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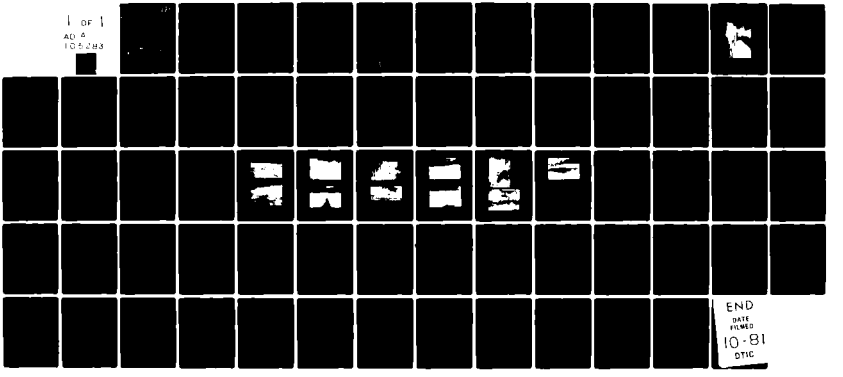

LEVEL II

OSAGE-GASCONADE BASIN

AD A105283

SWISS LAKE ESTATES DAM

GASCONADE COUNTY, MISSOURI

MO. 30109

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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National Dam Safety Program. Swiss Lake Estates Dam (MO 30109), Osage - Gasconade Basin, Gasconade County, Missouri. Phase I Inspection Report.

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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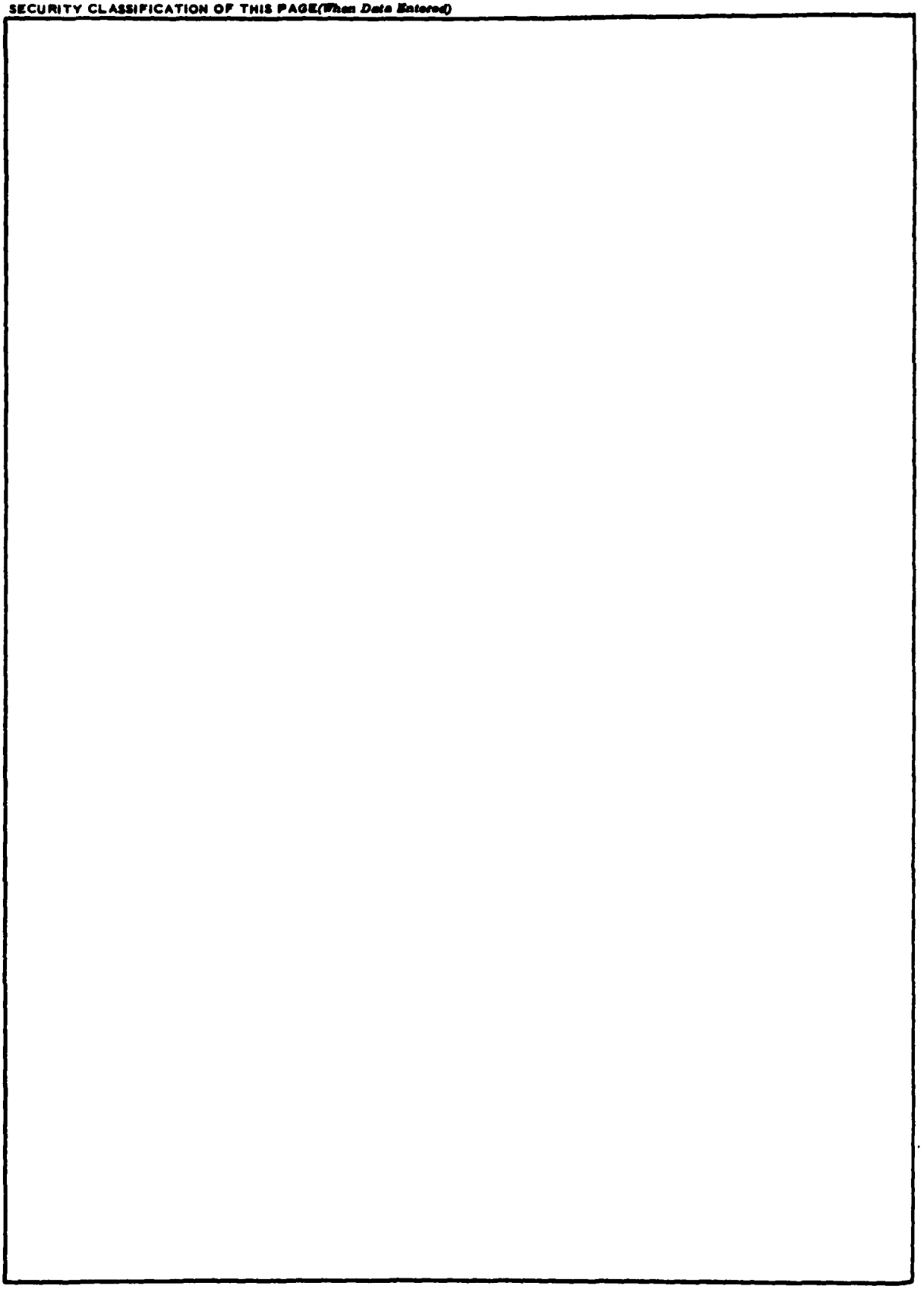

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SWISS LAKE ESTATES DAM

GASCONADE COUNTY, MISSOURI

MO. 30109

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

JUNE, 1979

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Swiss Lake Estates Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Swiss Lake Estates 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 — 14 MAR 1980
Chief, Engineering Division — Date

APPROVED: SIGNED — 14 MAR 1980
Colonel, CE, District Engineer — Date

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Swiss Lake Estates Dam
State Located	Missouri
County Located	Gasconade County
Stream	Tributary of Puncheon Creek
Date of Inspection	June 26, 1979

Swiss Lake Estates 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 a small size dam with a high downstream hazard potential. Failure would threaten life and property. The estimated damage zone extends approximately 5 miles downstream of the dam. Within the damage zone are 6 dwellings, an unimproved road and Highway W.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the recommended guidelines for a small dam having a high hazard potential. Considering the volume of water impounded and the number of dwellings downstream of the dam, one-half of the Probable Maximum Flood is the appropriate spillway design flood. The spillways will pass the 100-year flood (flood having a one percent chance of being exceeded in any year) without overtopping the dam. The spillways will pass 20% 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 meterologic and hydrologic conditions that are reasonably possible in the region.

No design data were available for this dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These analyses should be obtained in the future.

Other deficiencies observed during the inspection include a few small trees and brush growing along the water edge, a few small trees growing on the downstream slope and in the entrance to the emergency spillway, and growth of trees in the downstream channel.

This dam is reasonably well maintained. However, a program of regular maintenance should be initiated to remove and control the growth of trees and brush on the dam and in the spillway and channel and to assure unobstructed flow into the principal spillway.

Rey S. Decker
E-3703

Gordon Jamison

Garold Ulmer
E-4777

Harold P. Hoskins
Chairman of Board
Hoskins-Western-Sonderegger, Inc.
E-8696

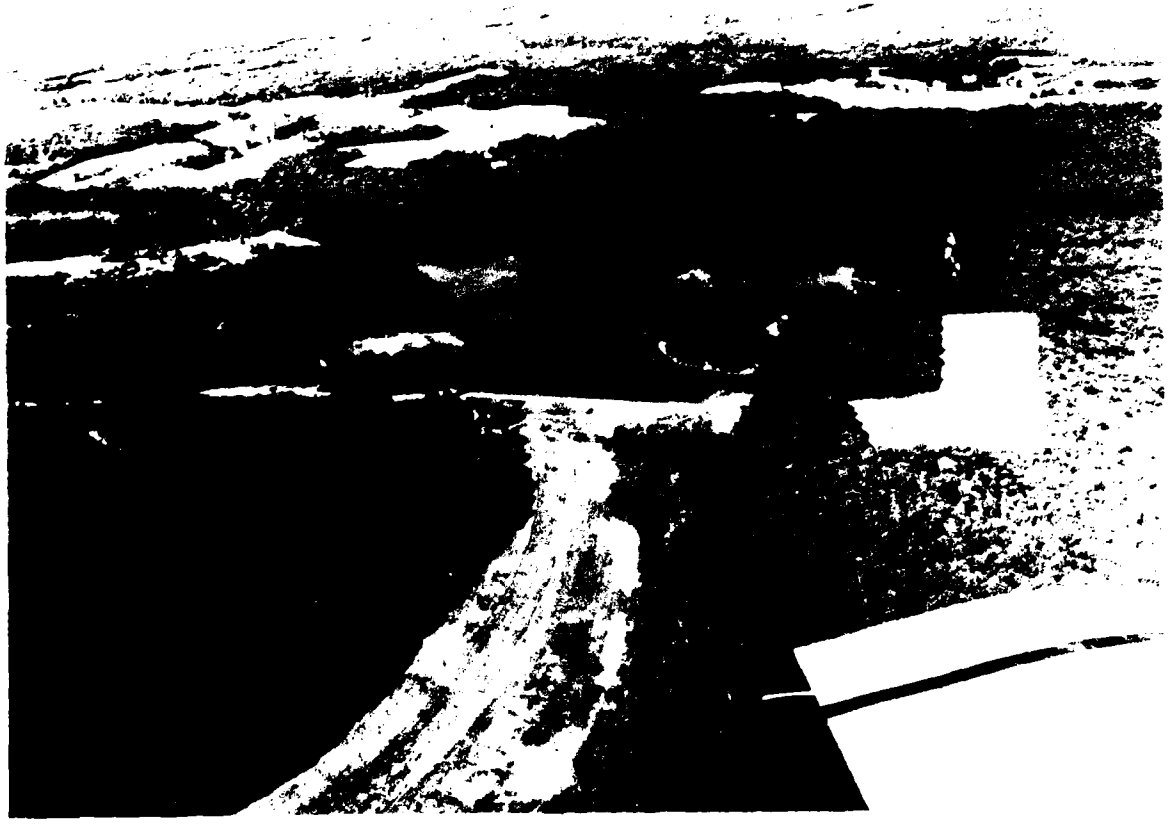


PHOTO NO. 1 - OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
SWISS LAKE ESTATES DAM - MO 30109
GASCONADE COUNTY, MISSOURI

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 Swiss Lake Estates 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", Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams", dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth fill about 730 feet in length and about 37 feet in height located in rolling hills of moderate relief with narrow minature valleys cut into limestone.

(2) The principal spillway consists of a 22 inch diameter steel pipe with a 4 X 4 foot weir drop inlet, antivortex plate and conical trash guard. The inlet end of the pipe is hooded and the pipe passes through the embankment.

(3) A vegetated earth emergency spillway is cut through cherty clay and the underlying limey shale on the left abutment.

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

b. Location. The dam is located in the north central portion of Gasconade County, Missouri, as shown on Plate A-2. The dam is shown on Plate A-1 in the NE ¼ of Section 28, T44N, R5W. The lake formed behind the dam is shown in the NE ¼ of Section 28, T44N, R5W, and the SE ¼ of Section 21, T44N, R5W.

