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NATIONAL DAM SAFETY PROGRAM. LAKE PAHO DAM (MO 10108), MISSOURI--ETC(U)
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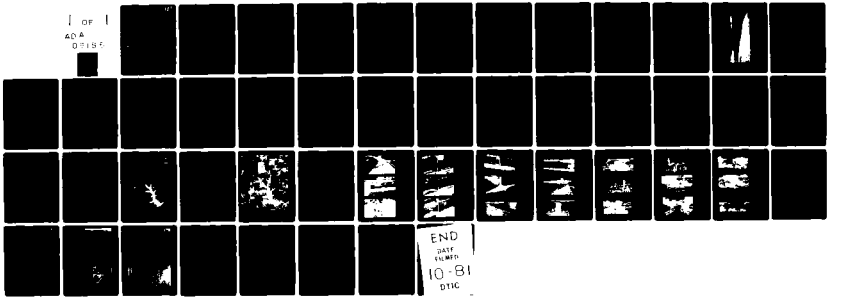

MISSOURI

MISSOURI-GRAND-CHARITON BASIN

AD A105155

LAKE PAHO DAM

MERCER COUNTY, MISSOURI

MO 10108

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY: HOSKINS-WESTERN-SONDEREGGER, INC.

FOR: STATE OF MISSOURI

JULY, 1978

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

IN REPLY REFER TO

LMSED-FI

6 October 1978

SUBJECT: National Program of Inspection of Dams

THRU: Division Engineer, Lower Mississippi Valley, ATTN: LMVED-G

TO: HQDA (DAEN-CWE-DS), WASH DC 20314

1. Reference letter DAEN-CWE-DS, your office, 16 February 1978, subject as above.

2. As requested in referenced letter, inclosed are the correspondence file and final inspection report for Lake Paho Dam (Mo. 10108), which has been classified as unsafe.

FOR THE DISTRICT ENGINEER:

2 Incl
as

JACK R. NIEMI
Chief, Engineering Division

LMSED-FI 6 October 1978

SUBJECT: Phase I Inspection Report

District Engineer
Department of the Army
Kansas City District, Corps of Engineers
700 Federal Building
Kansas City, Missouri 64106

Lake Paho Dam (Mo. 10108), which is within the boundaries of your district, was recently inspected under the provisions of the National Program of Inspection of Non-Federal Dams. Inclosed for your information and retention is a copy of the final inspection report.

FOR THE DISTRICT ENGINEER:

SIGNED
Jack R. Niemi

1 Incl
as

JACK R. NIEMI
Chief, Engineering Division

Copy furnished:
LMVD, ATTN: LMVED-G

(2)

LMUD Ltr, LMSED-F

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ST.LOUIS
CORPS OF ENGINEERS
210 NORTH 12th ST.
ST. LOUIS, MISSOURI 63101

LMSED-FI

29 September 1978

Honorable Joseph P. Teasdale
Governor of Missouri
State Capitol
Jefferson City, Missouri 65101

Dear Governor Teasdale:

Inclosed is a copy of the final inspection report for Lake Paho Dam (Mo 10108). As you realize, this dam has been classified in the unsafe, non-emergency category in accordance with criteria set forth in the National Program of Inspection of non-Federal Dams. The report on the dam's condition is presented to you for appropriate state use in assuring a safe dam. I ask that you keep me informed of the actions taken on implementing the recommendations in the dam inspection report. This follow-up action is a vitally important phase of this program.

A copy of the report has also been furnished the owner, the Missouri Department of Conservation, per your request.

As you realize, under the provisions of the Freedom of Information Act, this document will be subject to release, upon request, to interested parties, as soon as this letter arrives in your office.

At your request, we are furnishing copies of the Lake Paho Dam Inspection Report to Mr. Robert S. Townsend, Acting Director of the Missouri Department of Natural Resources, and to Dr. Wallace B. Howe, State Geologist.

LMSED-VI 29 September 1978
Honorable Joseph P. Teasdale

Copies of the report are also being furnished to MG R. C. Marshall, Division Engineer, U. S. Army Engineer Division, Lower Mississippi Valley, P. O. Box 80, Vicksburg, Mississippi 39180, and to the Office of the Chief of Engineers, Washington, D.C. 20314.

Sincerely yours,

1 Incl
As stated

LEON E. McKINNEY
Colonel, CE
District Engineer

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ST.LOUIS
CORPS OF ENGINEERS
210 NORTH 12th ST.
ST. LOUIS, MISSOURI 63101

LMSED-FI

29 September 1978

LMVD Ltr, LMVED-C

Mr. Carl R. Noren, Director
Missouri Department of Conservation
2901 North Ten Mile Drive
Jefferson City, Missouri 63101

Dear Mr. Noren:

Inclosed is a copy of the final inspection report for Lake Paho Dam (Mo. 10108). As you realize, this dam has been classified in the unsafe, non-emergency category in accordance with criteria set forth in the National Program of Inspection of non-Federal Dams. I have inclosed a copy of "Statement by The President" that explains the program.

Copies of the report have also been sent to Governor Teasdale; MG R. C. Marshall, Division Engineer, U. S. Army Engineer Division, Lower Mississippi Valley, P. O. Box 80, Vicksburg, Mississippi 39180; the Office of the Chief of Engineers, Washington, D.C. 20314; Mr. Robert S. Townsend, Acting Director of the Missouri Department of Natural Resources; and to Dr. Wallace B. Howe, State Geologist.

As you realize, under the provisions of the Freedom of Information Act, this document will be subject to release, upon request, to interested parties after receipt by Governor Teasdale or his representatives.

I would like to thank you for your cooperation in the program.

Sincerely yours,

2 Incl
As stated

LEON E. McKINNEY
Colonel, CE
District Engineer

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A105155	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Lake Paho Dam (MO 10108) Mercer County, Missouri	5. TYPE OF REPORT & PERIOD COVERED Final Report.
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Hoskins-Western-Sonderegger, Inc. (10) Harold F. Hoskins	8. CONTRACT OR GRANT NUMBER(s) DACW43-78-C-0155
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 1, 146
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	12. REPORT DATE July 1978
	13. NUMBER OF PAGES Approximately 40
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

National Dam Safety Program. Lake Paho Dam (MO 10108), Missouri - Grand - Chariton Basin, Mercer County, Missouri. Phase I Inspection Report.

Approved for release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

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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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data

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

IN REPLY REFER TO

SUBJECT: Lake Paho Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lake Paho 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
Chief, Engineering Division

29 SEP 1978
Date

APPROVED BY:
Colonel, CE, District Engineer

29 SEP 1978
Date

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Lake Paho Dam
State Located	Missouri
County Located	Mercer County
Stream	West Muddy Creek
Date of Inspection	July 13, 1978

Lake Paho Dam was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderegger, Inc. 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. Failure would threaten the life and property at three homes. The estimated damage zone extends five miles downstream of the dam. Within the damage zone are one fish hatchery, three homes and four improved road crossings. The floodplain is farmed.

Our inspection and evaluation indicates that 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 46% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. An additional deficiency, in accordance with the guidelines, is the lack of seepage analysis. These analyses should be obtained in the future.

Other deficiencies visually observed by the inspection team were spalling of spillway concrete, open joints in the spillway, some deterioration of riprap, bank erosion at the end of the spillway stilling basin and erosion in a few small areas on the upstream slope.

Several items of preventive maintenance need to be initiated by the owner. These are described in detail in the body of the report. Copies of the report have been furnished the dam owner and the Governor of Missouri.

H. P. Hoskins E8686

Harold P. Hoskins, P.E.
Hoskins-Western-Sonderegger, Inc.
Lincoln, Nebraska

SUBMITTED BY SIGNED — 29 SEP 1978
Chief, Engineering Division — Date

APPROVED BY _____ — 29 SEP 1978
Colonel, CE, District Engineer — Date

PHOTO NO. 1
OVERVIEW LOOKING SOUTH
FROM EAST SIDE ABOUT
ONE-HALF MILE NORTH OF DAM.
DAM IN CENTER BACKGROUND.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE PAHO DAM - ID NO. MO. 10103

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APPENDIX C - PLANS AND REPORTS

Mo. Cons. Comm.	Lake Paho Topographic Map
Mo. Cons. Comm.	Plan and Cross-Section
Mo. Cons. Comm.	Spillway Plan and Elevation
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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 St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Lake Paho 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 fill approximately 1075 feet in length with a maximum height of approximately 40 feet. Topography adjacent to the dam is gently rolling. Soils on the lower slopes/abutments are apparently derived from fine grained glacial till.

(2) The uncontrolled spillway consists of a reinforced concrete chute over the right (west) abutment.

(3) A controlled discharge system is located toward the left (east) end of the dam.

(4) Nine catfish rearing ponds are located immediately downstream from the toe of the dam. The water levels in these ponds is maintained by means of the controlled discharge system.

b. Location. The dam is located in the west central portion of Mercer County, Missouri, as shown on Plate 2. The lake formed by the dam is shown on Plate 1 in the SE 1/4 and the N 1/2 of Section 25, T65N, R25W and the S 1/2 of Section 24, T65N, R25W with fingers extending into the NW 1/4 of Section 24, T65N, R25W, the E 1/2 of Section 23N, T65N, R25W and the W 1/2 of Section 30, T65N, R24W. The lake is also shown on the Princeton NW Orthophotograph (Plate 3).

