slope protection on the upstream face. Seepage and stability analyses required by the guidelines were not available.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action and regular maintenance will be required to correct or control the described deficiencies. In addition, detailed seepage and stability analyses of the existing dam, as required by the guidelines, should be performed. A detailed report discussing each of these deficiencies is attached.

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Black & Veatch

OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BYINGTON LAKE DAM

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APPENDIX

Appendix A - Hydrologic Computations

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Byington Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure located in the valley of Owens Creek (see Plate 1). The watershed is an area of low hills with fairly steep slopes consisting of about 80 percent grassland used for pasture and 20 percent timberland (Plate 2). The dam is approximately 570 feet long along the crest and 33 feet high. The dam crest is 12 feet wide. The downstream face of the dam slopes uniformly from the crest to the valley floor below.

(2) The principal and emergency spillways are unlined channels cut through the natural abutment material on each end of the dam. The channel excavation was used to form a dike between each spillway channel and the embankment. The spillway channels have bottom widths of 17-18 feet and are about two feet deep.

(3) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located in central Osage County, Missouri. The location is shown on Plate 1. The lake formed by the dam is shown on the United States Geological Survey 7.5 minute series quadrangle map for Linn Northeast, Missouri in Section 28 of T43N, R08W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, the dam and impoundment are in the small size category. By this classification, a small dam is one which is between 25 and 40 feet high and has a storage capacity between 50 and 1000 acre-feet.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Byington Lake Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, agricultural, industrial and commercial facilities, and to important public utilities, main highways, or railroads. For the Byington Lake Dam the estimated flood damage zone extends approximately three miles downstream of the dam. Within the estimated damage zone are two dwellings, one trailer and several barns. The above hazard classification is based on the borderline possibility that a high hazard exist. A breach analysis and flood routing would be needed to definitely confirm that the high hazard classification for this dam is justified.

e. Ownership. The dam is owned by Mr. Thomas Byington, #19 Forest Crest Drive, Chesterfield, Missouri 63017.

f. Purpose of Dam. The dam forms an 11-acre lake used for recreation and as a water supply for livestock.

g. Design and Construction History. Data relating to the design and construction were not available. The owner stated that the dam is about ten years old.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, and overflow through the uncontrolled principal and emergency spillways all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 111 acres

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through two uncontrolled, unlined, trapezoidal spillway channels.

(2) Estimated experienced maximum flood at damsite - Unknown.

(3) Estimated ungated spillway capacity at maximum pool elevation 665 cfs (50 Percent Probable Maximum Flood Pool El. 867.8).

c. Elevation (Feet above m.s.l.).

(1) Top of dam - 866.9 (see Plate 3)

(2) Emergency spillway crest - 865.6

(3) Principal spillway crest - 864.9

(4) Streambed at toe of dam - 834 ±

(5) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 1,300 feet ± (50 Percent probable maximum flood pool level)

(2) Length of normal pool - 1,200 feet ± (Principal spillway crest)

e. Storage (Acre-feet).

(1) Top of dam - 149

(2) Emergency spillway crest - 133

(3) Principal spillway crest - 125

(4) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 12.2

(2) Emergency spillway crest - 11.5

(3) Principal spillway crest - 11

g. Dam.

(1) Type - Earth embankment

(2) Length - 570 feet

(3) Height - 33 feet ±

(4) Top width - 12 feet

(5) Side slopes - upstream face 1.0 V on 3.8 H, downstream face 1.0 V on 2.6 H (see Plate 4).

(6) Zoning - Unknown.

(7) Impervious core - Unknown.

(8) Cutoff - Unknown.

(9) Grout curtain - Unknown.

h. Diversion and Regulating Tunnel - None.

i. Principal Spillway.

(1) Type - Grass open channel.

(2) Princpal spillway crest - 864.9

(3) Gates - None.

(4) Upstream channel - Grass lined channel upstream of crest with no obstructions to flow.

(5) Downstream channel - Natural channel to the original streambed.

j. Emergency Spillway.

(1) Type - Grass open channel.

(2) Emergency spillway crest - 865.6

(3) Gates - None.

(4) Upstream channel - Grass lined channel upstream of crest with no obstructions to flow.

(5) Downstream channel - Natural channel to the original streambed.

k. Regulating Outlets.

(1) Type - 3 to 4-inch pipe (estimated).

(2) Pipe invert elevation - Unknown.

(3) Valve - Downstream of the embankment toe.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data were not available.

2.2 CONSTRUCTION

Construction records were unavailable, however the owner stated that the dam is about ten years old.

2.3 OPERATION

No records of operation or of past floods were available.

2.4 GEOLOGY

The site of the dam and reservoir is located in a broad, steep-sided valley. The dam impounds Owens Creek, a small intermittent tributary of the Gasconade River.

Information on the soils in the area of the dam and reservoir was not available. The bedrock in the area consists of the Jefferson City, Cotter, Powell and Smithville formations. These formations consist of fine-grained, *silty and cherty dolomite.*

2.5 EVALUATION

a. Availability. No engineering data were available.

b. Adequacy. No engineering data were available. Thus, an assessment of the design, construction, and operation could not be made. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. The validity of the design, construction, and operation could not be determined due to the lack of engineering data.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Byington Lake Dam was made on 16 July 1980. The inspection team included professional engineers with experience in dam design and construction, hydrology, hydraulic engineering, and geotechnical engineering. The inspection team consisted of Edwin Burton, hydrologist/hydraulic engineer and team leader; Robert Pinker, geologist; Gary Van Riessen, geotechnical engineer; and Andrew Dywan, civil engineer. The dam is in fair condition. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following conditions at the dam. The embankment was very irregular with cow paths and footprints. No cracking, sliding, sinkholes or other signs of settlement were observed. The embankment has no visible stability problems. No instruments to measure the performance of the dam were located.

Seepage was observed on the downstream slope of the embankment and at the downstream toe but no flow was evident. The seepage area on the downstream slope is about 40 feet wide and is midway between the crest and the toe. The standing water in the area of seepage at the toe contained sediments with a red iron oxide coloration. It should be noted that the banks along the lake contain soil with red coloration. An additional area of seepage is located below the valve box which controls a 3 to 4-inch pipeline (estimated since pipe was buried). The ground was wet in this area with some dead cattails. No toe drains or relief wells were observed.

The dam crest and upstream and downstream slopes have a fairly thin protective grass cover due to grazing. Trees up to 10 inches in diameter are growing on the embankment. Some minor erosion of the upstream slope from wave action was observed. No animal burrows were observed on the embankment. No evidence was found to indicate that the embankment had ever been overtopped.

c. Appurtenant Structures. The inspection team observed the following items pertaining to appurtenant structures. The principal and emergency spillways are nearly identical unlined channels cut through the natural abutment material at each end of the dam. The channel excavation was used to form a dike between each spillway channel and the embankment.

There was no evidence of erosion at the spillways or upstream and downstream of the spillways. An abnormally large spillway discharge would probably not damage the embankment, because the flow is directed away from the embankment. There was no development in the spillway area which could suffer damage due to flow through the spillway.

d. Geology. The soil in the area of the dam and reservoir consists of silty clay with numerous cobbles of chert, dolomite and sandstone. These soils are formed in colluvium from sandstone and residuum from dolomite. The soils are very thin to nonexistent on the slopes.

The spillways are cut into dolomite bedrock. They empty into a channel that contains numerous boulders of sandstone and dolomite. The dolomite is medium bedded with closed bedding planes. No joints were observed.

Samples of the embankment were taken near the center of the upstream crest. The materials in the samples consisted of sandy, silty clay classified as (CL). Based on these samples and visual observations, it is anticipated that the embankment consists of sandy, silty clay (CL).

The abutments and foundation of the dam are anticipated to be dolomite with a thin cover of residual, silty, sandy clay soil.

e. Reservoir Area. No slumping or slides of the reservoir banks were observed. The upstream channel to the lake consists of several inlets with trees and light brush as well as a lake in the upper reaches of the watershed. The lake has a minor amount of siltation noted by the growth of aquatic weeds around the edge of the lake.

f. Downstream Channel. No slumping or slides were observed in the downstream channel to the original streambed.

3.2 EVALUATION

The various deficiencies observed at the time of the inspection are not believed to represent an immediate safety hazard. They do, however, warrant monitoring and control.

The areas of seepage on the downstream slope and at the toe of the dam at the right abutment which were observed should be monitored regularly for quality and quantity. Seepage can cause internal erosion creating cavities and underground channels, thereby weakening the embankment and/or abutments.

The absence of riprap on the upstream slope of the dam has resulted in wave action erosion. If not corrected, wave action will continue to erode the embankment and could lead to slope stability problems.

The growth of trees and the uncut grass, if allowed to go unchecked, could cause deterioration of the embankment. The roots of trees can loosen the embankment material and also can leave voids through which water can pass. The uncut grass provides a habitat for burrowing animals which can damage the embankment.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, transpiration, and capacity of the uncontrolled principal and emergency spillways.

