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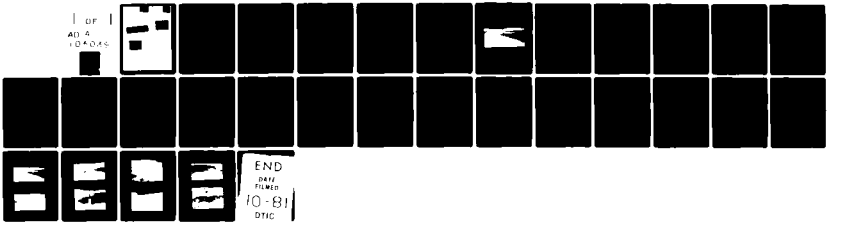

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National Dam Safety Program. Lac Carmel Dam, (MO 30287) Upper Mississippi - Mississippi - Kaskaskia - St. Louis Basin, St. Francois County, Missouri.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

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

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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LAC CARMEL DAM

ST. FRANCOIS COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30287

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY

Kenneth Balk & Associates, Inc.
St. Louis, Missouri
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St. Louis, Missouri

PREPARED FOR

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

SEPTEMBER, 1978

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Lac Carmel
State Located	Missouri
County Located	St. Francois County
Stream	Tributary To Three Hill Creek
Date ofInspection	August 3, 1978

Lac Carmel Dam was inspected by an interdisciplinary team of engineers from Kenneth Balk & Associates and Shannon & Wilson. 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 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. The estimated damage zone extends ten miles downstream of the dam. Within the damage zone are seven homes, a multiple celled waste stabilization pond treatment facility, one state highway brdige, and one county road bridge.

Our inspection and evaluation indicates that the spillway does meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will pass the Probable Maximum Flood (PMF), which for this dam also equaled the Spillway Design Flood (SDF).

The Probable Maximum Flood (PMF) is a flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The PMF is derived from probable maximum precipitation (PMP), which information is generally available from the National Weather Service, NOAA. Most Federal agencies apply reduction factors to the PMP when appropriate. Reductions may be applied because rainfall isohyetals are unlikely to conform to the exact shape of the drainage basin and/or the storm is not likely to center exactly over the drainage basin.

Deficiencies visually observed by the inspection team were seepage at the toe, and small trees on the downstream and upstream embankment slope. Other deficiencies found were the lack of seepage records, stability analysis, and engineer ng design data.

We recommend that the owner take action in the near future to correct or control the deficiencies described. A detailed report discussing each of these deficiencies is attached.

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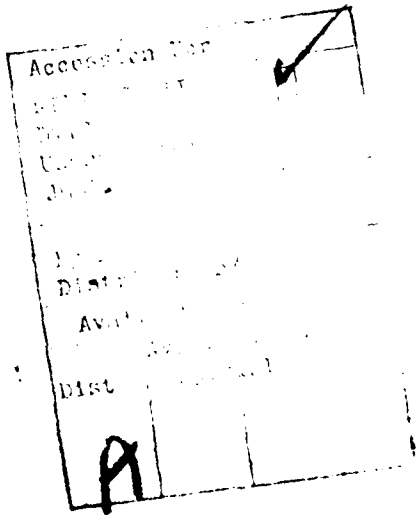
SUBMITTED BY: SIGNED
Chief, Engineering Division

17 OCT 1978
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

17 OCT 1978
Date



OVERVIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAC CARMEL DAM - ID NO. 30287

TABLE OF CONTENTS

APPENDIX

LIST OF PLATES

LIST OF PHOTOGRAPHS

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 St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Lac Carmel 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 built on Three Hill Creek in the northern part of St. Francois County, Missouri. Topography adjacent to the valley is rolling to steep. Most of the area in the vicinity of the dam is covered with a residual silty clay overlying dolomite. Topography in the vicinity of the dam is shown on Plate 1.

(2) A spillway is cut in arenaceous dolomite and dolomite on the left abutment (west end of the dam). A regulating structure exists near the right abutment in the lake for maintenance draw down.

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

b. Location. The dam is located in the northwestern portion of St. Francois County, Missouri, as shown on Plate 2. The lake formed by the dam is on the Missouri-St. Francois County Mineral Point quadrangle sheet in the SW 1/4 of Section 18, T37N, R4E.