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. The estimated damage zone extends five miles downstream of the dam. Within the damage zone are one fish hatchery, three homes and four improved road crossings. The floodplain is formed.

e. Ownership. The dam is owned by the Missouri Department of Conservation.

f. Purpose of Dam. The dam forms a recreational lake covering about 275 acres.

g. Design and Construction History. It was reported that construction of the dam began in 1949 and the lake was opened to the public in 1951. Construction plans for the dam were prepared by the Missouri Department of Conservation. Portions of these plans are included with this report as Appendix "C". The quality of reproduction is the best attainable from copy furnished.

h. Normal Operating Procedure. The reservoir level is relatively stable. It was reported that the maximum flow over the spillway was about 1 foot in depth in 1978. It was also reported that the lake level reached its lowest elevation in 1967 when it was 6 to 8 feet below spillway elevation.

1.3 PERTINENT DATA

a. Drainage Area - 2950± acres.

b. Discharge at Damsite.

(1) All discharge at the damsite is through an ungated concrete weir and chute spillway and a 10" ductile iron pipe which is used to supply water to downstream fish rearing ponds. The pipe is controlled by a hinged section which is raised and lowered by cable at its intake in the reservoir and a valve at its outlet box. There is a 36" corrugated metal pipe which was formerly used as a spillway. This pipe was plugged with concrete after the pipe collapsed in 1963.

(2) Estimated experienced maximum flood at damsite - 174 cfs which occurred in early 1978.

(3) Estimated ungated spillway capacity at maximum pool elevation (948.69) - 2026 cfs.

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

(1) Top of dam - 950±.

(2) Spillway crest - 944±.

(3) Streambed at centerline of dam - 910±.

(4) Maximum tailwater - unknown.

d. Reservoir. Length of maximum pool - 9600 feet ±.

e. Storage (Acre-feet). Top of dam - 5750 (from computed storage elevation curve).

f. Reservoir - Surface (Acres).

(1) Top of dam - 375.

(2) Spillway crest - 275.

g. Dam.

(1) Type - earth embankment.

(2) Length - 1075 feet ±.

(3) Height - 40 feet ±.

(4) Top width - 20 feet.

(5) Side Slopes -

(a) Upstream - Plans show 2.5H on 1V down to 5 foot wide berm with 3H on 1V below the berm.

(b) Downstream - Plans show 2.5H on 1V down to 5 foot wide berm and 3H on 1V below the berm.

(6) Zoning - none shown on plans.

(7) Impervious core - none shown on plans.

(8) Cutoff - Plans show a relatively shallow cutoff along the center-line with 12 foot bottom width and side slopes of 1H on 1V.

(9) Grout curtain - none shown on plans.

(10) Drains - unknown.

11) Riprap - none shown on plans but the upstream slope is covered from near the crest of the dam down to an unknown elevation with a 5 to 6 foot horizontal thickness of limestone riprap. The exposed riprap is on a slope of approximately 1.5H on 1V (determined with hand level).

h. Diversion and Regulating Tunnel. None.

i. Spillway.

(1) Type - concrete chute with modified S.A.F. stilling basin.

(2) Length of weir - 60 feet.

(3) Crest elevation - 943.69 feet m.s.l.

j. Regulating Outlets.

A 10" ductile iron pipe with hinged section at intake structure and valve at the outlet box. This outlet is used specifically to supply water to downstream fish rearing ponds. This outlet is not considered in the hydrologic analysis of the dam.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

A set of plans for constructing the dam was supplied by the Missouri Department of Conservation. Portions of these plans are shown in Appendix C.

2.2 CONSTRUCTION

It was reported that construction started in 1949 and the lake was opened to the public in 1951. No construction data were available.

2.3 OPERATION

The maximum loading on the dam was reported to be in 1978 when about 1 foot of water passed over the uncontrolled spillway.

The controlled discharge system on the left end of the dam supplies water, as needed, to the fish rearing ponds. The discharge flows through the control tower and into a 10 inch diameter ductile iron pipe which passes through the embankment to a controlled distribution box downstream from the toe of the dam.

2.4 EVALUATION

a. Availability. The only engineering data readily available were the construction plans shown in Appendix C.

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

c. Validity. Engineering data that were available were prepared by the Missouri Department of Conservation.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Lake Paho dam and appurtenances was made on July 13, 1978 by the following engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska: Garold Ulmer, Civil Engineer, Richard Walker, Hydrologist, Rey Decker, Geology and Soil Mechanics. The following Missouri Department of Conservation personnel were contacted at the dam site: Jim King and Marvin Quindorff.

Results of the observations are disucssed below.

b. Dam. Materials on the surface of the dam consist of plastic clays and sandy clays. The crest and downstream slope is well vegetated with grasses and legumes. They had been recently mowed and appeared to be well maintained. Rough measurements indicate that the crest of the dam slopes downward to the inlet section of the spillway from a point about 60 feet left (east) of the spillway. There is approximately 3.5 feet difference in elevation between the top of the spillway wall and the crest of the dam 60 feet eastward. (See Appendix C).

The exposed upstream slope is covered with moderately durable limestone riprap. The riprapped zone has a horizontal thickness of 5 to 6 feet and extends to the crest of the dam. It is relatively well graded with individual stones up to an estimated size of 400 lbs. The exposed riprap has a slope of about 1.5H on 1V. This upstream protection must have been added after the initial construction. There is no significant erosion on the upstream slope except in a few spots between centerline stations 1+00 and 2+00. (Stationing according to plans).

Rough measurements of the embankment section near centerline station 6+00 indicates downstream slopes of 2.5H on 1V from the crest down to the berm and 3H on 1V below the berm. A plot of the section measured during the inspection is shown in Appendix C. There was no indication of emergence of the phreatic line on the downstream slope.

There were no indications of cracks, slides, sinkholes, or abnormal deformations on the embankment.

The area adjacent to the downstream toe is very seepy from about centerline station 3+50 to 7+00 (Stationing according to plans). No boils were observed in the seepy area. The seepage water is clear and seems to be ponded in the shallow ditch that extends along the toe. Outlets from the tile lines shown on the plans were not evident.

Rough measurements indicate that the water surface in the first fish rearing pond, some 25 to 30 feet downstream from the toe of the dam, is approximately 0.6 foot below the elevation of the seepage water ponded along the toe.

The abutments apparently consist of fine grained glacial till (CL or CH) containing some gravel. Such material is exposed in the right abutment immediately downstream from the spillway stilling basin. No slips or slides were observed in the abutments.

A small seepy area was noted in the left abutment along the toe of the dam at about centerline station 9+50. This is very near the location of the outlet pipe from the controlled discharge tower. A very small seepy area was also noted on the right abutment upslope from about the midpoint of the spillway chute. This area was dry at the time of inspection but it was supporting water-loving vegetation.

An old farm pond, approximately 20 x 20 feet, is located in a side drainage on the left abutment about 250 feet downstream from the dam. There was water in the pond at the time of inspection but it was reported that it is empty during dry periods of the year. There is no apparent connection with water in the farm pond and the reservoir.

c. Appurtenant Structures.

(1) Spillway - Rough measurements of the spillway indicate that it was built according to plans shown in Appendix C.

The 10 inch wide concrete sill along the upstream lip of the spillway is absent for about 15 feet on the left side of the spillway.

The concrete floor of the spillway adjacent and upstream from point No. 1 (J-1) shown on the plans is spalled and deteriorating. (See photo 2). A hole about 6 x 6 inches was observed at the bottom of the right (looking downstream) side wall at J-1. The expansion joint in the right side wall at J-2 was open for a width of 0.5 to 0.75 inches. Expansion joints at J-3 and J-4 were open about 0.5 inches with a hole about 3 x 3 inches at the bottom of the right side at wall joint J-3.

The weep holes in the floor of the spillway were discharging a small flow of clear effluent. However, most of the iron pipe outlets for the weep holes are corroded to the point where much of the pipe is missing.

An area approximately 5 feet wide by 30 feet long is eroded into the channel bank adjacent to and downstream from the right wing wall of the S.A.F. energy dissipator.

Water about 1 inch in depth was flowing over about a 5 foot width of right side of the spillway on the day of the inspection.

(2) The plans show a gated discharge system consisting of a 36 inch corrugated metal pipe passing under the embankment at about centerline station 2+25.(Stationing according to plans). It was reported that the corrugated metal inlet structure for this system collapsed about 1963. At that time, this discharge system was "plugged with old mattresses and other materials and the inlet pumped full of concrete". No seepage was observed at the outlet of the discharge pipe for this system.

(3) The present controlled discharge system on the left end of the dam was constructed to supply the catfish bearing ponds after the failure of the initial system. This system consists of a gate tower with an inlet pipe attached to a swivel joint. The inlet end of the pipe is raised or lowered by means of a winch and cable mounted on the control tower. The discharge flows through the control tower and into a 10 inch diameter ductile iron pipe about 125 feet in length which passes through the embankment to a controlled distribution box about 70 feet downstream from the centerline and 13 feet ± below the reservoir surface of the dam. There is a shutoff valve in the discharge pipe located near the downstream toe of the dam, about 48 feet downstream from the centerline of the dam. The valve and the swiveled inlet were reported to be operable. The 10 inch discharge pipe was flowing full at the inspection.

The control or inlet tower for this system is tilted about 10 degrees off of vertical towards the left (east) and downstream (south) as shown in photo No. 13. It was reported that this vertical deformation was caused by ice the first year after installation. A plan view and cross section of this system is shown in Appendix C.

It was reported that this system is to be replaced in the near future. Asbestos/concrete pipe was on-site for the new system at the time of the inspection.

d. Reservoir Area. The reservoir area is bounded by rolling grassland and tree covered ridges. No significant erosion was noted around the shore line nor were any slips or slides evident.

e. Downstream Channel. The outlet channel for the spillway has a 20 foot ± bottom width, 5 foot ± depth with side slopes of approximately 3H on 1V from the channel banks to the flood plain. The channel is open, grassed and well maintained with no evidence of slides or erosion.

