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NATIONAL DAM SAFETY PROGRAM. BELL LAKE DAM (MO 10606), MISSOURI--ETC(U)
SEP 78 D P GUPTA, B A AINSWORTH, H L CALLAHAN DACW43-78-C-0148
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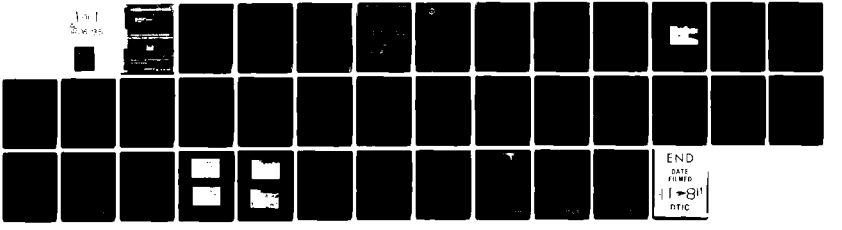

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Clay County, Missouri

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This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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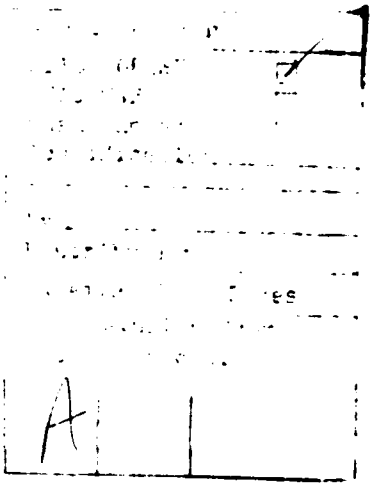
MISSOURI-KANSAS CITY BASIN

BELL LAKE DAM
CLAY COUNTY, MISSOURI
MO 10606

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

SEPTEMBER 1978

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Bell Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Bell Lake Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED
Chief, Engineering Division — 2 FEB 1979 — Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer — 2 FEB 1979 — Date

BELL LAKE DAM

CLAY COUNTY, MISSOURI

MISSOURI INVENTORY NO. 10606

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

SEPTEMBER 1978

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Bell Lake Dam
State Located	Missouri
County Located	Clay County
Stream	Tributary to First Creek
Date of Inspection	26 September 1978

Bell Lake Dam was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. 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.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as an intermediate size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers failure would threaten the life and property of approximately three families and four groups of farm buildings downstream of the dam and would potentially cause appreciable damage to State Highway 92 and the bridge of one improved road within the estimated damage zone which extends 2 miles downstream of the dam.

Our inspection and evaluation indicates the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will not pass the probable maximum flood without overtopping but will pass 25 percent of the probable maximum flood, which is greater than the estimated 100-year flood. The spillway design flood recommended by the guidelines is 100 percent of the probable maximum flood. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meterologic and hydrologic conditions that are reasonably possible in the region.

Deficiencies visually observed by the inspection team were erosion, sloughing of the riprap, sloughing of the upstream embankment, erosion of the discharge channel, undercutting of the concrete exit apron, and the presence of excessive brush and trees on the downstream embankment slope. 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 Lake and Dam

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BELL 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 Bell 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 a tributary to First Creek in northwestern Clay County, Missouri (Plate 1). Topography of the contributing watershed is characterized by rolling hills. The higher areas of the watershed consist of Sharpsburg and Higginsville soils which are loess. Moving down the slopes are Armster and Gara soils. The Armster is formed where the clayey, weathered till surface is exposed. The Gara is downslope from Armster where none of the weathered till remains. The last soil types are the Gosport and Sogn soils which are restricted to steep slopes or bluffs adjacent to streams. Gosport soils have shallow depths to shale bedrock. Sogn soils are shallow to limestone. The watershed is primarily comprised of residential areas and farmland. Topography in the vicinity of the dam is shown on Plate 2.

(2) A concrete chute spillway was constructed near the left abutment which empties into a discharge channel consisting of broken shale and limestone with moderate tree covered side slope.

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

b. Location. The dam is located in northwestern Clay County, Missouri, as indicated on Plate 1. The lake formed by the dam is shown on the United States Geological Survey 7.5 minute series quadrangle map for Nashua, Missouri in Section 3 of T52N, R33W.

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 intermediate size category.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Bell 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 Bell Lake Dam the flood damage zone extends downstream for 2.0 miles. Within the damage zone are three homes, four groups of farm buildings, State Highway 92 and one improved road crossing.

e. Ownership. The dam is owned by Drs. B. V. Matovich and Nathaniel Winer, 1007 Brentwood Cr., Independence, Missouri 64050.

f. Purpose of Dam. The dam forms a 6-acre recreational lake.

g. Design and Construction History. Data relating to the design and construction were not available.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, and evaporation all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 106 acres

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through an uncontrolled spillway.

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

(3) Estimated ungated spillway capacity at maximum pool elevation 250 cfs (top of Dam El.899.9).

c. Elevation (Feet Above M.S.L.).

(1) Top of dam - 899.9 ± (see Plate 4)

(2) Spillway crest - 897.0

(3) Streambed at toe of dam - 854.0 ±

(4) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 1,000 feet ±

(2) Length of normal pool - 950 feet ±

e. Storage (Acre-feet).

(1) Top of dam - 98

(2) Spillway crest - 76 (from 1974 inventory)

(3) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 9

(2) Spillway crest - 6

g. Dam.

(1) Type - Earth embankment

(2) Length - 575 feet

(3) Height - 46 feet ±

(4) Top width - 18 feet

(5) Side slopes - upstream face nearly vertical, downstream face 1V on 2.3H (see Plate 4)

(6) Zoning - Unknown.

