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NATIONAL DAM SAFETY PROGRAM. LAKE LOTAWANA DAM (MO 20040), MISS--ETC(U)
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Jackson 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

LAKE LOTAWANA DAM
JACKSON COUNTY, MISSOURI
MO. 20040

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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

FOR: STATE OF MISSOURI

AUGUST 1978

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

IN REPLY REFER TO

SUBJECT: Lake Lotawana Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lake Lotawana dam:

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass 50 percent of the Probable Maximum Flood.
2) Overtopping could result in dam failure.
3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — 28 SEP 1973
Chief, Engineering Division — Date

APPROVED BY: _____ — 29 SEP 1973
Colonel, CE, District Engineer — Date

LAKE LOTAWANA DAM

JACKSON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 20040

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

AUGUST 1978

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Lake Lotawana Dam
State Located	Missouri
County Located	Jackson County
Stream	West Fork of Sni-A-Bar Creek
Date of Inspection	24 August 1978

Lake Lotawana 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 10 families downstream of the dam and would potentially cause appreciable damage to the bridges of three improved roads within the first 3 miles of the estimated damage zone which extends 8 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 pass 30 percent of the probable maximum flood without overtopping.

Deficiencies visually observed by the inspection team were erosion, seepage, and presence of excessive brush and small trees on the downstream embankment slope. Also, the sloughing of the riprap on the upstream embankment slope has contributed to erosion of the embankment material. Seepage and stability analyses are not available as required for dams having the above size and hazard potential as required by the guidelines.

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 prevent additional vegetal growth on the embankment which could lead to the development of potential safety hazards. A detailed report discussing each of these deficiencies follows.

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Black & Veatch

OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE LOTAWANA DAM

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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 Lake Lotawana 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 and 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 the West Fork of Sni-A-Bar Creek in south-east Jackson County, Missouri (see Plate 1). A roadway has been constructed across the top of the dam. Topography of the contributing watershed is characterized by rolling hills. Land use consists of residential areas and farm land. Topography in the vicinity of the dam is shown on Plate 2.

(2) A concrete lined spillway channel was constructed after excavation of the limestone strata in the north abutment. A 7 by 12 feet channel was excavated within the spillway apron to permit lake drawdown of 7 feet during the reconstruction of the dam crest and downstream face. A vertical lift gate was provided to prohibit flow into the 7 by 12 feet channel. The lift mechanism and gate have been welded in place and are not operable.

(3) A wooden decked bridge crosses the spillway at the north abutment and a paved road continues across the dam. The bridge consists of a wooden deck supported by seven concrete piers (see Plate 3).

(4) A 3.5 inch siphon used to supply water to the fish hatchery ponds immediately downstream of Lake Lotawana is located approximately at the mid-point of the dam (see Plate 3).

(5) French drains have been located within the embankment and connected to perforated pipes running parallel to the longitudinal axis of the dam. Drain pipes connected to the perforated pipe extend downstream of the dam at several intervals along the downstream toe of the dam (see Plates 3 and 4).

(6) An 8 inch uncontrolled outlet pipe is located near the south abutment of the dam. The pipe reportedly discharges at all times to maintain flow in the creek below the dam. The alignment of the pipe through the dam is unknown.

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

b. Location. The dam is located in the south-east portion of Jackson 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 maps for Tarsney Lakes and Lake Jacomo, Missouri in Sections 29, 30, 31, and 32, T48N, R30W and Section 5, T47N, R30W.

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 as assigned by the Corps of Engineers is as follows: The Lake Lotawana Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, serious damage to homes, extensive agricultural, industrial and commercial facilities, important public utilities, main highways or railroads. For the Lake Lotawana Dam, the flood damage zone extends 8 miles downstream of the dam. Within the damage zone are ten homes, a fish hatchery and three improved road bridges.

e. Ownership. The dam is owned by the Lake Lotawana Association, Inc., Route 4, Lake Lotawana, Missouri 64063.

f. Purpose of Dam. The dam forms a 512-acre recreational lake. Water is supplied to the fish hatchery below the dam by means of a 3.5 inch siphon.

g. Design and Construction History. The original dam was designed by O.C. Sheley, Independence, Missouri in December, 1927. Construction reportedly began in 1928. Date of initial water impoundment is unknown. Improvements to the dam were designed by Charles A. Haskins, Consulting Engineer, Kansas City, Missouri in 1944. The improvements reportedly began in 1945.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, withdrawals for replenishing the fish hatchery ponds, and discharge from the uncontrolled outlet pipe all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 8,700 acres

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through an uncontrolled spillway and 8 inch uncontrolled outlet pipe near the south abutment. A 3.5 inch diameter siphon discharges water from the lake to the fish hatchery below the dam.

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

(3) Estimated ungated spillway capacity at maximum pool elevation - 7,050 cfs (top of dam).

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

(1) Top of dam - 890.0 ± (see Plate 3)

(2) Spillway crest - 883.0

(3) Streambed at centerline of dam - 845 ±

(4) Maximum tailwater - unknown.

d. Reservoir. Length of maximum pool - 12,000 feet ±

e. Storage (Acre-feet).

(1) Top of dam - 9,000 (from 1973 inventory)

(2) Design Surcharge - not available

f. Reservoir Surface (Acres).

(1) Top of dam - 640

(2) Spillway crest - 512

g. Dam.

(1) Type - earth embankment

(2) Length - 1,900 feet

(3) Height - 45 feet maximum (from 1973 inventory)

(4) Top width - 25 feet

(5) Side Slopes - (see Plate 4)

(6) Zoning - unknown

(7) Impervious Core - Embankment is reportedly constructed of clays typical of the area.

(8) Cutoff - unknown

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel - none.

i. Spillway.

(1) Type - concrete (see paragraph 3.1c)

(2) Width of Spillway - 200 feet (see paragraph 3.1c)

(3) Crest elevation - 883.0 feet m.s.l.

(4) Gates - none. Vertical lift gate at 7 by 12 feet channel is inoperable.

(5) Upstream Channel - none

(6) Downstream Channel - Broken limestone and shale. Side slopes one mile downstream of dam are typical of streams in the area.

j. Regulating Outlets - None. Siphon and uncontrolled outlet pipe are not used as regulating facilities.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design drawings for the original dam were made available by Mrs. Maurice A. Rhen, resident at Lake Lotawana. Improvement design drawings were made available by Clifford Sharp, Consulting Engineer, Shawnee Mission, Kansas. No other design data were available.

2.2 CONSTRUCTION

The original dam was reportedly constructed in 1928 and improvements made in 1945. No additional construction data are available.

2.3 OPERATION

The maximum recorded loading on the dam is unknown. Several post-construction studies have been performed since the impounding of water began. A flood insurance study was prepared for the Federal Insurance Administration by Black & Veatch, Consulting Engineers, Kansas City, Missouri in March, 1978. An inspection of the dam was performed by Woodward-Clyde Consultants, Kansas City, Missouri with a letter report submitted on May 4, 1978.

2.4 EVALUATION

a. Availability. Engineering data in the form of as-built drawings were made available from Clifford Sharp, Consulting Engineer and Mrs. Maurice A. Rhen, resident. No other engineering data were found. In accordance with section 3.6.1 of the "Recommended Guidelines for Safety Inspection of Dams" seepage and stability analyses should be on file for dams in the High Hazard classification.

b. Adequacy. The engineering data available were inadequate to make a detailed assessment of design, construction, and operation.

c. Validity. The engineering data available were insufficient to determine the validity of the design, construction, and operation.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Lake Lotawana dam was made on 24 August 1978. The inspection team included professional engineers with experience in dam design and construction, hydrologic - hydraulic engineering, and geotechnical 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 upper three feet of the upstream face of the embankment did not have riprap protection. Also an area of the upstream face extending from the south abutment to approximately 50 feet north of the south abutment was not protected by riprap. Some sloughing of the riprap on the upstream face was observed. This appeared to be due to the steep slope of the embankment. The existing riprap was limestone rock in sizes generally less than 50 pounds. At several locations on the upstream face the embankment material has eroded approximately 1 to 2 feet in depth leaving the riprap to bridge over the eroded area. An erosion ditch was observed along the upstream side of the south abutment. The surface material on the downstream side of the embankment and the south abutment was loose and uncompacted. This material is sloughing and eroding. Erosion and moist soil conditions in this same area indicate the presence of seepage through the south abutment. A heavy growth of brush and trees exist along the downstream toe of slope of the dam. The cast iron discharge pipe near the south abutment has been broken to about 2 feet from the embankment. Only one of the drains provided at the toe of the downstream slope was observed to flow freely. Others were either clogged or could not be observed.

c. Appurtenant Structures. The spillway is a concrete apron with a 7 by 12 feet, concrete lined channel constructed parallel to the north edge of the spillway slab. The spillway apron and channel continue east from the edge of the lake 382 feet to the crest of the curved outlet channel. The spillway then directs its discharge to the south, then drops 5 feet to a shale shelf and stream channel. Areas of small concrete spalls were observed on the spillway apron and outlet channel. Erosion was evident behind the north training wall of the spillway outlet. Minor seepage could be seen coming from a weep hole on the incline of the outlet channel. The weep hole on the vertical face of the outlet channel was dry. Minor erosion was observed in the stream channel. A 3.5 inch diameter siphon located at the mid-point of the dam was operating at the time of the inspection. Extremely moist soil was noted in the area to the south of the fish hatchery pond closest to the siphon on the west side of the creek (downstream channel) (see Plate 3).