4.2 MAINTENANCE OF DAM

No maintenance was evident. According to the owner, the dam was inspected by the State of Missouri. The date and extent of inspection are unknown and no inspection report was available.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist except for a valved 3 or 4-inch (estimated since pipe was buried) pipe of undetermined purpose.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no existing warning system or preplanned scheme for alerting downstream residents for this dam.

4.5 EVALUATION

A maintenance program should be initiated which would include mowing the grass cover on the embankment in order to discourage animal burrowing. The trees on the embankment should be removed. The areas of seepage should be monitored periodically and, if flow increases significantly or if seepage flow becomes muddy, a qualified engineer should be consulted.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No design data were available.

b. Experience Data. The drainage area and lake surface area are developed from the USGS Linn Northeast, Missouri Quadrangle Map. The dam layout is from a survey made during the inspection.

c. Visual Observations.

(1) The principal and emergency spillways appear to be in good condition. The lake level at the time of the inspection (El. 864.0) was below the crest elevations of the spillways. There were no obstructions to flow in the downstream channels.

(2) Spillway discharges do not endanger the integrity of the dam.

d. Overtopping Potential. The spillways will not pass the probable maximum flood without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The spillways will pass 20 percent of the probable maximum flood without overtopping the dam. The spillways will pass the one percent chance flood estimated to have a peak outflow of 226 cfs developed by a 24-hour, one percent chance rainfall. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of small size should pass 50 to 100 percent of the probable maximum flood. Considering the volume of water impounded by the dam, and the downstream hazard, the appropriate spillway design flood should be 50 percent of the probable maximum flood. The portion of the estimated peak discharge of 50 percent of the probable maximum flood overtopping the dam would be 160 cfs of the total discharge from the reservoir of 825 cfs. The estimated duration of overtopping is 1.3 hours with a maximum height of 0.9 feet. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 940 cfs of the total discharge from the reservoir of 2,040 cfs. The estimated duration of overtopping is 5.3 hours with a maximum height of 1.6 feet. The embankment could be jeopardized should overtopping occur for these periods of time.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately three miles downstream of the dam. Two dwellings, one trailer and several barns could be severely damaged and lives could be lost should failure of the dam occur. There does not appear to be any floodplain regulations or other constraints in force to limit future downstream development.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which affect the structural stability of this dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design data relating to the structural stability of the dam were found. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. No operational records exist.

d. Postconstruction Changes. It is not known whether any post-construction changes have been made.

e. Seismic Stability. The dam is located in Seismic Zone 1 which is a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservatism should pose no serious stability problems during earthquakes in this zone. The seismic stability of an earth dam is dependent upon a number of factors: embankment and foundation material classifications and shear strengths; abutment materials, conditions, and strengths; embankment zoning; and embankment geometry.

Adequate descriptions of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the stability analysis required by the guidelines.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several conditions observed during the visual inspection by the inspection team should be monitored and/or controlled. These are seepage areas on the downstream slope and at the toe of the embankment, the absence of adequate slope protection on the upstream slope and the growth of grass and trees on the embankment. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

b. Adequacy of Information. Due to the absence of engineering design data, the conclusions in this report were based only on performance history and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. A program should be developed as soon as possible to monitor at regular intervals the deficiencies described in this report. The remedial measures recommended in paragraph 7.2b should be accomplished in the near future. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam nor does it identify any serious dangers which would require a Phase II investigation. However, the additional analyses noted in paragraph 2.5b are necessary for compliance with the guidelines.

e. Seismic Stability. This dam is located in Seismic Zone 1. Adequate description of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the recommended stability analysis.

7.2 REMEDIAL MEASURES

a. Alternatives. The emergency spillway size and/or height of the dam would need to be increased or the lake level would need to be permanently lowered to increase available flood storage in order to pass the spillway design flood. The emergency spillway should be protected to prevent erosion.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures should be carried out under the direction of a professional engineer experienced in the design, construction, and maintenance of earth dams:

(1) Riprap should be placed on the upstream face of the dam at the normal lake level to prevent erosion of the embankment material.

(2) The seepage areas noted during the visual inspection should be closely monitored and documented as to quantity of flow. Any significant changes should be evaluated.

(3) An improved maintenance program to remove and control the growth of trees on the embankment should be developed. Grass cover on the embankments should be cut periodically.

(4) Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of dams.

(5) A detailed inspection of the dam should be made periodically. This inspection should include measurement of seepage flows. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increase.

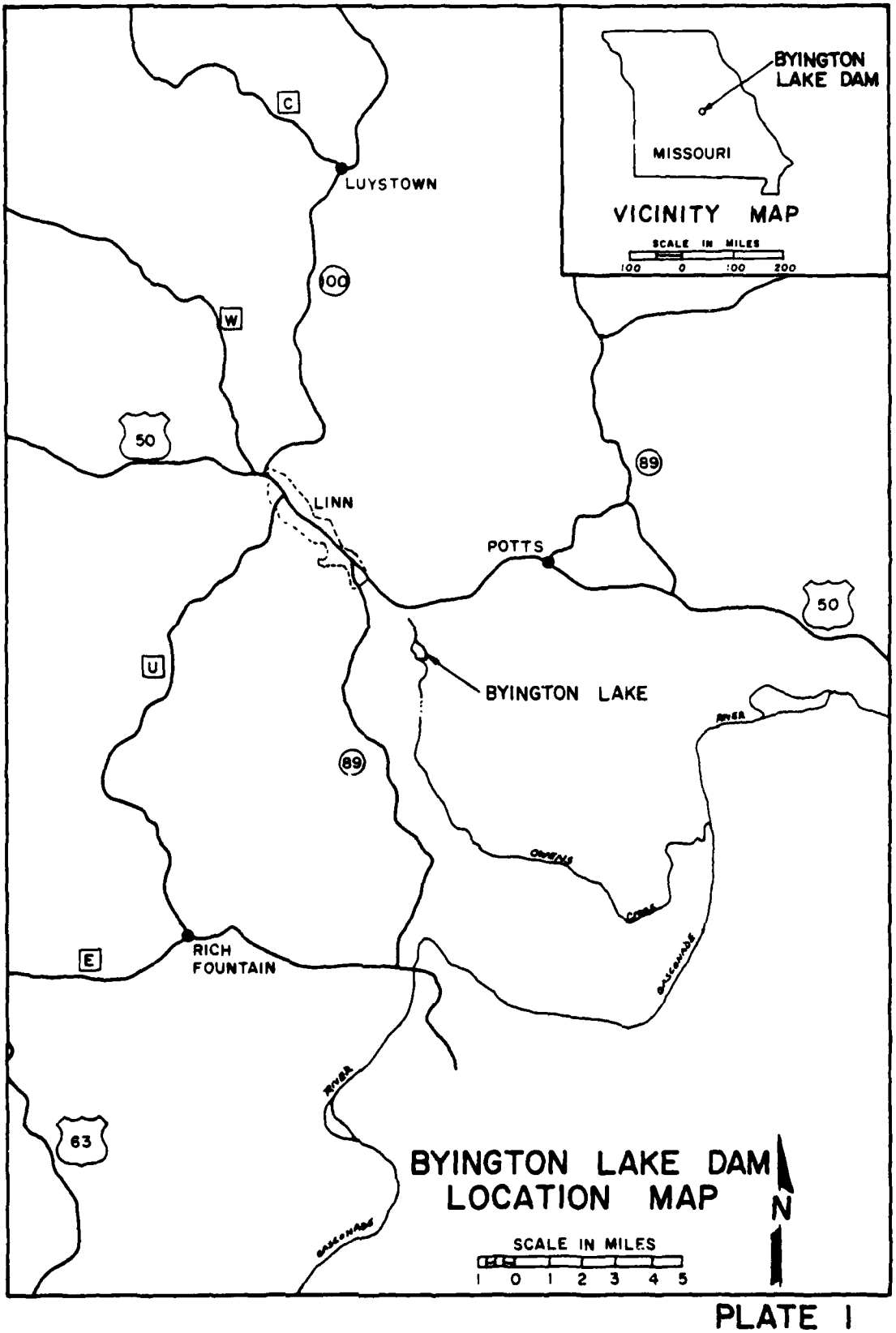

BYINGTON LAKE DAM
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
LUYSTOWN
C
100
W
50
LINN
89
POTTS
50
U
BYINGTON LAKE
89
E
RICH FOUNTAIN
63
BYINGTON LAKE DAM
LOCATION MAP
N
SCALE IN MILES
1 0 1 2 3 4 5