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 small size category.

d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph 1.1c above. Based on referenced guidelines, this dam is in the High Hazard Classification. The estimated damage zone extends some 4 to 5 miles downstream, and includes two dwellings and an unimproved road before the stream enters a larger drainage way some 2 miles downstream from the dam. There are 4 dwellings and Highway W located along the larger drainage way between the confluence of the Boggs Creek with the larger creek and its confluence with Puncheon Creek about 4.5 miles below the dam.

e. Ownership. The dam is owned by Swiss Lake Estates, c/o R. O. Boggs, Box 257, Hermann, MO. 68041.

f. Purpose of Dam. The dam impounds a recreational lake covering some 40 acres and containing about 520 acre-feet of water.

g. Design and Construction History. The dam was constructed in 1967. Geologic investigations of the site were made by the Missouri Geological Survey and others (SCS and/or Browning Testing Laboratories, Fulton, MO). Design and construction plans for the dam were prepared by the Soil Conservation Service (SCS), Columbia, MO. Copies of the Missouri Geologic Survey Report and SCS plans are included with this report as Appendix C.

h. Normal Operating Procedure. There are no operating facilities for this dam. The reservoir level is controlled by rainfall, evaporation and the capacity of the spillways. It was reported by Mr. R.O. Boggs that the emergency spillway has never operated.

1.3 PERTINENT DATA

a. Drainage Area. 649 acres (1.014 square miles).

b. Discharge at Damsite.

(1) All discharges at the damsite are through a principal spillway consisting of a 4' X 4' steel riser connected with a 22 inch diameter smooth iron pipe outlet and a grassed earth channel ungated emergency spillway.

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

(3) The principal spillway capacity varies from 0 cfs at elevation 773.0 feet to 66 cfs at the crest of the emergency spillway (elevation 776.0 feet) to 68 cfs at the minimum top of dam (elevation 778.0 feet).

(4) The emergency spillway capacity varies from 0 cfs at its crest elevation 776.0 feet to 360 cfs at elevation 778.0 feet (*minimum top of dam*).

(5) Total spillway capacity at the minimum top of dam is 428 cfs ±.

c. Elevations (feet above MSL).

(1) Top of dam - 778±
(2) Principal spillway crest - 773±
(3) Emergency spillway crest - 776±
(4) Streambed at centerline - 739±
(5) Maximum tailwater - unknown

d. Reservoir. Length (feet) of maximum pool - 2500±

e. Storage (Acre-feet).

(1) Top of dam - 747±
(2) Principal spillway crest - 520±

f. Reservoir Surface (Acres).

(1) Top of dam - 49±
(2) Principal spillway crest - 40±

g. Dam.

(1) Type - earth fill
(2) Length - 730 ft. ±
(3) Height - 37 ft. ± (measured)
(4) Top width - 15 ft. ± (measured)
(5) Side slopes
    (a) Downstream 2.5H on 1V w/10' berm (plans); 2.4H on 1V with 2.9H on 1V below berm (measured)
    (b) Upstream - 2.5H on 1V w/8' berm (plans) 2.8H on 1V (measured)
(6) Zoning - plans show selective placement of most impervious material in center section and least impervious materials in the outside sections.
(7) Impervious core - as above
(8) Cutoff - a core trench was excavated to sound bedrock up to the permanent pool elevation on the abutments.
(9) Grout curtain - none
(10) Wave protection - 8 foot sacrificial berm, no riprap
(11) Internal drainage - unknown

h. Diversion Channel and Regulating Tunnel. None

i. Spillway.

(1) Principal
    (a) Type - hooded inlet, 22 inch diameter steel pipe with 4 x 4 ft. steel drop box inlet
    (b) Crest (invert) elevation - 771 ft. ± = el. 98.0 on plans
    Outlet - 737.4 ft. (plans); 742.8 ft. ± (measured)
    (c) Length - 142 ft. ±

(2) Emergency

    (a) Type - vegetated earth on left abutment. Bottom width = 45 ft. ±
    (b) Control section - 45 ft. ± bottom, trapezoidal section with 2H on 1V side slopes
    (c) Crest elevation - 776 ft. = 103 ft. on plans
    (d) Upstream Channel- 3% ± slope. Sparsely vegetated.
    (e) Downstream Channel - open and clear, well vegetated, slope = 2.5% ±

j. Regulating Outlets. None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data available for this dam are included as Appendix C.

2.2 CONSTRUCTION

No construction data were available. It was reported by Mr. R. O. Boggs that the dam was constructed in accordance with SCS specifications.

2.3 OPERATION

No data were available on spillway operation. It was reported by Mr. R. O. Boggs that the emergency spillway has never operated.

a. Availability. The owner willingly supplied all data that were available.

b. Adequacy. The available data, field surveys and visual observation presented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. The data are considered to be valid. Information supplied by the owner, Mr. R. O. Boggs, is considered to be valid.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Swiss Estates Lake Dam was made on June 26, 1979. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska making the inspection were: R.S. Decker, Geotechnical; Gordon Jamison, Hydrology; Garold Ulmer, Civil Engineer. Mr. R. O. Boggs, Owner, was present during the inspection.

b. Dam.

1. Geology and Soils (Abutment and Embankment). The report of the Missouri Geological Survey (MGS) described geological conditions at the site. Visual observations confirm the findings in the report. All material for the dam was borrowed from the abutments. (Nothing from the bottom). One high abutment borrow area shows as the cleared area, left of the dam, in Photo No. 1. One sample of borrow for the dam was tested by the MGS and produced LL = 37, PI = 20 with maximum standard density (ASTM D 698) of 113 pcf at opt. moisture of 18%. Borings on the dam showed CL or CH materials (based on field classification) to a depth of 2 feet.

2. Upstream Slope. The upstream slope is well vegetated with a few small trees and brush growing along the water edge. No significant erosion was noted on the face. No indication of slides, slumps or rodent activity was noted.

3. Crest. The roadway across the crest is well graveled with cherty limestone. The remainder of the crest is well vegetated. No pot holes, slides or slumps were noted along the crest. A few drying cracks were observed which would be expected from the plastic materials used to construct the dam. Measurements on the crest indicate that the dam was constructed essentially as shown on the plans with the constructed top elevation 1 to 1.5 feet higher than the settled elevation (104' = 777') shown. This planned 5% settlement apparently has not occurred to date.

4. Downstream Slope. The downstream slope is well vegetated with adapted grasses and no erosion was noted. A few small cedar trees are growing on the slope. No cracks, slides, slumps or other deformations were observed on the slope or at the toe. There was no indication of emer-

gence of the phreatic line on the slope nor any sign of seepage along the toe of the dam. There is some water loving grass 20 to 30 feet below the toe on the right side of the spillway scour hole, but it is from surface drainage from the right abutment.

5. Miscellaneous. The vegetative cover and plastic nature of materials in the dam indicate that this dam would withstand considerable overtopping without serious damage.

c. Appurtenant Structures.

(1) The principal spillway. No deterioration of the pipe spillway was noted. The reservoir level was just below the inlet elevation of the weir at the time of inspection. Rough measurements made during the inspection indicate that the outlet elevation of the pipe is about 5+ feet higher than shown on the plans. This does not affect the operation of the spillway but increases the outlet drop into the scour hole. The protective screen over the inlet is in poor condition.

(2) The emergency spillway is well vegetated with no indications of erosion slides or slumps. A few small trees are growing in the entrance. Discharge from the emergency spillway should not endanger the integrity of the dam. Measurements on the spillway indicate that the crest elevation of 776' is one foot higher than the planned elevation of 775' (102' on plans). This should not adversely affect the planned function and operation of the spillway. It should be beneficial since it increases the flood storage, reduces the incidence of spillway operation, and still maintains the planned 2 feet of freeboard on the dam.

(3) Drawdown Facilities. There are no drawdown facilities for this dam.

d. Reservoir Area. No significant erosion was noted around the shoreline of the reservoir.

e. Downstream Channel. The scour hole at the outlet of the pipe spillway has eroded (or was originally excavated) to depth of about 5 feet below the pipe. It is well armored with limestone cobble and large gravel and appears to be stable. The downstream channel is pretty well overgrown with trees but appeared capable of carrying principal spillway discharges. The channel appeared to be stable.

3.2 EVALUATION

This structure appears to be in good condition with no serious potential of failure. The discrepancies in measured and planned elevations of the emergency spillway, top of dam and principal spillway outlet should not adversely affect the safety of the dam. None of the deficiencies noted (few trees on slopes and in the entrance to the emergency spillway, lack of an adequate trash rack on the principal spillway, and lack of seepage and stability analyses) indicate a need for any immediate remedial action.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no controlled outlet works for this dam. The pool level is controlled by rainfall, evaporation, and the capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

The dam is reasonably well maintained. Action should be taken to correct the minor deficiencies noted in Sections 3 and 7.2.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect for this dam.

4.5 EVALUATION

There does not appear to be any serious potential of failure of this structure.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Detailed plans for the structure were furnished by the owner. The field inspection and survey indicate that both the emergency spillway crest and the top of the dam are 1 foot higher than per the original plans. Both the owner's plans and the plan, profiles, and cross-sections obtained from the field survey are attached in Appendix C.

b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the owner's plans and the USGS Swiss, Missouri 7 1/2 minute topographic quadrangle map. The hydraulic computations for the spillway and dam overtopping discharge ratings were based on data collected in the field at the time of the field inspection.

c. Visual Observations.

(1) The principal spillway appeared to be in good condition except for the protective screen on the inlet.

(2) The channel downstream of the principal spillway outlet is fairly well clogged with trees and brush.

(3) The emergency spillway is located in the left abutment of the dam. A few small trees are located at the entrance to the spillway. Spillway release should not endanger the integrity of the dam, since it outlets on the natural slope some distance downstream from the structure.

(4) No drawdown facilities are available to evacuate the pool.

d. Overtopping Potential. The spillways are too small to pass 50% of the probable maximum flood without overtopping. The spillways will pass 20% of the PMF without overtopping. The 100-year (1 percent) peak outflow discharge is approximately 16% of the spillway capacity. The dam should withstand considerable overtopping without serious damage.

The results of the routings through the dam are tabulated in regards to the following conditions.