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, this dam and impoundment is in the intermediate size category.

d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph c above. Based on referenced guidelines, this dam is in the High Hazard Classification.

e. Ownership. This dam is owned by Terre Du Lac Inc., Bonne Terre, Mo.

f. Purpose of Dam. The dam forms a 50 acre recreational lake.

g. Design and Construction History: There are no known design plans or construction records. The dam was completed in 1969. According to James Bennett, the present project engineer of Terre Du Lac, Inc., some cracking with accompanying vertical displacement was observed at the crest and parallel to the axes of the dam during a winter construction shutdown. Horner & Shifrin, Inc. were consulted regarding this crack, and reportedly it was their opinion that the cracking and vertical displacement were associated with a downstream slope movement. At their recommendation, a downstream berm was constructed. According to Mr. Bennett, the dam is zoned, is believed to have a core trench, and the spillway excavation was used in the upstream random zone of the dam. Rock was shot separately for the toe berm.

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 - 650 acres.

b. Discharge at Damsite.

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

(2) Estimated experienced maximum flood at damsite - 233 c.f.s.

(3) Estimated ungated spillway capacity at maximum pool elevation - 4725 c.f.s.

c. Elevation (U.S.G.S.)

(1) Top of dam - 881± (see Plate 3).

(2) Spillway crest - 872.4.

(3) Streambed at centerline of dam - 816 (est.).

(4) Maximum tailwater - unknown.

d. Reservoir. Length of maximum pool - 2800 feet ±.

e. Storage (Acre-feet). Top of dam 566.

f. Reservoir Surface (Acres).

(1) Top of dam - 72.

(2) Spillway crest - 50 (est.).

g. Dam.

(1) Type - earth embankment.

(2) Length - 1200 feet.

(3) Height - 65 feet maximum.

(4) Top width - 50 feet.

(5) Side Slopes

(a) Downstream - upper 1.5 H. to 1 V., lower 1 H. to 1 V.

(b) Upstream - 3 H. to 1 V.

(6) Zoning - yes)
) Reference to paragraph 1.2g

(7) Impervious core - yes)

(8) Cutoff - unknown

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel. - Valve in concrete regulating structure.

i. Spillway.

(1) Type - rock

(2) Length of Weir - 55 feet.

(3) Crest elevation - 872.4 feet m.s.l.

j. Regulating Outlets. - 16" c.i.p.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were found to be readily available.

2.2 CONSTRUCTION

The dam was completed in 1969. Remedial design construction data relative to correcting a partial failure of the embankment during construction was available and was considered in this report.

2.3 OPERATION

No records of the maximum loading on the dam were available.

2.4 EVALUATION

a. Availability. No engineering or geological data were readily available.

b. Adequacy. The engineering data available was insufficient to make a detailed assessment of the design, construction, and operation. The owner should have an engineer experienced in the design of dams to perform detailed seepage and stability analyses.

c. Validity. No valid engineering data on design were available. Remedial design construction data was available, however was considered insufficient.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General. A visual inspection of the Lac Carmel Dam was carried out on August 3, 1978. Personnel making inspection were employees of Kenneth Balk and Associates, Inc. and Shannon and Wilson, Inc. of St. Louis and included civil, geotechnical, and structural engineers and an engineering geologist. Specific observations are discussed below.

B. Dam. The inspection team observed the following at the dam. Some trees are growing on the upstream slope and downstream berm of the dam. The upstream slope of the embankment is approximately 3 H. to 1 V. and the slope above the berm on the downstream side of the embankment is approximately 1.5 H. to 1 V. while the lower half is approximately 1 H. to 1 V. No animal burrows were observed. Some seepage was observed at the toe of the rock berm, approximately 5 to 10 gallons per minute.

C. Appurtenant Structures. A spillway is cut on the left abutment in moderately hard dolomite and arenaceous dolomite. A regulating structure exists in the lake near the right abutment and has a controlled inlet at low level and an apparent uncontrolled drop inlet. No water was flowing over the spillway but some seepage (about 5 to 10 gallons per minute) was observed in the spillway outlet channel on the left abutment and approximately the same amount in the outlet channel of the regulating structure on the right abutment. The spillway outlet channel is cut into moderately jointed and hard compact dolomite. A number of small trees are growing in it. There is a small amount of seepage from the outlet channel, mainly through joints.

D. Reservoir Area. No wave wash, excessive erosion or slides were observed along the shore of the reservoir.

E. Damsite Geology.

1) Left Abutment. The left abutment is covered with a thick blanket of silty clay except near the spillway. To avoid duplication, these have been described under Spillway. No other outcrop is visible in the vicinity of the dam on the left abutment.