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

e. Downstream Channel. Spillway discharge flows over the concrete spillway apron to an excavated shale channel, then to a natural streambed channel. Heavy vegetation and mild slopes typical of streams in the area characterize the area downstream of the spillway (see Photos 9 and 11). A bridge crossing the downstream channel is located within one mile of the spillway (see Photo 13).

3.2 EVALUATION

None of the conditions observed are significant enough to indicate a need for immediate remedial action or a serious potential of failure. However, the erosion on the upstream face should be corrected by placement of additional riprap to prevent continued erosion which will eventually lead to serious potential of failure. The seepage observed at various locations appeared to be minor at its present rate but should be monitored by regular perodic observations. The vegetal growth along the downstream toe of slope if left uncontrolled could lead to the deterioration of the embankment integrity resulting in an increased potential of failure. The partially clogged embankment drains if uncorrected could result in increased saturation of the downstream slope.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, capacity of the uncontrolled spillway, siphon withdrawals, and discharge from the uncontrolled outlet pipe.

4.2 MAINTENANCE OF DAM

Maintenance performed was unknown. Improvements are noted in paragraph 6.1d.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

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 seepage, deterioration of the uncontrolled outlet pipe, and excessive growth of small timber and brush observed on the downstream side of the dam increase the potential for failure and warrant regular monitoring and control.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. As-built drawings of the original dam and improvements made in 1947 were available. Design calculations, construction history, and reports were not available for the previously mentioned drawings. The May, 1978 Woodward-Clyde inspection report and the March, 1978 Black & Veatch flood insurance study were obtained.

b. Experience Data. The drainage area and lake surface area were spillway and dam layout are from surveys made during the inspection and drawings provided by Clifford Sharp and Mrs. Maurice A. Rehn.

c. Visual Observations.

(1) Concrete spillway and the spillway discharge channel are in good condition. Seepage was observed from the weep hole on the inclined face of the spillway outlet at the end of the channel. Minor erosion was noted behind the north training wall of the spillway outlet.

(2) To the inspection teams knowledge no drawdown facilities are available to totally evacuate the pool.

(3) The spillway and outlet channel are located at the north abutment. Spillway releases will not endanger the integrity of the dam.

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 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 existing spillway will pass 30 percent of the probable maximum flood without overtopping. This flood is greater than the 100-year flood estimated according to the Flood Insurance Study for the City of Lake Lotawana, Jackson County, Missouri, U.S. Department of Housing and Urban Development, Federal Insurance Administration, March, 1978. 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 without overtopping. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 44,900 cfs of the total discharge from the reservoir of 56,200 cfs. The overtopping duration is estimated to be 400 minutes. The portion of the estimated peak discharge of 50 percent of the probable maximum flood overtopping the dam would be 11,000 cfs of the total discharge from the reservoir of 19,300 cfs. The overtopping duration is estimated to be 250 minutes.

According to the St. Louis District, Corps of Engineers, the effect from failure of the dam could extend approximately 8 miles downstream of the dam. There are 10 inhabited homes downstream of the dam which could be severely damaged and lives of the inhabitants 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.

c. Operating Records. No operational records exist.

d. Post Construction Changes. In May, 1947, plans were completed by Charles A. Haskins, Consulting Engineer, Kansas City, Missouri for improvements to the Lake Lotawana Dam. A 3.5 inch siphon was buried in the embankment to supply water to the Lake Lotawana fish hatchery. The top 7 feet of the embankment was removed as well as portions of the downstream face to allow for optimum bonding between the original embankment material and berm material used to increase the height of the dam by as well as provide for a milder downstream embankment slope. The concrete channel excavated within the spillway apron was added at this time. Training walls for the spillway outlet downstream of the 7 by 12 feet channel were added later at an unknown time.

e. Seismic Stability. The dam is located in Seismic Zone 1 which is a zone of minor seismic risk. Unless difficult geologic conditions exist, 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 materials and shear strengths; abutment materials, conditions, and strength; embankment zoning; and embankment geometry. 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.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several items were noted during the visual inspection by the inspection team which should be monitored or controlled. Seepage along the spillway outlet channel and south abutment, erosion at the south abutment and upstream face, the uncompacted material, the clogged drain system, and vegetal growth along the downstream face are of concern.

b. Adequacy of Information. Due to the inadequacy of engineering design data, the conclusions in this report were based on performance history, review of drawings, and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Additional data is needed, however, to satisfy the requirements of Section 3.6.1 of the guidelines.

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 7.2 could be accomplished now or delayed until observations of this monitoring program and/or the recommendation of a qualified engineer indicate the necessity of action. 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. Presently immediate action is not considered necessary.

d. Seismic Stability. This dam is located in Seismic Zone 1. Because stability analyses are not available, the seismic stability of the dam cannot be assessed.

7.2 REMEDIAL MEASURES

a. Alternatives. In order to pass the probable maximum flood as required by the Recommended Guidelines, the spillway size and/or height of dam would need to be increased.

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 increased seepage flows are observed or deterioration of the foundations of the embankment noted, the dam should be inspected and the pending condition evaluated by an engineer experienced in design and construction of earthen dams.

(2) Measures to curtail seepage along the spillway and south abutment could be undertaken to minimize water loss and potential hazards.

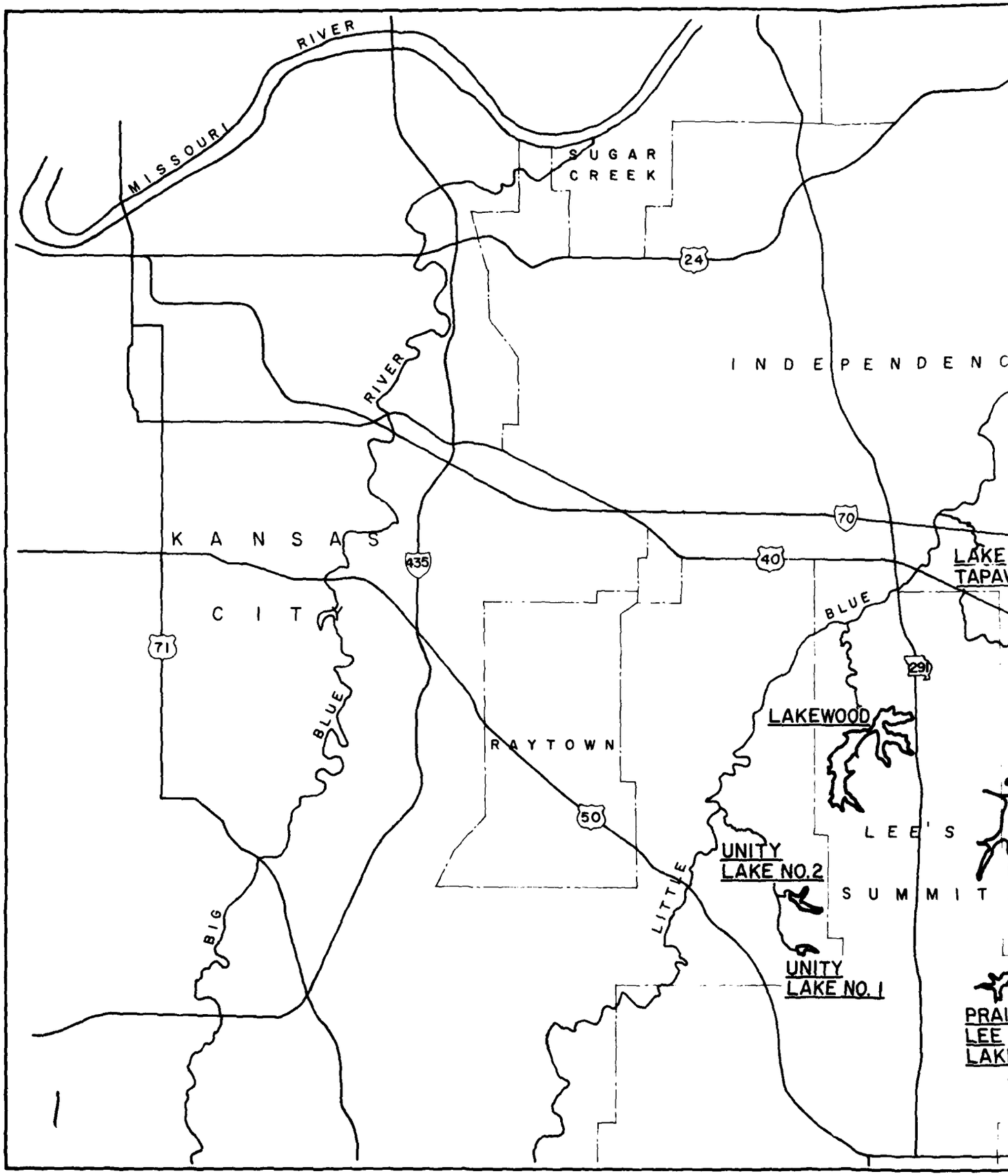
(3) The riprap surface on the upstream face should be repaired to prevent further erosion of embankment material.