Frequency	Inflow Discharge cfs	Outflow Discharge cfs	Maximum Pool Elevation	Freeboard Top of Dam Min. Elev. 778.0	Time Dam Overtopping Hr.
100 Yr.	1600	70	775.9	+2.1	0
1/2 PMF	4500	3900	779.3	-1.3	4+
PMF	8900	7900	780.2	-2.2	6+
0.2 PMF	1800	380	777.8	+0.2	0

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard rating and a small size. Therefore, the 1/2 PMF to the PMF is the test for the adequacy of the dam and its spillway. The estimated damage zone is described in Paragraph 1.2d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation. The dam appears to be structurally stable. Embankment slopes and CL-CH materials in the dam should provide adequate safety against shear failures. Analyses presented in Section 5 indicate that the dam will be overtopped by 1.3 feet of water for a period of 4 hours ± by one-half the Probable Maximum Flood. It would appear, however, that such an occurrence would not seriously damage the structure.

b. Design and Construction Data. The design data that were available did not contain slope stability nor seepage analyses which is considered a deficiency.

c. Operating Records. There are no controlled operating facilities for this dam. It was reported by Mr. R. O. Boggs that the emergency spillway has not operated.

d. Post Construction Changes. The inspection team is not aware of any post-construction changes on this dam.

e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of the magnitude predicted in this area is not expected to cause structural failure of this dam. However, the dam is located in an area that could have been affected by the structural activity of the Pershing-Bay-Gerald anticlinal formations and appropriate earthquake loadings should be included in stability analyses.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. This dam does not appear to have any serious potential of failure. The dam will impound the flood resulting from the 100 year storm without flow in the emergency spillway. The flood from one-half the Probable Maximum Flood will overtop the dam. The effects of such overtopping are not known but it would appear that it would not seriously impair the safety of the structure. The lack of seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" is considered to be a deficiency.

b. Adequacy of Information. The investigational and design data available along with visual observations and performance history are considered adequate to support the conclusions in this report. Seepage and stability analyses comparable to the requirements of the guidelines were not available which is considered a deficiency.

c. Urgency. The items recommended in paragraph 7.2.a should be pursued on a high priority basis.

d. Necessity for Phase II. Phase II investigation is not considered necessary.

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. However, additional studies should be performed to assess the actual seismic potential in the specific area. The lack of seismic stability analysis is considered a deficiency.

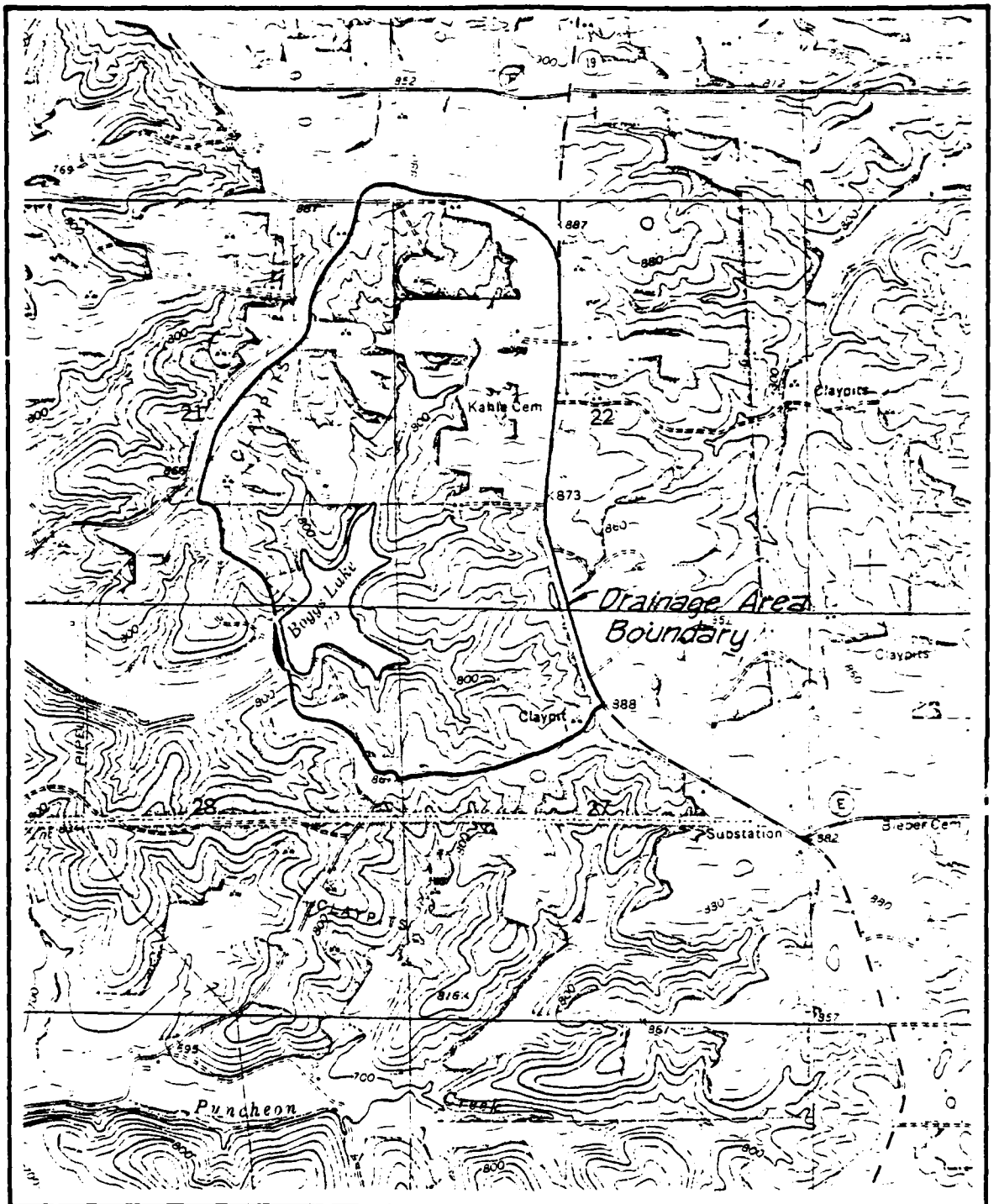
7.2 REMEDIAL MEASURES

a. Alternatives. Additional information should be obtained to determine the increase in the height of dam or the size of the spillway that is necessary to pass one half the Probable Maximum Flood without overtopping the dam. The services of an engineer experienced in the design and construction of dams should be obtained to evaluate the overtopping potential and resultant effects, to provide seepage and stability analyses, including earthquake loads, of the present dam, and to design protective measures, if required.

b. O & M Maintenance and Procedures

(1) The trees and shrubs should be removed from the embankment slopes and from the inlet of the emergency spillway,and the trash rack (screen) on the principal spillway should be rehabilitated. A program of regular inspection and maintenance should be initiated to prevent their recurrence.

APPENDIX A
MAPS



Scale in feet

2000 1000 0 2000 4000

Contour Interval 20 Feet

N

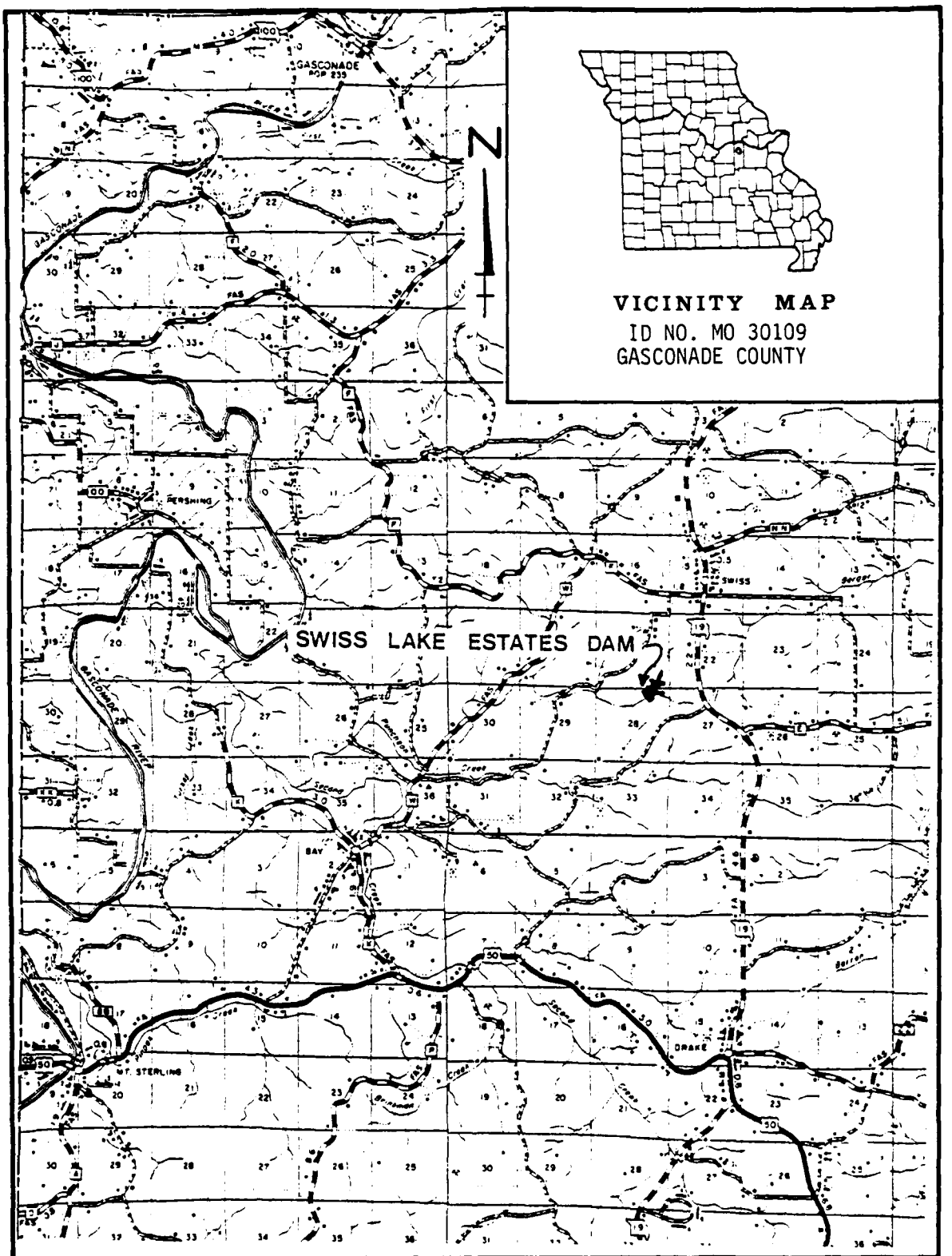
VICINITY TOPOGRAPHY

SWISS LAKE ESTATES DAM

GASCONADE COUNTY, MO.