The outlet channel passes under U.S. Highway 36 about 1400 feet downstream from the dam. A house and 10 stall trailer court are located on the right (west) side of the channel just upstream from the highway bridge.

3.2 EVALUATION

None of the conditions observed are significant enough to indicate a need for immediate remedial action or a serious failure potential. Deterioration of the concrete and the open joints in the spillway channel bank erosion at the end of the spillway and erosion under and around the upstream riprap toward the right (west) end of the dam could lead to potential problems if left uncontrolled or uncorrected.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The controlled discharge system is operated whenever water is needed for the fish rearing ponds. This system is well above the bottom of the reservoir and could not lower the normal level of the lake more than a few feet if allowed to flow uncontrolled.

4.2 MAINTENANCE OF DAM

The dam is well maintained. The spillway and riprap have suffered some deterioration.

4.3 MAINTENANCE OF OPERATING FACILITIES

The inlet tower of the controlled discharge system has been tilted for many years. This has had no apparent adverse effects on the operation of the facility. However, it was reported that this system is to be replaced.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

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

4.5 EVALUATION

If the observed deterioration of the spillway, erosion of the outlet channel and upstream riprap are allowed to continue, danger of failure of the structure could develop.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No original hydrologic design data were received from the owner.

b. Experience Data. The drainage area is developed from USGS Princeton, Mo. (15') Quadrangle. The reservoir water surface areas and volumes were developed from a topographic sheet furnished by the Missouri Department of Conservation. The hydraulic computations for the spillway and dam overtopping discharge ratings were made from a set of as-built plans furnished also by the Missouri Department of Conservation. These plans were checked from surveys made during the inspection.

c. Visual Observations.

(1) Approximately 15 feet of the 10" sill on the left bank of the spillway crest is broken. The spillway has some spalling near its throat. There is also some spall near the bottom of the chute.

(2) There is some erosion at the right bank at the end of the spillway stilling basin.

(3) The gate tower for the discharge pipe to the spawning ponds is leaning approximately 10^{o} out of plumb.

(4) There are no drawdown facilities for evacuating the reservoir at present. The original low level spillway has been plugged, and the 10" diameter discharge line to the fish rearing ponds is not feasible for this purpose. However, there is pipe on the site to rebuild the discharge system to the fish rearing ponds.

(5) The spillway and exit channel are located at the immediate right abutment of the dam.

d. Overtopping Potential. The spillway is too small to pass the probable maximum flood without overtopping. One-half the PMF will overtop the dam by 0.3' for a period of 3.5 hours. The spillway will pass the 46% of PMF without overtopping. The existing spillway will pass the 100- year frequency flood without overtopping. The results of the routings through the dam are tabulated in regard to the following conditions.

Frequency	Inflow Discharge c.f.s.	Outflow Discharge c.f.s.	Maximum Pool Elevation	Freeboard Top of Dam Min. Elev. 950.1	Time Dam Overtopping Hr.
100 Yr.	3800	900	946.7	+ 3.4	0
1/2 PMF	9500	4100	950.5	- 0.4	2.0
PMF	19200	15200	952.8	- 2.7	6.0
0.47 PMF	8800	3400	950.1	0	0

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as intermediate size by height and storage and has a high hazard classification. Therefore, the PMF is the test for the adequacy of the dam and its spillway.

The estimated damage zone extends five miles downstream of the dam. Within the damage zone are one fish hatchery, three homes and four improved road crossings. The floodplain is farmed. This information was furnished by the St. Louis District, Corps of Engineers, in a letter dated 13 July, 1978.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations which adversely affect the structural stability of this dam are discussed in Sections 3 and 4.

The seepage along the toe of the dam has apparently been present for many years without apparent adverse affects on the structural stability of the dam.

b. Design and Construction Data. No design or construction data were available relative to the structural stability of the dam.

c. Operating Records. No operating records were available other than as reported in Section 4.

d. Post Construction Changes. Post construction changes include the plugging of the initial discharge system, installation of the present discharge system and the addition of riprap on the upstream face. None of these have any apparent adverse affect upon the structural stability of the structure.

e. Seismic Stability. This dam is in seismic Zone 1. An earthquake of this magnitude is not expected to cause structural failure of this dam. However, such an earthquake might cause damage to the present controlled outlet system and to the abandoned (plugged) system. Displacement of rupture of these systems could cause serious danger of failure of the dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several items noted during the visual inspection should be corrected. These items include spalling of the concrete and open joints in the spillway, bank erosion at the end of the spillway stilling basin, some deterioration of the riprap and erosion in a few small areas on the upstream slope. Seepage along the downstream toe does not appear to have an adverse affect upon the structural stability of the dam. The 2.5/3H on 1V downstream slopes on this dam will generally provide adequate factors of safety against shear failures for a dam of this height. Additional studies by an engineer experiences in earth dam design to determine seepage pressures in the downstream section and along the toe of the dam and subsequent seepage and uplift analyses would bee required to assess the affects of increasing the pool level to the top of the dam. The source of the downstream seepage near the controlled outlet structure (℄ Sta. 9+50±) should also be investigated. The inlet tower for the controlled outlet should be repaired or replaced and control valves(s) for the system installed at or near the upstream crest of the dam.

The maximum design flood (PMF) will overtop the dam, however, the spillway will pass the flood that would result from one-half the probable maximum precipitation.

b. Adequacy of Information. Due to the lack of engineering design and construction data, the conclusions in this report are based upon performance history and visual observations. Seepage analyses were not found which is a deficiency that should be corrected in the future. The inspection team considers these data sufficient to support the conclusions herein.

c. Urgency. There does not appear to be an immediate urgency to correct the deficiencies noted in paragraph "a". These deficiencies could ultimately lead to structural failure if not corrected.

d. Necessity for Phase II. Based on results of the Phase I inspection, no Phase II investigation is recommended.

e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of this magnitude is not expected to be hazardous to this dam. Detailed studies of historical seismic activity in the area and related analyses would be required to evaluate the potential damage to the present controlled outlet system and to the abandoned (plugged) outlet that might result from an earthquake of this magnitude.