2) Spillway. The spillway (open channel type) and discharge channel are cut in the bedrock on the left abutment. Exposed in the discharge channel are the following three types of dolomites, slightly different from each other;

Arenaceous Dolomite. Exposed on the left side of the spillway channel and underlain by red clay is about a four feet thick bed of arenaceous dolomite (probably Gunther member, lower Canadian series), buff to gray in color, coarse to medium grained, having rounded frosted quartz grains, moderately weathered, medium hard, slightly porous, moderately jointed.

Joints. Three sets of joints were observed in this formation. They are:

dip 85^{o} SW strike 80^{o} NW

dip 90^{o} strike 10^{o} NNW

These have been cut by horizontal joints:

joint width - 1/4 inch to 4 inches

joint spacing - moderate

filling material - quartz and red clay

percentage - open joints about 30%
closed joints about 70%

Dolomite. Underlain by arenaceous dolomite and exposed on the left side of the spillway is a five to six feet thick bed of light gray dolomite (of Eminence Formation?), medium to coarse grained, massive, medium bedded at base, moderately jointed. Trend of dip and strike of joints is similar to its overlying bed of arenaceous dolomite.

joint width - 1/4 inch to 3-1/2 inches

joint spacing - moderate

filling material - quartz and red clay

percentage - open joints about 25%
closed joints about 75%

Contact between arenaceous dolomite and the underlying dolomite is not well defined.

Dolomite. Rest of the bedrock exposed inthe spillway consists of moderately weathered, gray to brownish-gray, medium to fine grained, massive compact, thickly bedded, moderate to closely jointed dolomite, probably belonging to the Potosi Formation.

Three sets of joints similar to and having the same trend as in arenaceous dolomite have been observed in this formation.

joint width - 1/8 inch to 4-1/2 inches

joint spacing - moderate

filling material - quartz and red clay

percentage - open joints 20%
closed joints 80%

Quartz druse is also exposed at places in the spillway. One large outcrop is in the base of the spillway eight feed wide and 12 feet in length.

3) Right Abutment. Exposed in the outlet channel in the right abutment are the same three formations with the same characteristics as the left abutment outlet channel. Exposed thickness of the beds range as follows:

Arenaceous dolomite - one to three feet

Dolomite (Eminence) - two to four feet

Dolomite (Potosi) - five to eight feet

Bedrock is overlain by a thick blanket of red silty clay and is only exposed at the right abutment in the outlet channel.

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. Trees and seepage left uncontrolled and uncorrected, may cause problems.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

A regulating structure exists in the lake near the right abutment for maintenance draw down. The lake level is controlled by rainfall, runoff, evaporation, and the capacity of uncontrolled spillway and an apparent drop inlet on the regulating structure.

4.2 MAINTENANCE OF DAM

No maintenance records of the dam were available. Terre Du Lac, Inc. has a project engineer at the site.

4.3 MAINTENANCE OF OPERATING FACILITIES

No maintenance records of the regulating structure were available.

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

None of the conditions observed are considered significant enough to cause alarm.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No design data available.

b. Experience Data. The drainage area and lake surface area are developed from USGS Mineral Point Mo. Quadrangle. The spillway and dam layout are from surveys made during the inspection.

c. Visual Observations.

(1) Rock spillway and the falls at exit channel are in good condition. Some trees are growing in spillway outlet channel.

(2) Drawdown facilities are available to regulate the pool level.

(3) The spillway and exit channel are located at the farthermost left or west abutment. Spillway releases will not endanger the integrity of the dam.

d. Overtopping Potential. The spillway will pass the minimum required flood of the probable maximum without overtopping. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

The estimated damage zone extends ten miles downstream of the dam. Within the damage zone are seven homes, one state highway bridge, and one county road bridge.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visually observed conditions which can affect the structural stability of this dam have been discussed in Section 3, paragraph 3.1 b.

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam were found except that discussed in Section 1.2, paragraph 1.2 g.

c. Operating Records. There is a regulating structure in the lake near the right abutment, however no records were available at the time of the inspection. According to Mr. Bennett, the pool level was lowered for the sanitary sewer repairs. The outlet regulating structure is a 4' x 4' concrete box with a 16" C.I. outlet pipe. The top of the structure is approximately elevation 874. The low level outlet invert is elevation 860.70 and consists of a 16" slide gate with a spigot frame.

d. Post-Construction Changes. No post-construction changes other than referenced in Section 1, paragraph 1.3 g exists.