MO. 30109

PLATE A-1



LOCATION MAP

PLATE A-2

APPENDIX B
PHOTOGRAPHS

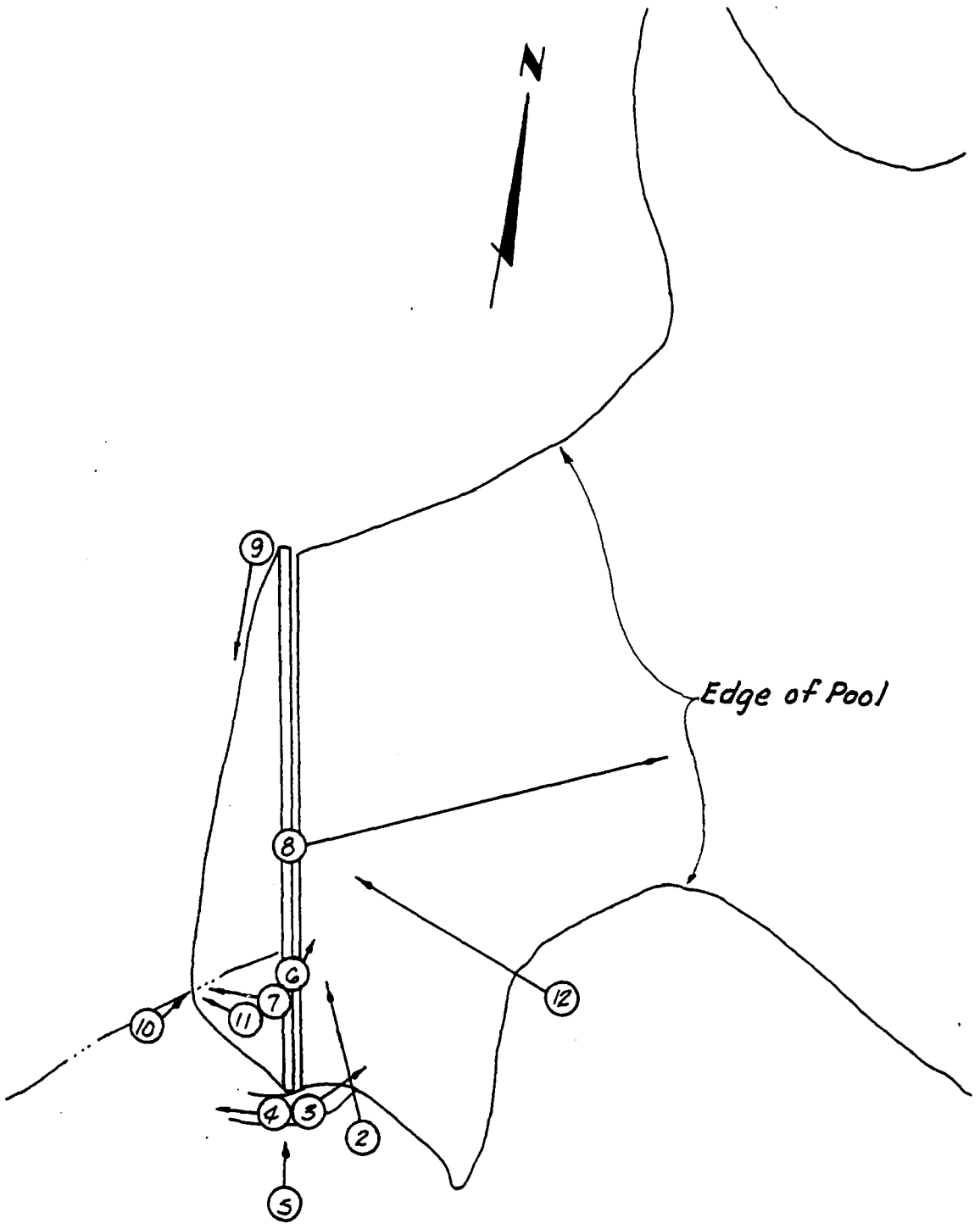


PHOTO INDEX

SWISS LAKE ESTATES DAM

GASCONADE COUNTY, MISSOURI

MO. 30109

PLATE B-1

PHOTO NO. 2 - UPSTREAM SLOPE FROM LEFT ABUTMENT

PHOTO NO. 3 - LOOKING UPSTREAM IN EMERGENCY SPILLWAY

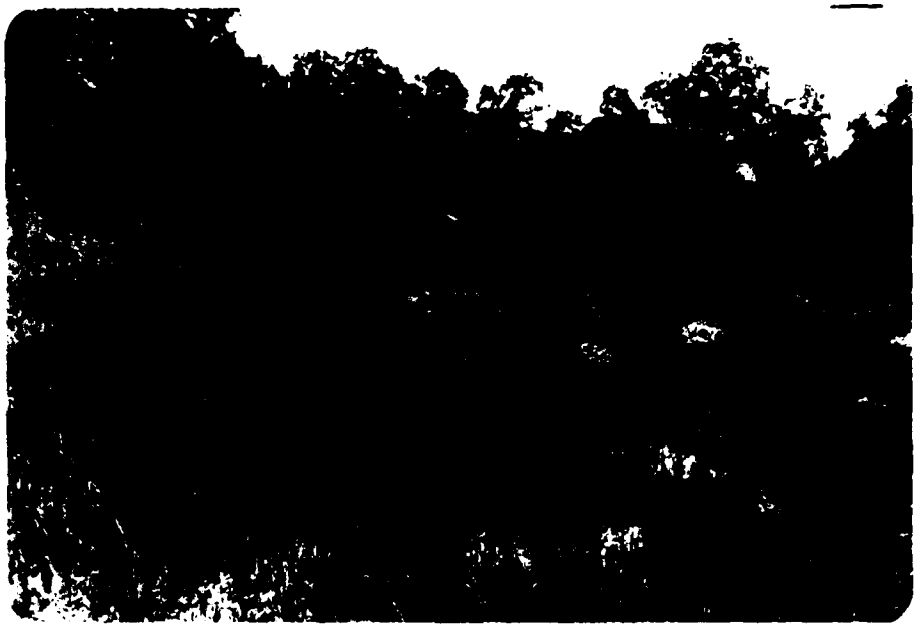


PHOTO NO. 4 - LOOKING DOWNSTREAM IN EMERGENCY SPILLWAY

PHOTO NO. 5 - CREST AND DOWNSTREAM SLOPE FROM LEFT

PHOTO NO. 6 - PRINCIPAL SPILLWAY INLET

PHOTO NO. 7 - OUTLET END OF PRINCIPAL SPILLWAY IN CENTER OF PICTURE

PHOTO NO. 8 - LOOKING UPSTREAM ACROSS LAKE FROM STA. 4 + 00

PHOTO NO. 9 - DOWNSTREAM SLOPE FROM RIGHT ABUTMENT

PHOTO NO. 10 -
OUTLET END OF PRINCIPAL
SPILLWAY

PHOTO NO. 11 - OUTLET END OF PRINCIPAL SPILLWAY

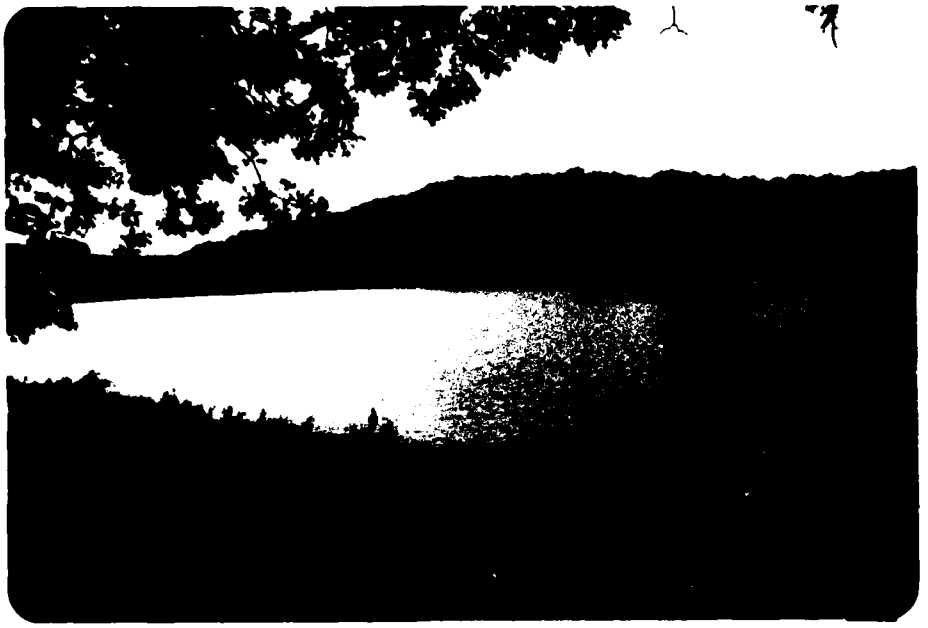
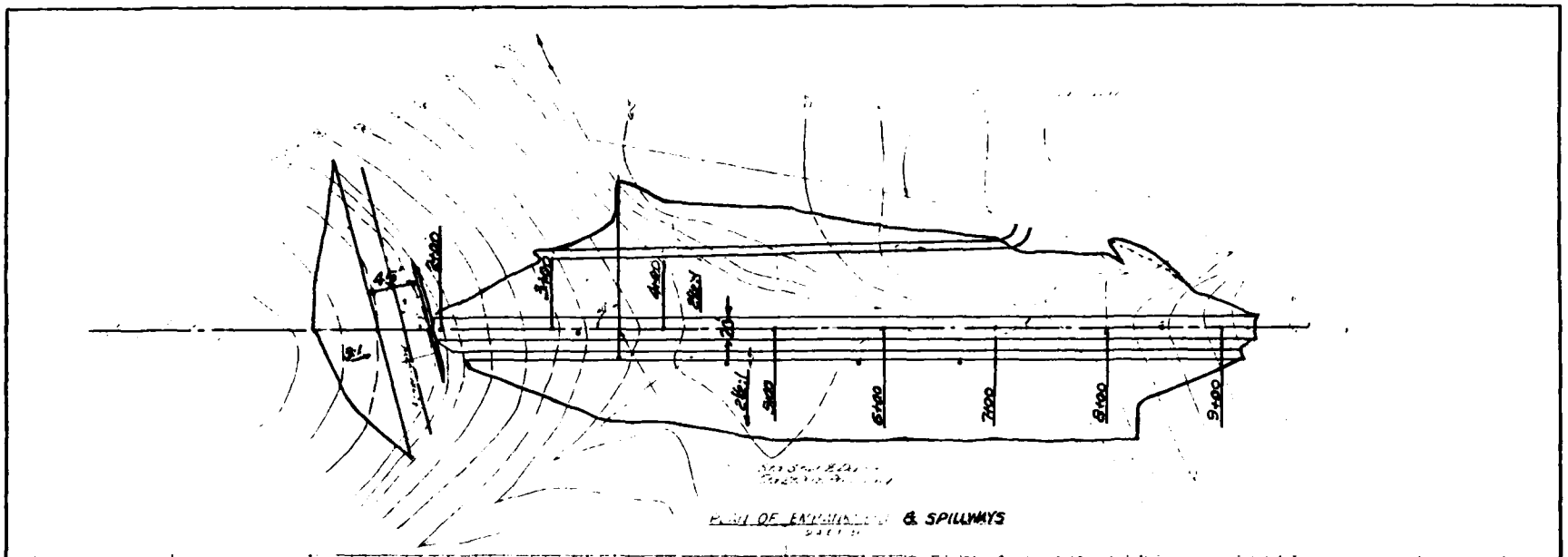