(7) Impervious core - Unknown.

(8) Cutoff - Unknown.

(9) Grout curtain - Unknown.

h. Diversion and Regulating Tunnel - None.

i. Spillway.

(1) Type - Chute.

(2) Width of channel - 17.4 feet.

(3) Crest elevation - 897.0 feet m.s.l.

(4) Gates - None.

(5) Upstream channel - Not applicable.

(6) Downstream channel - Open channel comprised of broken limestone and shale located near the toe of the downstream embankment slope.

j. Regulating Outlets - None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data were unavailable.

2.2 CONSTRUCTION

Construction records were unavailable, however the owners estimated that the dam was built about 1951.

2.3 OPERATION

The maximum recorded loading on the dam is unknown.

2.4 EVALUATION

a. Availability. No engineering data could be obtained.

b. Adequacy. No engineering data were available upon which to make a detailed assessment of the design, construction, and operation. Detailed seepage and stability analyses should be performed as required by the guidelines.

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 Bell Lake Dam was made on 26 September 1978. The inspection team included professional engineers with experience in dam design and construction, hydrology - hydraulic engineering, and structural engineering. 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 items at the dam. The upstream slope of the embankment above the water level is very steep due to erosion and sloughing. The riprap on the upstream face has slid beneath the water level. On the downstream slope erosion has occurred near the spillway. The downstream face is covered with a heavy growth of trees and brush. Some of the trees were observed as being dead. No sloughing or seepage was observed on the downstream embankment.

c. Appurtenant Structures. The inspection team observed the following items pertaining to appurtenant structures. A concrete chute spillway that was constructed near the left abutment appears in fair condition. The spillway is acting as a broad-crested weir. The base of the spillway is concrete with side slope protection of one layer of concrete masonry block (8-inches in height). Above the concrete masonry block no side slope protection is provided and the earth embankment material has been eroded slightly. Undercutting of the concrete exit apron has occurred for approximately three feet causing a transverse crack in the concrete slab just behind where the undercutting stops.

d. Reservoir Area. No slides or excessive erosion due to wave action were observed along the shore of the reservoir.

e. Downstream Channel. Open channel comprised of broken limestone and shale located near the toe of the downstream embankment slope.

3.2 EVALUATION

Remedial action should be taken on the following reservoir conditions, or a serious potential for failure will develop.

(1) Undercutting of the downstream end of the spillway.

(2) Sloughing and erosion on the upstream side of the embankment.

(3) Erosion on the downstream side of the embankment near the spillway.

(4) Heavy tree growth on the downstream slope of the embankment. Indescriminate cutting of large trees could allow the roots to decay and develop a piping problem.

(5) Sloughing of upstream riprap.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, and capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM

Maintenance performed was unknown.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities are known to exist.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

Existing erosion, and sloughing observed on the upstream side of the dam, a heavy growth of trees and vegetation on the downstream side of the dam, undercutting of the downstream end of the spillway, and erosion of the downstream embankment near the spillway increase the potential for failure and warrant repair and regular monitoring.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data pertaining to hydrology and hydraulics were unavailable.

b. Experience Data. The drainage area and lake surface area are developed from USGS Nashua Quadrangle Map. The spillway and dam layouts are from surveys made during the inspection.

c. Visual Observations.

(1) The spillway is in fair condition. The discharge channel and exit apron of the spillway need better slope protection. The concrete exit apron is being undermined.

(2) No facilities are available that could serve to draw down the pool.

(3) A spillway and exit channel are located near the left abutment. Spillway discharges may endanger the integrity of the dam due to the fact that overflow from the spillway has caused erosion of the embankment material.

d. Overtopping Potential. The spillway will not pass the probable maximum flood, which is the spillway design flood recommended by the guidelines, 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 spillway will pass 25 percent of the probable maximum flood without overtopping the dam. This flood is greater than the 100-year flood estimated to be 300 cfs according to the methodology outlined by the USGS in "Technique for Estimating the Magnitude and Frequency of Missouri Floods". According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of intermediate size should pass 100 percent of the probable maximum flood. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 1,400 cfs of the total discharge from the reservoir of 1,900 cfs. The estimated duration of overtopping is 4.6 hours with a maximum height of 1.4 feet. The portion of the estimated peak discharge of 50 percent of the probable maximum flood overtopping the dam would be 490 cfs of the total discharge of the reservoir of 780 cfs. The estimated duration of overtopping is 0.8 hours. Failure of upstream water impoundments shown on the 1975 revised USGS map would not have a significant impact on the hydrologic or hydraulic analysis.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately 2 miles downstream of the dam. There are three homes four groups of farm buildings, State Highway 92, and one improved road crossing downstream of the dam which could be severely damaged and lives could be lost should failure of the dam occur.

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. Detailed seepage and stability analysis should be performed as required by the guidelines.

c. Operating Records. No operational records exist.

d. Post Construction Changes. No known post construction changes.

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: The important factors being embankment and foundation material classification and shear strengths; abutment materials, conditions, and strength; 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 items noted during the visual inspection by the inspection team which should be monitored or controlled are movement of upstream riprap, sloughing of the upstream embankment slope, erosion of the downstream slope near the spillway, undercutting of the concrete exit apron, and an uncontrolled stand of brush and trees on the downstream embankment slope.

b. Adequacy of Information. Due to the lack 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. Due to the lack of data, detailed analyses of the dam comparable in scope to the requirements of Chapter 4 of the Recommended Guidelines should be performed.

c. Urgency. It is the opinion of the inspection team that a program should be developed as soon as possible to implement remedial measures recommended in paragraph 7.2b. If the safety deficiencies listed in paragraph 7.1a are not corrected, they will continue to deteriorate and lead to a serious potential of failure.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam or identify any serious dangers that would require a Phase II investigation.