e. Seismic Stability. The location of Lac Carmel Dam is in Seismic Zone 2, however, the available engineering data was insufficient to evaluate the seismic stability of the dam and the affect of an earthquake of the magnitude expected in this zone on a dam of this type and size would have to be assessed after a Phase II inspection.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Corrective measures should be taken for the deficiencies visually observed by the inspection team, i.e. seepage and growth of trees on the embankment and in the spillway outlet channel.

b. Adequacy of Information. Due to insufficient engineering design and construction data, except that discussed in Section 1, paragraph 1.3 g, the conclusions of this report were mostly based on performance history and external visual conditions. The inspection team considers that these data are sufficient to support the conslusions herein.

c. Necessity for Phase II. Based on the results of the Phase I inspection, a Phase II inspection is not recommended as outlined in St. Louis District, Corps of Engineers' letter dated August 25, 1978.

d. Seismic Stability. The location of Lac Carmel Dam is in Seismic Zone 2, however, the engineering data was insufficient to evaluate the seismic stability of the dam.

7.2 REMEDIAL MEASURES

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

(1) Trees and excessive vegetations should be removed from the upstream and downstream slopes and the spillway outlet channel.

(2) Seepage should be checked periodically and controlled.

(3) Clean out spillway outlet channel.

(4) The owner should keep up-to-date records of all future maintenance and repairs.

APPENDIX A

HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

1. Triangle unit hydrograph is used to develop the inflow hydrographs, hydrologic inputs are as follows:

a. Twenty-four hour, probable maximum precipitation from hydrometeorological report No. 33.

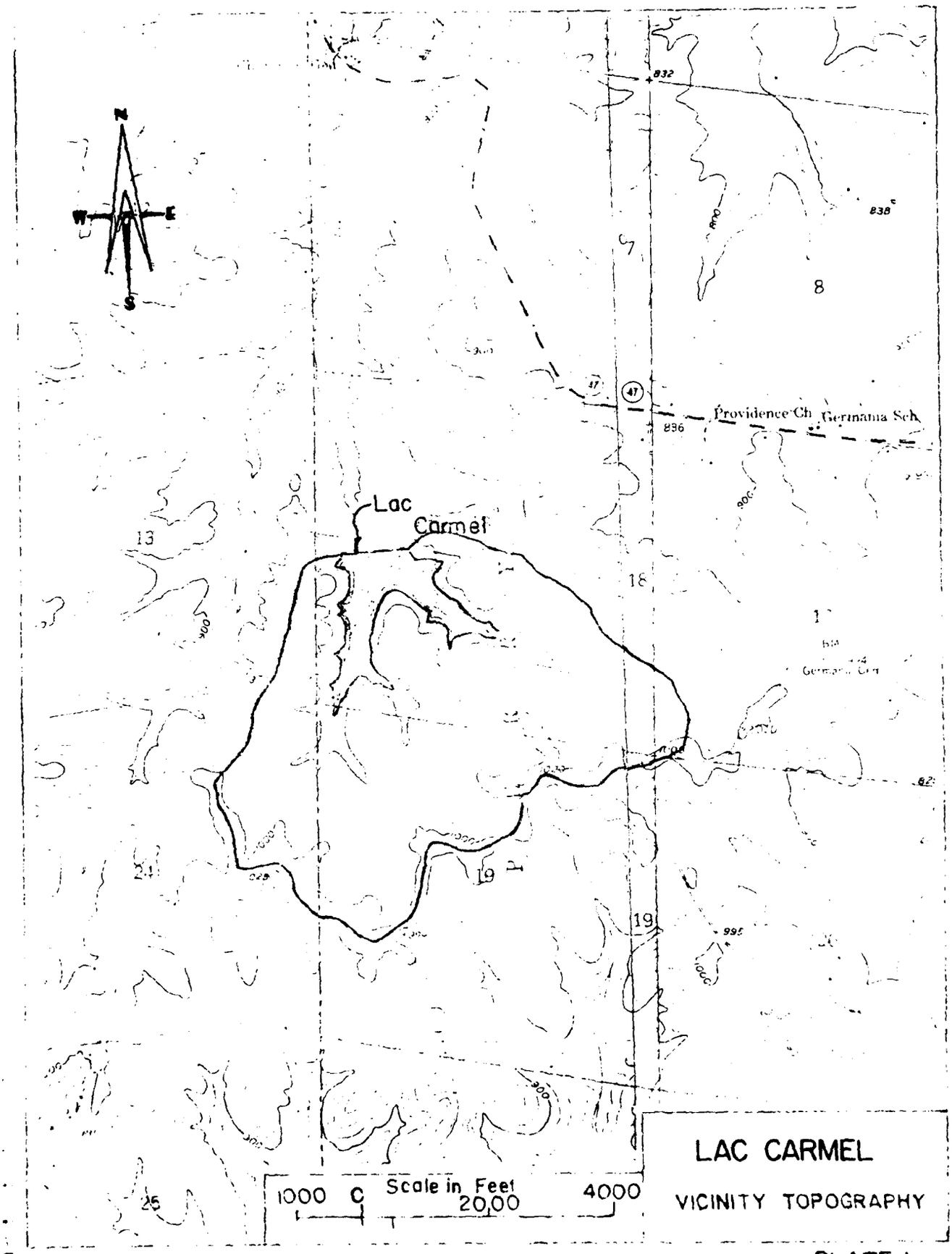
b. Drainage area = 1.02 square miles, Soils Conservation Service (S.C.S.) Hydrologic Soils Group "B".