(4) The uncontrolled outlet pipe should be repaired and extended from the toe of the embankment slope to prevent further erosion.

(5) The embankment drain outlets should be unclogged and provisions made for the free flow of water from the drains.

(6) A regular maintenance program should be initiated to control the growth on the downstream slope of the dam.

(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 items of distress are observed other than those already mentioned.


MISSOURI RIVER
SUGAR CREEK
24
INDEPENDENC
RIVER
70
KANSAS
435
40
LAKE
TAPAV
CIT
BLUE
71
291
BLUE
LAKEWOOD
RAYTOWN
50
LEE'S
UNITY
LAKE NO.2
SUMMIT
LITTLE
BIG
UNITY
LAKE NO. 1
PRAI
LEE
LAK

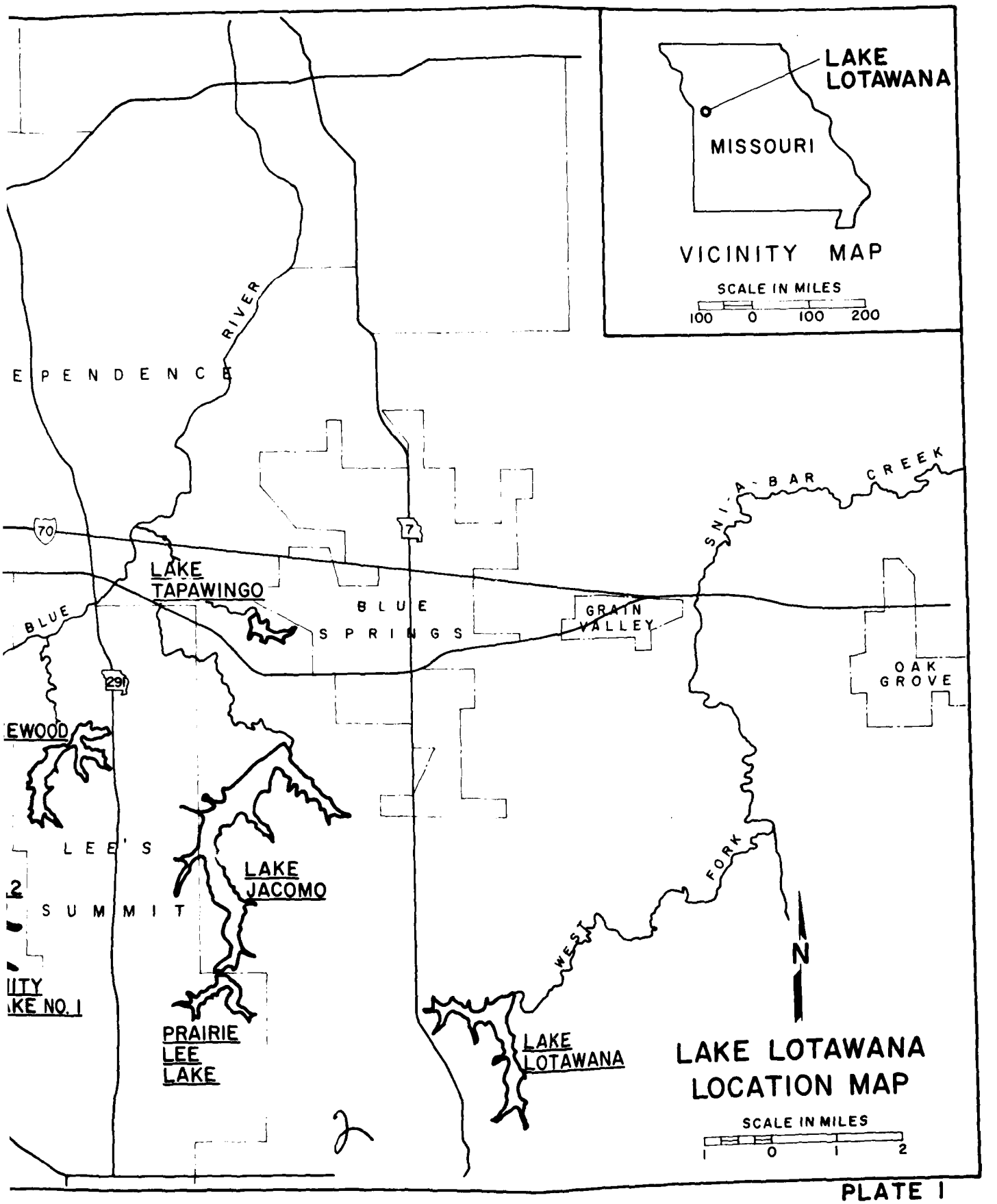

LAKE LOTAWANA
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
RIVER
E P E N D E N C E
SNI-A-BAR CREEK
70
7
LAKE TAPAWINGO
BLUE
BLUE SPRINGS
GRAIN VALLEY
OAK GROVE
291
EWOOD
LEE'S
SUMMIT
LAKE JACOMO
ITY
KE NO. 1
PRAIRIE LEE LAKE
WEST FORK
LAKE LOTAWANA
N
LAKE LOTAWANA LOCATION MAP
SCALE IN MILES
1 0 1 2