PLATE 1

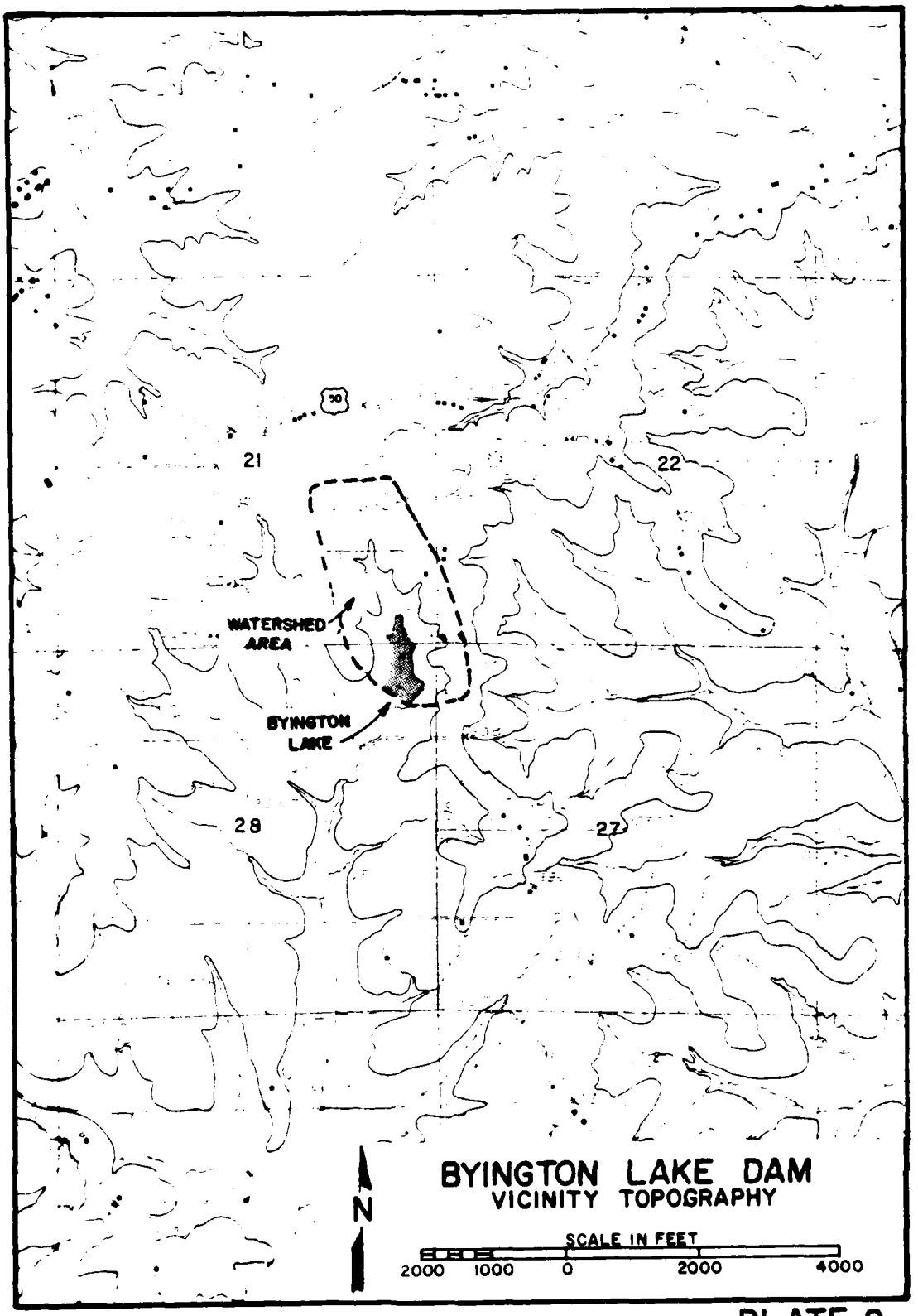

50
21
22
WATERSHED AREA
BYINGTON LAKE
28
27
N
BYINGTON LAKE DAM
VICINITY TOPOGRAPHY
SCALE IN FEET
2000 1000 0 2000 4000

PLATE 2

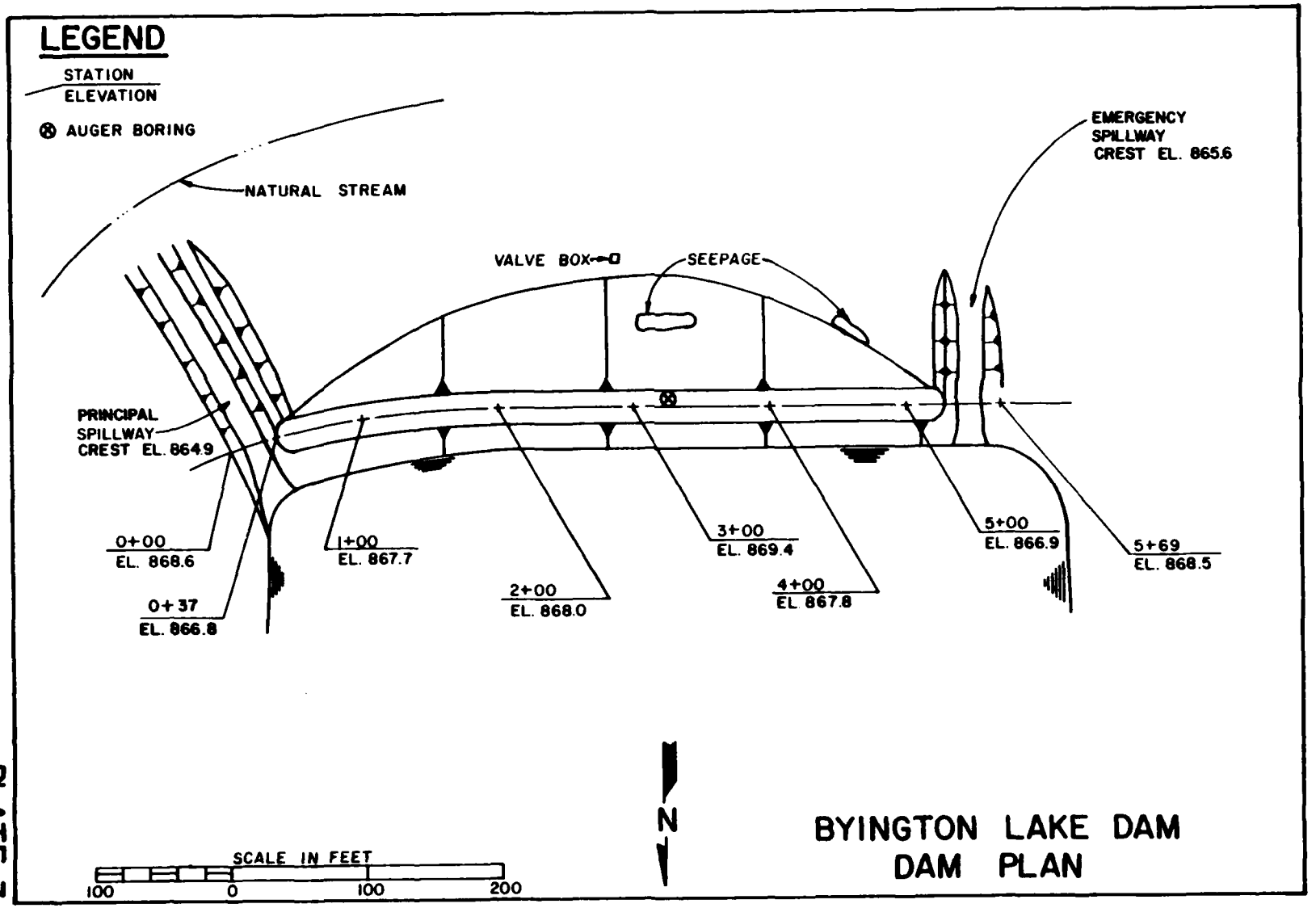


PLATE 3

BYINGTON LAKE DAM
DAM PLAN

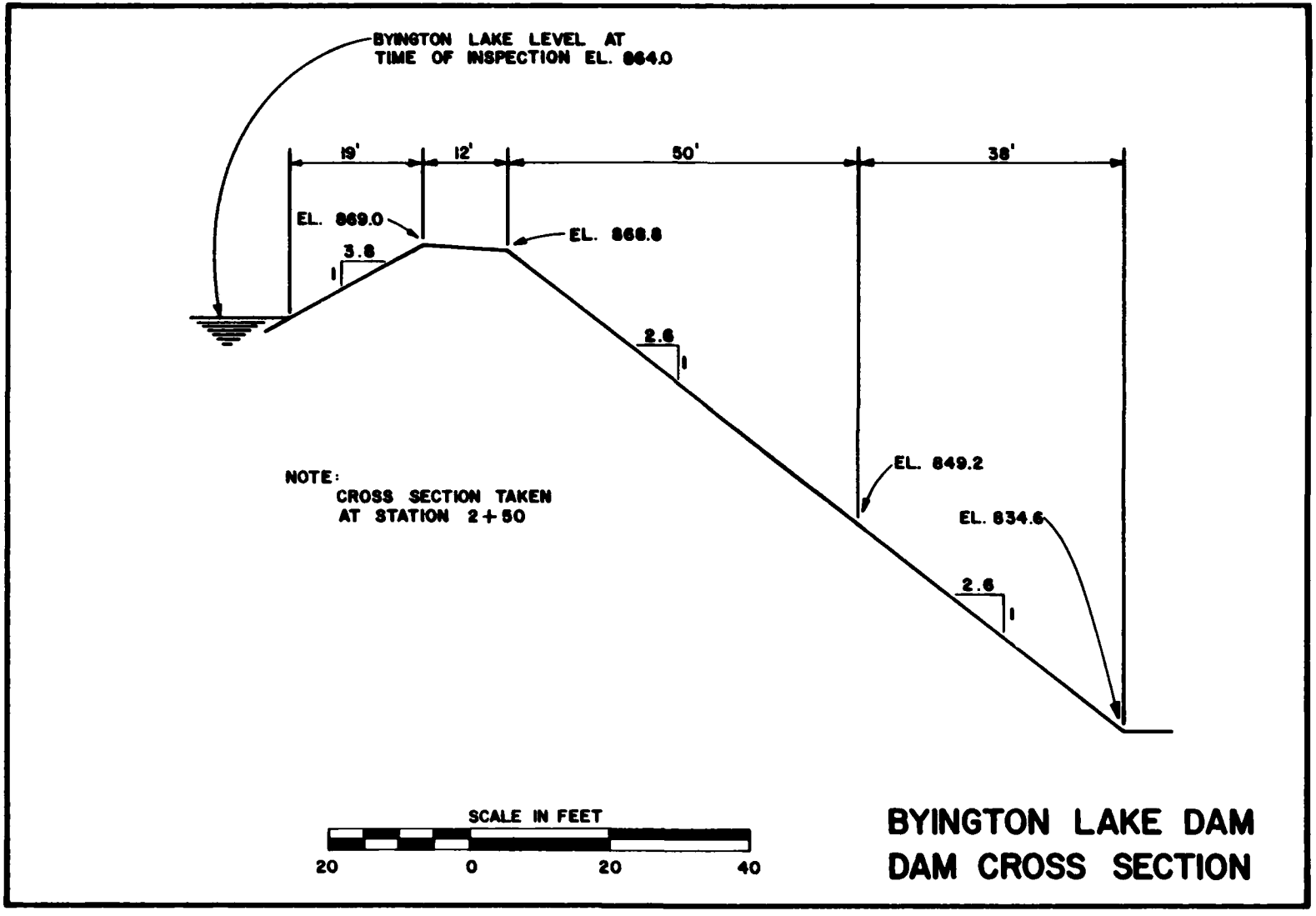
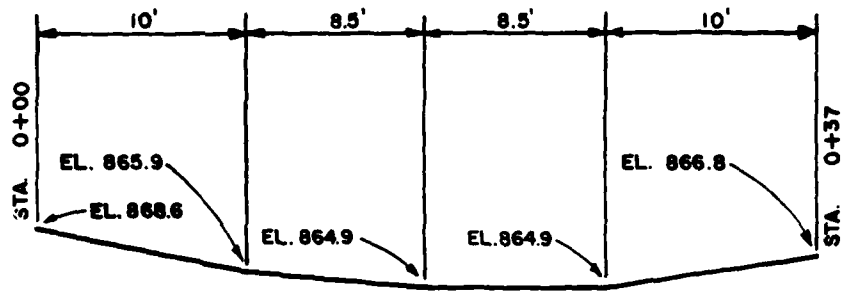
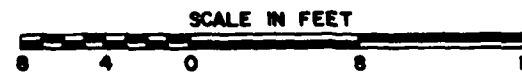

BYINGTON LAKE LEVEL AT
TIME OF INSPECTION EL. 864.0
19'
12'
50'
38'
EL. 869.0
EL. 868.8
3.8
1
2.6
1
NOTE:
CROSS SECTION TAKEN
AT STATION 2+50
EL. 849.2
EL. 834.6
2.6
1
SCALE IN FEET
20
0
20
40
BYINGTON LAKE DAM
DAM CROSS SECTION