PHOTO NO. 12 - OVERVIEW FROM LEFT SIDE

APPENDIX C
PROJECT PLATES


& SPILLWAYS

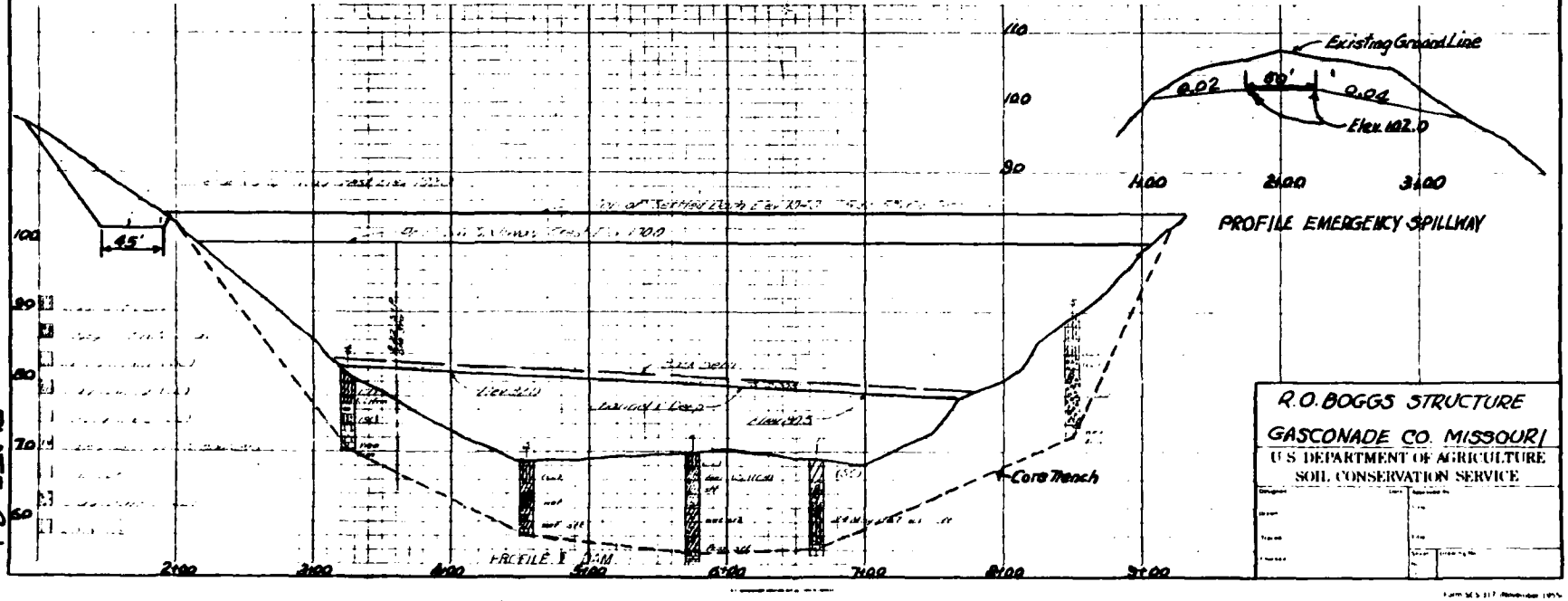

45'
Core Trench
PROFILE EMERGENCY SPILLWAY
Existing Ground Line
Elev. 102.0
R.O. BOGGS STRUCTURE
GASCONADE CO. MISSOURI
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PLATE C-1

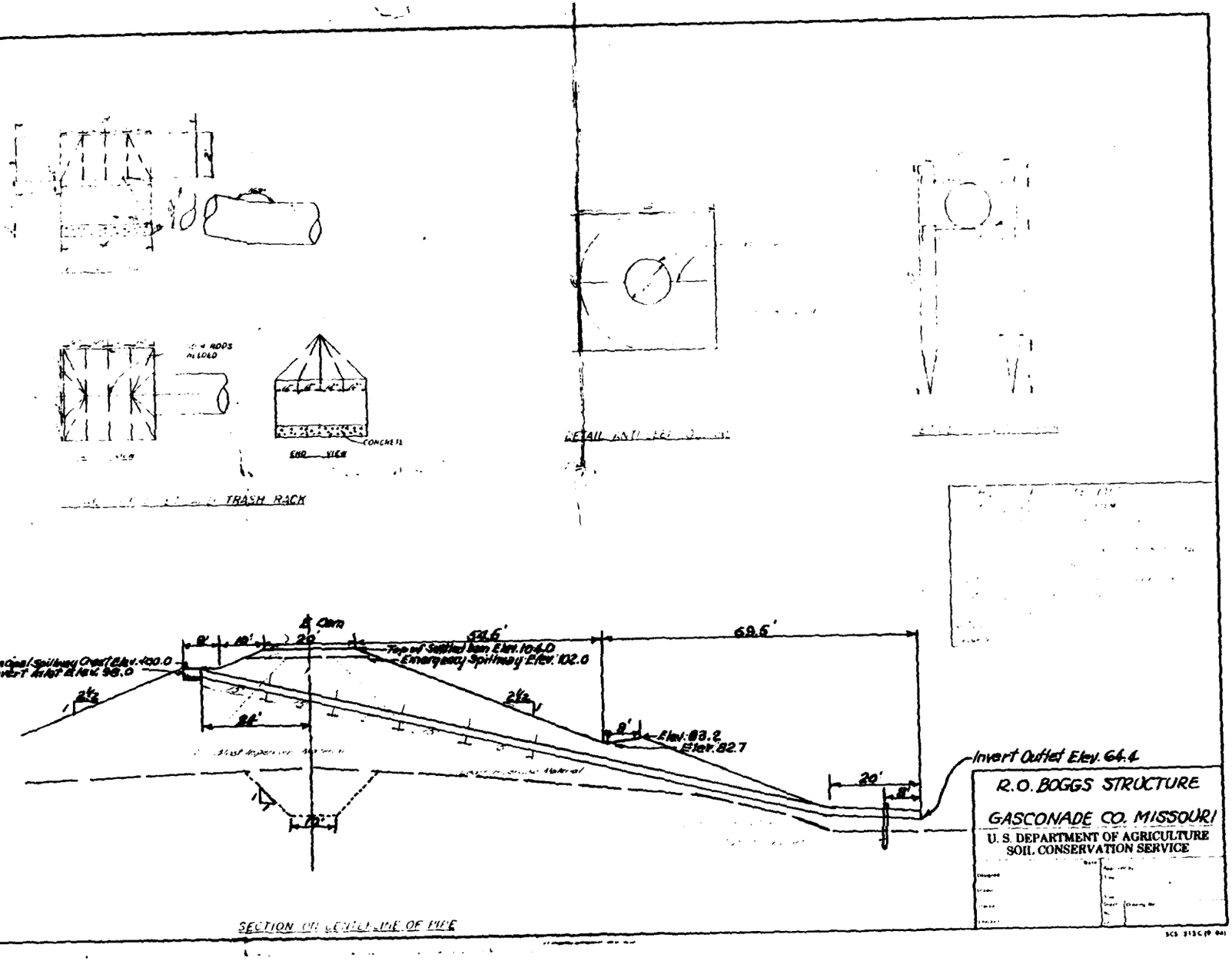
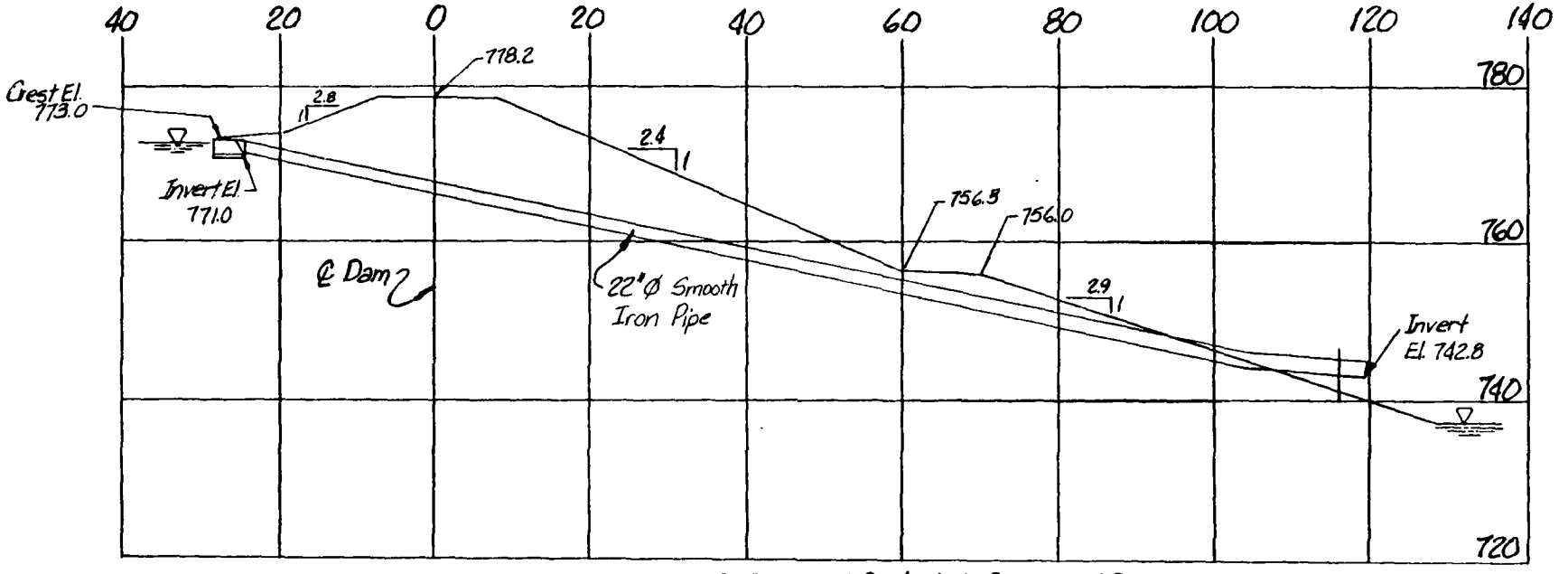
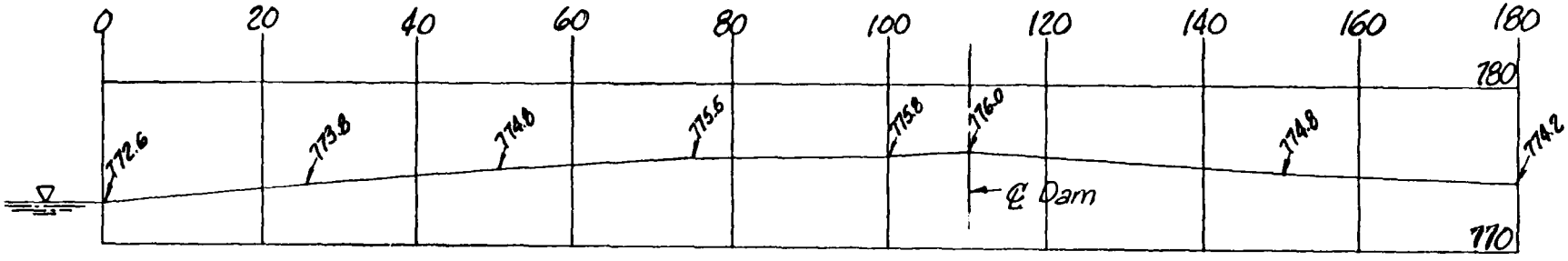

TRASH RACK
END VIEW
CONCRETE
4 Cells
8'
48'
20'
69.6'
69.6'
Top of Settled Ban Elev. 104.0
Emergency Spillway Elev. 102.0
Principal Spillway Crest Elev. 100.0
Invert Inlet Elev. 98.0
2½
2½
24'
8'
Elev. 83.2
Elev. 82.7
Invert Outlet Elev. 64.4
20'
8'
70'
SECTION ON CENTER LINE OF PIPE
R.O. BOGGS STRUCTURE
GASCONADE CO. MISSOURI
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PLATE C-2