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 was 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 present spillway has the capacity to pass 25 percent of the probable maximum flood without overtopping the dam. In order to pass 100 percent of the probable maximum flood as required by the Recommended Guidelines, the spillway size and/or height of dam would need to be increased. It is the opinion of the inspection team that the freeboard above the spillway crest is inadequate when compared to current design practices.

b. O&M Maintenance and Procedures. The following O&M maintenance and procedures are recommended:

(1) Check the downstream face of the dam periodically for seepage and stability problems. If seepage flows are observed or sloughing on the downstream embankment slope is noted, the dam should immediately be inspected and the condition evaluated by an engineer experienced in design and construction of earthen dams.

(2) Due to the density and large size of the trees on the downstream slope of the dam, an engineer experienced in the maintenance and design of earthen dams should be retained to recommend procedures to control the growth of the trees and establish proper slope protection.

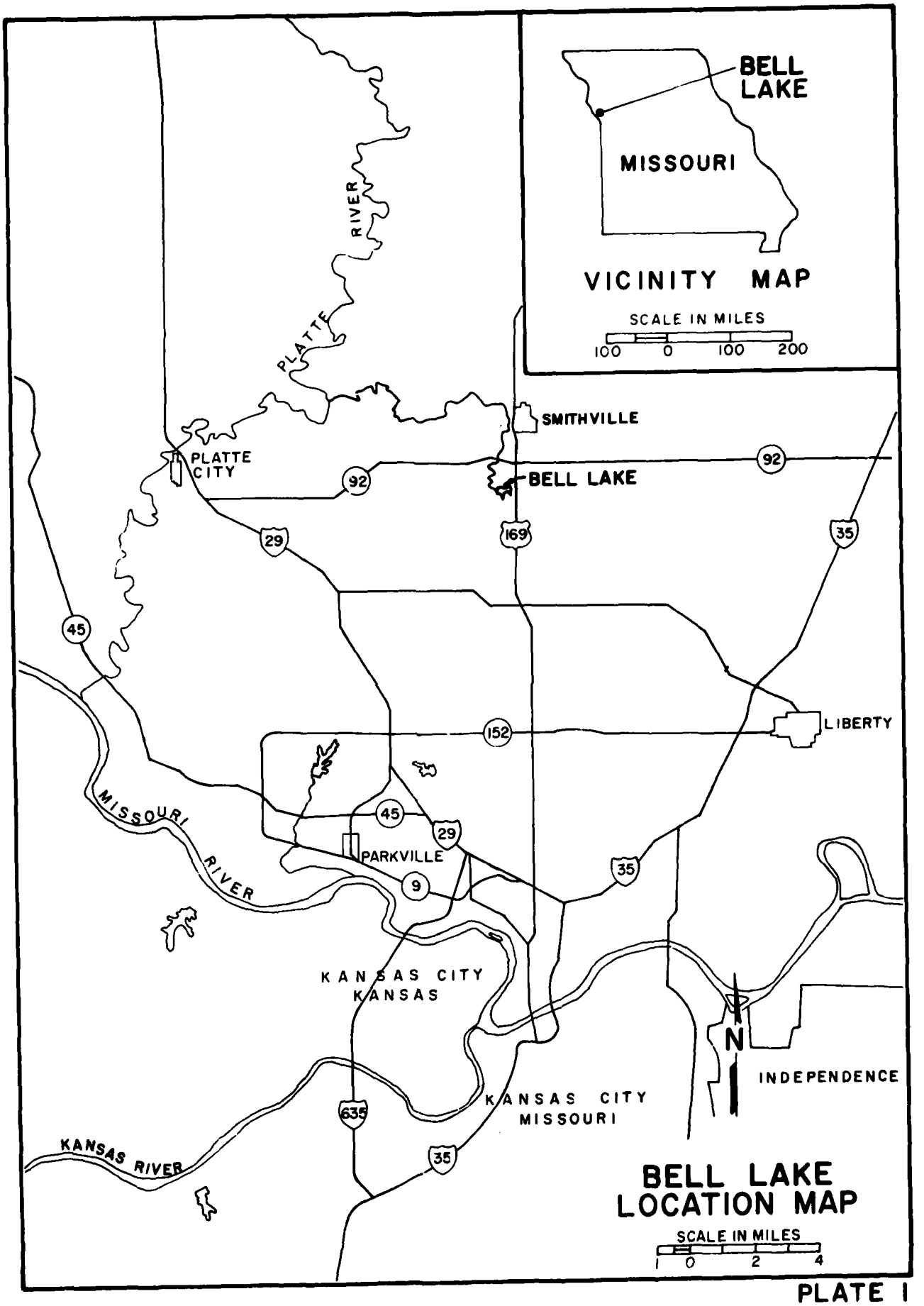
(3) The side slopes of the spillway discharge channel should be protected from erosion especially near the dam embankment to prevent additional erosion and undermining of the dam embankment.

(4) An engineer experienced in the design and construction of earth dams should be retained to develop procedures to prevent further undermining of the spillway exit apron.

(5) Erosion protection should be added on the upstream slope to take the place of the riprap that slid into the lake. This protection is needed to prevent erosion of the embankment material due to wave action.