PLATE 4

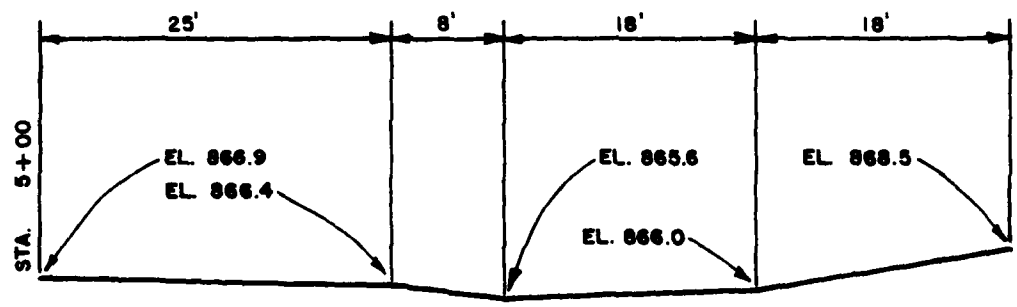
NOTE:
SECTION ALONG CENTERLINE
OF DAM LOOKING DOWNSTREAM



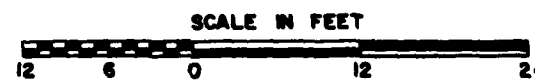
PRINCIPAL SPILLWAY



NOTE:
SECTION ALONG CENTERLINE
OF DAM LOOKING DOWNSTREAM



EMERGENCY SPILLWAY



BYINGTON LAKE DAM
SPILLWAY CROSS SECTIONS

PLATE 5

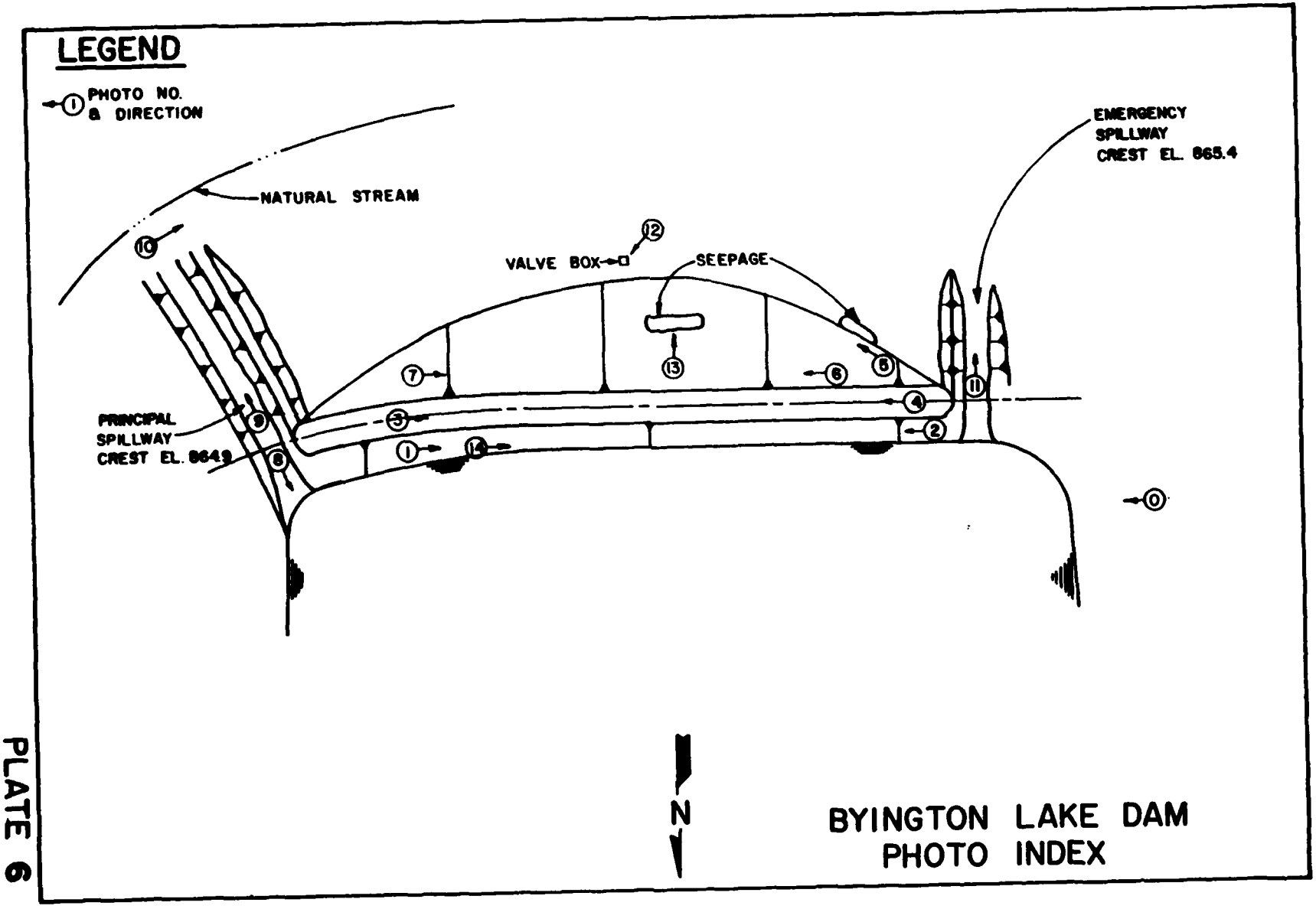


PLATE 6

BYINGTON LAKE DAM
PHOTO INDEX

PHOTO 1: UPSTREAM FACE OF DAM LOOKING WEST

PHOTO 2: UPSTREAM FACE OF DAM LOOKING EAST

PHOTO 3: CREST OF DAM LOOKING WEST

PHOTO 4: CREST OF DAM LOOKING EAST

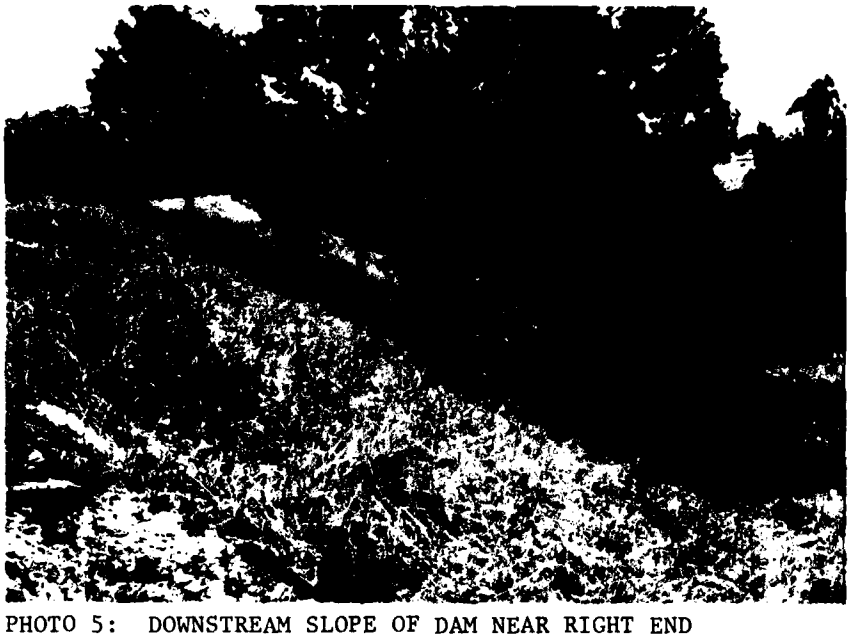


PHOTO 5: DOWNSTREAM SLOPE OF DAM NEAR RIGHT END

PHOTO 6: DOWNSTREAM SLOPE OF DAM NEAR CENTER

PHOTO 7: DOWNSTREAM SLOPE OF DAM NEAR LEFT END

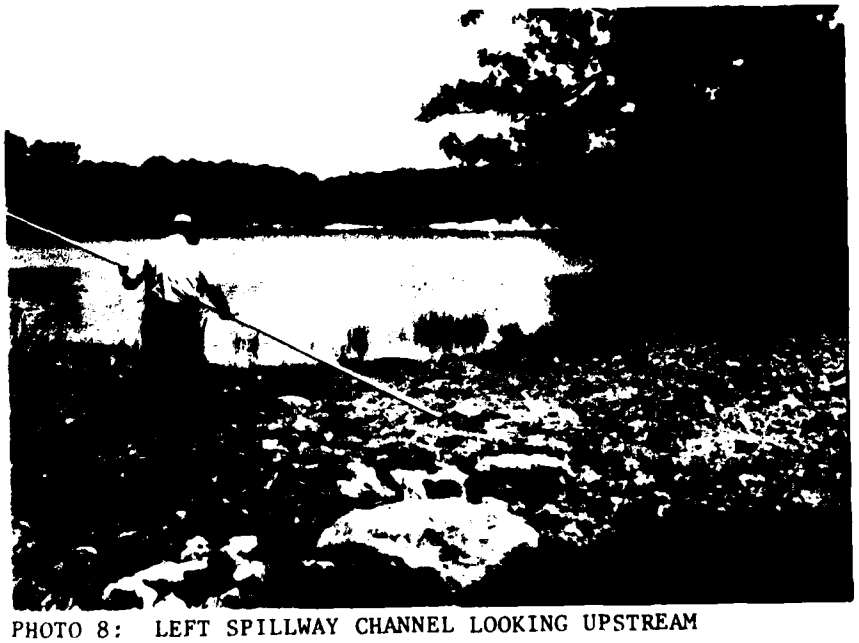


PHOTO 8: LEFT SPILLWAY CHANNEL LOOKING UPSTREAM

PHOTO 9: LEFT SPILLWAY CHANNEL LOOKING DOWNSTREAM

PHOTO 10: NATURAL CHANNEL BELOW LEFT SPILLWAY CHANNEL

PHOTO 11: RIGHT SPILLWAY CHANNEL LOOKING DOWNSTREAM

PHOTO 12: VALVE BOX AT DOWNSTREAM TOE OF DAM

PHOTO 13: SEEPAGE ON DOWNSTREAM SLOPE OF DAM

PHOTO 14: TYPICAL UPSTREAM SLOPE OF DAM AT WATERLINE

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC ANALYSES

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillways. The overtopping analysis was determined using the computer program HEC-1 (Dam Safety Version) (1).

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33" (HMR-33). Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm was determined according to the procedures outlined in HMR-33 and EM 1110-2-1411. The Jefferson City, Missouri rainfall distribution (5 min. interval - 24 hours duration), as provided by the St. Louis District, Corp of Engineers, was used when the one percent chance probability flood was routed through the reservoir and spillways.

The synthetic unit hydrograph for the watershed was developed by the computer program using the Soil Conservation Service (SCS) method. The parameters for the unit hydrograph are shown in Table 1.

The SCS curve number (CN) method was used in computing the infiltration losses for the rainfall-runoff relationship. The CN values used, and the result from the computer output, are shown in Table 2.

The reservoir routing was performed using the Modified Puls Method. The initial reservoir pool elevation for the routing of each storm was determined to be equivalent to the crest elevation of the principal spillway at elevation 864.9 feet m.s.l. in accordance with antecedent storm conditions preceding the one percent probability and probable maximum storms outlined by the U.S. Army Corps of Engineers, St. Louis District (2). The hydraulic capacity of the spillways and the storage capacity of the reservoir were defined by the elevation, surface area, storage, and discharge relationships shown in Table 3.