PLATE 1

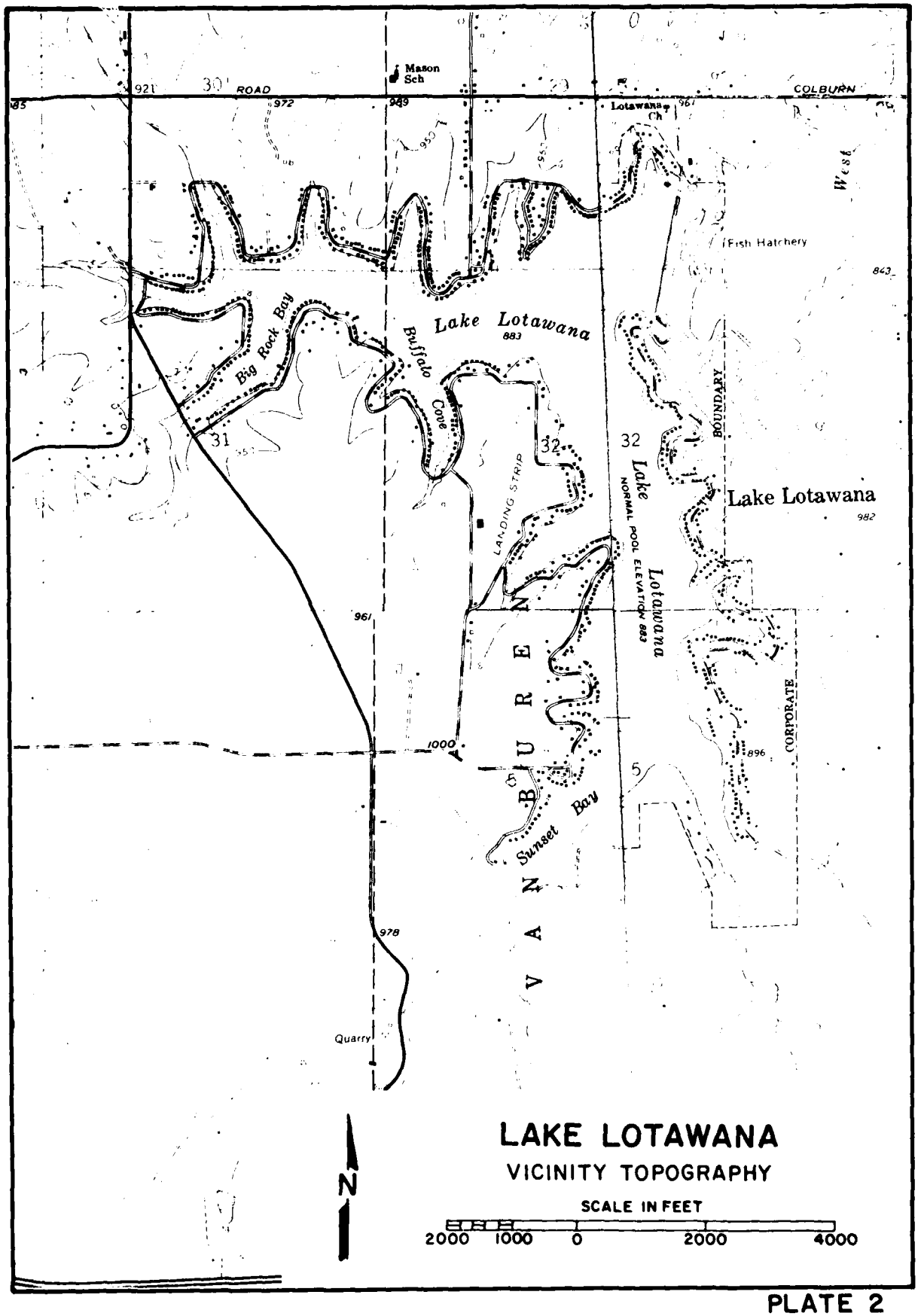
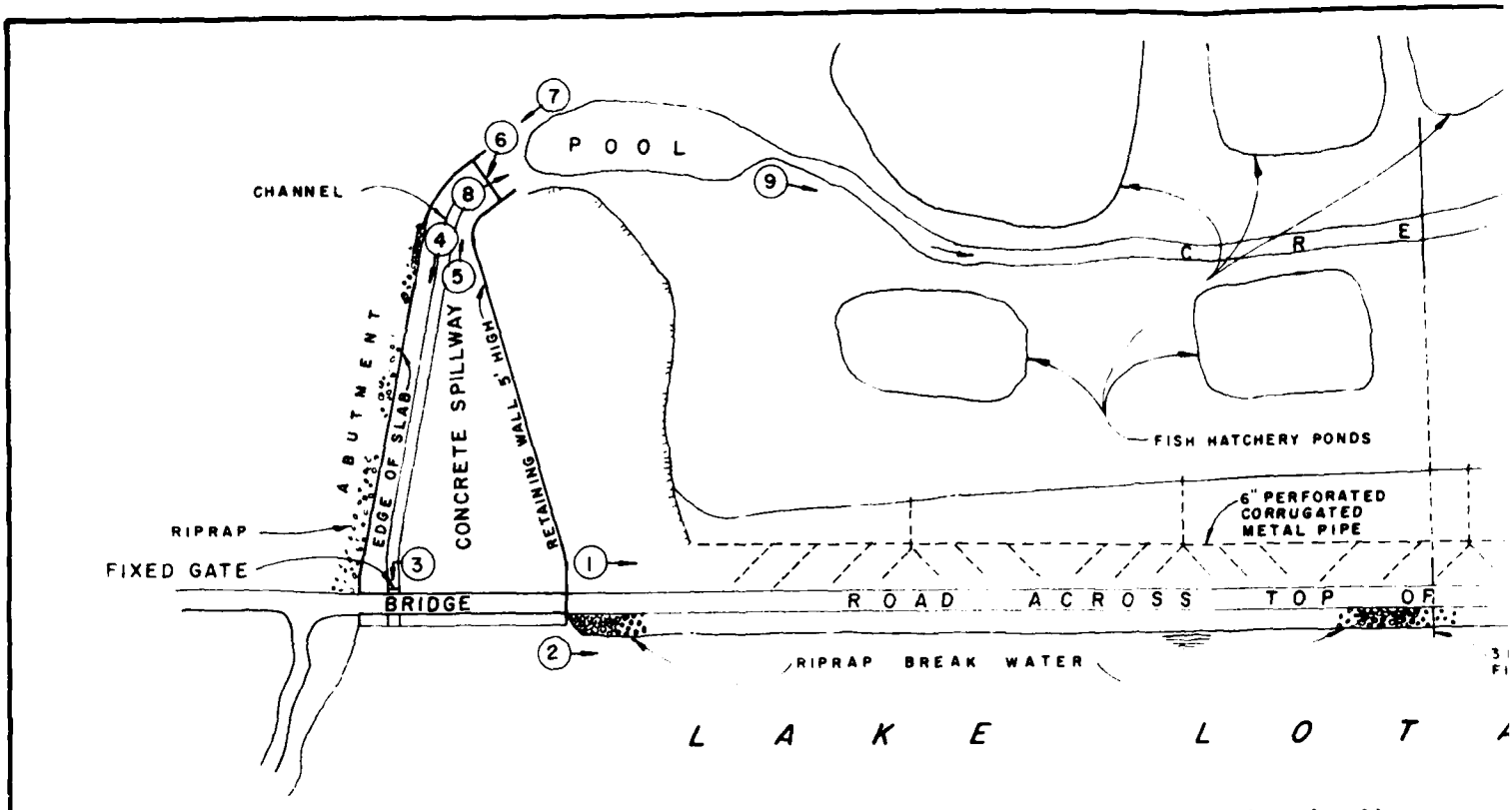
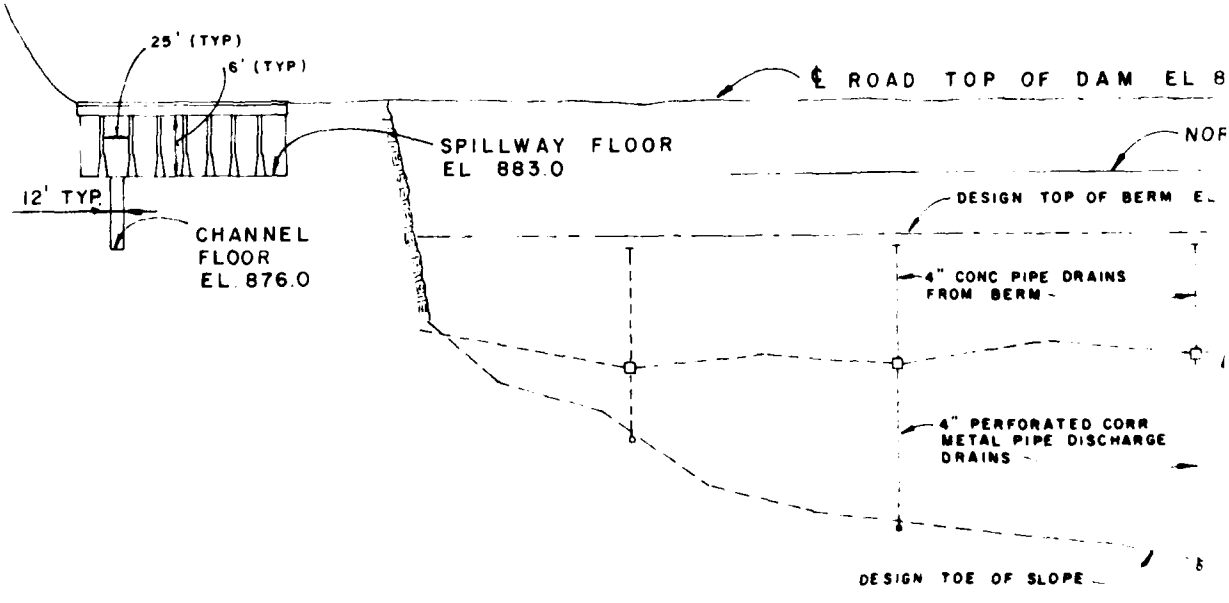

Mason Sch
ROAD
COLBURN
Lotawana
Fish Hatchery
West
Lake Lotawana
883
Big Rock Bay
Buffalo Cove
LANDING STRIP
BOUNDARY
Lake Lotawana
982
NORMAL POOL ELEVATION 883
Lotawana
CORPORATE
VAN BUREN
Sunset Bay
Quarry
31
32
5
921
949
961
1000
978
896
843
N
LAKE LOTAWANA
VICINITY TOPOGRAPHY
SCALE IN FEET
2000 1000 0 2000 4000

