for the lower dam.

The Outlet Works

A 14-inch diameter cast iron pipe is installed near the bottom of the upper reservoir to regulate the flow into the lower reservoir. In addition, an 8-inch pipe is located to the spillway side of the upper dam to pass excess flow into the passway.

There are two 12-inch cast iron outlet conduits through the lower dam at the elevation of the river bed. The pipes are valved and connected to the blow-off and piping leading to the water supply for the Village of Waverly.

PRESENT CONDITION OF FACILITIES

The Dams

The lower dam is in relatively good condition. Burrowing animals have dug holes to a size and depth of approximately a foot into the crest of the dam. The crest is no longer level, indicating some movements in the dam. The downstream slope is heavily vegetated. The riprap on the upstream side appears in relatively good condition.

Some seepage was noted at the east abutment. The seepage water is clean and exits through the rock foundation, not through the dam. It appears to be spring fed.

It is reported that wetting and softening of the soil at the downstream face of the dam occurs when the water surface in the reservoir is near the crest. This is likely caused by seepage through the relatively permeable earth material in the dam when the reservoir level is above the top of the concrete core wall.

The crest of the upper dam is tilted slightly toward the reservoir, indicating some movement caused by creep and repeated reservoir level fluctuations. Along the middle of the crest, a longitudinal crack 4 to 6 inches deep and wide extending approximately 150 feet was observed within a foot of the downstream crest edge. From the appearance of the crack it can be deduced that it is relatively recent, though possibly not from this year. A change in type of vegetation one-third to half-way down the slope indicates a possible change in water content of the surface soils, related either to surface movements or to the proximity of the phreatic line in the dam to the soil surface. No seepage through the dam has been reported, but it is judged that seepage could occur at high water elevations in the reservoir. Seepage was observed through the foundation of the east abutment, presumably bypassing the concrete core and the soil material of the dam itself. The water appeared clear at the time of inspection.

Hydraulic Works

A spillway is the safety valve for a dam. The estimated spillway discharge of the upper dam is approximately 2700 cfs per square mile of watershed with an equivalent rainfall intensity of 5.6 inches per hour as derived by the "rational method". The spillway seems to have adequate capacity for releasing the flood flows of the upper reservoir, but the capacity of the downstream passway channel is apparently inadequate for carrying this estimated spillway flow around the lower reservoir.

The concrete lining and rip-rap cover of the passway are in poor condition of repair near the lower reservoir and dam. The bottom of the passway is heavily over grown and has deposits of debris.

Properly designed energy dissipators or stilling basins are essential to dam safety. The flood flows passing the spillway gain energy that must be properly dissipated or severe scour may endanger the structure, especially the portion downstream of the passway near the lower reservoir and dam.

MAINTENANCE AND MINOR RESTORATION

To preserve the integrity of the dams and prevent erosion, maintenance inspection should be carried out on a regular basis such that events such as holes from burrowing aminmals are filled and tamped before further erosion and significant structural damage occurs. Though low vegetation on the slope is beneficial in that it retards surface erosion, tree and brush growth should be eliminated to facilitate inspection and to avoid any loosening and soil movements caused by extensive root systems. To prevent the occurrence of soggy areas in areas of seepage, it may be considered prudent to intercept seepage at the east abutments and at the toe of the lower dam by gravel filled drainage ditches.

It is extremely important to maintain the spillway clean and clear of obstructions and to prevent erosion and overtopping of the bank in the vicinity the lower reservoir. At this time a program should be undertaken to clean the spillway, straighten and widen it, reinforce the walls adjacent to the lower reservoir, and eliminate the center pier of the foot bridge leading onto the lower dam.

We understand that one of the two outlet pipes through the lower dams will be closed in the near future. Considering the possible deterioration of the two pipes and the consequences of potential leakage from the pipes, we recommend that both pipes be closed and sealed throughout their length, and an alternate source be constructed.

PROPOSED FURTHER STUDIES

Although it appears that the dams are not in immediate danger, it would be prudent to explore the quality of the earth fill and the location of the phreatic zone in the dams. The slopes are unusually steep (earth dams are now constructed with flatter slopes), and some earth movement has been detected. Thus, depending on the results of an exploratory program, a slight flattening of the downstream slopes may be indicated.