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

(7) A detailed inspection of the dam should be made at least every year by an engineer experienced in design and construction of dams. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increases.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SMITHVILLE
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MISSOURI RIVER
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635
KANSAS RIVER
BELL LAKE LOCATION MAP
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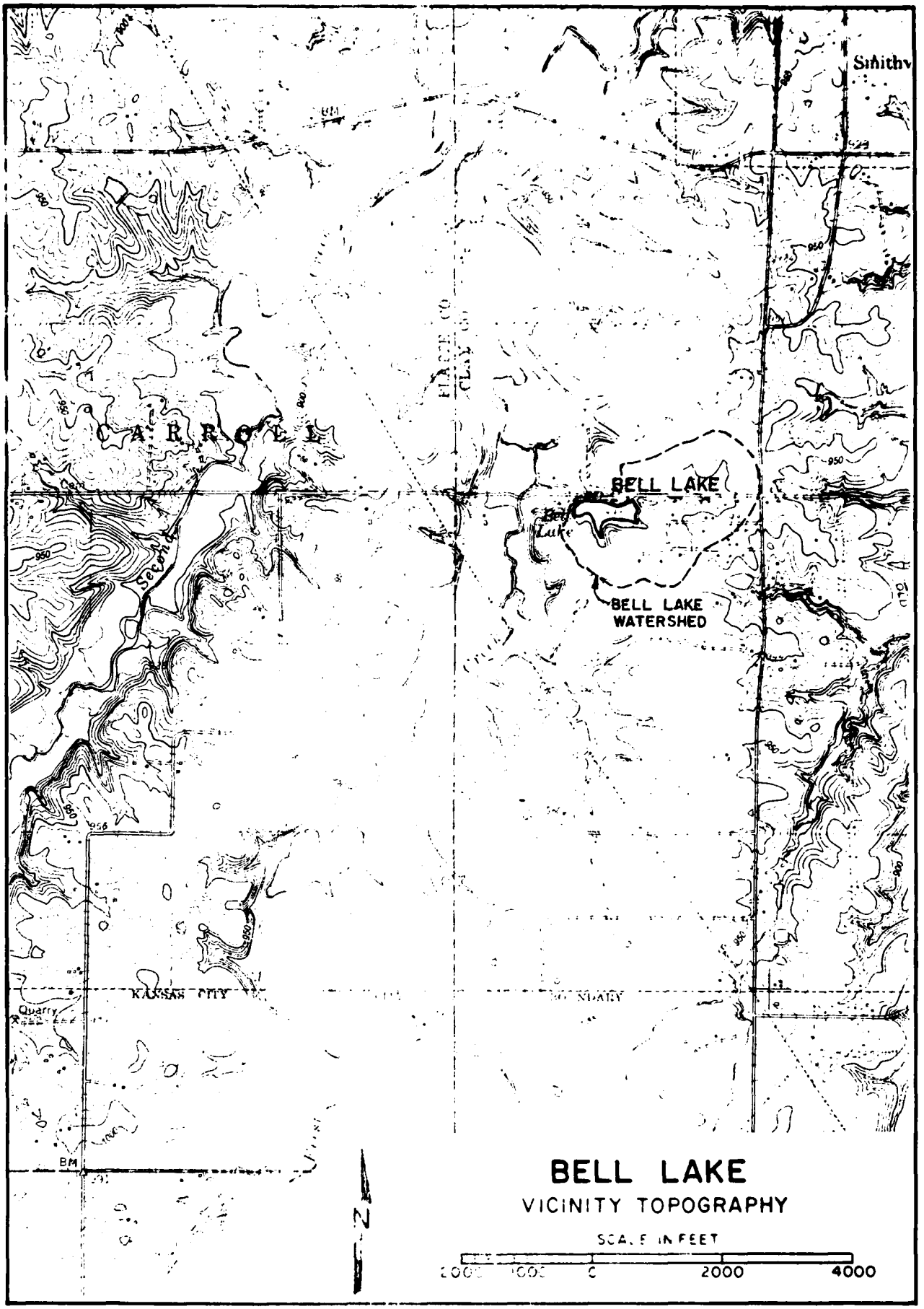
0 2 4