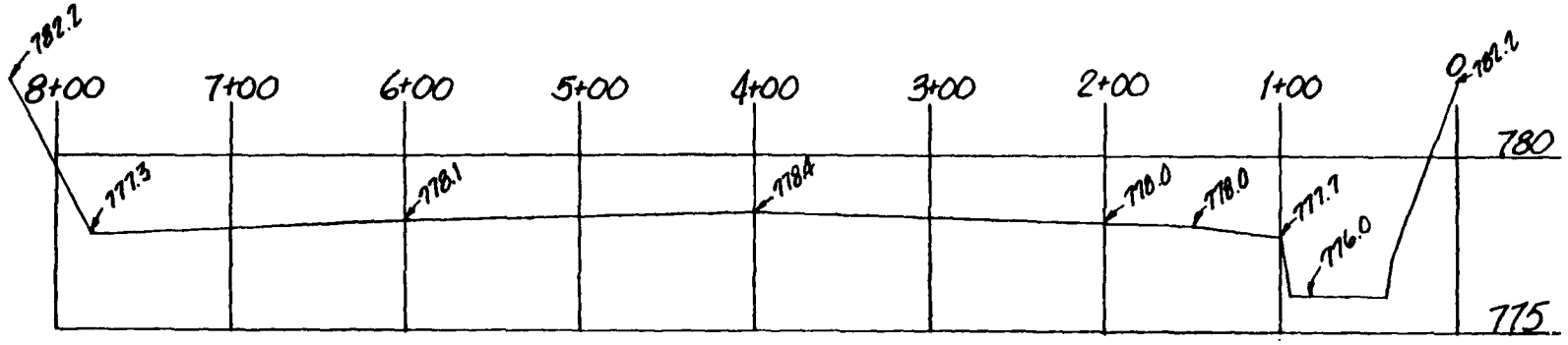


CROSS-SECTION AT STA. 2+62
Scale: 1" = 20' H. & V.

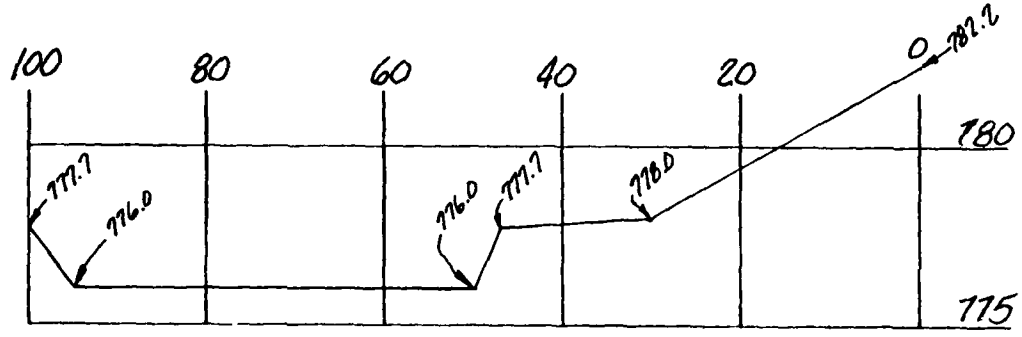


℄ PROFILE OF SPILLWAY
Scale: 1" = 20' H.
1" = 10' V.

PLATE C-3



PROFILE ALONG CENTERLINE OF DAM
Scale: 1" = 100' H.
1" = 5' V.



SPILLWAY SECTION (℄ OF DAM)
Scale: 1" = 20' H.
1" = 5' V.

PLATE C-4

February 12, 1963

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
Columbia, Missouri

EARTH FILL SPECIFICATIONS FOR PL-46 WORK

A. PURPOSE

The following specifications for earth fills are to be used as minimum requirements in building earth fills for farm ponds, grade stabilization structures, floodwater retarding structures, etc. Parts of the specifications are also applicable in the building of dikes and levees.

B. PREPARATION OF FILL SITE AND BORROW AREA

1. All trees, stumps, trash, brush, sod, large roots, perishable material and loose soil shall be removed from the site.

2. Topsoil material shall be stripped from the foundation and borrow areas and deposited in storage piles.

3. After the stripping operation, the ground surface within the foundation area shall be roughened by scarifying or plowing to provide a bond between the foundation and earth fill.

4. Overhanging banks, pits, and holes within the foundation area shall be graded to 1:1 slope or flatter to provide bond with the fill.

5. Springs encountered in preparing the site shall be properly drained or sealed.

C. CORE TRENCH CONSTRUCTION

1. The core trench shall be excavated to the extent and dimensions shown on the plans or directed by the SCS technician. The side slopes of the core trench shall be 1:1 or flatter.

2. The core trench shall be backfilled with the most impervious material available at the site. Moisture content of the backfill material shall be sufficient to secure proper compaction. (When kneaded in the hand the soil should just form a ball which does not readily separate to meet the requirements for adequate moisture content.)

D. PIPES FOR PRINCIPAL SPILLWAY AND STOCK WATER

1. Pipes and appurtenances for the pipe spillway and stock watering system shall be placed according to the plans as directed by the SCS technician. The pipes shall be placed on solid foundations either (1) in trenches excavated in undisturbed soil or (2) on fill material placed in 6-inch layers and properly compacted with equipment. Anti-seep collars shall be installed on both stockwater pipe and one conduit pipe as planned or as

directed by the SCS technician. Where no cradle is provided under the spillway pipe, the foundation shall be shaped (circular) to fit the pipe for a depth equal to 1/4 the diameter of the pipe. Anti-swirl walls or baffles shall be installed as called for on the plans or as directed by the SCS technician.

E. CONSTRUCTION OF FILL

1. Earth fill material shall not contain any appreciable concentration of vegetation, roots, large rocks, frozen soil, or other foreign substances. Moisture content shall be sufficient to secure proper compaction. (When kneaded in the hand, the soil should just form a ball which does not readily separate to meet the requirements for adequate moisture content.)

2. The fill material shall be placed in approximately 6-inch layers that extend over the full width and length of the dam. Each layer shall be compacted by the operation of tractors, earth moving equipment, or rollers. If the moisture content of the fill material is deficient, water shall be sprinkled on the surface of each lift of the fill material and thoroughly mixed then compacted prior to placing additional fill. If moisture content of the fill material is excessive, the fill material shall not be used or shall be air dried to proper moisture content before placement.

3. Backfill adjacent to the pipe spillway and stock watering system shall be placed in 6-inch layers and tamped by hand or with mechanical tampers. Rubber-tired tractors may be used to supplement the tamping along the sides of the pipe. Backfill shall be brought up approximately equal on each side of the pipe so as to prevent side movement of the pipe. Heavy equipment shall not be driven over the pipes until a minimum of 2 feet of compacted fill has been placed over the top of the pipe.

4. Frozen material shall not be placed in a fill nor shall fill material be placed on frozen earth. When fill material starts to freeze during placement, fill construction shall be stopped until proper temperatures prevail. When it is desired to place fill on an area that is frozen, the frozen soil shall be permitted to thaw completely and dry to the proper moisture content before placement, or the frozen material shall be removed completely before placing additional fill.

5. At sites where there is a limited amount of the most impervious fill material, (1) this material shall be placed in the core trench and the center section of the embankment and (2) the least impervious material shall be placed in the downstream part of the embankment.

6. The topsoil material saved in the site preparation shall be placed as a top dressing on the surface of the earth fill and side spillway. It shall be evenly spread to a thickness as shown on the plans or directed by the SCS technician.

7. The finished grade of the earth fill and side spillway shall be to the dimensions and side slopes shown on the plans.

ENGINEERING GEOLOGY OF THE R. O. BOGGS LAKE SITE, GASCONADE COUNTY

The proposed lake site for R. O. Boggs located in the NW¼ NW¼ sec. 28, T.41 N., R.5 W., Gasconade County (Hermann Quad.) was examined and found to be a poor risk geologically. Surficial investigation of the geological conditions revealed the following.

1. The right valley slopes are fairly gentle and apparently covered with a fairly thick soil cover, 10 - 20 feet. Whereas the left (south) valley slopes are much steeper and have numerous isolated rock outcrops along the bluff for approximately 500 yards upstream from the proposed centerline. However, beyond this both valley slopes are fairly gentle.

2. The bedrock at this site is thin bedded Jefferson City Dolomite. These bedding planes are generally less than 1 foot apart and the majority appear to be loosely bedded. This condition will allow for considerable water loss.

3. Numerous vertical joints are also present from hairline to an inch or more in width.

4. There is a zone of solution channels approximately 6 feet above the stream bed at the vicinity of the proposed centerline. This zone can be traced about 200 yards upstream. At this point the zone is either covered by soil or is at creek level. Although these solution channels appear to be filled with clay at the surface large volumes of water could be lost.

5. Springs were reported above the dam by SCS field men as flowing in the fall with water disappearing into the ground before reaching the proposed centerline. The water was either entering the alluvium but more probably a fracture in the rock.

This site can not be considered as a good risk at this time. However, should the owner wish to verify that the same geologic conditions do or do not occur underground as noticed and reported as existing then the following steps are recommended prior to future design.

1. Drill several (3 to 5) core holes on the left abutment from proposed centerline to approximately 500 yards upstream and 2 or more in the valley floor at centerline. These holes should be diamond cored in order to allow a geologist to examine bedding plane characteristics and detect presence of voids. The exact number of holes will be, of necessity, determined by what is found by the geologist. If possible to get the drill at desired surface elevation each hole will be about 40 feet deep.

2. Pressure test at least 3 of the borings to determine how much water loss, if any, will result.

3. Drill approximately 20 feet into bedrock plus pressure testing in the floor of the valley to determine water loss in this manner.

4. Check will drill or back hoe to see if water is moving through the alluvium as field evidence exists that the creek was forced to the left wall by man.

PLATE C-7

Should the above program indicate that a dam can be built at the desired location economically then the following suggestions are offered.

1. Obtain borrow from the right side of the valley, preferably above the waterline.

2. Cut the abutment core trench quite deep into the rock. It may be necessary to cut the core trench a few feet into rock in the valley floor. The Jefferson City when thin bedded is rippable on loose bedding planes with a back mounted ripper.

3. Cover most of the outcrops especially the solution channel zone with grout or clay.

The lack of a heavy soil cover on the left valley wall in the vicinity of the proposed centerline makes completely sealing seepage areas quite expensive. The drilling program may not expose all hazards and extreme care must be utilized in interpreting the data. Even with the boring investigation and utilizing all economical remedial methods the lake, if built, will in all probability leak.

A geologist from the Missouri Geological Survey will be able to assist in the drilling program if so desired.

Edwin E. Lutzen

Edwin E. Lutzen
Engineering Geologist
Missouri Geological Survey
February 7, 1967

Note: This site not used.

PLATE C-8

ADDENDUM TO THE BOGGS LAKE SITE, GASCONADE COUNTY

Subsurface exploration has shown that both sites are suitable geologically and recommended for construction. Only two particular items of importance were noted. One item on the downstream lake site is that the bedrock surface should be ripped with heavy duty back mounted rippers on large caterpillars so that seepage through the weathered surface rock cannot occur. The other item is at the upstream site where the wet soupy silt under the dam foundation in one section of the stream channel should be removed so that all of the dam can be founded on firm material. This will require over excavation more than necessary for the core trench.