The rating curve for the spillways is shown in Table 4. The flow over the crest of the dam and through the spillways was determined using the non-level dam crest option ($L and $V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir.

The result of the routing analysis indicates that 20 percent of the PMF will not overtop the dam.

A summary of the routing analysis for different ratios of the PMF is shown in Table 5.

The computer input data and a summary of the output data are presented at the back of this appendix.

TABLE 1

SYNTHETIC UNIT HYDROGRAPH

Parameters:

Drainage Area (A)	111 acres
Length of Watercourse (L)	0.44 miles
Difference in Elevation (H)	106 feet
Time of concentration (T_c)	0.17 hours
Lag Time (L_g)	0.10 hours
Duration (D)	1.4 min. (use 5 min.)

Time (Min.) *	Discharge (cfs) *
0	0
5	381
10	564
15	248
20	96
25	37
30	14
35	6
40	2

* From HEC-1 computer output

FORMULAS USED:

$$T_c = \frac{(11.9\ L^3)^{0.385}}{H} \qquad (3)$$

$$D = 0.133\ T_c$$

$$L_g = 0.6\ T_c$$

TABLE 2

RAINFALL-RUNOFF VALUES

Selected Storm Event	Storm Duration (Hours)	Rainfall (Inches)	Runoff (Inches)	Loss (Inches)
PMP	24	33.02	32.13	0.89
1% Probability	24	7.44	5.44	2.00

Additional Data:

1) No data on the soil associations in this watershed was available.
   100 percent of drainage area in hydrologic soil group C.
   80 percent of the land use was grassland.
   20 percent of the land use was timberland.
2) SCS Runoff Curve CN = 93 (AMC III) for the PMF.
3) SCS Runoff Curve CN = 83 (AMC II) for the one percent probability flood.

TABLE 3

ELEVATION, SURFACE AREA, STORAGE, AND DISCHARGE RELATIONSHIPS

Elevation (feet-MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
*864.9	11.0	125	0
**865.6	11.5	133	13
***866.9	12.2	149	246

*Principal spillway crest elevation
**Emergency spillway crest elevation
***Top of dam elevation

The relationships in Table 3 were developed from the Linn Northeast, Missouri. 7.5 minute quadrangle map and the field measurements.

TABLE 4

SPILLWAY RATING CURVE

Reservoir Elevation (ft)	Principal Spillway Discharge (cfs)	Emergency Spillway Discharge (cfs)	Total Spillway Discharge (cfs)
*864.9	0	-	0
**865.6	13	0	13
***866.9	145	101	246

*Principal Spillway Crest Elevation
**Emergency Spillway Crest Elevation
***Top of Dam Elevation

METHOD USED:

Spillway releases were computed by HEC-1 from spillway geometry data input on $L and $V cards. The following equations calculate the spillway discharges:

For a rectangular section:

$$d_c = 2/3\ H_m$$
$$A = Td_c$$
$$Q = (A^3 g/T)^{0.5}$$

For a trapazoidal section:

$$d_c = 2/3\ (H_m + 1/4\ \Delta Y)$$
$$A = 1/2\ T\ (2d_c - \Delta Y)$$
$$Q = (A^3 g/T)^{0.5}$$

where:

d_c = critical depth (feet)
H_m = available specific energy which is taken to be the height of the water surface in the reservoir above the bottom of the section (feet)
ΔY = change in elevation across the section (feet)
A = flow area (sq. ft.)
T = top width (feet)
Q = flow (cfs)
g = 32.2 ft/sec^2 = acceleration due to gravity.