PLATE 2

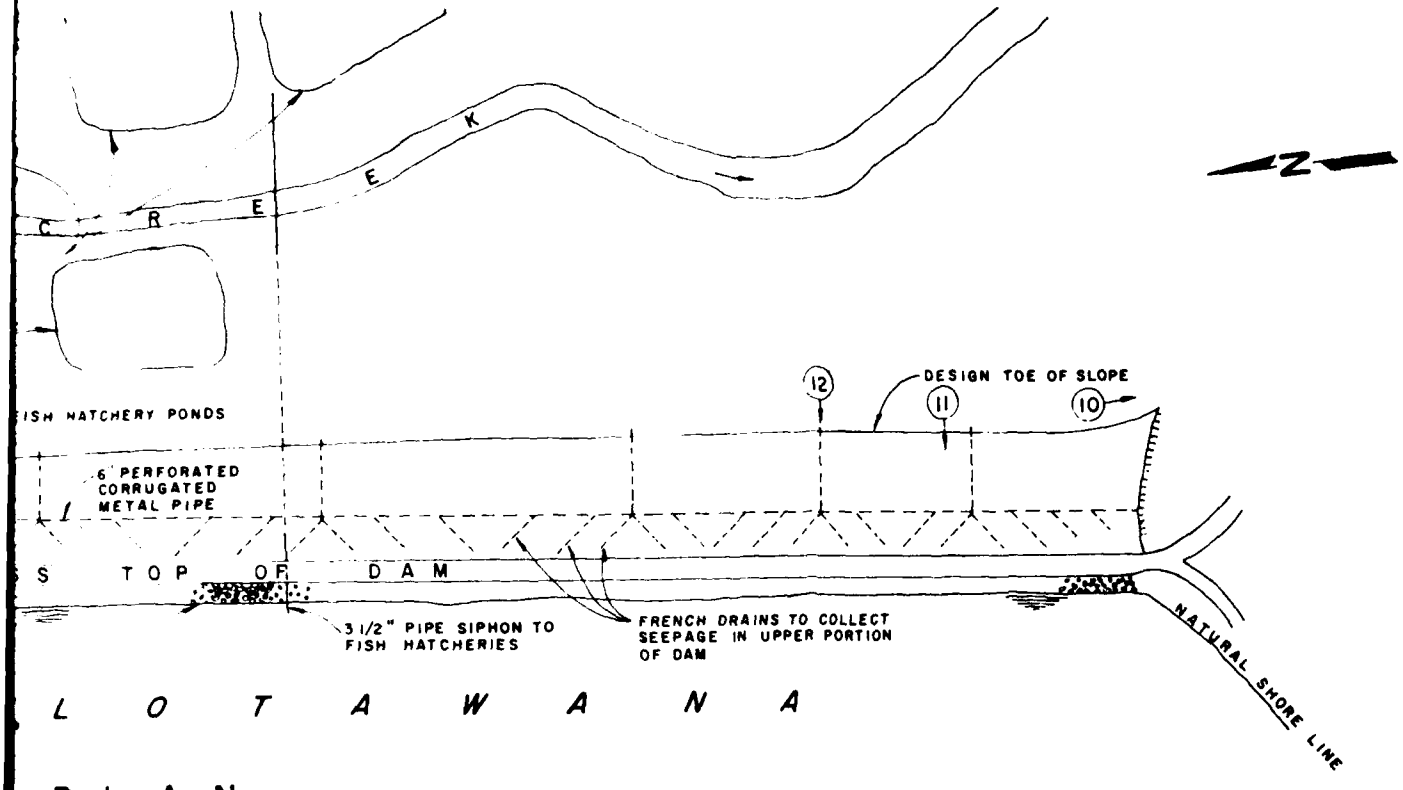


PLAN

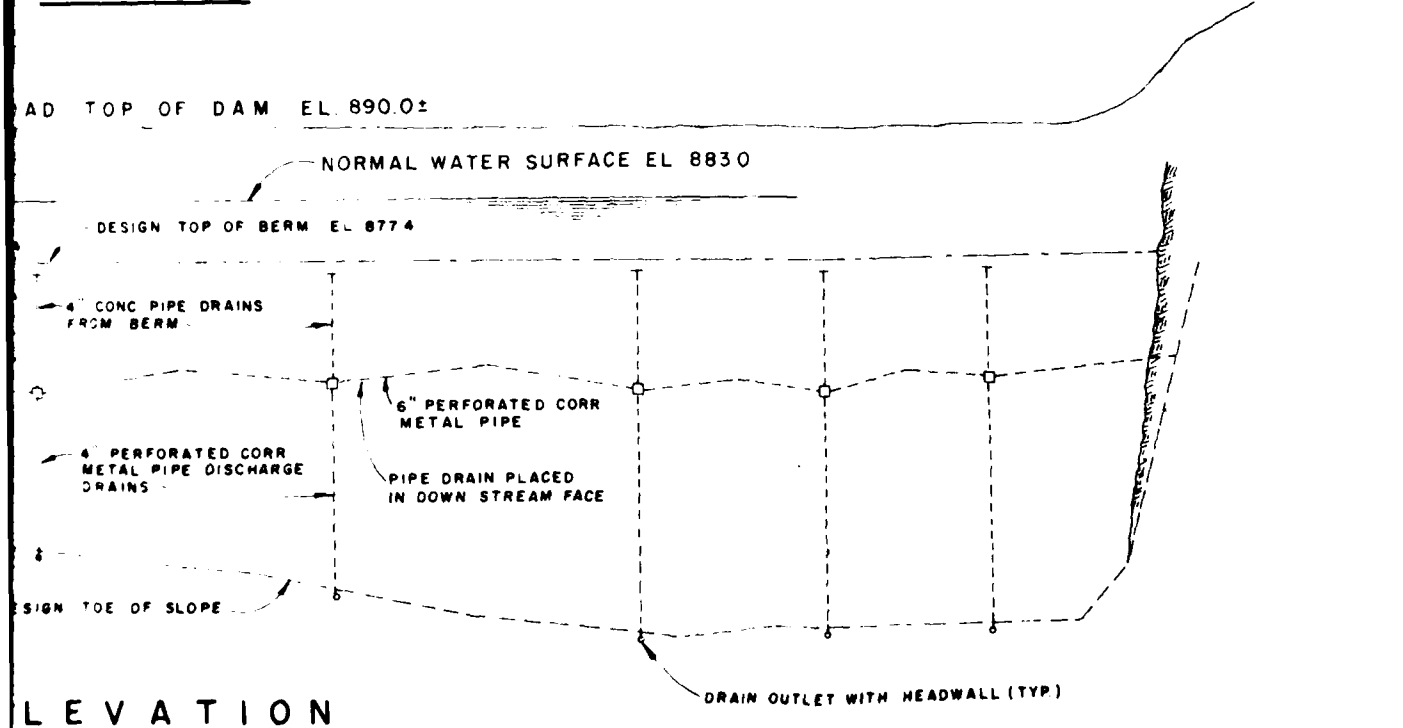


ELEVATION

SCALE RATIO { 1 - HORIZONTAL
10 - VERTICAL



P L A N



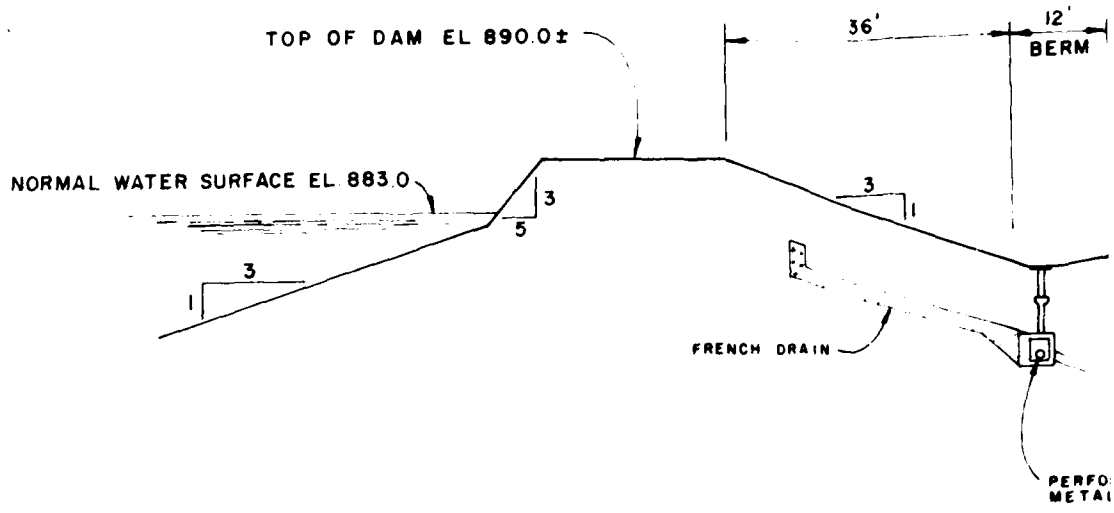
L E V A T I O N

LE RATIO { 1 - HORIZONTAL
10 - VERTICAL

2

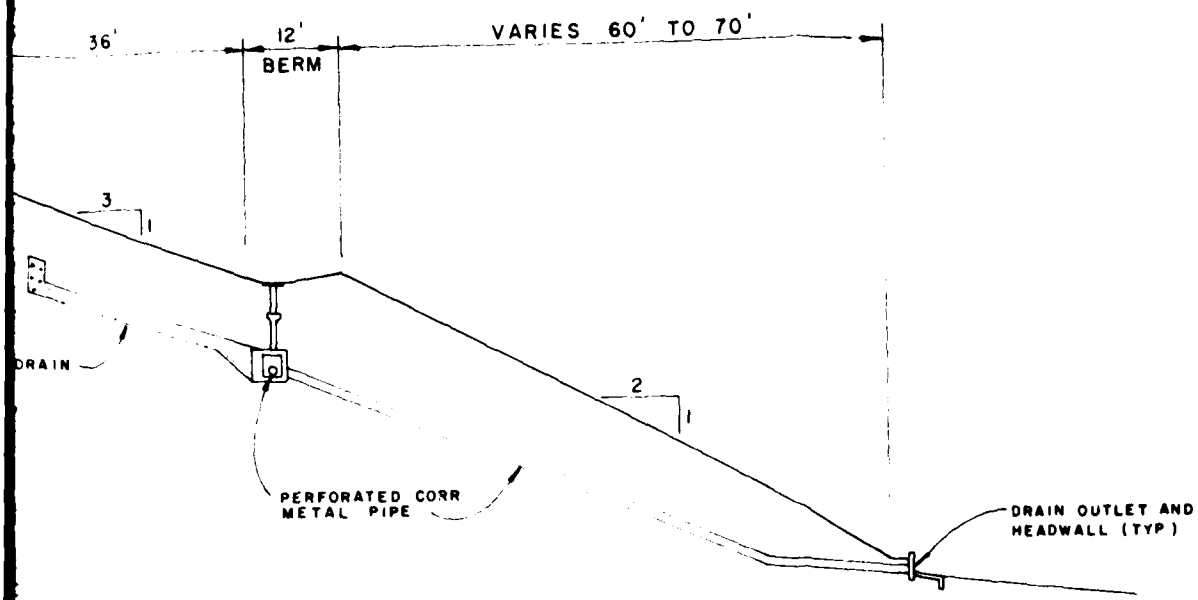
LAKE LOTAWANA
PLAN AND ELEVATION

PLATE 3



TYPICAL SECTION - AS D

(WITH IMPROVEMENTS)



SECTION - AS DESIGNED

(WITH IMPROVEMENTS)

2

LAKE LOTAWANA
SECTION

PLATE 4