The upper dam should be explored by at least 3 borings across the dam, near the crest and at the 1/3 and 2/3 points, down the slope. Standard Penetration Test samples should be taken at 5-foot intervals, and the borings should be carried 5 to 10 feet into the foundation of the dam or to rock. Observation wells should be installed in all the boreholes and the elevation of the water surface determined as a function of the pool water elevation.

For the lower dam, a boring program consisting of two borings may suffice. Also here, the water elevation should be observed in observation wells. It would be advisable to determine, by probing, the exact top elevation of the concrete core wall.

Of these two exploratory programs, the one for the upper dam has priority, but we recommend that both programs be executed at the same time for practical and economical reasons. We would be pleased to assist you in preparing specifications for the exploration and in supervising the work. After the completion of the program, we are prepared to study the data to develop final recommendations.

It is also recommended that a detailed study involving possibly a redesign of the existing spillway and passway for improvement and to check the possibility and need for a spillway for the lower dam be undertaken as well as the replacement of the outlet pipes.

For your general information, we enclose captioned photographs which illustrate the above remarks.

We appreciate the opportunity of being of service to you in this matter and thank you for the courtesies extended by you and your colleagues on June 28, 1972.

Under separate cover, we are returning the documents and plans loaned to us. Also, the invoice for our services will be rendered as soon as our computer gives us permission to do so.

If you feel that we can be of further assistance to you both in the matter of technical advice and help in exploring possible available funding sources, please do not hesitate to call on us.

Very sincerely yours,
PARSONS, BRINCKERHOFF, QUADE & DOUGLAS, INC.

Henry L. Michel
Senior Vice President

HLM:pg

2626

I reviewed by TRK. before sending

October 31, 1973

Mr. William M. Donnelly
Attorney at Law
328 Broad Street
Waverly, New York 14892

Ref.: Waverly Water Supply Dams

Gentlemen:

On Wednesday, October 10, 1973, Messrs. G.R. Lloyd and D. Rafaeli of Parsons, Brinckerhoff, Quade & Douglas, Inc., visited the referenced site with Messrs. Connor and Lohman of the Village of Waverly, New York. The purpose of this visit was to inspect leakage of water into the valve house at the foot of the lower dam. Mr. Connor indicated that the amount of water leaking alongside the 14" diameter distribution valve had increased noticeably during the past year, and estimates that the flow now amounts to roughly 2 gallons per minute.

The leaking water was found to be clear, with no visible suspended soil particles. It is believed that the source of the flow is a leak in the distribution line, presumably just behind the valve house.

We then proceeded to inspect the two dams. While the lower dam is in relatively good condition, there seems to be some further deterioration in the condition of the upper dam since the previous inspection. The crest of the dam, previously a horizontal surface, is visibly canted towards the upper pool, with the upstream edge of the crest approximately 1.5 ft. lower than the downstream edge, indicating a continuation of the movements on the upstream slope. We were advised that the pool elevation of the upper reservoir was lowered some 15 ft. from its normal elevations, after the dam was inspected by State inspectors, and strongly recommend that the lowered level be maintained.

Control points were installed on both sides of the crack on the upstream edge of the crest approximately three months ago and we were advised that measurements of these points indicated no change in their relative positions.

Based on our observations, the following specific suggestions can be made:

1. Leakage of Water into the Valve House
   Water seeping through an earth dam is a cause of concern if it carries soil particles since "piping" created by the loss of fine particles can cause further, rapid movements of material. In this case, the seeping water is clear, and does not appear to pose any immediate problems with respect to the loss of dam material. It is recommended that the pit floor under the valves be cleaned of the existing rusty deposits, and that it be inspected once a week or more frequently. If additional deposits are detected in the pit, or if the water becomes murky in appearance, a program for immediate action to stop the flow will be required.

2. Condition of the Upper Dam
   A critical condition for an earth dam occurs during a rapid drawdown of the pool elevation, particularly after the water has achieved a high elevation. This occurred in June 1972, during the storm known as "Hurricane Agnes", when very heavy rainfalls occurred in the basin. During that storm, water surface elevations in the upper reservoir were reported to be some 3 feet above the spillway elevation, and for the first time on record water flowed through the emergency spillway under approximately 6 inches of head.