Downstream Site* - Subsurface exploration borings of the downstream site on the steep left abutment, and two holes in the valley floor show that the bedrock is firm, fresh and tight. Pressure testing showed no water loss. Therefore no hazards are expected to occur to the lake from the bedrock aspect other than possible seepage through weathered zones of the surface bedrock exposed on the steep hillslope on the left side of the valley and on the gently sloping right valley slope.

The drilling exploration showed that near the stream channel 12 to 15 feet of alluvial gravels cover the underlying bedrock. The bedrock is weathered for a depth of 2 to 3 feet so that firm bedrock was not encountered until about 18 feet in depth. It is recommended that the core trench be deepened to fresh bedrock even in the deeper portion of the stream channel. This is a relatively narrow sector and the bedrock profile seems to be a uniform "U" shaped profile that drops from the steep left abutment slope and rises somewhat more gently to the right valley slope. On the right slope soil cover is only about 7 feet in thickness so that the problems of excavating to bedrock will be much less on this slope. Except for the recommendation that the core trench be excavated to bedrock across the entire valley floor and that weathered bedrock be removed by excavation so that the dam can be seated into firm fresh material no other unusual features were noted at this site.

Toe drains on the downstream dam should be considered if a lagoon is to be constructed there. Even with an "impervious" clay core there is a certain amount of water passage through the dam. This seepage will be of sufficient amount to weaken the backslope of a lagoon and with time could be a serious detriment to the lagoon. Sand and gravel filled or perforated pipe leading away from the lagoon will prevent this.

Upstream Site** - Subsurface exploration of the upstream site indicates that the foundation material consists of water saturated silts, sands and clays especially near the stream channel on the right portion of the valley. Much of this material consists of soupy silt and water saturated gravels. It has insufficient bearing strength even for the foundation of the dam upstream of the core. Depths to bedrock across the valley floor averaged 13 feet becoming somewhat less toward the left side of the valley where it is only 9 feet. Bedrock was encountered at about 7 feet with about 3 feet of weathered bedrock on the left valley slope. Depth to bedrock on the right valley slope is 17 feet due to a terrace. This is the terrace on which the barn and house are situated. The terrace material consists of yellow silty clay (CL) with boulder and gravel layers. While this

** Site used
* Site not used

excavation will be somewhat deep on the lower portion of the terrace it is nevertheless recommended that the core trench of the dam be cut to bedrock across the entire valley floor and on the abutments. Seepage by lateral water movement through the terrace could be high due to possible stratified layers of sands or gravels. It would be much cheaper to excavate a cutoff core trench through the terrace than repair seepage at a later date by grouting.

Because of the unstable material that is associated with the spring upstream of the dam site, a relatively large amount of excavation will be required under part of the dam foundation in the floodplain. In order to reduce the amount of excavation, it is suggested that the core trench at the centerline of the dam be placed near or in the stream channel as it cuts across the valley so that the core trench can be somewhere near the right bank of the stream channel. This would perhaps reduce the amount of overexcavation needed under the dam upstream of the core trench. Where material in the dam foundation consists of the unstable wet silts and gravels it must be removed. The amount of this material cannot be judged at present without an extensive amount of subsurface boring. Even then it would be somewhat difficult to estimate the yardage accurately. Therefore close examination of the foundation must be maintained during the construction of the dam so that it can be assured that all unstable material is removed from the foundation.

Due to the high water content within the soils at this site, it will probably be necessary to excavate with a drag line. However, if the flow through the soils is spotty as indicated by surface spring, the excavation can be made with mobile equipment provided that adequate pumps are available. The slopes of the trench will have to be much flatter than in a dry operation since the water bearing soils will have a tendency to slide. For safety it is recommended that the backslopes be cut on 3½ on 1 or flatter.

James H. Williams
Chief, Eng. Geol. Section
Missouri Geological Survey
June 12, 1967

SOILS DATA BOGGS LAKE SITE, GASCONADE COUNTY

Sample No. 1 taken from Borrow Site - Downstream Dam*

The Atterbergs consisting of the plastic limit, liquid limit, and shrinkage limit were determined on this sample. The liquid limit using the one point method is 40%, the plastic limit is 16% with a plastic index of 24, the shrinkage limit is 14% of the volume, therefore this test puts this material in the lean clay (CL). Using the standard proctor of 1/30th cubic foot mold with a 5 lb. hammer three lifts, maximum density is then determined to be 108 lb. per cubic foot dry at 18% moisture.

Sample No. 2 taken from Borrow Site - Upstream Dam **

In tests on sample No. 2, the liquid limit was determined to be 37%, the plastic limit was 17% with a shrinkage limit of 13% of the volume, the plastic index is therefore 20. The maximum dry density as determined on the standard proctor was 113 lb. per cubic foot at 18% moisture. The curve on this one indicates that it blow beyond maximum density quite rapidly on the wet side.

From the testing of these two samples it is apparent or evident that if this material is used as a borrow for the dam that it will be quite satisfactory. However, the compaction with a sheeps foot or rubber tired roller should be maintained throughout the project. The compaction should be in 95% or better of the standard and the moisture content should not vary from 18% moisture, that can be approximately 2% on the dry side. Due to the behavior of the soils in the laboratory, it is not recommended that the soil be compacted too wet. The material will have a tendency to shrink and crack and could cause problems in this manner prior to the filling of the dam. However, when placed on the slightly dry side or at optimum, the soil will maintain its equilibrium until the lake is full and the phreatic line has been established.

* Site not used
** Site used

Edwin E. Lutzen

Edwin E. Lutzen
Engineering Geologist
Missouri Geological Survey
June 13, 1967

APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs.

   a. Twenty-four hour, 100-year rainfall for the dam location were taken from the data for the rainfall station at Sullivan, MO. as supplied by the St. Louis District, Corps of Engineers per their letter dated 6 March 1979. The twenty-four hour probable maximum precipitation was taken from the curves of the Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and guidance for hydraulics and hydrology.

   b. Drainage area = 1.014 square miles (649 acres).

   c. Time of concentration of runoff = 34 minutes (computed from Kirpich formula).

   d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The antecedent storm conditions for the 100-year precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). The initial pool elevation was assumed at the crest of the principal spillway riser.

   e. The total twenty-four hour storm duration losses for the 100-year storm were 3.84 inches. The total losses for the PMF storm were 2.50 inches. These data are based on SCS runoff curve No. 82 and No. 66 for antecedent moisture conditions SCS AMC III and AMC II respectively. The watershed is composed of primarily SCS soil groups B and C and consists of mostly wooded areas with approximately 20% in pasture.

   f. Average soil loss rates = 0.10 inch per hour approximately (for PMF storm, AMC III).

2. The combined discharge rating consisted of three components: the flow through the principal spillway, the flow through the emergency spillway and the flow going over the top of the dam.

a. The principal spillway rating was developed by using the weir and full conduit flow equations.

(1) Weir Flow equation ($Q = CLH^{1.5}$)
where C = weir coefficient = 3.1
L = effective weir length, ft. = 16
H = total head, ft.

(2) Full conduit flow equation

$$Q = a\sqrt{\frac{2gH}{1 + K_e + K_b + K_pL}}$$

where a = cross-sectional area of pipe, ft^2 = 2.64
H = total head, ft.
K_e = coefficient for entrance loss = 0.5
K_b = coefficient for bend loss = 0.034
K_p = coefficient for pipe friction loss = 0.0119
L = length of pipe, ft. = 148

b. The emergency spillway ratings were developed using the Corps of Engineers Surface Water Profile HEC-2 computer program.

c. The flows over the dam were determined using the dam overtopping analysis within the HEC-1 (Dam Safety Version) program.

3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The output and plotted hydrographs are attached.