PHOTO 1: DOWNSTREAM FACE OF DAM (LOOKING SOUTH)

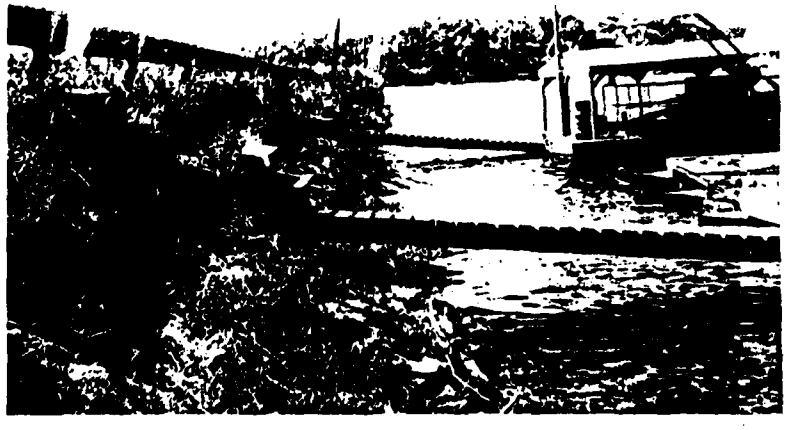


PHOTO 2: UPSTREAM FACE OF DAM (LOOKING SOUTH)

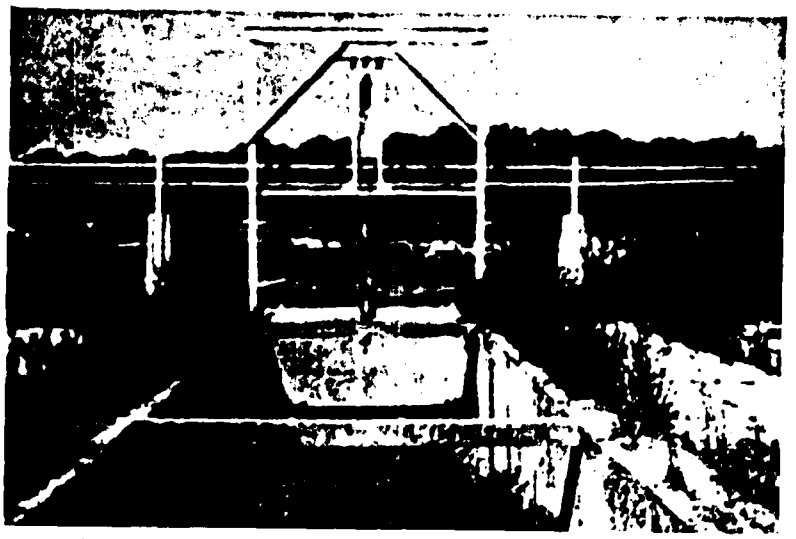


PHOTO 3: VERTICAL LIFT GATE AND BRIDGE OVER SPILLWAY

PHOTO 4: SPILLWAY AND CHANNEL (LOOKING UPSTREAM)

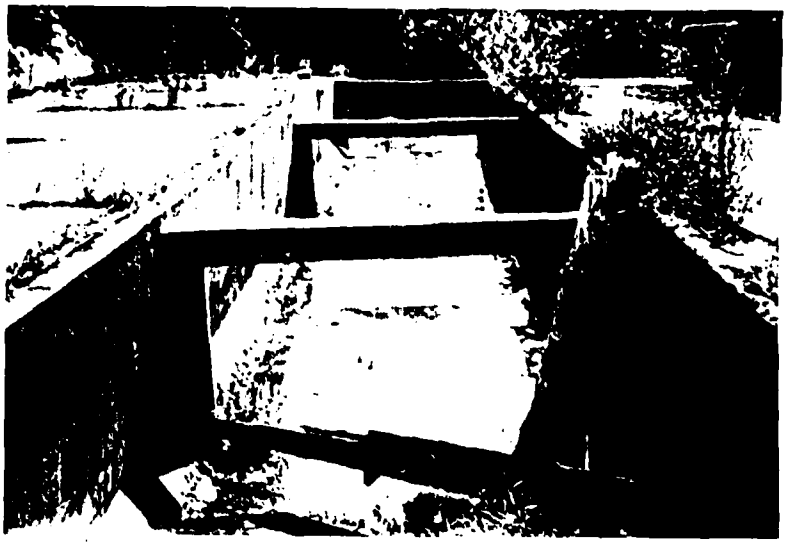


PHOTO 5: SPILLWAY AND CHANNEL (LOOKING DOWNSTREAM)

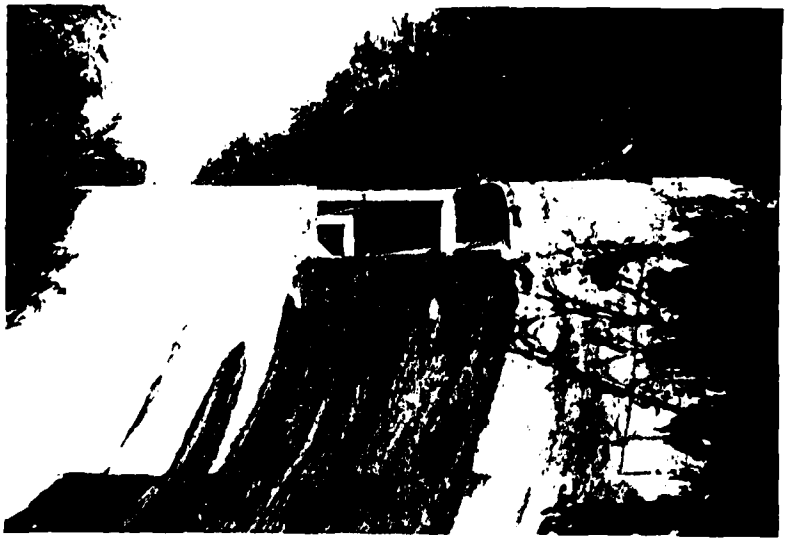


PHOTO 6: SPILLWAY DROP AND END OF CHANNEL (LOOKING UPSTREAM)