   Subsequent drawdown of the upper reservoir occurred in two stages: A very rapid drawdown of approximately 3 feet from the extreme high water to the spillway elevation, and an additional slower drawdown of 15-foot to the present pool elevation at the recommendation of the State's inspector.

   It is our evaluation that these drawdowns particularly the first stage of very rapid drawdown when the dam was saturated by the heavy storm, were instrumental in initiating the movement of the upstream slope of the dam and the related slumping of the crest.

2. Condition of the Upper Dam (Cont'd.)
In order to prevent additional movements of the upstream slope, pending permanent measures to correct the condition of the dam, it is recommended that steps be taken to prevent rapid flucutations in the pool elevation. To implement this recommendation, the following suggestions are made:

a. During periods of rapid inflow, the outlet valves of the dam should be kept open, with the water level kept under constant surveillance.

b. After the inflow slows, if the water has risen above the present elevation, the valves should be regulated so that the rate of pool drawdown does not exceed 4 inches per day, until the water has receded to the present elevation.

c. In addition to the control points which have been installed on both sides of the crack, additional control points should be installed along the upstream edge of the crest of the dam at 50-foot intervals, with measurements of the position of the points taken frequently and recorded.

d. During periods of drawdown of the pool and for two weeks afterwards, elevations of all control points should be measured twice a week together with measurements of pool elevation. Whenever a settlement of the crest is detected the drawdown should be halted until the impact of the settlements can be evaluated, and a course of action determined.

We are currently in the process of evaluating the capacity of the drawdown system, and we will submit our recommendations as to whether additional facilities such as pumps or siphon pipes are required.

We trust you will find this in good order, and remain

Very truly yours,

PARSONS, BRINCKERHOFF, QUADE & DOUGLAS, INC.

G. R. Lloyd

GRL:ml

bc: D. Rafaeli
CKL
cc Wm. Joseph Hemler
Balt. CoE

STATE OF NEW YORK
DIVISION OF MILITARY AND NAVAL AFFAIRS
PUBLIC SECURITY BUILDING
STATE CAMPUS
ALBANY, NEW YORK 12226

JOHN C. BAKER
MAJOR GENERAL
CHIEF OF STAFF TO THE GOVERNOR

MNDP

November 2, 1973

Mr. Thomas R. Casey, Regional Director
Federal Disaster Assistance Administration
Region II
26 Federal Plaza (Rm. 1349)
New York, New York 10007

Dear Mr. Casey:

This Office has been advised by the Tioga County Director of Civil Defense and the Village of Waverly of the hazardous condition of the earthen dams above Waverly.

At the time of the Agnes floods the water behind these dams rose to unprecedented levels and soaked portions of the embankment which had not previously been so exposed. This condition plus a sudden drawoff has resulted in a weakening of the structures to the point that in the estimation of local officials and technical resource personnel from the New York State Department of Environmental Conservation, these dams constitute a hazard to life and property. At the present time, the Village has engaged the engineering firm of Parsons and Brinkerhof to advise them as to what actions may be taken to reduce this hazard. In the interim the water levels have been reduced drastically in order to eliminate as much of the threat as possible. The condition of these dams and the present status have been reported to the New York Division of the Corps of Engineers by the Department of Environmental Conservation. They have informally advised the Corps that these dams constitute a greater threat than any other existing dams in the State at the present time.

Mr. Thomas R. Casey
November 2, 1973
Page 2

The Village of Waverly was an applicant under the Agnes disaster. Their application OEP 338 DR 94 has been completed and the project file closed. However, in view of the seriousness of this situation it is requested that you consider either the eligibility of the Village of Waverly to submit a new claim under the Agnes disaster or alternatively review what other federal assistance may be available to the Village from the Corps of Engineers or other federal agencies, to assist them in alleviating this threat to their community. Your early attention and response to this inquiry will be greatly appreciated.