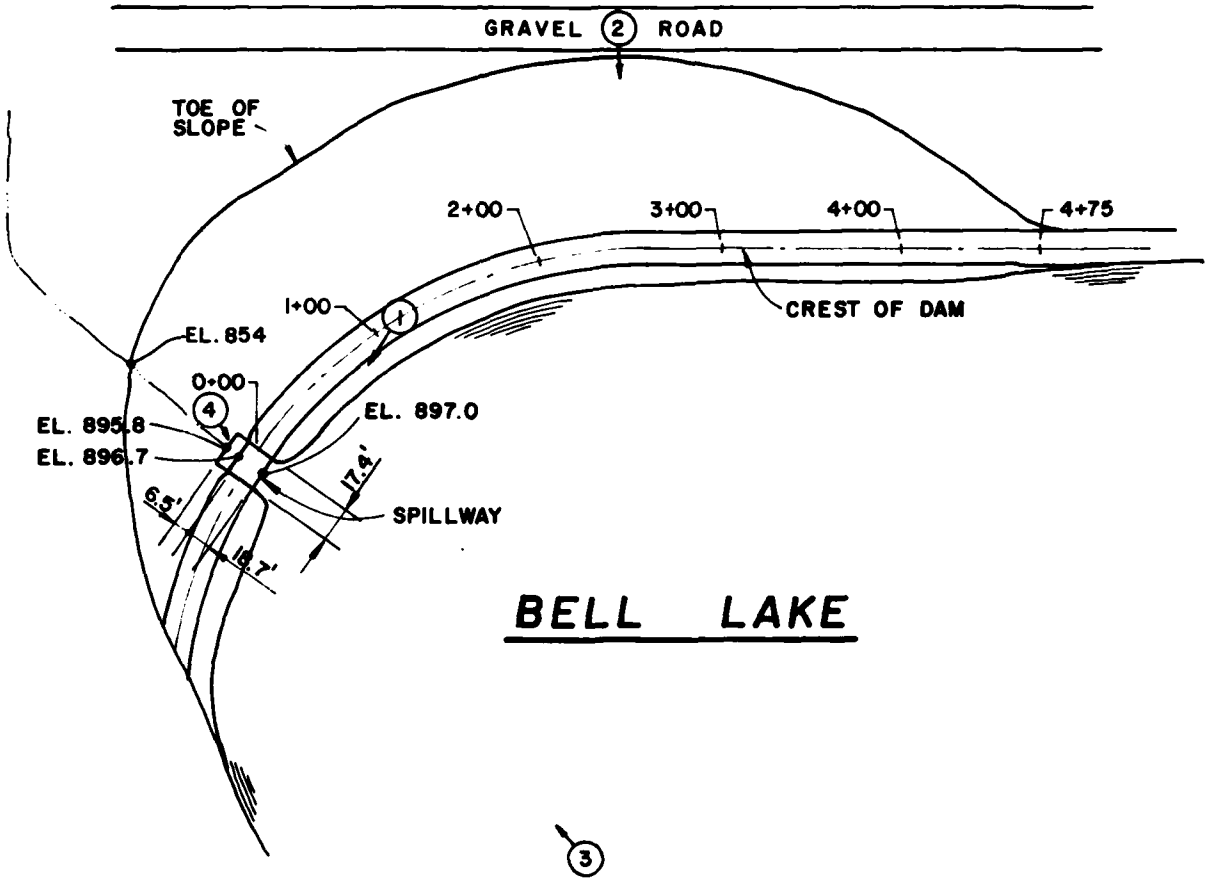
PLATE 1



BELL LAKE

VICINITY TOPOGRAPHY

PLATE 2



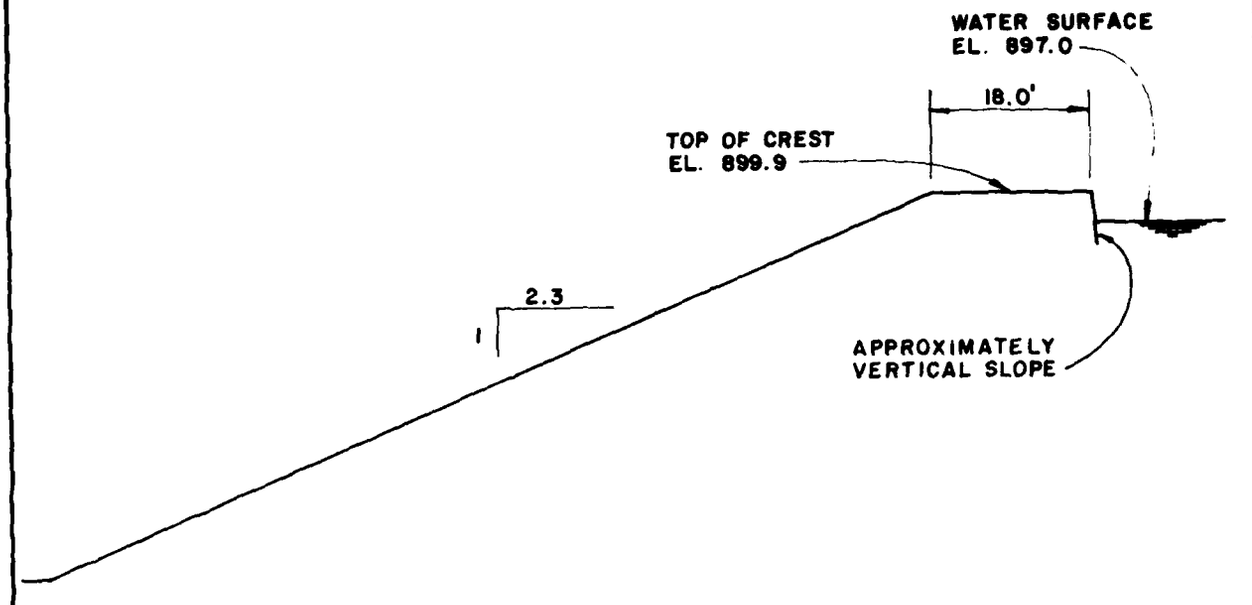
LEGEND

(1)→ NUMBER AND DIRECTION OF PHOTOGRAPHS

N

BELL LAKE
PLAN

PLATE 3



BELL LAKE
SECTION

PLATE 4

PHOTO 1: Upstream Face of Dam (Looking West)