c. Travel time of runoff = 50 minutes.

d. Loss Rates. S.C.S., CN #82 used to determine rainfall excess.

2. Spillway release rates are based on the open channel equation: Stage = depth of flow + 1.5 x velocity head.

3. Floods are routed through the spillway to determine the capability of the spillway.



LAC CARMEL

VICINITY TOPOGRAPHY

PLATE I

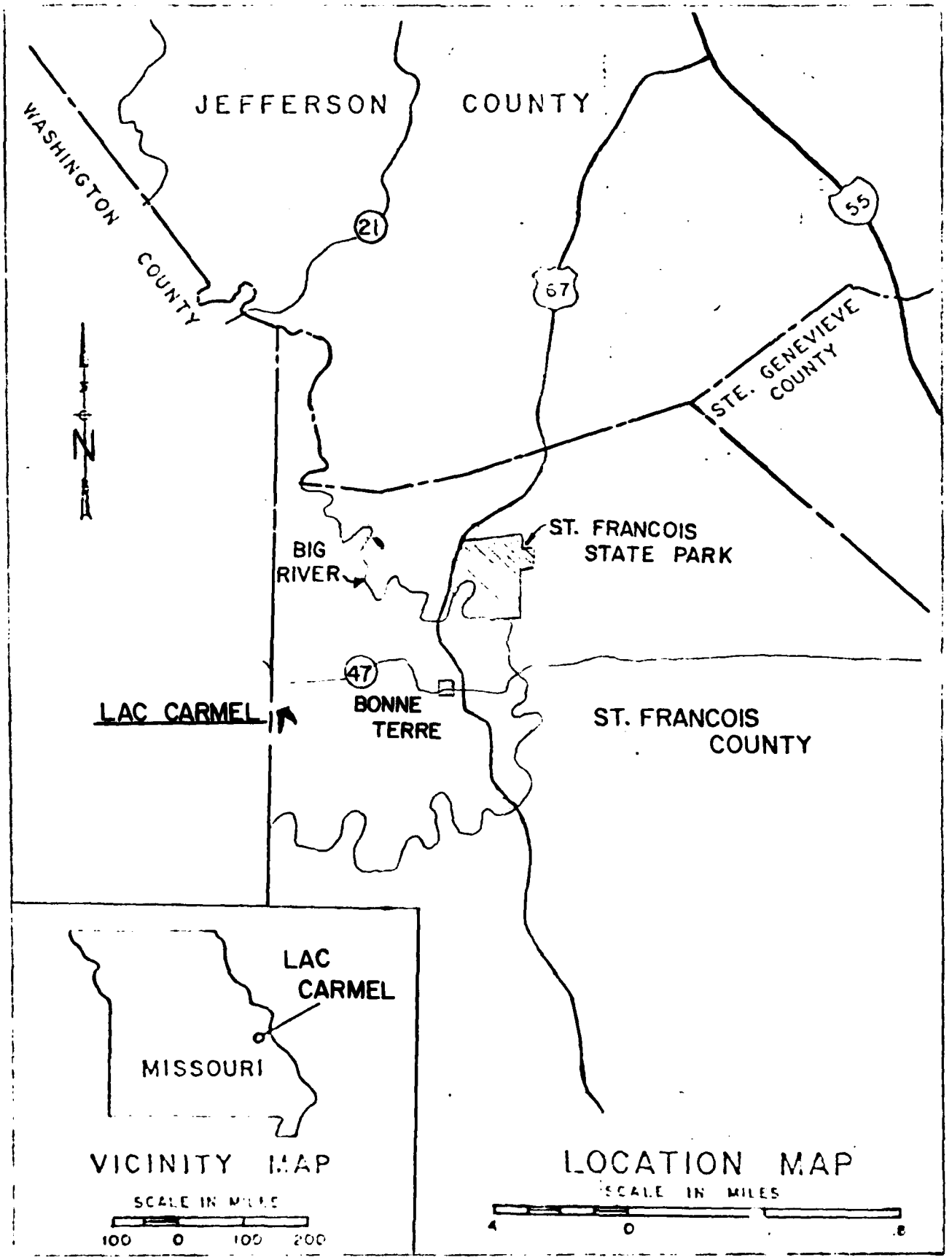
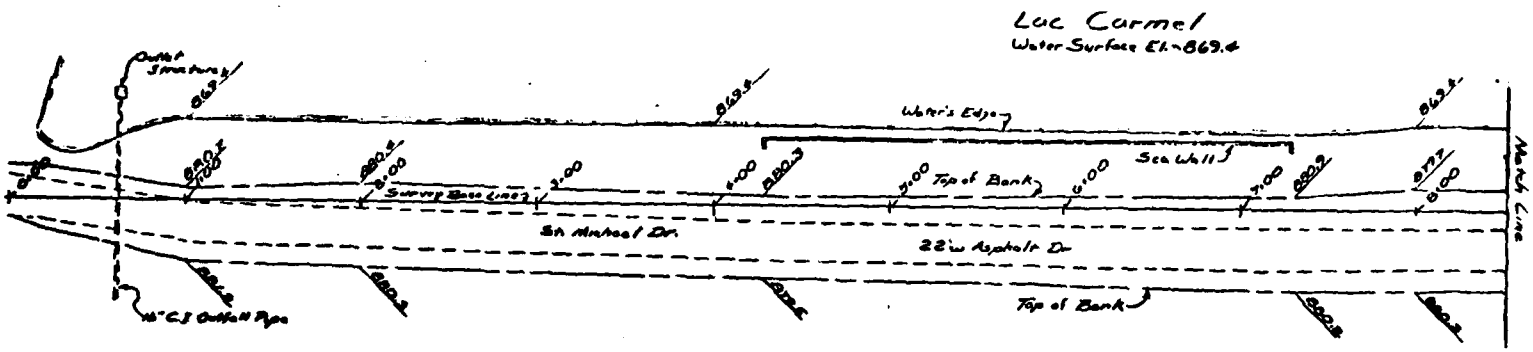
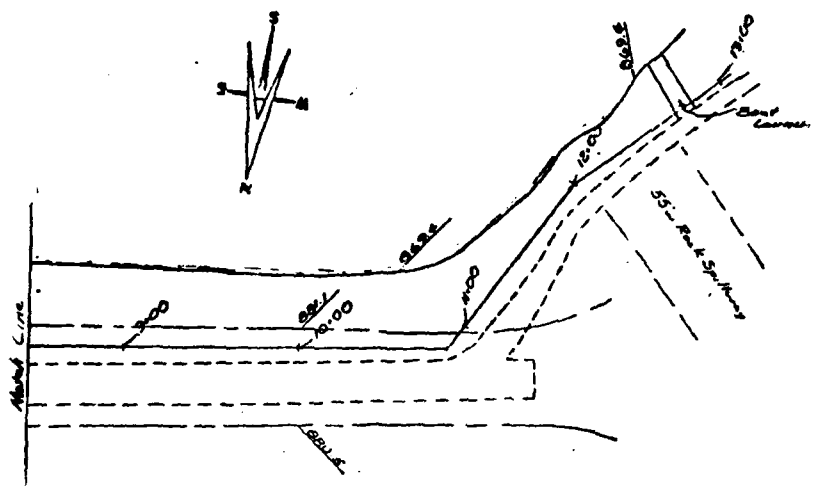

JEFFERSON COUNTY
WASHINGTON COUNTY
21
67
55
STE. GENEVIEVE COUNTY
N
ST. FRANCOIS STATE PARK
BIG RIVER
47
LAC CARMEL
BONNE TERRE
ST. FRANCOIS COUNTY
LAC CARMEL
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
LOCATION MAP
SCALE IN MILES
4 0 8