Sincerely,

ARNOLD W. GRUSHKY
Deputy Director of
Civil Defense

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FEDERAL DISASTER ASSISTANCE ADMINISTRATION
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007

REGION II

IN REPLY REFER TO:

Date: November 14, 1973

To: Col. R. S. McGary, District Engineer, Baltimore District
P. O. Box 1715, Baltimore, Maryland

From: T. Casey, Director of Disaster Program, FDAA, Region 2

Subj: Investigation of Potential Dam Failure
Village of Waverly, Tioga County, New York

Dear Col. McGary:

A situation has been brought to my attention by Local and State officials, that a dam in a weakened condition threatens the Village of Waverly. I have determined that the Federal Disaster Assistance Administration does not have any authority in this matter.

Inquiries have been made by my staff with COE personnel and it was indicated that the Baltimore District has the statute authority to initiate a study and provide the localities with recommendations and technical assistance. I understand that upon my request on behalf of the Village of Waverly, you can immediately start an investigation.

I would like to hereby request you to initiate a study under your authority to investigate and make recommendations to the Village of Waverly concerning a potential dam failure.

I am doing this on behalf of the Village, and State but FDAA does not assume any fiscal or managerial responsibility and does not wish to infringe on the Corps of Engineer authority. Copies of pertinent correspondence are attached.

Your rapid response would be most appreciated.

Sincerely,

for Thomas R. Casey
Regional Director for Disaster Assistance

Attachments

NADF-SQ 14 November 1973

MEMORANDUM FOR RECORD

SUBJECT: Weakening of Water Supply Dams at Waverly, New York

1. On 14 November 1973 I received a call from Mr. Jim Hilton, PL 91-606 representative (Phone - 607-739-8727) for the Corps in New York concerning a request by FDAA. The FDAA was seeking information on possible action by the Corps concerning a weakened water supply dam near Waverly, New York. The dam is the upper of two contiguous dams above the town of Waverly, and is "saturated" according to non-technical reports.

2. Waverly Officials have requested assistance from their Congressman, Rep Howard Robinson, who in turn had asked the FDAA New York Office for help. FDAA asked Mr. Hilton what the Corps could do in this situation.

3. I suggested the following response by Mr. Hilton to FDAA, based on a conversation with Mr. Veskimets, Design Branch, Engineering Division, EDO, who has been involved in several previous situations of this kind.

a. The village (and the Congressman, if thought necessary) should write a letter to the District Engineer ~~requesting technical assistance~~ from the Corps. This assistance would take the form of an inspection and a report recommending a course of action.

b. The Corps has no funds available for detailed investigation, design or construction unless specifically provided for by Congressional action, or by another agency such as FDAA. If the dam damage is shown to be connected to Agnes by a thorough investigation conducted after the Corps inspection, then FDAA would be in a position to render a decision on PL 91-606 funding of work done on the dam.

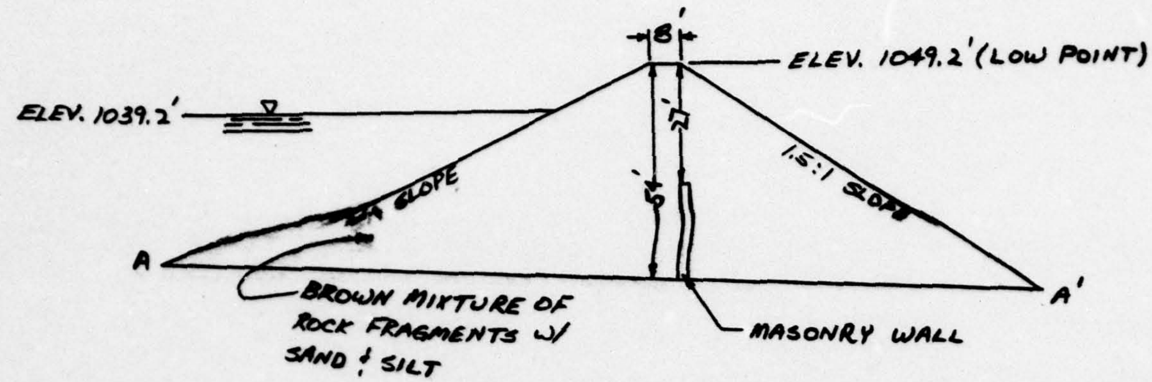
4. In addition I suggested that, if the engineering firm already engaged by the village had not so advised, the village should take those precautionary measures which are appropriate such as to reduce the level of the upper dam, and the lower dam, so that the water remaining in the upper dam is no greater than the available volume in the lower dam.