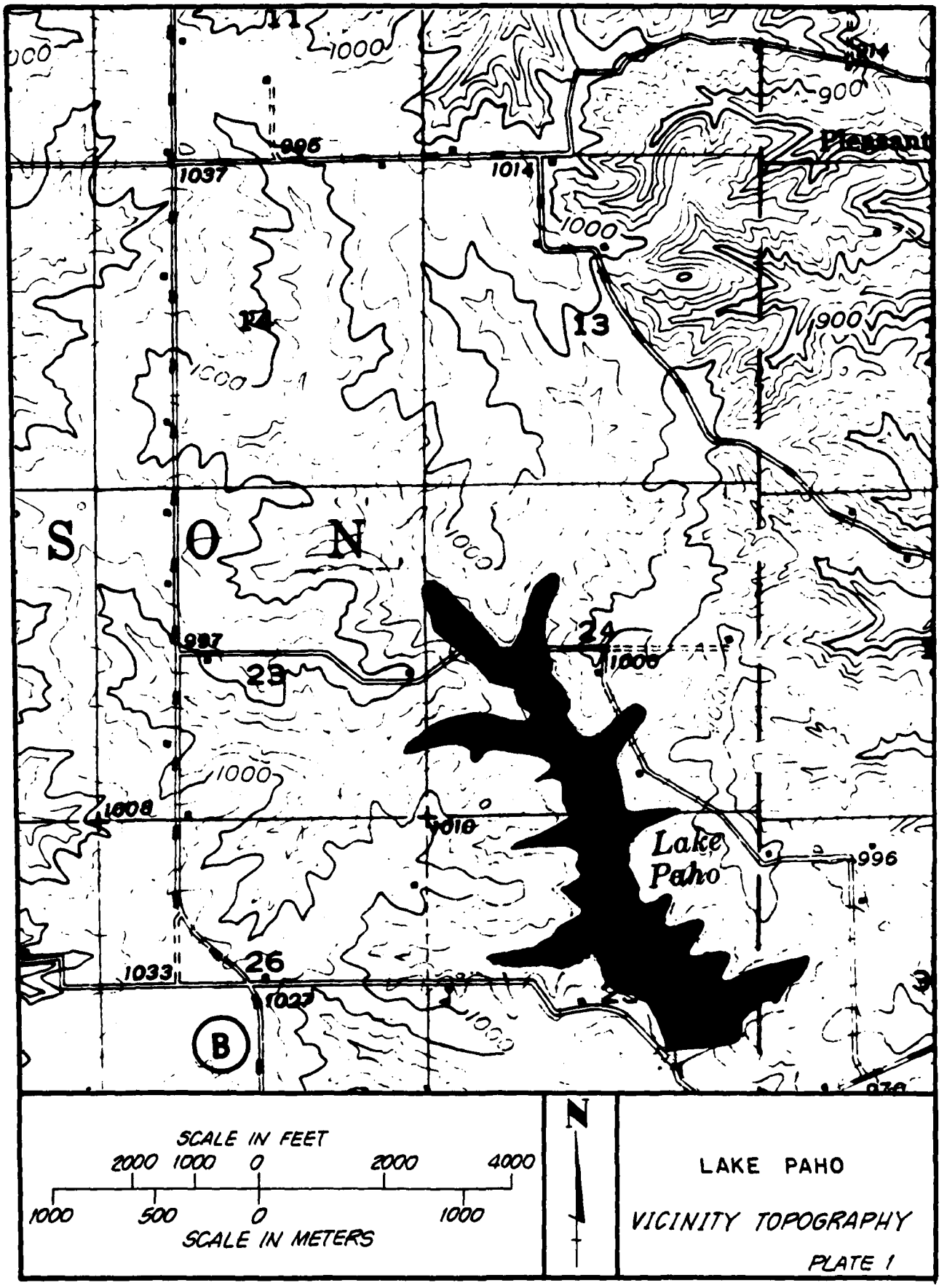
7.2 REMEDIAL MEASURES

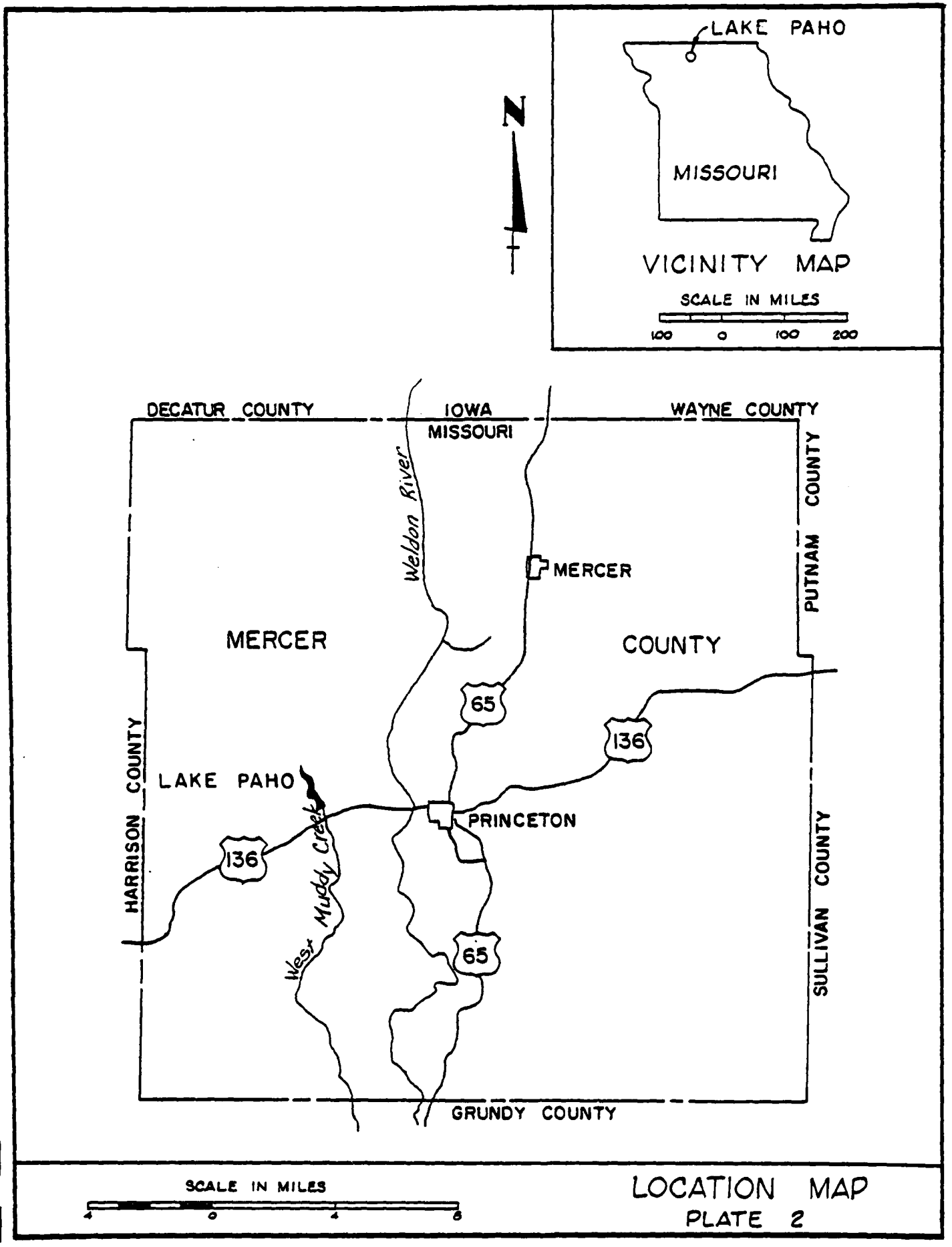
a. Alternatives. An auxiliary spillway on the left abutment would alleviate the hazards of overtopping by the probable maximum flood.

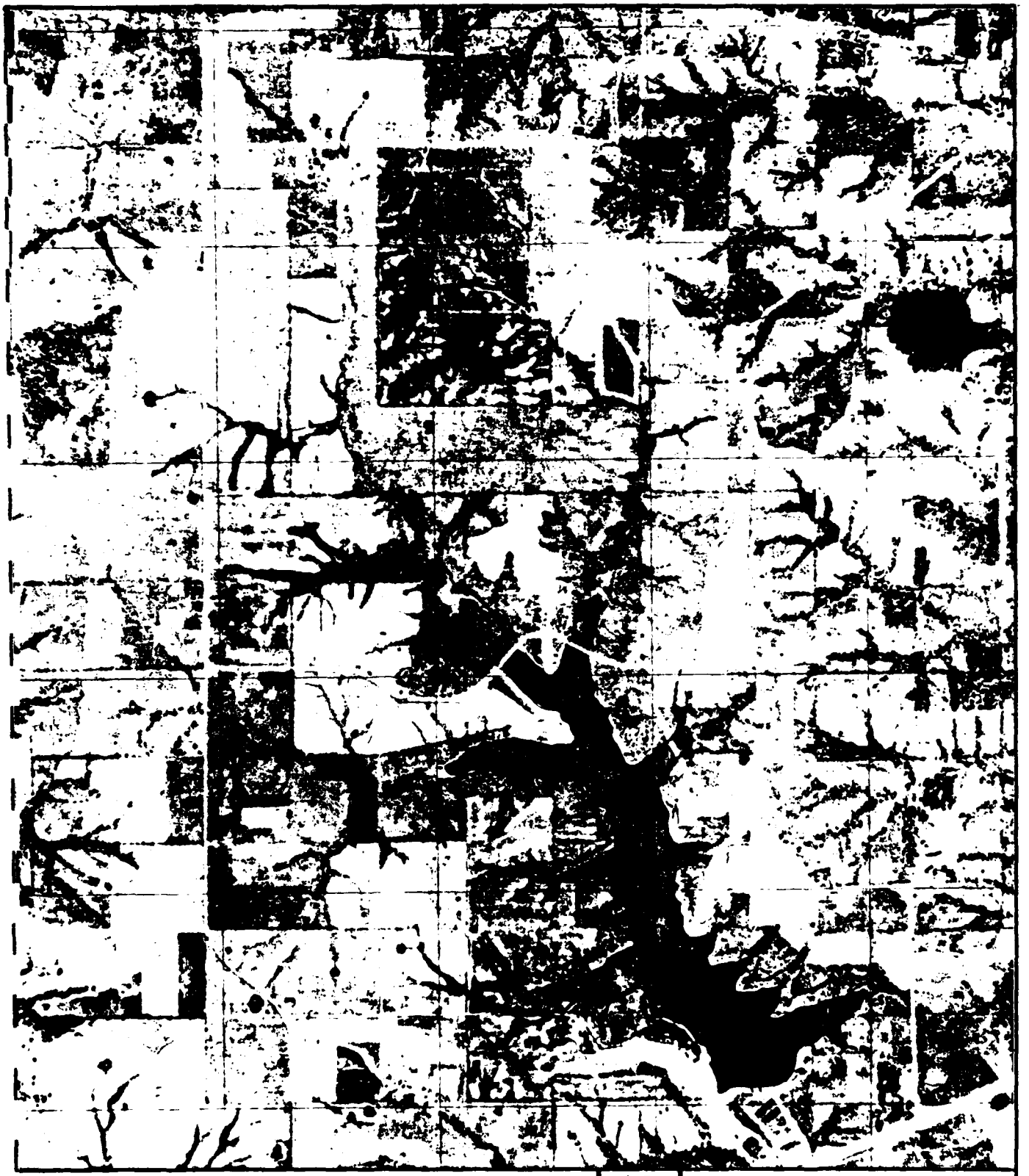
b. O&M Maintenance and Procedures.

(1) The observed deficiencies in maintaining the spillway and the upstream slope of the dam should be corrected and regular maintenance procedures should be initiated. Seepage pressures and quantities should be monitored. Periodic inspections should be made of the dam and appurtenances, with special attention to the condition of the controlled outlet and the abandoned outlet systems.