TABLE 5

RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (CFS)	Peak Lake Elevation (ft.-MSL)	Total Storage (AC.-FT.)	Peak Outflow (CFS)	Depth (ft.) Over Top of Dam
-	0	*864.9	125	0	-
0.20	490	866.8	148	214	0
0.50	1,225	867.8	160	825	0.9
1.00	2,450	868.5	170	2,038	1.6

Principal spillway crest elevation

(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Davis, California.

(2) U.S. Army Corps of Engineers, St. Louis District, Hydrologic/ Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams, 12 December 1979.

(3) U.S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, 1974, Washington, D.C.

(4) U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, August 1972.

(5) U.S. Department of Agriculture, Soil Conservation Service, Soil Survey Interpretations and Field Maps, 1980.

(6) Mary H. McCracken, Missouri Division of Geological Survey, Geologic Map of Missouri, 1961.

FLOOD HYDROGRAPH PACKAGE - HEC-1 PROGRAM H21/02-0U TIME 12:44:28 CASE PMF

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  06 FEB 80
     1              A1PISSOURI DAM INSPECTION PROGRAM
     2              A2ST. LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
     3              A3BYINGTON LAKE DAM - PMF
     4              B    280       0       5       0       0       0       0       0       0       0
     5              B1     5
     6              J      1       8       1
     7              J1    .1      .15      .2      .25      .3      .35      .5     1.0
     8              K      0       1                        3       1
     9              K1   BYINGTON LAKE (24 HR. PROBABLE MAXIMUM RUNOFF)
    10              M      1       2     .174                       1
    11              P             25.4     101     120     130
    12              T                                                      -1     -93
    13              M2            .10
    14              X                      1
    15              K      1       2                                       1
    16              K1   ROUTE THROUGH SPILLWAY
    17              Y                                      1       1
    18              Y1     1                                          -864.9
    19              S40.0   11.1    19.7    35.1
    20              SE833.  864.    880.    900.
    21              SS864.9
    22              SD866.9
    23              SL0.    18.     36.     45.     55.     82.     90.    174.    330.    428.
    24              SV864.9 865.6   865.9   866.0   866.4   866.8   866.9   867.4   867.7   868.5
    25              K     99
```

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 06 FEB 80

MISSOURI DAM INSPECTION PROGRAM
ST. LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
BYINGTON LAKE DAM - PMF

JOB SPECIFICATION

NB	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	0	0

JOPER	NUT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= .10 .15 .20 .25 .30 .35 .50 1.00

SUB-AREA RUNOFF COMPUTATION

BYINGTON LAKE (24 HR, PROBABLE MAXIMUM RUNOFF)

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

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAPE	LOCAL
1	2	.17	.00	.17	1.00	.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
.00	25.40	101.00	120.00	130.00	.00	.00	.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	.00	.00	1.00	.00	.00	1.00	-1.00	-93.00	.00	.00

CURVE NO = -93.00 WETNESS = -1.00 EFFECT CN = 93.00

UNIT HYDROGRAPH DATA
TC= .00 LAG= .10

RECESSION DATA
STRTQ= .00 QRCSN= .30 RTIOR= 1.00

TIME INCREMENT TOO LARGE--(DLTG IS GT LAG/2)

UNIT HYDROGRAPH 8 END OF PERIOD ORDINATES, TC= .00 HOURS, LAG= .10 VOL= 1.00
381. 564. 248. 96. 37. 14. 6. 2.

UNIT HYDROGRAPH 8 END OF PERIOD ORDINATES, TC= .00 HOURS, LAG= .10 VOL= 1.00
381. 564. 248. 96. 37. 14. 6. 2.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	0.	1.01	12.05	145	.21	.21	.00	164.
1.01	.10	2	.01	.00	.01	0.	1.01	12.10	146	.21	.21	.00	226.
1.01	.15	3	.01	.00	.01	0.	1.01	12.15	147	.21	.21	.00	262.
1.01	.20	4	.01	.00	.01	0.	1.01	12.20	148	.21	.21	.00	276.
1.01	.25	5	.01	.00	.01	0.	1.01	12.25	149	.21	.21	.00	282.
1.01	.30	6	.01	.00	.01	0.	1.01	12.30	150	.21	.21	.00	284.
1.01	.35	7	.01	.00	.01	0.	1.01	12.35	151	.21	.21	.00	285.
1.01	.40	8	.01	.00	.01	0.	1.01	12.40	152	.21	.21	.00	285.
1.01	.45	9	.01	.00	.01	0.	1.01	12.45	153	.21	.21	.00	285.
1.01	.50	10	.01	.00	.01	0.	1.01	12.50	154	.21	.21	.00	285.
1.01	.55	11	.01	.00	.01	0.	1.01	12.55	155	.21	.21	.00	286.
1.01	1.00	12	.01	.00	.01	0.	1.01	13.00	156	.21	.21	.00	286.
1.01	1.05	13	.01	.00	.01	1.	1.01	13.05	157	.26	.25	.00	302.
1.01	1.10	14	.01	.00	.01	1.	1.01	13.10	158	.26	.25	.00	326.
1.01	1.15	15	.01	.00	.01	2.	1.01	13.15	159	.26	.25	.00	337.
1.01	1.20	16	.01	.00	.01	2.	1.01	13.20	160	.26	.25	.00	341.
1.01	1.25	17	.01	.00	.01	3.	1.01	13.25	161	.26	.25	.00	343.
1.01	1.30	18	.01	.00	.01	3.	1.01	13.30	162	.26	.26	.00	343.
1.01	1.35	19	.01	.00	.01	4.	1.01	13.35	163	.26	.26	.00	344.
1.01	1.40	20	.01	.00	.01	4.	1.01	13.40	164	.26	.26	.00	344.
1.01	1.45	21	.01	.00	.01	5.	1.01	13.45	165	.26	.26	.00	344.
1.01	1.50	22	.01	.00	.01	5.	1.01	13.50	166	.26	.26	.00	344.
1.01	1.55	23	.01	.00	.01	6.	1.01	13.55	167	.26	.26	.00	344.
1.01	2.00	24	.01	.00	.01	6.	1.01	14.00	168	.26	.25	.00	344.
1.01	2.05	25	.01	.01	.01	7.	1.01	14.05	169	.32	.32	.00	368.
1.01	2.10	26	.01	.01	.01	7.	1.01	14.10	170	.32	.32	.00	405.
1.01	2.15	27	.01	.01	.01	7.	1.01	14.15	171	.32	.32	.00	420.
1.01	2.20	28	.01	.01	.01	8.	1.01	14.20	172	.32	.32	.00	427.
1.01	2.25	29	.01	.01	.01	8.	1.01	14.25	173	.32	.32	.00	429.
1.01	2.30	30	.01	.01	.01	8.	1.01	14.30	174	.32	.32	.00	430.
1.01	2.35	31	.01	.01	.01	9.	1.01	14.35	175	.32	.32	.00	430.
1.01	2.40	32	.01	.01	.01	9.	1.01	14.40	176	.32	.32	.00	431.
1.01	2.45	33	.01	.01	.01	9.	1.01	14.45	177	.32	.32	.00	431.
1.01	2.50	34	.01	.01	.01	9.	1.01	14.50	178	.32	.32	.00	431.
1.01	2.55	35	.01	.01	.01	10.	1.01	14.55	179	.32	.32	.00	431.
1.01	3.00	36	.01	.01	.01	10.	1.01	15.00	180	.32	.32	.00	431.
1.01	3.05	37	.01	.01	.01	10.	1.01	15.05	181	.19	.19	.00	383.
1.01	3.10	38	.01	.01	.01	10.	1.01	15.10	182	.39	.39	.00	367.