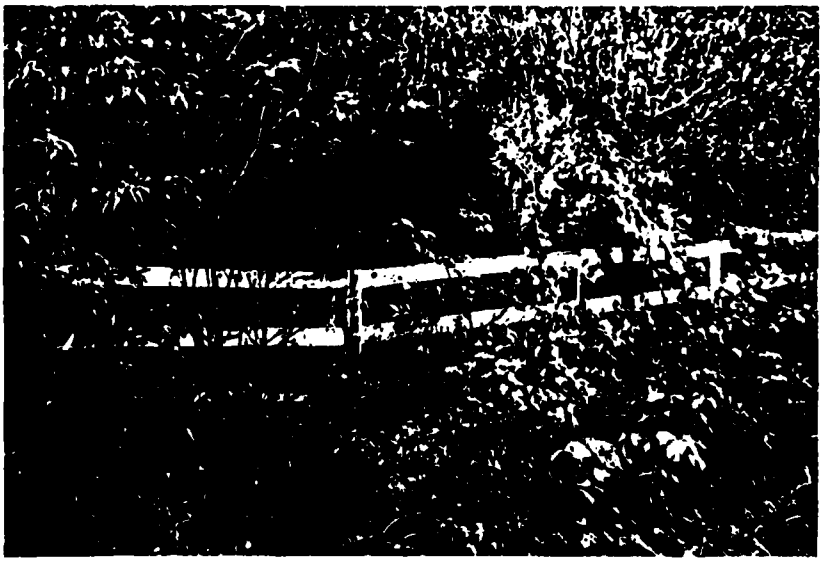


PHOTO 2: Typical Vegetation on Downstream Embankment

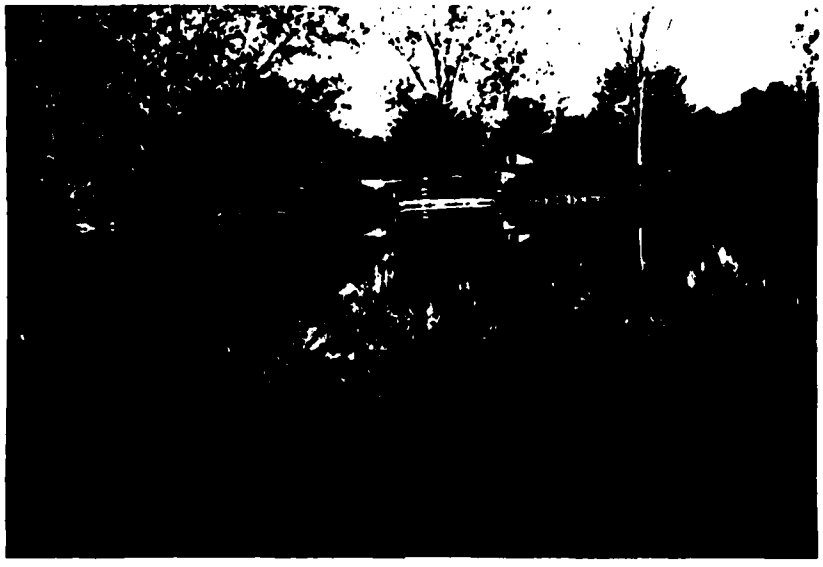


PHOTO 3: Looking Downstream at Spillway Area

PHOTO 4: Undercutting of Spillway Slab

APPENDIX A

HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

1. The Soil Conservation Service (SCS) dimensionless unit hydrograph and HEC-1 (1) were used to develop the inflow hydrographs (see Plates A-1, A-2, and A-3), and hydrologic inputs are as follows:

a. Twenty-four hour, probable maximum precipitation determined from U.S. Weather Bureau Hydrometeorological Report No. 33.

200 square mile, 24 hour rainfall inches	- 24.5
10 square mile, 6 hour percent of 24 hour 200 square mile rainfall	- 101%
10 square mile, 12 hour percent of 24 hour 200 square mile rainfall	- 120%
10 square mile, 24 hour percent of 24 hour 200 square mile, rainfall	- 130%

b. Drainage area = 106 acres.

c. Time of concentration: $Tc = (11.9 \times L^3/H)^{0.385}$ = 0.18 hours = 11 minutes (L = length of longest watercourse in miles, H = elevation difference in feet) (2)

d. Losses were determined in accordance with SCS methods for determining runoff using a curve number of 86 and antecedent moisture condition III. The hydrologic soil groups in the basin where B, C, and D.

2. Spillway release rates are based on the broad-crested weir equation.

Broad-crested weir equation:

$Q = CLH^{1.5}$ (C = 2.9, L = 17.4 feet, H is the head on weir).

Discharge rates over the top of the dam are also based on the broad-crested weir equation:

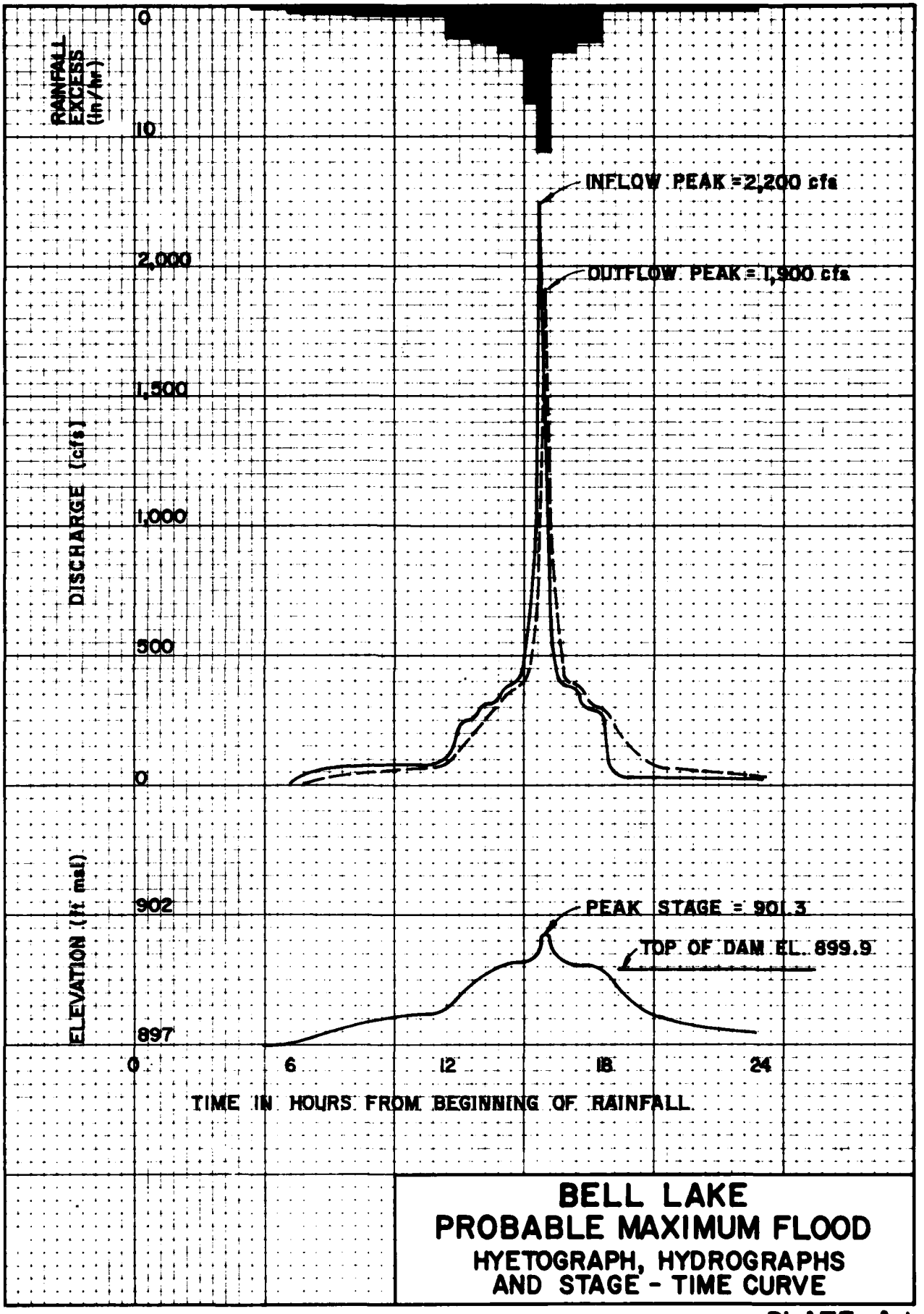
$Q = CLH^{1.5}$ (C = 2.5, L = 30 to 575 feet).