PLATE 2



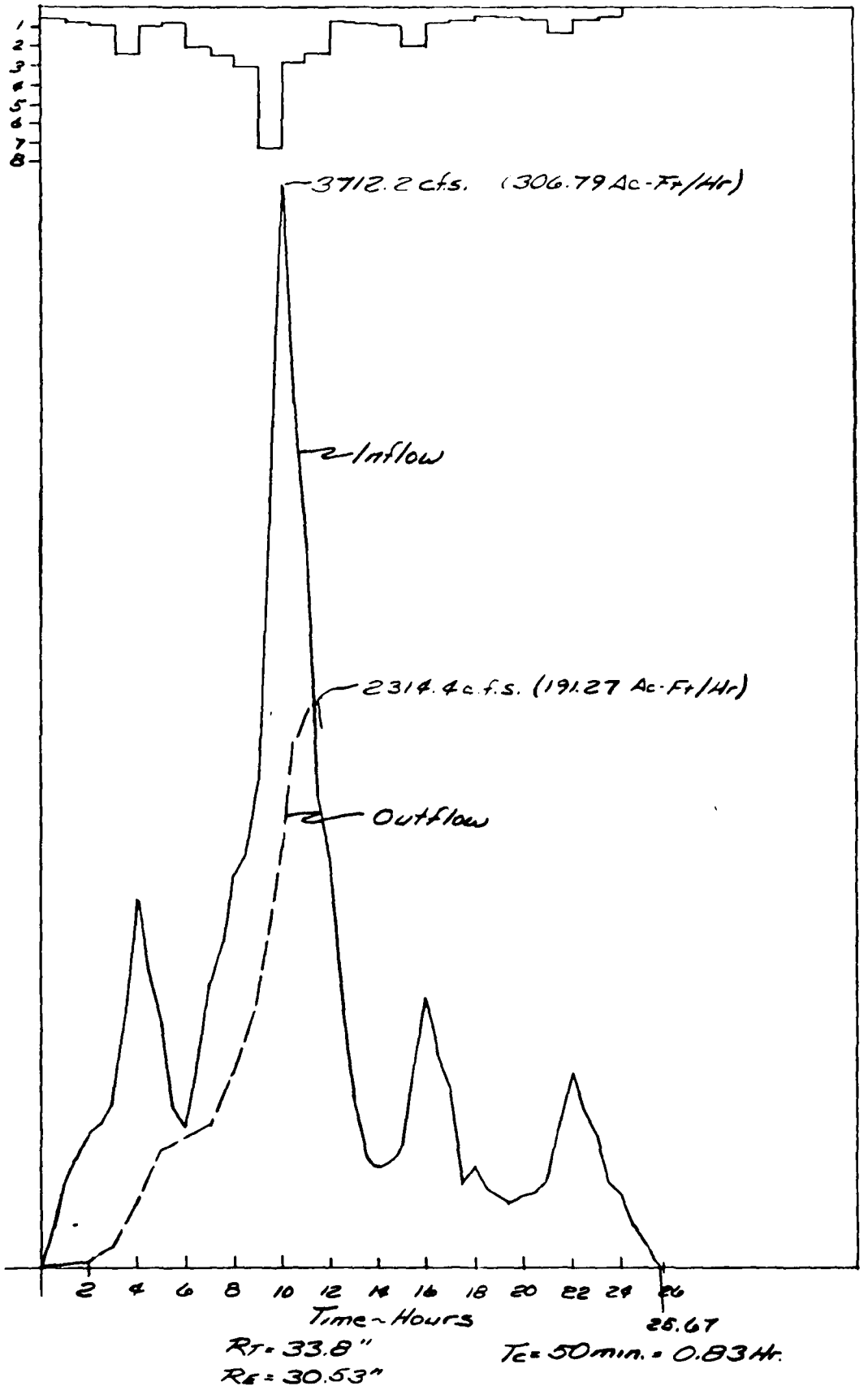
PLAN



LAC CARMEL

TOP OF DAM ELEVATIONS

SCALE: 1"=100' PLATE 3



Lac Carmel Inflow-Outflow Hydrograph 24 Hr. P.M.P.
RATE 4

$R_T = 33.8''$
$R_E = 30.53''$

$T_c = 50 \text{ min.} = 0.83 \text{ Hr.}$

PHOTO 1: Overview of Lake and Dam

PHOTO 2: Crest of Dam

PHOTO 3 View Easterly from West Abutment of Spillway and Dam

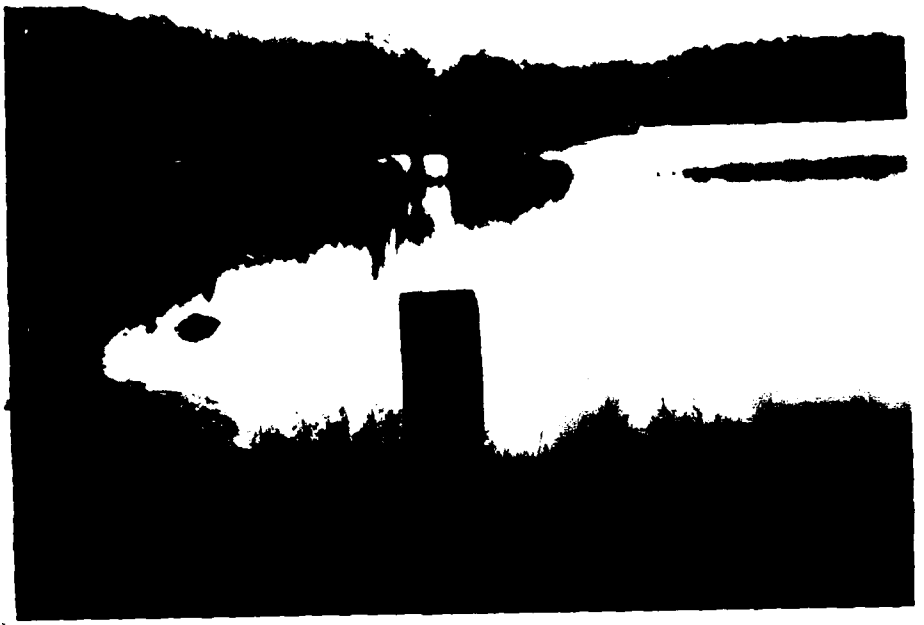