1.01	3.15	39	.01	.01	.01	11.	1.01	15.15	183	.39	.39	.00	465.
1.01	3.20	40	.01	.01	.01	11.	1.01	15.20	184	.58	.58	.00	575.
1.01	3.25	41	.01	.01	.01	11.	1.01	15.25	185	.68	.68	.00	736.
1.01	3.30	42	.01	.01	.01	11.	1.01	15.30	186	1.66	1.65	.00	1215.
1.01	3.35	43	.01	.01	.01	11.	1.01	15.35	187	2.73	2.73	.00	2217.
1.01	3.40	44	.01	.01	.01	12.	1.01	15.40	188	1.07	1.07	.00	2450.
1.01	3.45	45	.01	.01	.01	12.	1.01	15.45	189	.68	.68	.00	1734.
1.01	3.50	46	.01	.01	.01	12.	1.01	15.50	190	.58	.58	.00	1209.
1.01	3.55	47	.01	.01	.01	12.	1.01	15.55	191	.39	.39	.00	878.
1.01	4.00	48	.01	.01	.00	12.	1.01	16.00	192	.39	.39	.00	667.
1.01	4.05	49	.01	.01	.00	12.	1.01	16.05	193	.30	.30	.00	545.
1.01	4.10	50	.01	.01	.00	12.	1.01	16.10	194	.30	.30	.00	458.
1.01	4.15	51	.01	.01	.00	13.	1.01	16.15	195	.30	.30	.00	422.
1.01	4.20	52	.01	.01	.00	13.	1.01	16.20	196	.30	.30	.00	410.
1.01	4.25	53	.01	.01	.00	13.	1.01	16.25	197	.30	.30	.00	405.

1.01	4.10	50	.01	.01	.00	12.	1.01	16.10	196	.30	.30	.00	458.
1.01	4.15	51	.01	.01	.00	13.	1.01	16.15	195	.30	.30	.00	422.
1.01	4.20	52	.01	.01	.00	13.	1.01	16.20	196	.30	.30	.00	4
1.01	4.25	53	.01	.01	.00	13.	1.01	16.25	197	.30	.30	.00	
1.01	4.30	54	.01	.01	.00	13.	1.01	16.30	198	.30	.30	.00	403.
1.01	4.35	55	.01	.01	.00	13.	1.01	16.35	199	.30	.30	.00	403.
1.01	4.40	56	.01	.01	.00	13.	1.01	16.40	200	.30	.30	.00	403.
1.01	4.45	57	.01	.01	.00	13.	1.01	16.45	201	.30	.30	.00	403.
1.01	4.50	58	.01	.01	.00	13.	1.01	16.50	202	.30	.30	.00	403.
1.01	4.55	59	.01	.01	.00	14.	1.01	16.55	203	.30	.30	.00	403.
1.01	5.00	60	.01	.01	.00	14.	1.01	17.00	204	.30	.30	.00	403.
1.01	5.05	61	.01	.01	.00	14.	1.01	17.05	205	.24	.24	.00	378.
1.01	5.10	62	.01	.01	.00	14.	1.01	17.10	206	.24	.24	.00	342.
1.01	5.15	63	.01	.01	.00	14.	1.01	17.15	207	.24	.24	.00	326.
1.01	5.20	64	.01	.01	.00	14.	1.01	17.20	208	.24	.24	.00	320.
1.01	5.25	65	.01	.01	.00	14.	1.01	17.25	209	.24	.24	.00	318.
1.01	5.30	66	.01	.01	.00	14.	1.01	17.30	210	.24	.24	.00	317.
1.01	5.35	67	.01	.01	.00	14.	1.01	17.35	211	.24	.24	.00	317.
1.01	5.40	68	.01	.01	.00	14.	1.01	17.40	212	.24	.24	.00	317.
1.01	5.45	69	.01	.01	.00	15.	1.01	17.45	213	.24	.24	.00	317.
1.01	5.50	70	.01	.01	.00	15.	1.01	17.50	214	.24	.24	.00	317.
1.01	5.55	71	.01	.01	.00	15.	1.01	17.55	215	.24	.24	.00	317.
1.01	6.00	72	.01	.01	.00	15.	1.01	18.00	216	.24	.24	.00	317.
1.01	6.05	73	.07	.05	.01	31.	1.01	18.05	217	.02	.02	.00	235.
1.01	6.10	74	.07	.05	.01	55.	1.01	18.10	218	.02	.02	.00	115.
1.01	6.15	75	.07	.06	.01	66.	1.01	18.15	219	.02	.02	.00	82.
1.01	6.20	76	.07	.06	.01	72.	1.01	18.20	220	.02	.02	.00	61.
1.01	6.25	77	.07	.06	.01	74.	1.01	18.25	221	.02	.02	.00	33.
1.01	6.30	78	.07	.06	.01	76.	1.01	18.30	222	.02	.02	.00	30.
1.01	6.35	79	.07	.06	.01	77.	1.01	18.35	223	.02	.02	.00	29.
1.01	6.40	80	.07	.06	.01	78.	1.01	18.40	224	.02	.02	.00	28.
1.01	6.45	81	.07	.06	.01	79.	1.01	18.45	225	.02	.02	.00	28.
1.01	6.50	82	.07	.06	.01	79.	1.01	18.50	226	.02	.02	.00	28.
1.01	6.55	83	.07	.06	.01	80.	1.01	18.55	227	.02	.02	.00	28.
1.01	7.00	84	.07	.06	.01	81.	1.01	19.00	228	.02	.02	.00	28.
1.01	7.05	85	.07	.06	.01	81.	1.01	19.05	229	.02	.02	.00	28.
1.01	7.10	86	.07	.06	.01	82.	1.01	19.10	230	.02	.02	.00	28.
1.01	7.15	87	.07	.06	.01	82.	1.01	19.15	231	.02	.02	.00	28.
1.01	7.20	88	.07	.06	.01	83.	1.01	19.20	232	.02	.02	.00	28.
1.01	7.25	89	.07	.06	.01	83.	1.01	19.25	233	.02	.02	.00	28.
1.01	7.30	90	.07	.06	.00	83.	1.01	19.30	234	.02	.02	.00	28.
1.01	7.35	91	.07	.06	.00	84.	1.01	19.35	235	.02	.02	.00	28.
1.01	7.40	92	.07	.06	.00	84.	1.01	19.40	236	.02	.02	.00	28.
1.01	7.45	93	.07	.06	.00	84.	1.01	19.45	237	.02	.02	.00	28.
1.01	7.50	94	.07	.06	.00	84.	1.01	19.50	238	.02	.02	.00	28.
1.01	7.55	95	.07	.06	.00	85.	1.01	19.55	239	.02	.02	.00	28.
1.01	8.00	96	.07	.06	.00	85.	1.01	20.00	240	.02	.02	.00	28.
1.01	8.05	97	.07	.06	.00	85.	1.01	20.05	241	.02	.02	.00	28.
1.01	8.10	98	.07	.06	.00	85.	1.01	20.10	242	.02	.02	.00	28.
1.01	8.15	99	.07	.06	.00	86.	1.01	20.15	243	.02	.02	.00	28.
1.01	8.20	100	.07	.06	.00	86.	1.01	20.20	244	.02	.02	.00	28.
1.01	8.25	101	.07	.06	.00	86.	1.01	20.25	245	.02	.02	.00	28.
1.01	8.30	102	.07	.06	.00	86.	1.01	20.30	246	.02	.02	.00	28.
1.01	8.35	103	.07	.06	.00	86.	1.01	20.35	247	.02	.02	.00	28.
1.01	8.40	104	.07	.06	.00	86.	1.01	20.40	248	.02	.02	.00	28.
1.01	8.45	105	.07	.06	.00	87.	1.01	20.45	249	.02	.02	.00	28.
1.01	8.50	106	.07	.06	.00	87.	1.01	20.50	250	.02	.02	.00	28.
1.01	8.55	107	.07	.06	.00	87.	1.01	20.55	251	.02	.02	.00	28.
1.01	9.00	108	.07	.06	.00	87.	1.01	21.00	252	.02	.02	.00	28.
1.01	9.05	109	.07	.06	.00	87.	1.01	21.05	253	.02	.02	.00	28.

1.01	8.50	106	.07	.06	.00	87.	1.01	20.50	250	.02	.02	.00	28.
1.01	8.55	107	.07	.06	.00	87.	1.01	20.55	251	.02	.02	.00	28.
1.01	9.00	108	.07	.06	.00	87.	1.01	21.00	252	.02	.02	.00	28.
1.01	9.05	109	.07	.06	.00	87.	1.01	21.05	253	.02	.02	.00	28.
1.01	9.10	110	.07	.06	.00	87.	1.01	21.10	254	.02	.02	.00	28.
1.01	9.15	111	.07	.06	.00	87.	1.01	21.15	255	.02	.02	.00	28.
1.01	9.20	112	.07	.06	.00	87.	1.01	21.20	256	.02	.02	.00	28.
1.01	9.25	113	.07	.07	.00	87.	1.01	21.25	257	.02	.02	.00	28.
1.01	9.30	114	.07	.07	.00	88.	1.01	21.30	258	.02	.02	.00	28.
1.01	9.35	115	.07	.07	.00	88.	1.01	21.35	259	.02	.02	.00	28.
1.01	9.40	116	.07	.07	.00	88.	1.01	21.40	260	.02	.02	.00	28.
1.01	9.45	117	.07	.07	.00	88.	1.01	21.45	261	.02	.02	.00	28.
1.01	9.50	118	.07	.07	.00	88.	1.01	21.50	262	.02	.02	.00	28.
1.01	9.55	119	.07	.07	.00	88.	1.01	21.55	263	.02	.02	.00	28.
1.01	10.00	120	.07	.07	.00	88.	1.01	22.00	264	.02	.02	.00	28.
1.01	10.05	121	.07	.07	.00	88.	1.01	22.05	265	.02	.02	.00	28.
1.01	10.10	122	.07	.07	.00	88.	1.01	22.10	266	.02	.02	.00	28.
1.01	10.15	123	.07	.07	.00	88.	1.01	22.15	267	.02	.02	.00	28.
1.01	10.20	124	.07	.07	.00	88.	1.01	22.20	268	.02	.02	.00	28.
1.01	10.25	125	.07	.07	.00	88.	1.01	22.25	269	.02	.02	.00	28.
1.01	10.30	126	.07	.07	.00	88.	1.01	22.30	270	.02	.02	.00	28.
1.01	10.35	127	.07	.07	.00	88.	1.01	22.35	271	.02	.02	.00	28.
1.01	10.40	128	.07	.07	.00	88.	1.01	22.40	272	.02	.02	.00	28.
1.01	10.45	129	.07	.07	.00	88.	1.01	22.45	273	.02	.02	.00	28.