5. Mr. Hilton stated that he would inform FDAA of the response outlined in paras 3 and 4 and would also visit the dam site to make a personal judgment as to the seriousness of the problem.

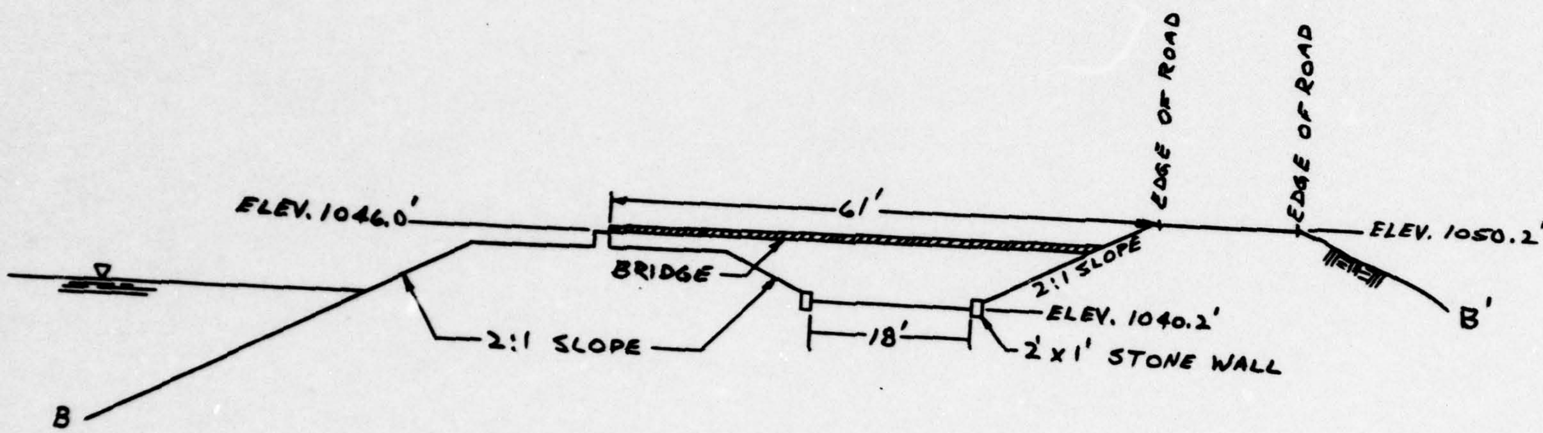
STANLEY R. JOHNSON
MAJ CE

APPENDIX E

CONSTRUCTION DRAWINGS

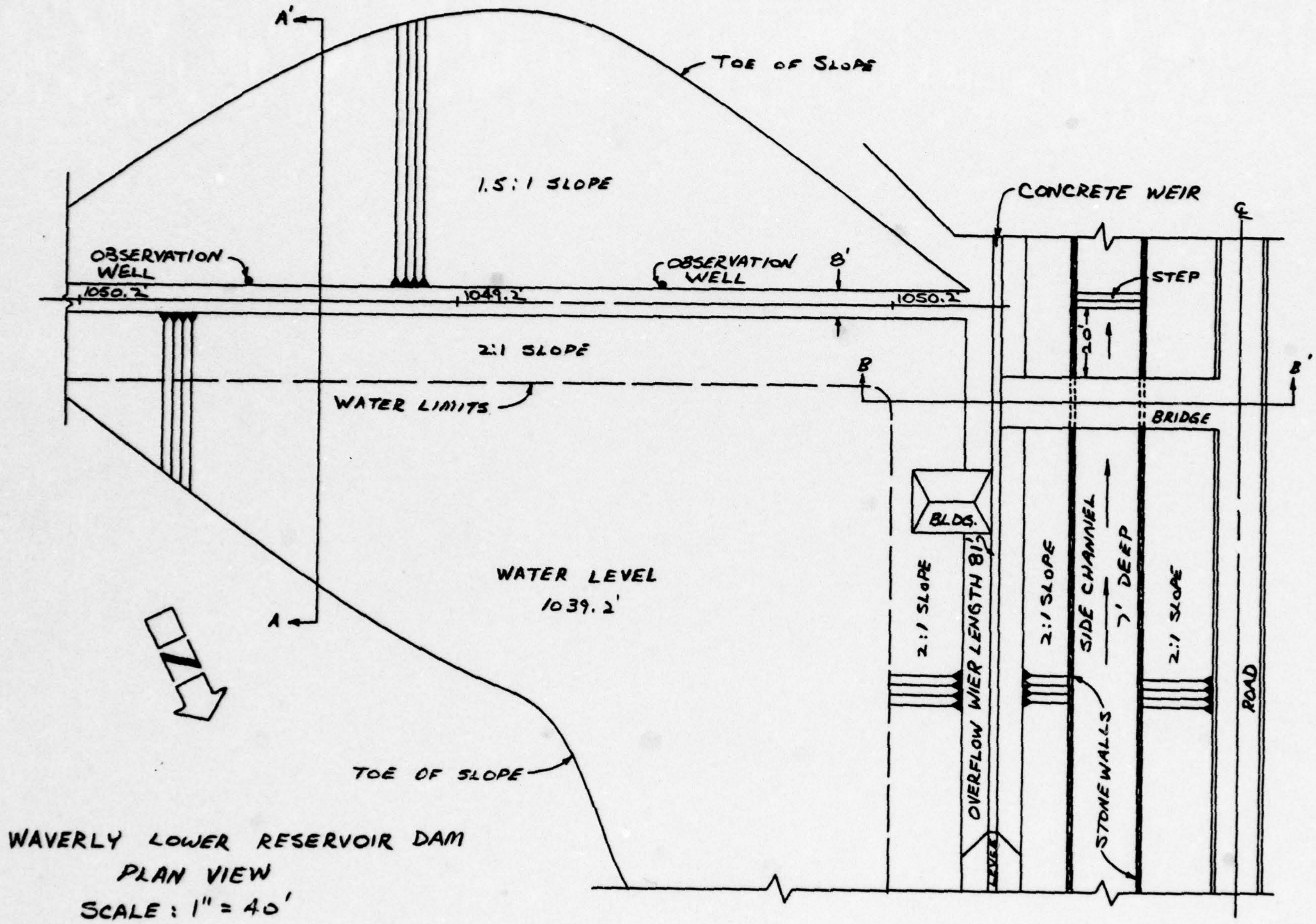


SECTION A-A'
SCALE: 1" = 40'



SECTION B-B'
SCALE: 1" = 20'

WAVERLY LOWER RESERVOIR DAM



WAVERLY LOWER RESERVOIR DAM
PLAN VIEW
SCALE: 1" = 40'

APPENDIX F

VISUAL CHECK LIST

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME DAM Waverly Lower Reservoir Dam COUNTY Tioga STATE New York ID# 623

TYPE OF DAM Earthfill HAZARD CATEGORY High

DATE(s) INSPECTION June 13, 1978 WEATHER rain, cloudy, cool TEMPERATURE 60°

POOL ELEVATION AT TIME OF INSPECTION 1,038.3 M.S.L. TAILWATER AT TIME OF INSPECTION None M.S.L.