PHOTO 7: DISCHARGE CHANNEL AND LEDGE (LOOKING UPSTREAM)

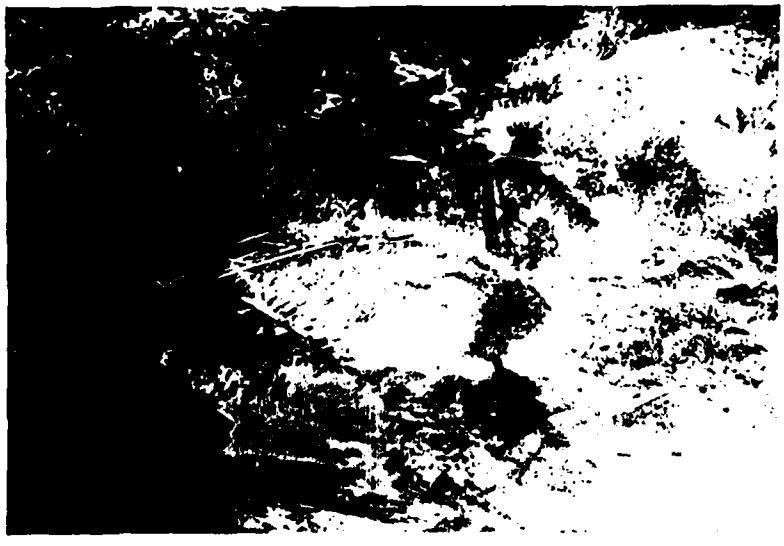


PHOTO 8: DISCHARGE CHANNEL IMMEDIATELY DOWNSTREAM OF SPILLWAY

PHOTO 9: DOWNSTREAM CHANNEL

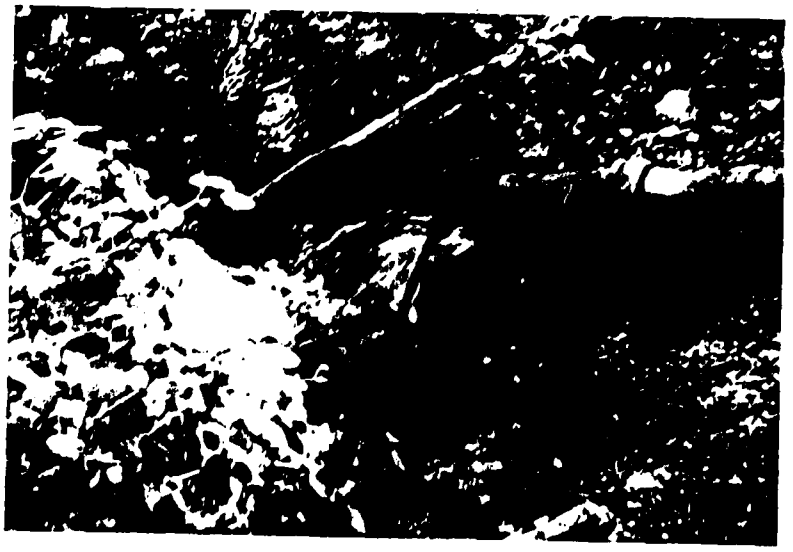


PHOTO 10: UNCONTROLLED OUTLET PIPE AT SOUTH ABUTMENT

PHOTO 11: DOWNSTREAM TOE OF EMBANKMENT

PHOTO 12: DRAIN OUTLET PIPE AND HEADWALL

PHOTO 13: COLBURN ROAD BRIDGE (APPROX. 1 MILE DOWNSTREAM OF DAM)

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 hydrograph (see Plate A-1) 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	- 24.8 inches
10 square mile, 6 hour percent of 24 hour 200 square mile rainfall	- 99%
10 square mile, 12 hour percent of 24 hour 200 square mile rainfall	- 118%
10 square mile, 24 hour percent of 24 hour 200 square mile rainfall	- 127%

b. Drainage area = 8,700 acres.

c. Time of concentration (Tc) = $(11.9 \times L^3/H)^{0.385}$ = 85 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 83 and antecedent moisture condition III.

2. Spillway release rates are based on backwater analysis within the spillway apron using HEC-2_3 with n = 0.02 to 0.03.

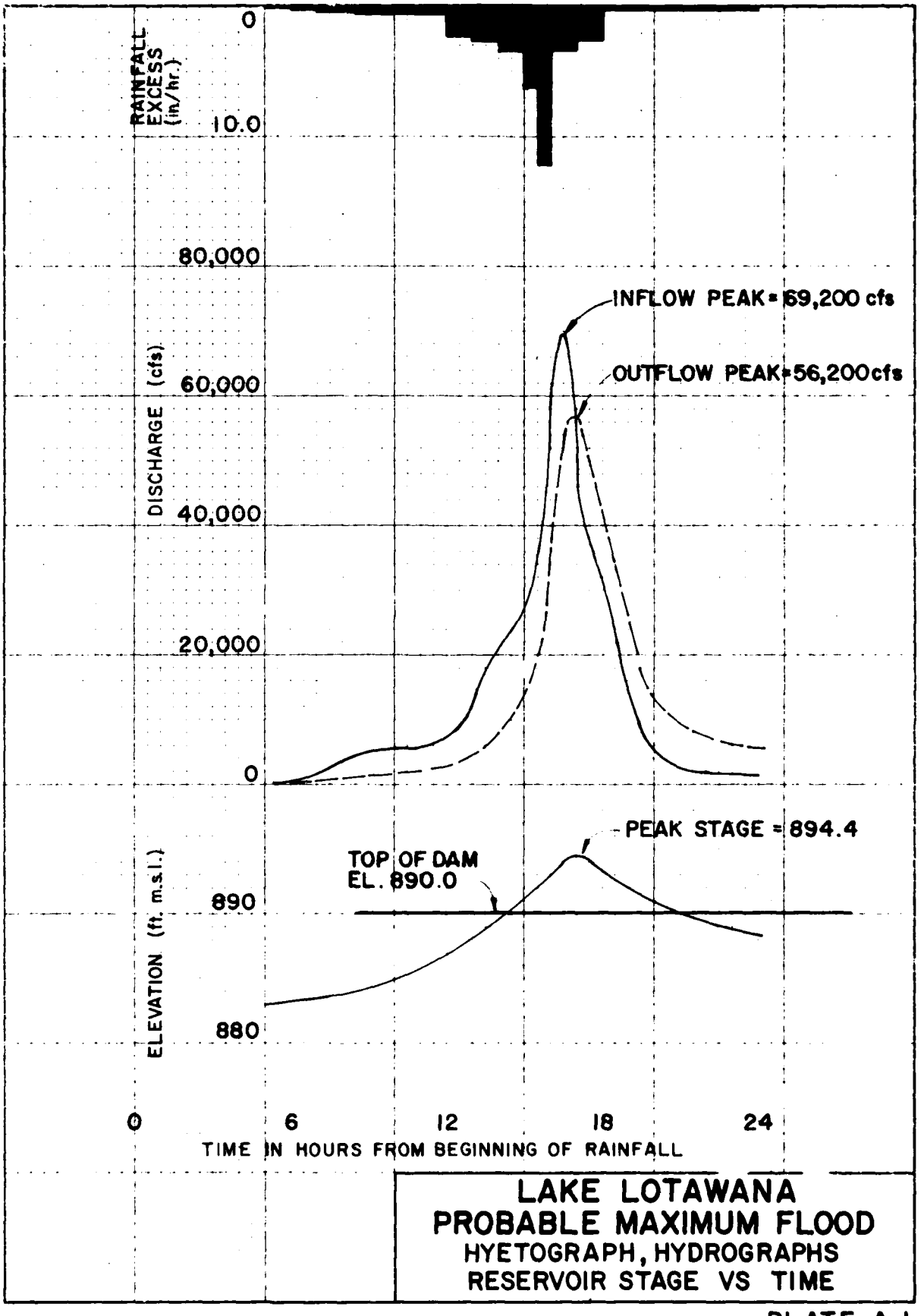
3. The elevation-storage relationship above normal pool elevation was constructed by planimetering the area enclosed within each contour above normal pool. The storage between two elevations was computed by multiplying the average of the areas at the two elevations by the elevation difference. The summation 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