APPENDIX A
MAPS


1000
900
1037
1014
996
1000
900
13
1000
S
O
N
1000
997
24
23
1000
1000
1008
1010
Lake
Paho
996
26
1033
1027
1000
B
SCALE IN FEET
2000 1000 0 2000 4000
1000 500 0 1000
SCALE IN METERS
N
LAKE PAHO
VICINITY TOPOGRAPHY
PLATE 1


LAKE PAHO
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
N
DECATUR COUNTY
IOWA
MISSOURI
WAYNE COUNTY
Weldon River
MERCER
PUTNAM COUNTY
MERCER
COUNTY
65
136
LAKE PAHO
PRINCETON
HARRISON COUNTY
136
West Muddy Creek
65
SULLIVAN COUNTY
GRUNDY COUNTY
SCALE IN MILES
4 0 4 8
LOCATION MAP
PLATE 2



SCALE IN FEET

2000 1000 0 2000 4000

1000 500 0 1000

SCALE IN METERS

N

LAKE PAHO

ORTHOPHOTOGRAPH

PLATE 3

APPENDIX B
PHOTOGRAPHS

PHOTO NO. 2
SPALLING OF CONCRETE IN SPILLWAY INLET

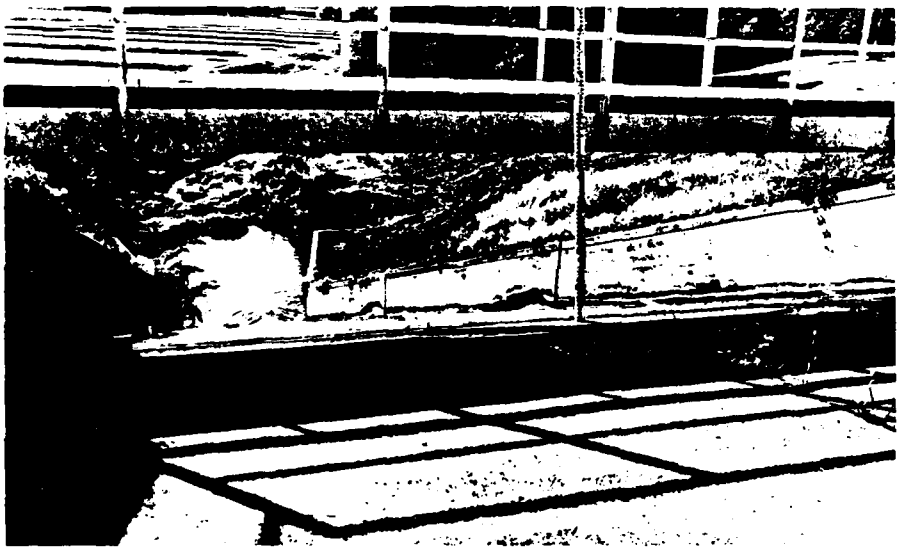


PHOTO NO. 3
SPILLWAY LOOKING DOWN-STREAM. NOTE SPALLING OF CONCRETE AND DOWNSTREAM BANK EROSION

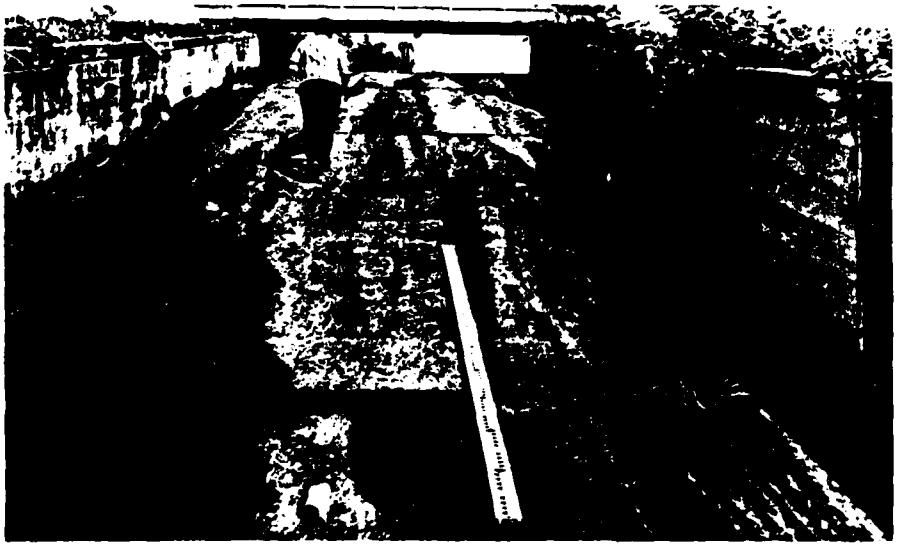


PHOTO NO. 4
LOOKING UPSTREAM IN SPILLWAY

PHOTO NO. 5
EXPANSION JOINT
J-4 (LOWEST JOINT)
JOINT OPEN
APPROX. 1/2 INCH

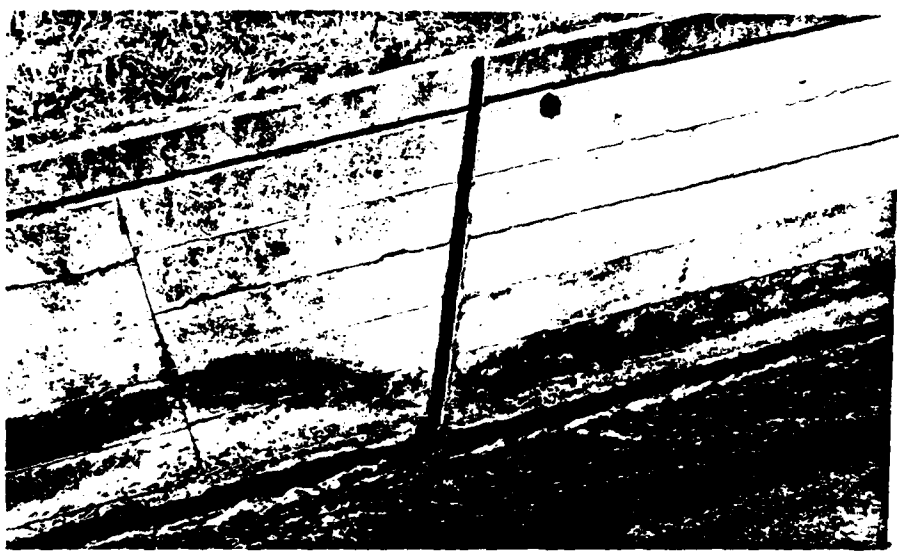


PHOTO NO. 6
EXPANSION JOINT
J-3 (RIGHT SIDE)
JOINT OPEN APPROX.
1/2 INCH. 3" X 3"
HOLE AT BOTTOM
OF JOINT

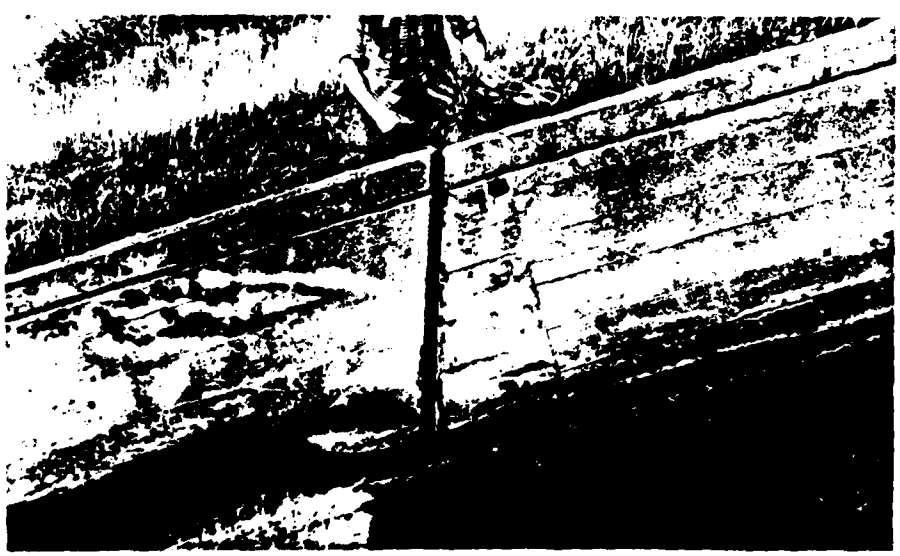


PHOTO NO. 7
EXPANSION JOINT
J-2 (RIGHT SIDE)
JOINT OPEN APPROX.
1/2 TO 3/4 INCH

PHOTO NO. 8
EXPANSION JOINT
J-2 (LEFT SIDE)