3. The elevation-storage relationship above normal pool elevation was constructed by planimetering the area enclosed within each contour above normal pool. The storage between two elevations was computed by multiplying the average of the areas at the two elevations by the elevation difference. The summation of these increments below a given elevation is the storage below that level.

4. Floods are routed through the spillway using HEC-1, modified Puls to determine the capability of the spillway. Inflow and outflow hydrographs are shown on Plates A-1, A-2, and A-3.

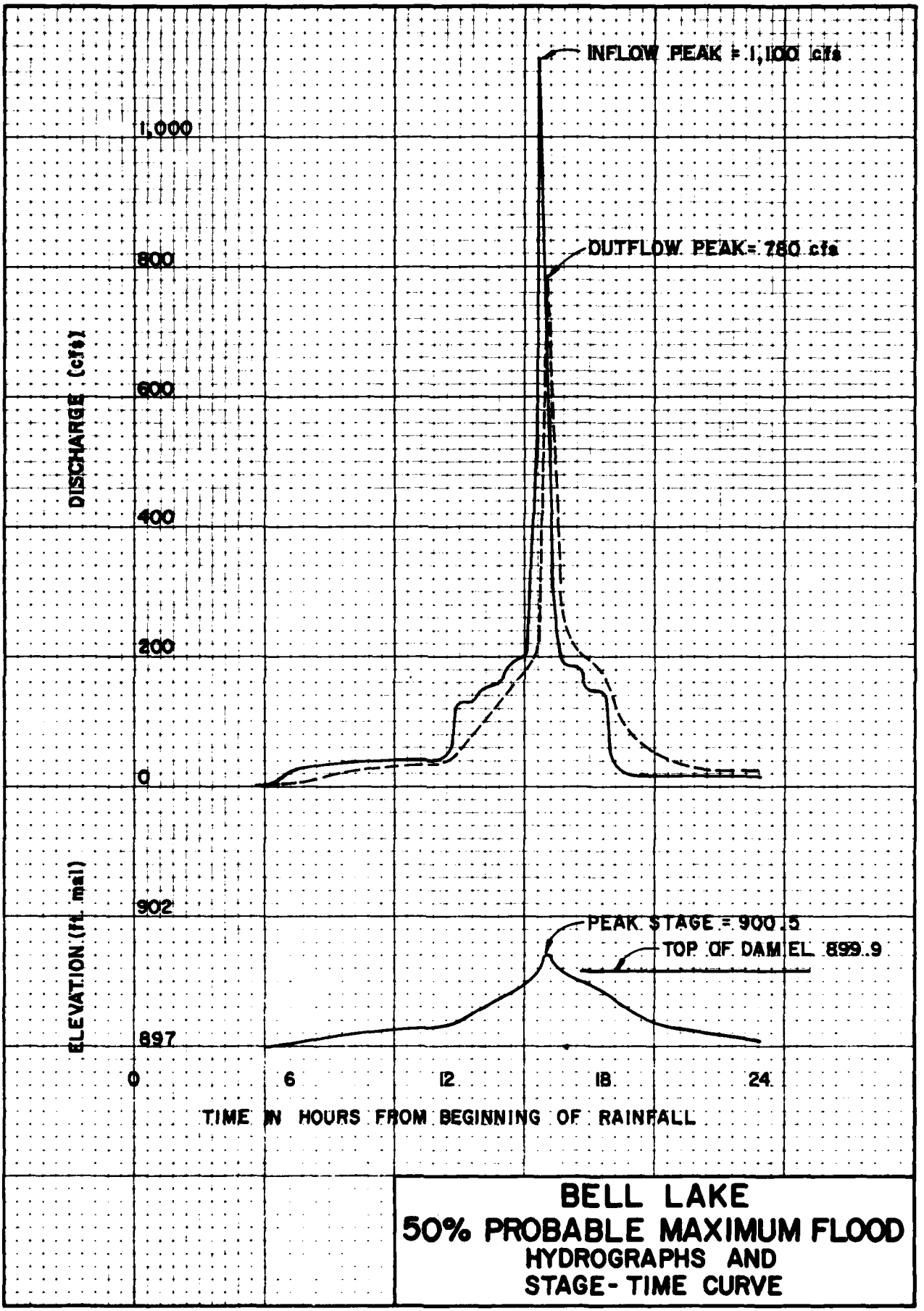
(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Davis, California.