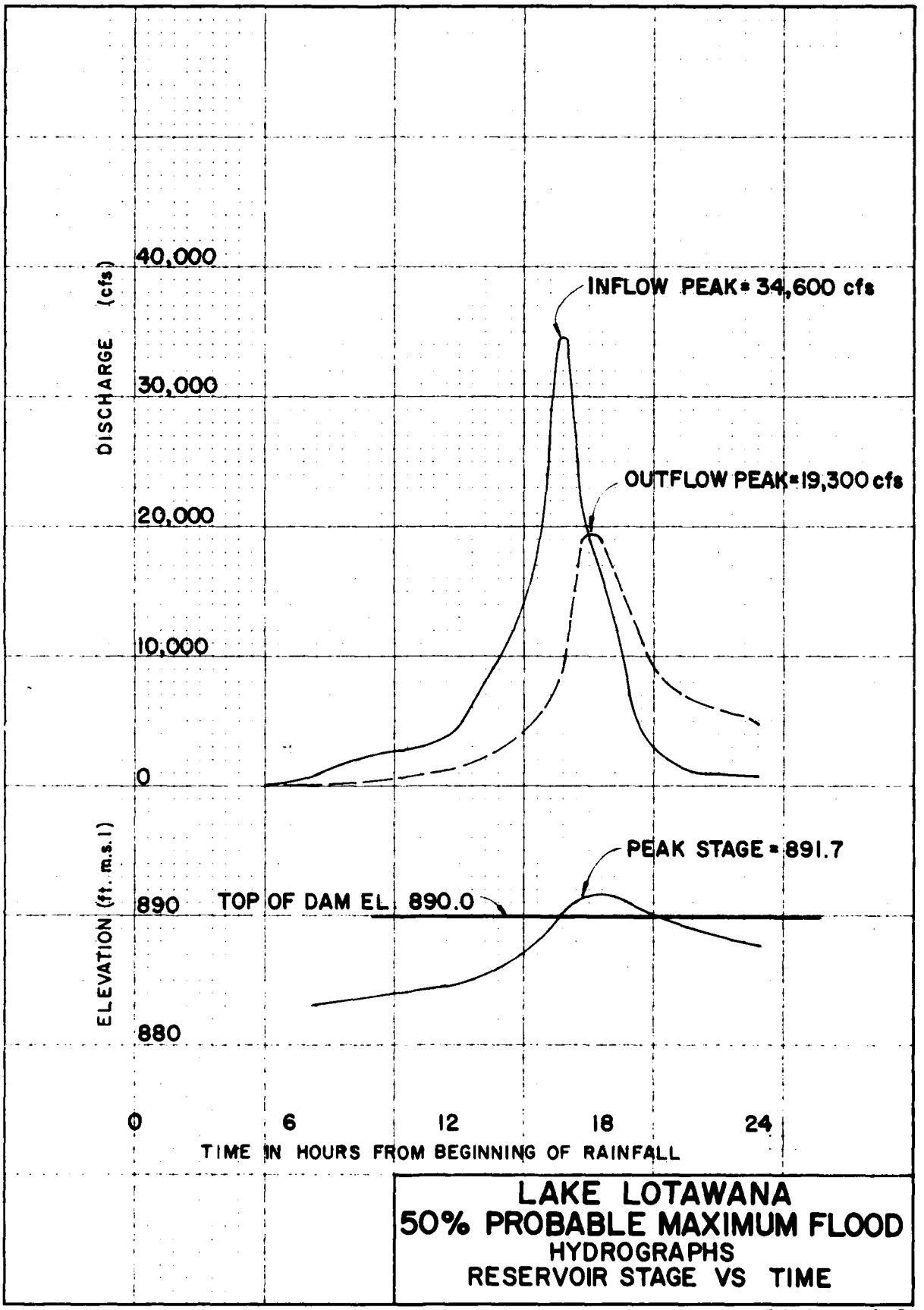
2. U.S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, 1974, Washington, D.C.

3. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2, Water Surface Profiles, October, 1973, Davis, California.



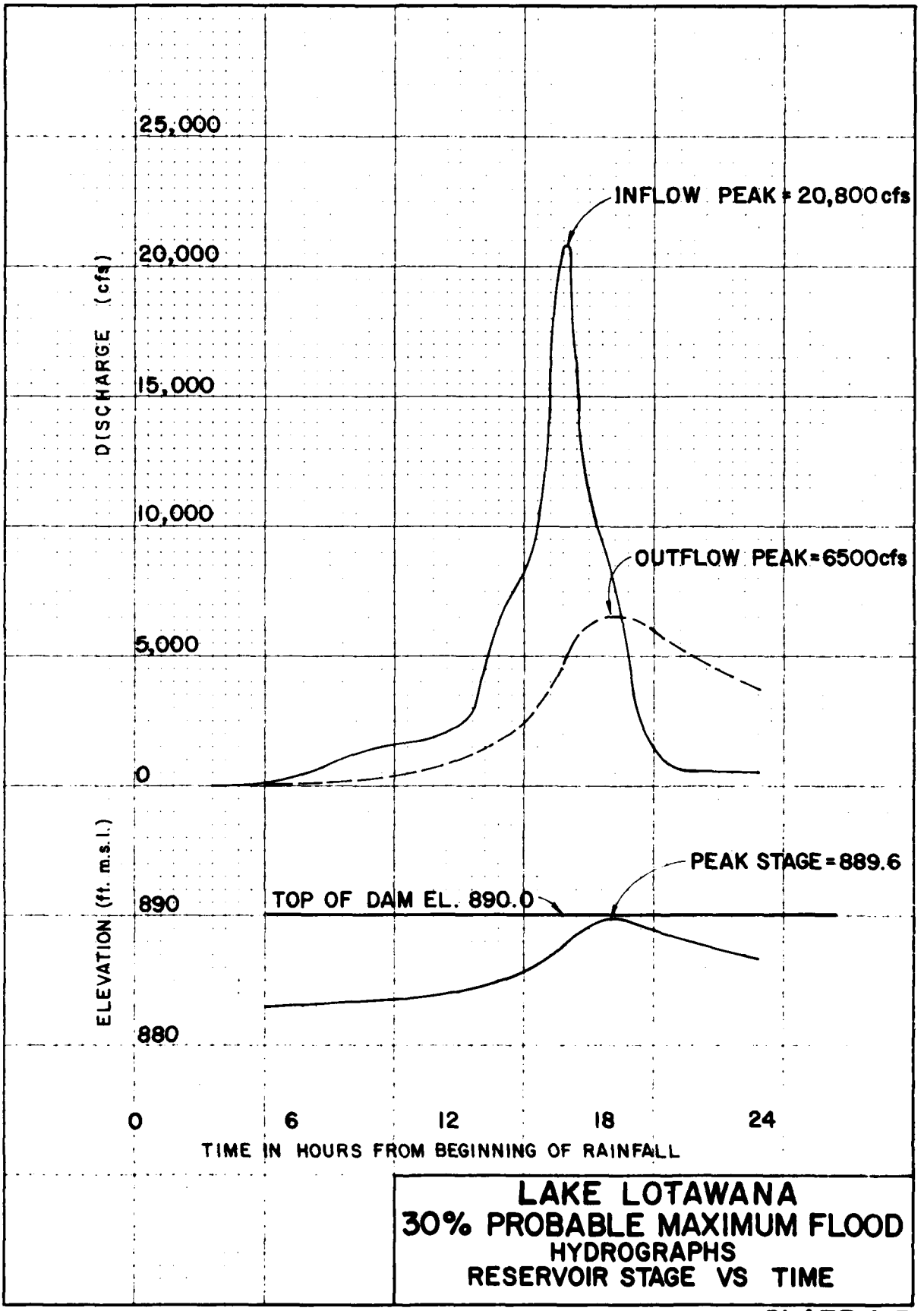
LAKE LOTAWANA
PROBABLE MAXIMUM FLOOD
HYETOGRAPH, HYDROGRAPHS
RESERVOIR STAGE VS TIME

PLATE A-1



LAKE LOTAWANA
50% PROBABLE MAXIMUM FLOOD
HYDROGRAPHS
RESERVOIR STAGE VS TIME

PLATE A-2



LAKE LOTAWANA
30% PROBABLE MAXIMUM FLOOD
HYDROGRAPHS
RESERVOIR STAGE VS TIME

PLATE A-3

END

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