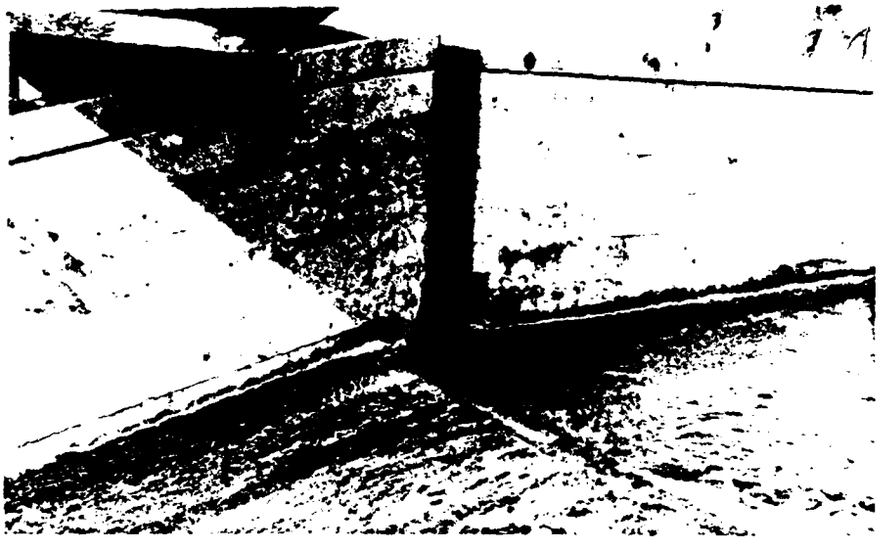


PHOTO NO. 9
EXPANSION JOINT
J-1 (RIGHT SIDE)
NOTE APPROX.
6" X 6" HOLE AT
BOTTOM OF JOINT

PHOTO NO. 10
LOOKING EAST
ALONG CREST

PHOTO NO. 11
FISH REARING
PONDS DOWN-
STREAM

PHOTO NO. 12
UPSTREAM FACE
AND OUTLET
TOWER FROM
WEST

PHOTO NO. 13
OUTLET TOWER
FROM SOUTH

PHOTO NO. 14
UPSTREAM SLOPE
FROM EAST END

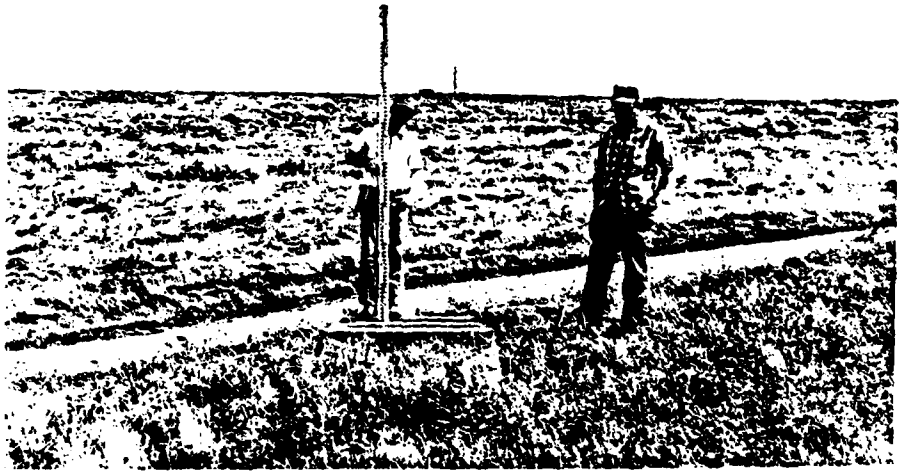


PHOTO NO. 15
DISCHARGE CONTROL
BOX DOWNSTREAM
FROM STA. 14+15

PHOTO NO. 16
SEEPS ALONG
TOE OF DAM
LOOKING WEST
FROM EAST END

PHOTO NO. 17
SEEP AT TOE NEAR CENTER OF DAM. FISH REARING PONDS WATER LEVEL IS 0.6' LOWER THAN SEEP

PHOTO NO. 18
ORIGINAL SPILLWAY THAT HAS BEEN PLUGGED

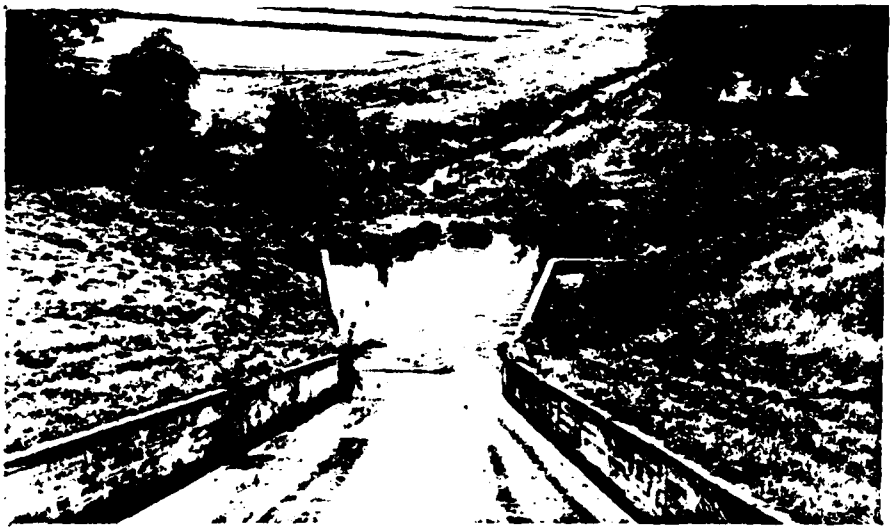


PHOTO NO. 19
SPILLWAY CHUTE OUTLET CHANNEL AND FISH REARING PONDS

PHOTO NO. 20
OUTLET CHANNEL

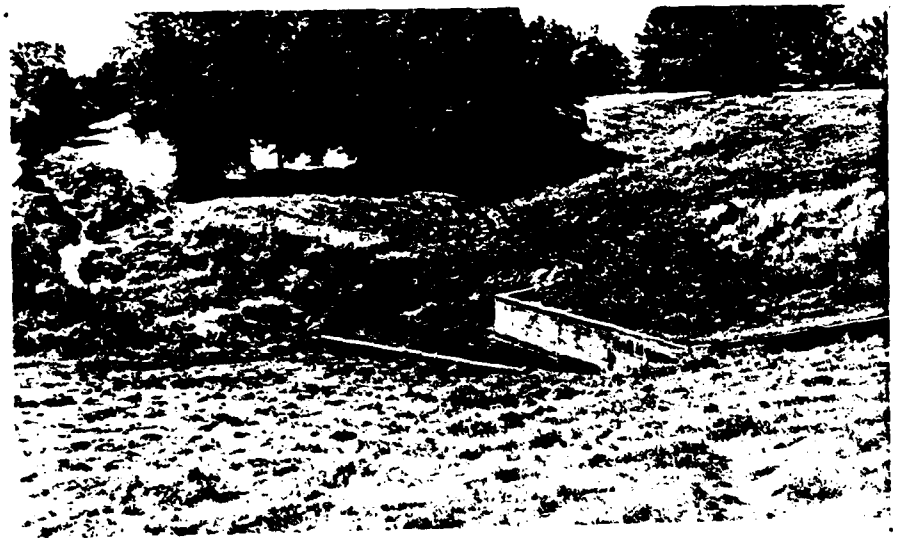
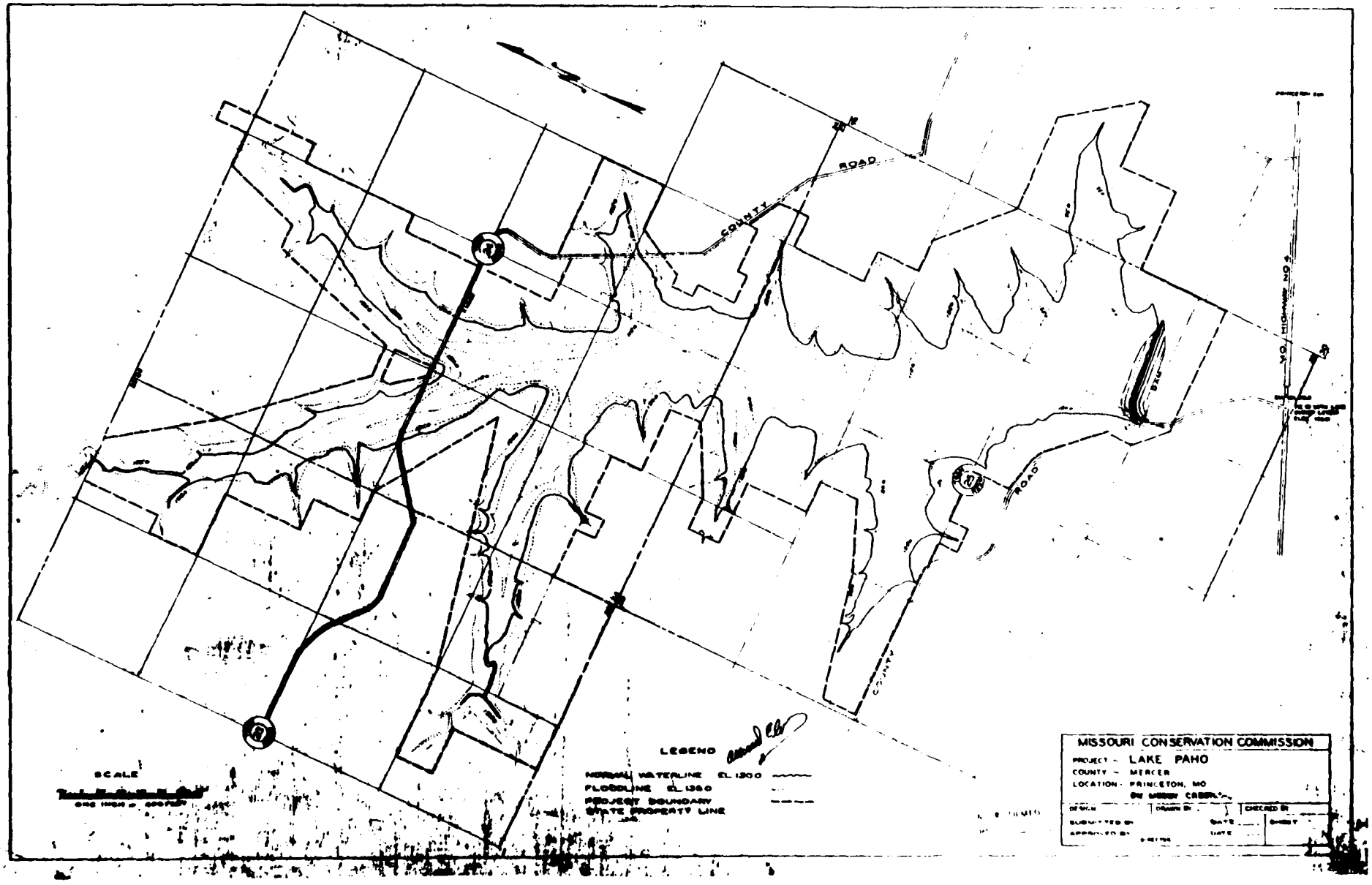
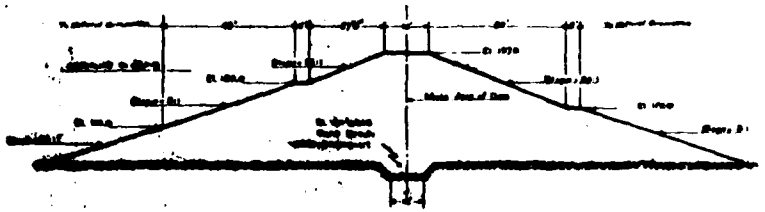


PHOTO NO. 21
EROSION AT
RIGHT SIDE OF
SPILLWAY STILL-
ING BASIN

PHOTO NO. 22
LOOKING UPSTREAM
ACROSS FISH
REARING PONDS
TO DAM. PHOTO
TAKEN FROM
HIGHWAY 136.