1.01	10.50	130	.07	.07	.00	89.	1.01	22.50	274	.02	.02	.00	28.
1.01	10.55	131	.07	.07	.00	89.	1.01	22.55	275	.02	.02	.00	28.
1.01	11.00	132	.07	.07	.00	89.	1.01	23.00	276	.02	.02	.00	28.
1.01	11.05	133	.07	.07	.00	89.	1.01	23.05	277	.02	.02	.00	28.
1.01	11.10	134	.07	.07	.00	89.	1.01	23.10	278	.02	.02	.00	28.
1.01	11.15	135	.07	.07	.00	89.	1.01	23.15	279	.02	.02	.00	28.
1.01	11.20	136	.07	.07	.00	89.	1.01	23.20	280	.02	.02	.00	28.
1.01	11.25	137	.07	.07	.00	89.	1.01	23.25	281	.02	.02	.00	28.
1.01	11.30	138	.07	.07	.00	89.	1.01	23.30	282	.02	.02	.00	28.
1.01	11.35	139	.07	.07	.00	89.	1.01	23.35	283	.02	.02	.00	28.
1.01	11.40	140	.07	.07	.00	89.	1.01	23.40	284	.02	.02	.00	28.
1.01	11.45	141	.07	.07	.00	89.	1.01	23.45	285	.02	.02	.00	28.
1.01	11.50	142	.07	.07	.00	89.	1.01	23.50	286	.02	.02	.00	28.
1.01	11.55	143	.07	.07	.00	89.	1.01	23.55	287	.02	.02	.00	28.
1.01	12.00	144	.07	.07	.00	89.	1.02	.00	288	.02	.02	.00	28.
								SUM		33.02	32.13	.89	63217.
										(839.)(816.)(23.)(1223.77)			

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2450.	475.	150.	150.	43228.
CMS	69.	13.	4.	4.	1224.
INCHES		25.42	32.10	32.10	32.10
MM		645.55	815.28	815.28	815.28
AC-FT		236.	298.	298.	298.
THOUS CU M		291.	367.	367.	367.

HYDROGRAPH AT STA 1 FOR PLAN 1, RT10 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	245.	48.	15.	15.	4323.
CMS	7.	1.	0.	0.	122.
INCHES		2.56	3.21	3.21	3.21
MM		64.55	81.53	81.53	81.53

CFS	245.	48.	15.	15.	4323.
CMS	7.	1.	0.	0.	122.
INCHES		2.56	3.21	3.21	3.21
MM		64.55	81.53	81.53	81.53

AC-FT	24.	30.	30.	30.
THOUS CU M	29.	37.	37.	37.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	367.	71.	23.	23.	6484.
CMS	10.	2.	1.	1.	184.
INCHES		3.81	4.81	4.81	4.81
MM		96.83	122.29	122.29	122.29
AC-FT		35.	45.	45.	45.
THOUS CU M		44.	55.	55.	55.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	490.	95.	30.	30.	8646.
CMS	14.	3.	1.	1.	245.
INCHES		5.08	6.42	6.42	6.42
MM		129.11	163.06	163.06	163.06
AC-FT		47.	60.	60.	60.
THOUS CU M		58.	73.	73.	73.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	612.	119.	38.	38.	10807.
CMS	17.	3.	1.	1.	306.
INCHES		6.35	8.02	8.02	8.02
MM		161.39	203.82	203.82	203.82
AC-FT		59.	74.	74.	74.
THOUS CU M		73.	92.	92.	92.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	735.	143.	45.	45.	12968.
CMS	21.	4.	1.	1.	367.
INCHES		7.62	9.63	9.63	9.63
MM		193.66	244.58	244.58	244.58
AC-FT		71.	89.	89.	89.
THOUS CU M		87.	110.	110.	110.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 6

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 6

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	857.	166.	53.	53.	15130.
CMS	24.	5.	1.	1.	428.
INCHES		8.94	11.23	11.23	11.23
MM		225.94	285.35	285.35	285.35
AC-FT		83.	104.	104.	104.
THOUS CU M		102.	129.	129.	129.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 7

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1225.	238.	75.	75.	21614.
CMS	35.	7.	2.	2.	612.
INCHES		12.71	16.05	16.05	16.05
MM		322.77	407.64	407.64	407.64
AC-FT		118.	149.	149.	149.
THOUS CU M		145.	184.	184.	184.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 8

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2450.	475.	150.	150.	43226.
CMS	69.	13.	4.	4.	1224.
INCHES		25.42	32.10	32.10	32.10
MM		645.55	815.28	815.28	815.28
AC-FT		236.	298.	298.	298.
THOUS CU M		291.	367.	367.	367.

****

HYDROGRAPH ROUTING

ROUTE THRGUGH SPILLWAY

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

GLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
.0	.000	.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	.000	.000	.000	-665.	0

SURFACE AREA=	0.	11.	20.	35.
CAPACITY=	0.	115.	358.	898.
ELEVATION=	833.	864.	880.	900.

CAPACITY=	0.	115.	358.	898.
ELEVATION=	833.	864.	880.	900.

CREL	SPWID	COGL	EXPW	ELEVL	COQL	CAREA	EXPL
864.9	.0	.0	.0	.0	.0	.0	.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
866.9	.0	.0	0.

CREST LENGTH AT OR BELOW	0.	18.	38.	45.	55.	82.	90.	174.	330.	428.
ELEVATION	864.9	865.6	865.9	866.0	866.4	866.8	866.9	867.4	867.7	868.5

STATION 2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	2.	2.	2.	2.	2.	2.	2.	2.	2.
2.	2.	2.	2.	2.	2.	3.	3.	3.	4.
4.	4.	4.	5.	5.	5.	6.	6.	7.	7.
9.	8.	9.	9.	10.	10.	11.	11.	12.	13.
14.	14.	15.	16.	17.	18.	19.	20.	20.	21.
22.	23.	24.	25.	27.	30.	38.	52.	65.	72.
75.	75.	74.	72.	69.	67.	65.	63.	61.	59.
58.	56.	55.	54.	53.	52.	50.	49.	48.	47.
46.	45.	44.	43.	42.	41.	41.	39.	37.	35.
34.	32.	30.	29.	28.	26.	25.	24.	23.	22.
22.	21.	20.	20.	19.	18.	18.	17.	17.	16.
16.	16.	15.	15.	15.	14.	14.	14.	13.	13.
13.	13.	12.	12.	12.	12.	11.	11.	11.	11.
11.	10.	10.	10.	10.	10.	10.	10.	9.	9.
9.	9.	9.	9.	9.	9.	8.	8.	8.	8.
8.	8.	8.	8.	8.	8.	7.	7.		

STORAGE

125.	125.	125.	125.	125.	125.	125.	125.	125.	125.
125.	125.	125.	125.	125.	125.	125.	125.	125.	125.
125.	125.	125.	125.	125.	125.	125.	125.	125.	125.
125.	125.	125.	125.	125.	125.	125.	125.	125.	125.
125.	125.	125.	125.	125.	125.	125.	125.	125.	125.
125.	125.	125.	125.	125.	125.	125.	125.	125.	125.
125.	125.	125.	125.	125.	125.	125.	125.	125.	125.
125.	125.	125.	125.	125.	125.	125.	126.	126.	126.
126.	126.	126.	126.	126.	126.	126.	126.	126.	126.

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

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .15	RATIO 3 .20	RATIO 4 .25	RATIO 5 .30	RATIO 6 .35	RATIO 7 .50	RATIO 8 1.00
HYDROGRAPH AT	1	.17	1	245.	367.	490.	612.	735.	857.	1225.	2450.
		(.45)		(6.94)(	10.40)(	13.87)(	17.34)(	20.81)(	24.28)(	34.68)(	69.36)(
ROUTED TO	2	.17	1	75.	143.	214.	294.	383.	478.	825.	2038.
		(.45)		(2.12)(	4.04)(	6.06)(	8.34)(	10.85)(	13.53)(	23.36)(	57.70)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	864.00	864.00	866.90
STORAGE	125.	125.	149.
OUTFLOW	0.	0.	246.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	866.21	.00	140.	75.	.00	16.00	.00
.15	866.55	.00	144.	143.	.00	15.92	.00
.20	866.80	.00	148.	214.	.00	15.83	.00
.25	867.03	.13	150.	294.	.42	15.83	.00
.30	867.22	.32	153.	383.	.67	15.83	.00
.35	867.38	.48	155.	478.	.63	15.83	.00
.50	867.78	.88	160.	825.	1.25	15.75	.00
1.00	868.51	1.61	170.	2038.	5.25	15.75	.00

END

DATE
FILMED

11-81

DTIC