INSPECTION PERSONNEL:

R. Jeffrey Kimball, P.E. Les Marshall

James T. Hockensmith Willard Updike

James T. Hockensmith RECORDER

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None noted	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None noted	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None noted, however, slopes were covered with flagstone which appears to be constantly sliding downslope. Abutment slopes consist of outcrops of rock.	
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	There is a low point near the center of the dam. This point is approximately one foot lower than the abutment. Horizontal alignment appears to be good.	
RIPRAP FAILURES	None noted	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPE	Slopes were measured to be approximately 1.5:1 downstream and 2:1 upstream. Slopes were extensively tree covered.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	All appear good and stable. Dam and spillway channel reportedly set into rock.	
ANY NOTICEABLE SEEPAGE	In valve house around one of the 12 inch pipes there is seepage which has been estimated in 1972 to be approximately 25 gpm. There was some seepage noted on the left abutment above toe. This seepage appears to be coming through the rock abutment.	
STAFF GAGE AND RECORDER	None	
DRAINS	None	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	N/A	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	N/A	
DRAINS	N/A	
WATER PASSAGES	N/A	
FOUNDATION	N/A	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	N/A	
STRUCTURAL CRACKING	N/A	
VERTICAL AND HORIZONTAL ALIGNMENT	N/A	
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	N/A	
STAFF GAGE OF RECORDER:	N/A	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Two 12 inch cast iron pipes in fair condition. Valves at toe in valve house and filtration plant.	
INTAKE STRUCTURE	One pipe goes straight through embankment and opens at upstream toe. Other pipe slopes up upstream face and has riser openings.	
OUTLET STRUCTURE	One pipe goes through to water system. Water from other pipe can be diverted into other 12 inch pipe for water system or used as blow off. This pipe outlets as open pipe.	
OUTLET CHANNEL	Very narrow with rock slopes through the town park and exits into the town of Waverly.	
EMERGENCY GATE	One 12 inch outlet pipe.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	A 22 inch high concrete side channel weir 100 ft. long. Effective length approximately 82 feet long because of building blockage. Weir wall in need of repairs (wall is overturning).	
APPROACH CHANNEL	None	
DISCHARGE CHANNEL	Side waste channel with a bottom width of 18 feet. Side channel discharges into an exit channel and eventually discharges over a rock cut (waterfall) into valley bottom.	
BRIDGE AND PIERS	A bridge crosses exit channel near axis of dam - possible obstruction.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE AND PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Very narrow with few obstructions.	
SLOPES	Rock outcrops throughout - stable.	
APPROXIMATE NO. OF HOMES AND POPULATION	Western half of Waverly - 2,000 people	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Stable - mostly forested or vegetated.	
SEDIMENTATION	Not serious	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None known	
OBSERVATION WELLS	2 wells installed by Corps of Engineers - no readings except initial (1973).	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	

APPENDIX G

ENGINEERING DATA CHECK LIST

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Waverly Lower Res.Dam

ID# 623

ITEM	REMARKS	
AS-BUILT DRAWINGS	None known	
REGIONAL VICINITY MAP	None known	
CONSTRUCTION HISTORY	Interview	
TYPICAL SECTIONS OF DAM	One typical	Dam Report 1916- New York State Department of Environmental Conservation
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHANCE RATINGS	None known	
RAINFALL/RESERVOIR RECORDS	Les Marshall has some records - past caretaker	

ITEM	REMARKS
DESIGN REPORTS	None known
GEOLOGY REPORTS	None known
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None known
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	2 borings by Corps of Engineers — New York State Department of Environmental Conservation None known
POST-CONSTRUCTION SURVEYS OF DAM	None known
BORROW SOURCES	None known

ITEM	REMARKS	
MONITORING SYSTEMS	Observation wells installed by Corps of Engineers	New York State Department of Environmental Conservation
MODIFICATIONS	Unknown	
HIGH POOL RECORDS	Unknown	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Unknown	
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None known	
MAINTENANCE OPERATION RECORDS	None known	

	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	None known
OPERATING EQUIPMENT PLANS & DETAILS	None known

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: wooded, grassed slopes; square miles

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1,046 feet 300 acre-feet

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Top of dam 360 acre-feet

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1,049.2 feet

CREST:

a. Elevation 1,046
b. Type concrete weir
c. Width 1.5 feet
d. Length 82 feet
e. Location Spillover right abutment
f. Number and Type of Gates none

OUTLET WORKS:

a. Type Two 12 inch cast iron pipes
b. Location through center of dam
c. Entrance inverts unknown
d. Exit inverts unknown
e. Emergency draindown facilities one 12 inch cast iron pipe

HYDROMETEOROLOGICAL GAGES:

a. Type none
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE Unknown