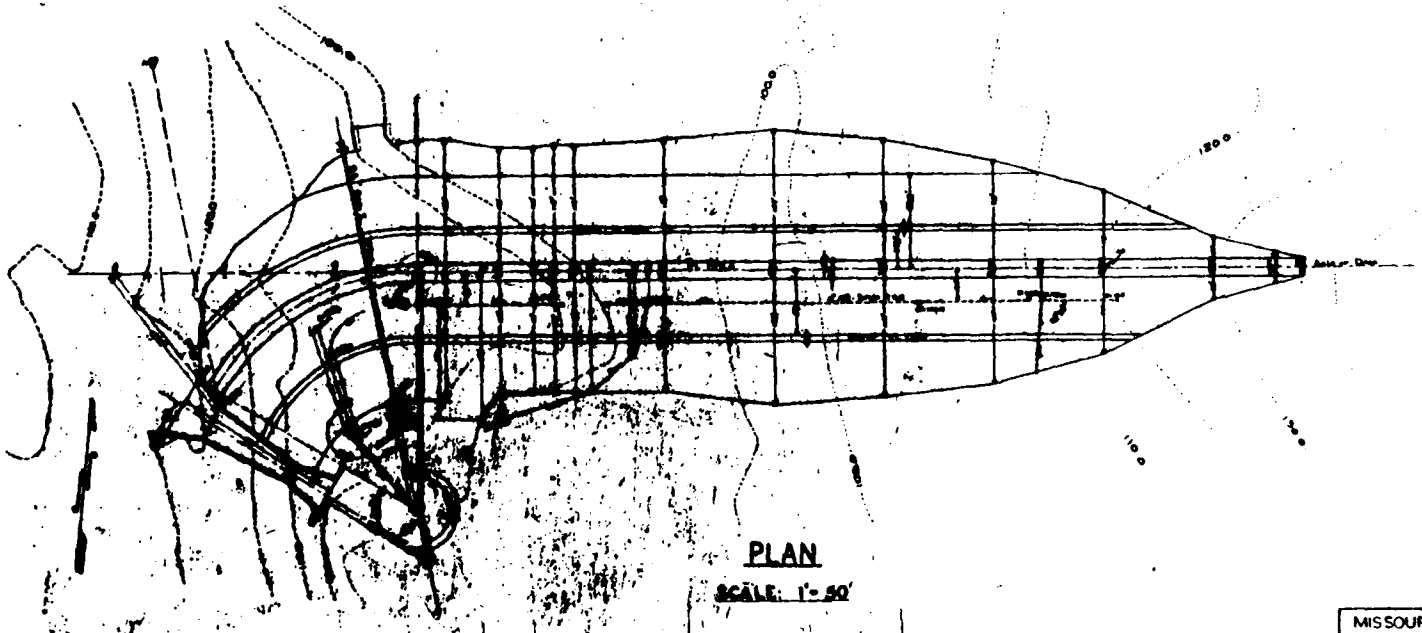
APPENDIX C
PLANS AND REPORTS


COUNTY ROAD
ROAD
LEGEND
NORMAL WATERLINE EL 1300
FLOODLINE EL 1360
PROJECT BOUNDARY
STATE PROPERTY LINE
SCALE
MISSOURI CONSERVATION COMMISSION
PROJECT - LAKE PAHO
COUNTY - MERCER
LOCATION - PRINCETON, MO
ON MISSY CREEK



SECTION THRU DAM

SCALE: 1"=20'



PLAN

SCALE: 1"=50'

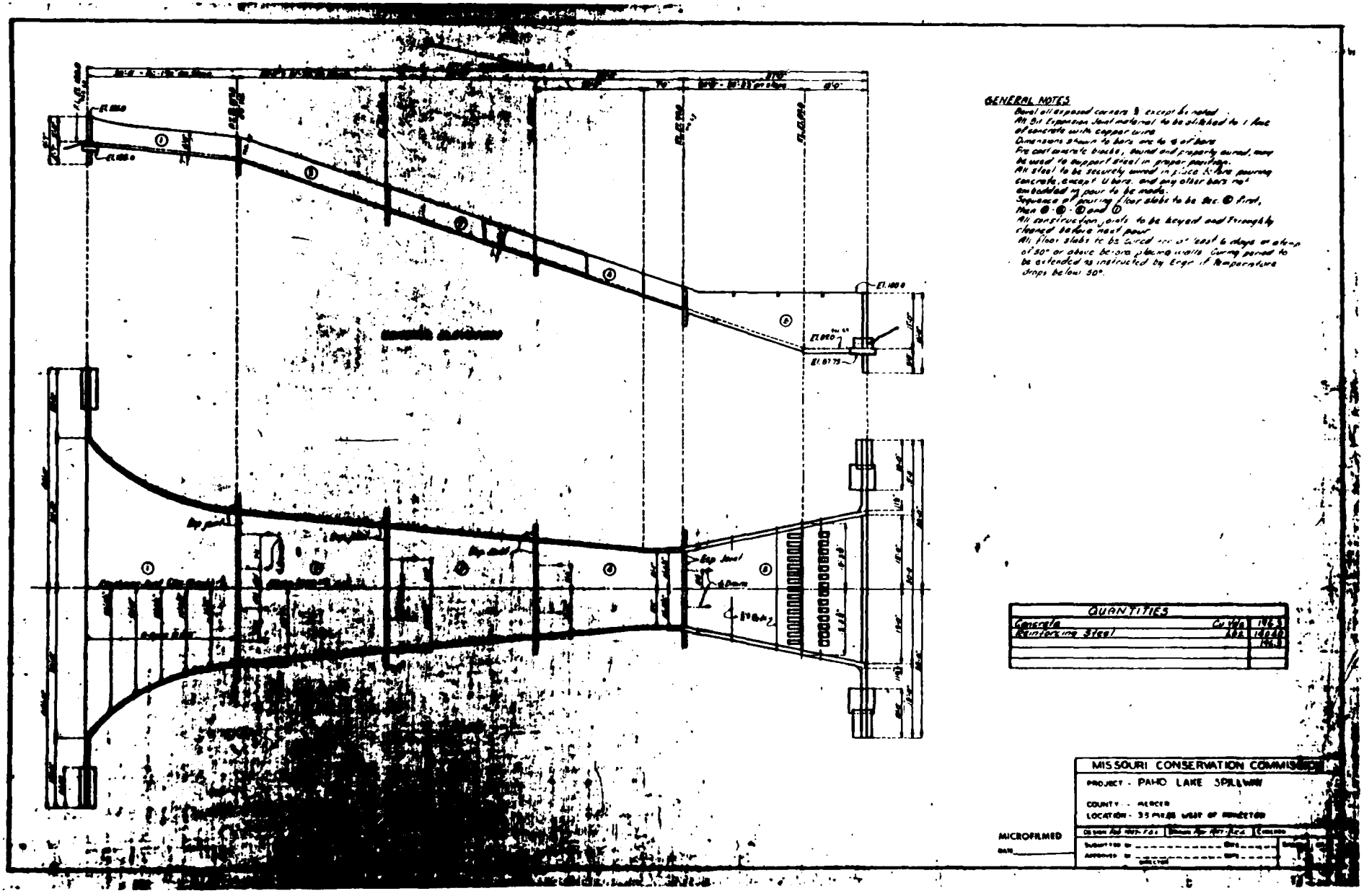
MISSOURI CONSERVATION COMMISSION

MERCER COUNTY LAKE PROJECT

DAM LAYOUT

MICROFILMED

DATE



GENERAL NOTES

Bend all exposed corners 3 except as noted.
All Bit Expansion Joint material to be shielded by 1 face of concrete with copper wire.
Dimensions shown to bars are to ℄ of bars.
Pre cast concrete blocks, tested and properly cured, may be used to support steel in proper position.
All steel to be securely anchored in place before pouring concrete, except U bars, and any other bars not embedded in pour to be made.
Sequence of pouring floor slabs to be thus: ⑥ first, then ④ · ⑤ · ⑦ and ⑧.
All construction joints to be keyed and thoroughly cleaned before next pour.
All floor slabs to be cured moist at least 6 days at a temp of 50° or above before placing walls. Curing period to be extended as instructed by Engr if temperature drops below 50°.