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



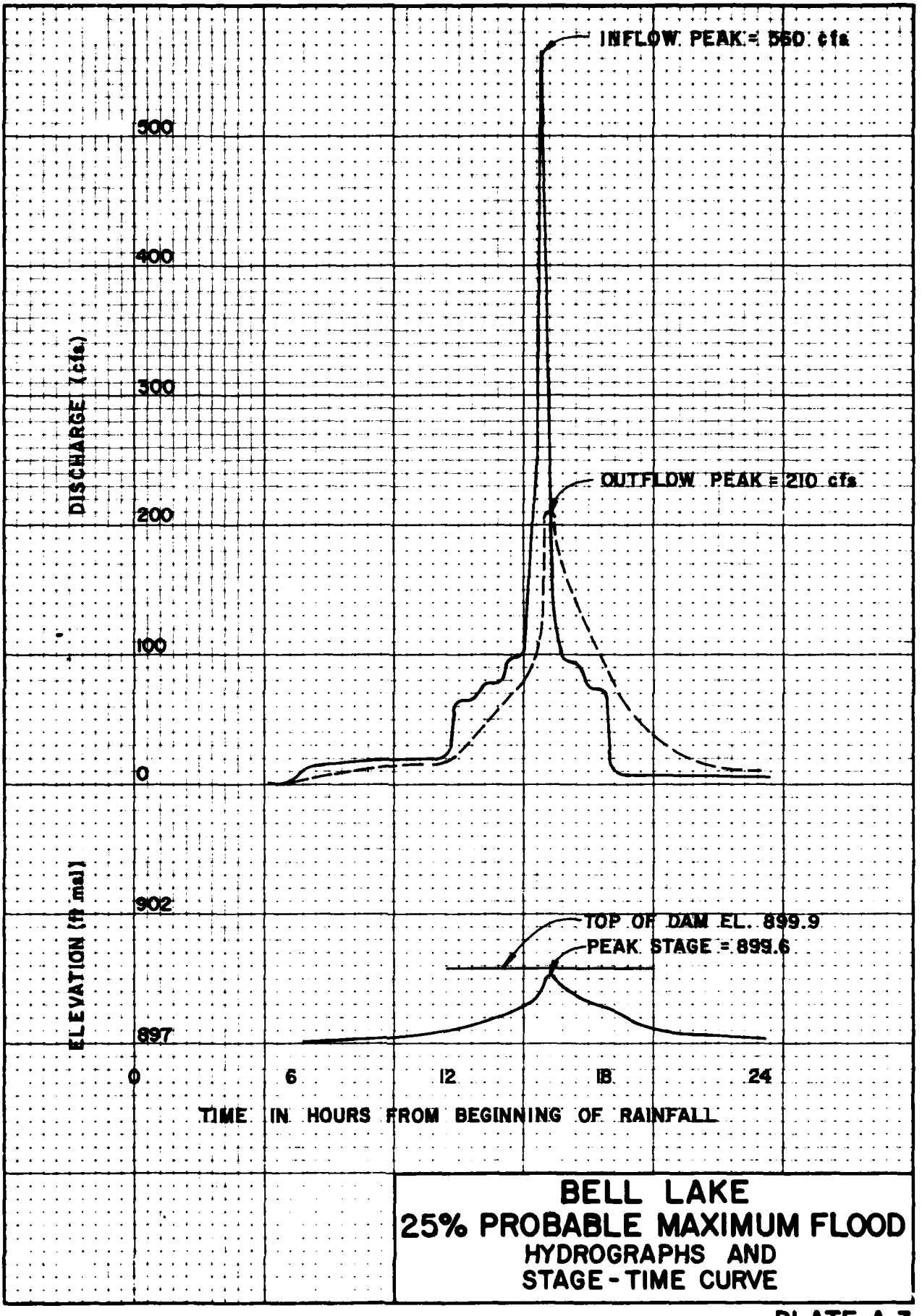
BELL LAKE
PROBABLE MAXIMUM FLOOD
HYETOGRAPH, HYDROGRAPHS AND STAGE - TIME CURVE

PLATE A-1



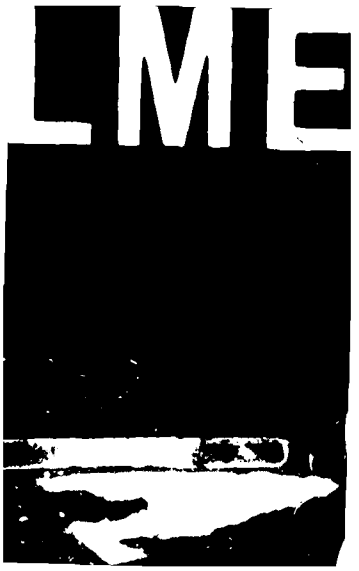
BELL LAKE
50% PROBABLE MAXIMUM FLOOD
HYDROGRAPHS AND STAGE-TIME CURVE

PLATE A-2



BELL LAKE
25% PROBABLE MAXIMUM FLOOD
HYDROGRAPHS AND STAGE - TIME CURVE

PLATE A-3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