PHOTO 4 Reservoir Drawdown Structure

PHOTO 5 Rock Spillway looking Downstream from Lake.

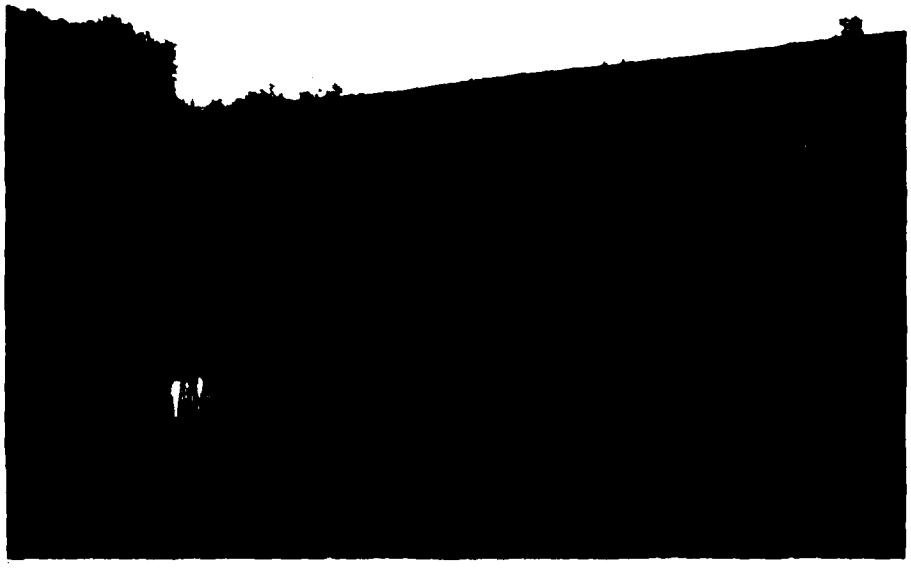
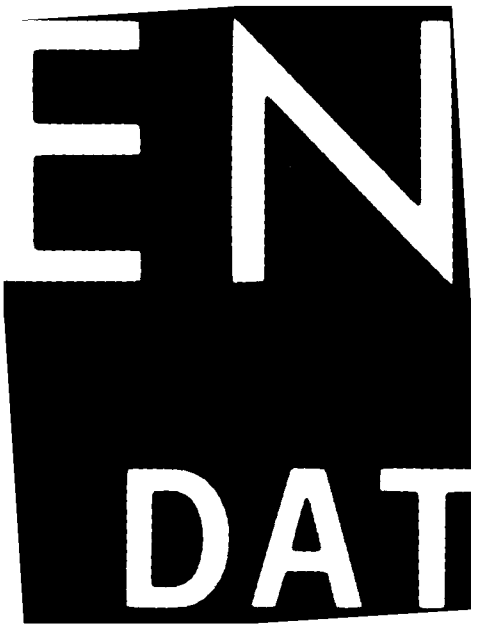


PHOTO 6 View from Toe showing Rock Berm and Small Pool at Toe

PHOTO 7: View from South Abutment of Downstream Face Showing Detail

PHOTO 8: View of Rock Outcrop at Left Abutment of Spillway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