QUANTITIES		
Concrete	Cu Yds	1963
Reinforcing Steel	Lbs	168430
		86.1

MISSOURI CONSERVATION COMMISSION

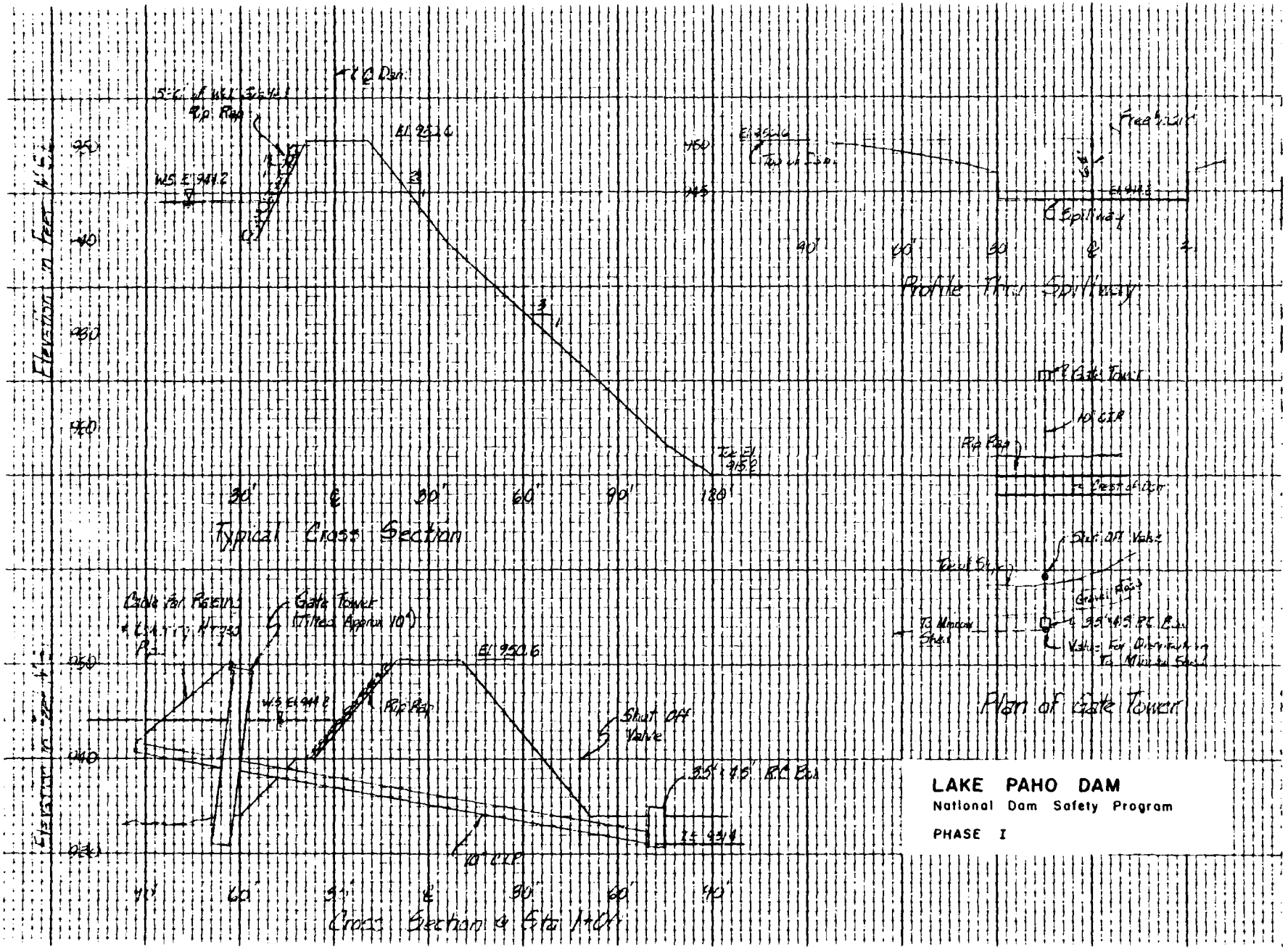
PROJECT - PAHO LAKE SPILLWAY

COUNTY - MERCER

LOCATION - 35 miles WEST OF PRINCETON

MICROFILMED

DATE


Typical Cross Section
Profile Thru Spillway
Plan of Gate Tower
Cross Section of Gate Tower
LAKE PAHO DAM
National Dam Safety Program
PHASE I

APPENDIX D
HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

1. The Mockes dimensionless standard curvalinear unit hydrograph and the SCS TR-20 program were used to develop the inflow hydrographs (see Plate D1).

a. Twenty-four hour, 100-year rainfall for the dam location was taken from NOAA Technical Paper 40. The 24-hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current OCE directives furnished 3 August 1978.

b. Drainage area = 4.61 square miles.

c. Time of concentration of runoff = 1.79 hours.

d. The antecedent storm conditions were heavy rainfall and low temperatures which occurred on the previous 5 days, i.e. greater than 2.1 inches, (SCS AMCIII). The initial pool elevation was assumed at the crest of the spillway.

e. The total 24-hour storm duration losses for the 100-year storm were 1.06 inches (SCS) which is a 0.22 PMF storm. The total losses for the 24-hour duration 1/2 PMF storm were 1.1 inches. The total losses for the PMF storm were 1.2 inches. These data are based on SCS runoff curve No. 90 for 100 year storm and No. 91 for 1/2 PMF and PMF. Antecedent moisture conditions were from SCS AMCIII.

f. Average soil loss rates = 0.05 inch per hour approximately.

2. The dam outflow rates are based on the broad-crested weir equation ($Q=CLH^{1.5}$) for both components; that is, the flow through the concrete chute spillway and the component of flow going over the dam top or over low elevation abutment areas H is the head on the spillway weir crest or the dam crest, L is the effective length acting as a weir, and C is an appropriate weir coefficient which varies with head and is based on U.S. Geological Survey criteria. The discharge through the 10" diameter pipe which supplies the fish rearing ponds was assumed not to contribute to the combined rating curve for the dam.

3. The Probable Maximum Flood and fractions of it were routed through the dam to determine that percentage of PMF which just overtops the dam. This result was obtained by interpolating between the 0.4 and 0.5 PMF routings respectively. The routings were made using SCS TR-20 computer program. The 100 year flood was also routed through the dam. The input PMP rainfall distributions, reservoir inflow hydrographs, and outflow hydrographs are shown on Plate D1 for the PMF and 1/2 PMF.

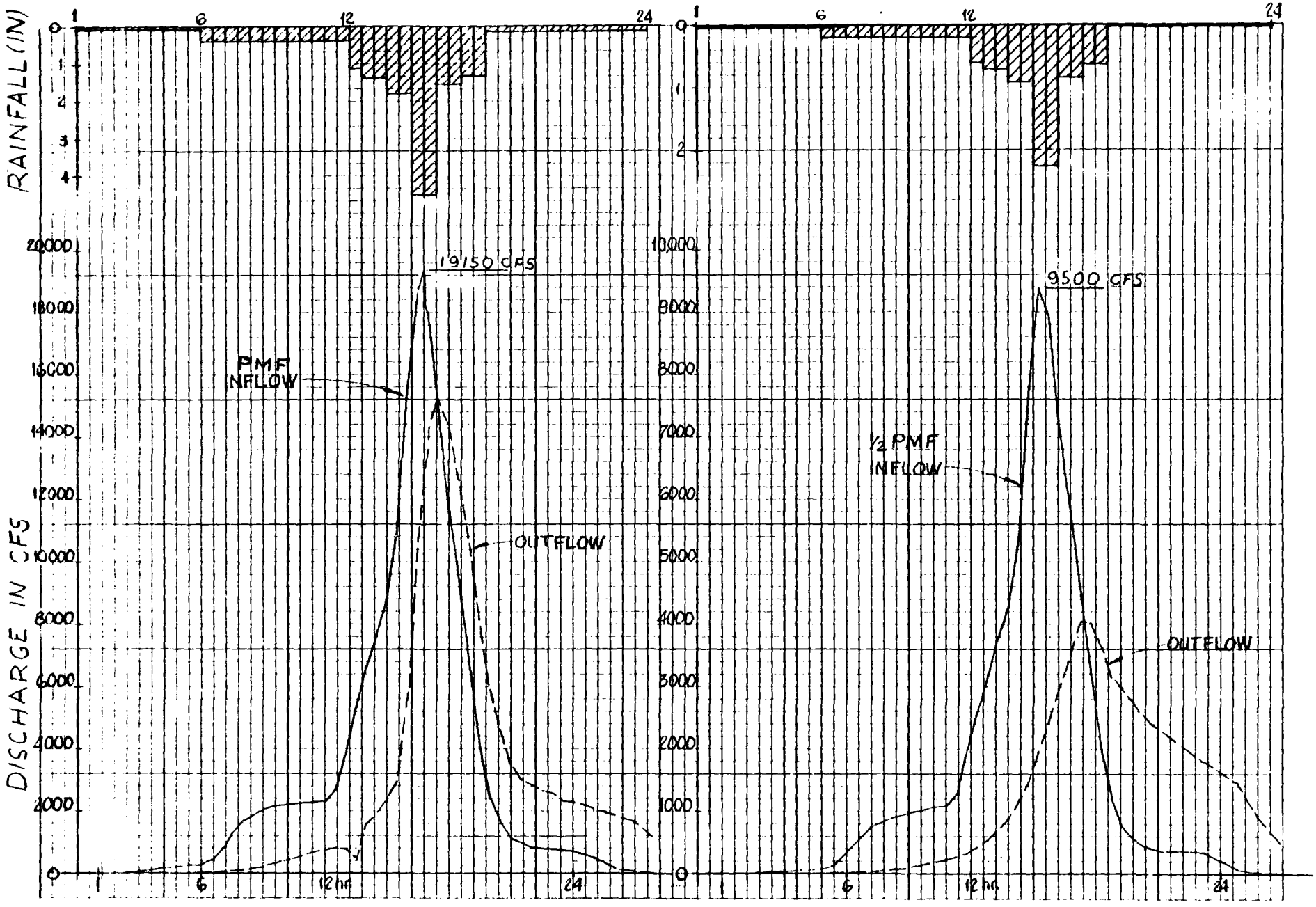

RAINFALL (IN)
DISCHARGE IN CFS
TIME IN HOURS FROM BEGIN RAINFALL
19150 CFS
PMF INFLOW
OUTFLOW
9500 CFS
½ PMF INFLOW
OUTFLOW

PLATE D1