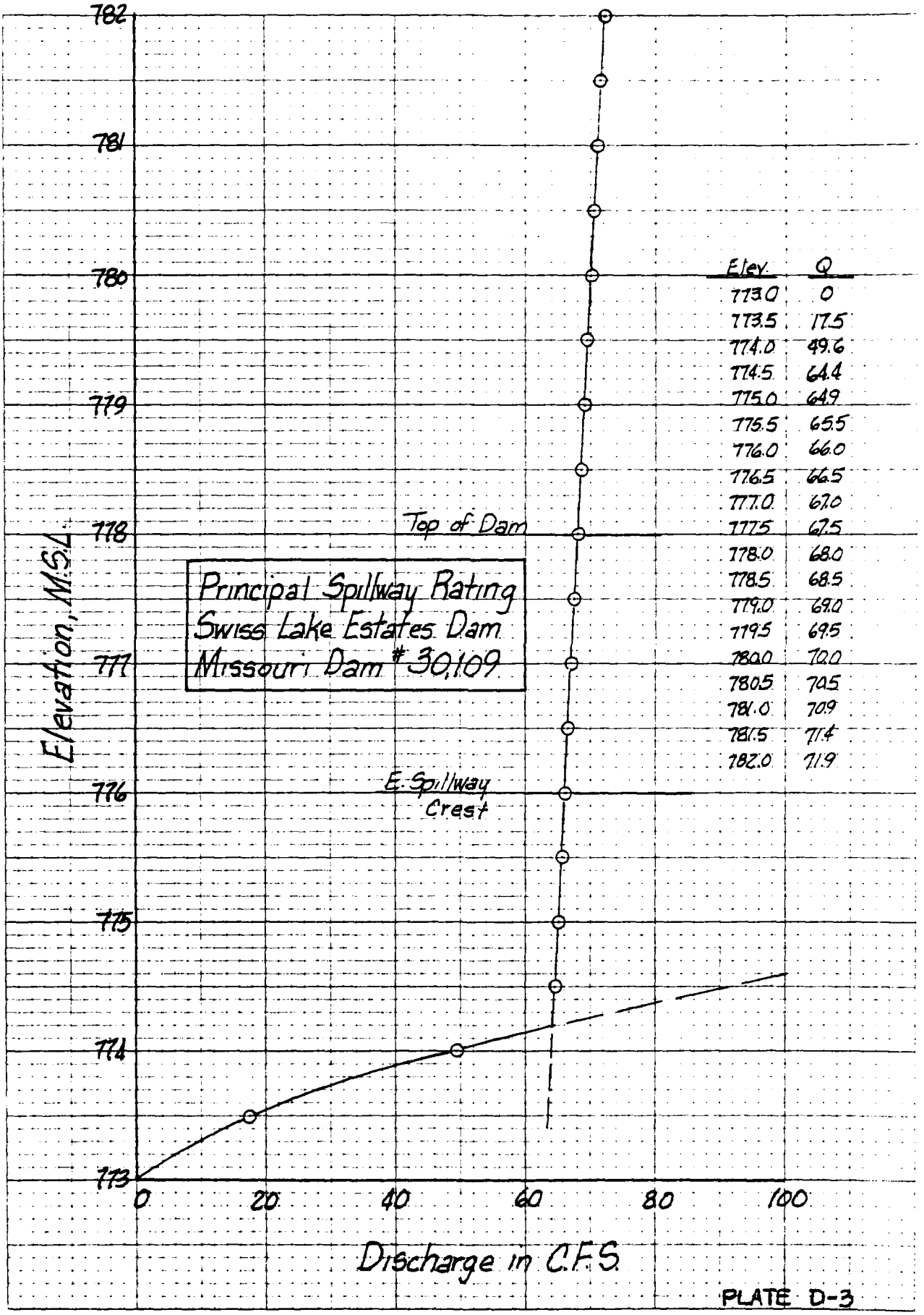
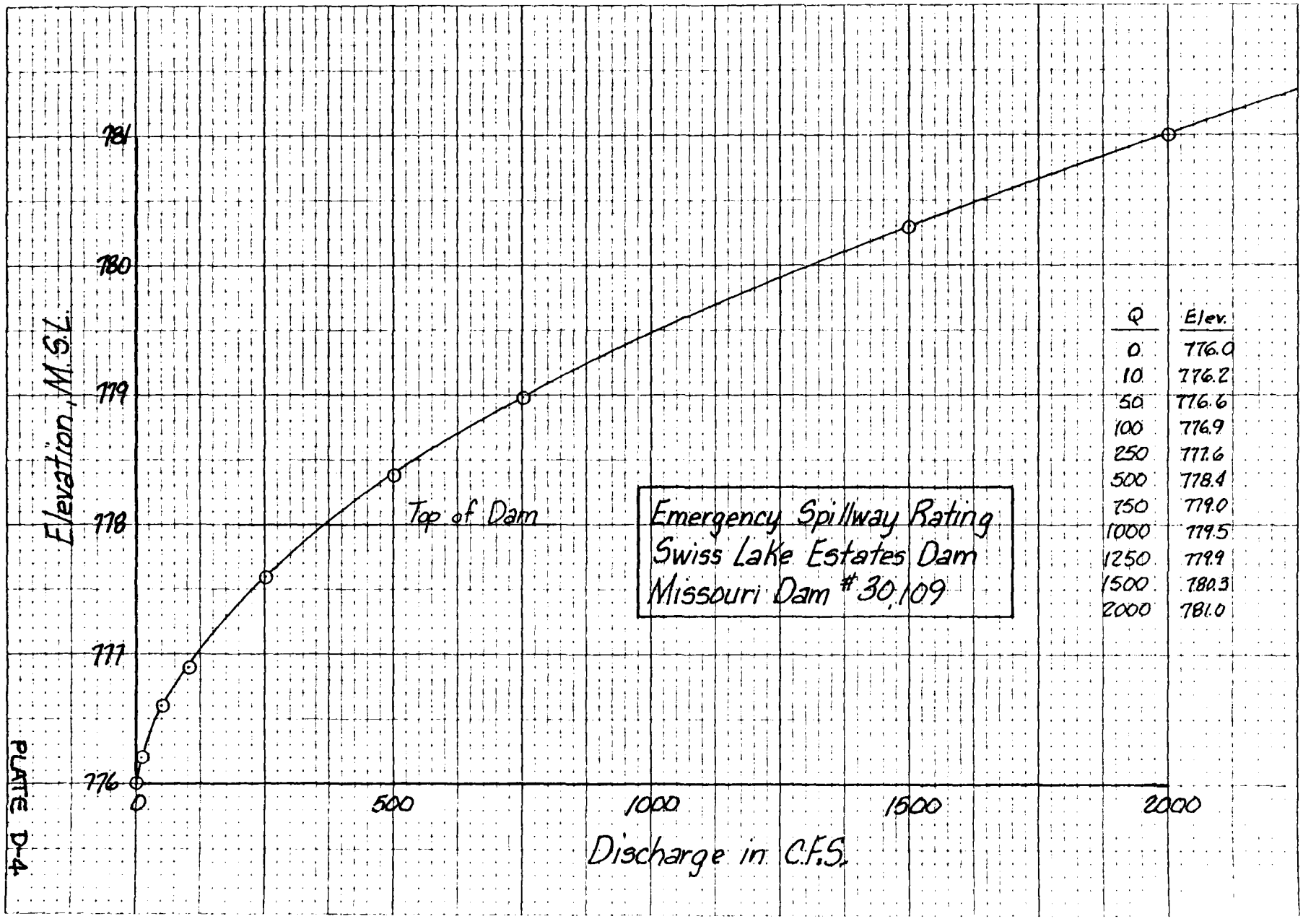


PLATE D-3



Emergency Spillway Rating
Swiss Lake Estates Dam
Missouri Dam # 30,109

Q	Elev.
0	776.0
10	776.2
50	776.6
100	776.9
250	777.6
500	778.4
750	779.0
1000	779.5
1250	779.9
1500	780.3
2000	781.0

PLATE D-4

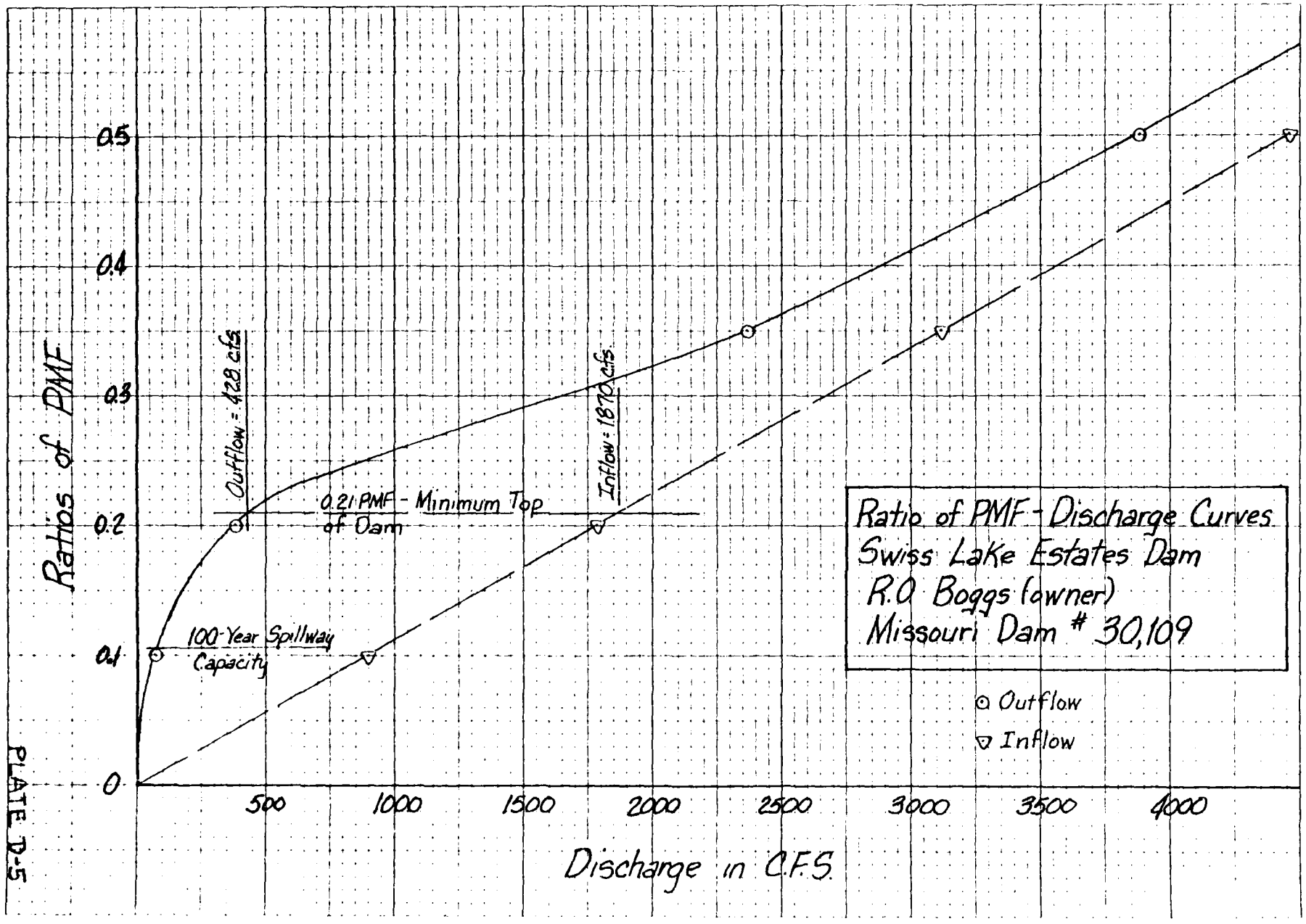


PLATE D-5

```
A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF R D BUGGS DAM--30109
A3       RATIOS OF PMF ROUTED THROUGH THE RESERVOIR
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
P1       CALCULATION OF INFLOW HYDROGRAPH TO 30109 RESERVOIR
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
A1       ROUTED FLOWS THRU 30109 RESERVOIR
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
A
A
A
A
A
```

PLATE D-6

****
HECDC HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 77/07/23.
TIME= 17.51.15.

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF R D BOGGS DAM-30109
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	3	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 7 LRTIO= 1
RTIOS= .10 .20 .35 .50 .65 .80 1.00

****

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDROGRAPH TO 30109 RESERVOIR

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	30JG01	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	1.01	0.00	1.01	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.30	102.00	121.00	130.00	0.00	0.00	0.00

LOSS DATA

LOSS	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
3	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-82.00	0.00	0.00

CURVE NO = -82.00 WETNESS = -1.00 EFFECT CN = 82.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .34

RECESSION DATA
STRTQ= 0.00 QRCSN= -.01 RTIOR= 1.00

UNIT HYDROGRAPH 22 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .34 VOL= 1.00

1572.	483.	977.	1264.	1278.	1330.	616.	539.	374.	267.
186.	130.	91.	63.	44.	31.	22.	15.	11.	8.
	2.								

PLATE D-7

HYDROGRAPH ROUTING

ROUTED FLOWS THRU JOINT RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000002	1	0	0	2	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-773.	-1

STAGE	773.00	773.50	774.00	774.50	775.00	775.50	776.00	776.50	777.00	777.50
	778.00	778.50	779.00	779.50	780.00	780.50	781.00	781.50	782.00	
FLOW	0.00	17.50	49.60	64.40	64.90	65.50	66.00	101.50	182.00	247.50
	428.00	603.50	819.00	1074.50	1370.00	1700.50	2070.90	2421.40	2821.90	
CAPACITY=	0.	520.	604.	696.	848.	2448.				
ELEVATION=	747.	773.	775.	777.	780.	800.				

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
773.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
778.0	3.0	1.5	680.

STATION 000002, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	1.	1.
1.	1.	1.	1.	1.	1.	2.	2.	2.	2.
2.	2.	3.	3.	3.	3.	3.	4.	4.	4.
4.	4.	5.	5.	5.	5.	5.	6.	6.	6.
6.	6.	7.	7.	7.	7.	7.	8.	8.	8.
8.	8.	9.	9.	9.	9.	9.	10.	10.	10.
10.	10.	11.	11.	11.	11.	12.	12.	12.	12.
12.	13.	13.	13.	13.	13.	14.	14.	14.	15.
15.	16.	17.	19.	19.	21.	22.	24.	25.	27.
29.	30.	31.	33.	35.	37.	38.	40.	41.	43.
45.	46.	48.	50.	51.	52.	52.	53.	54.	55.
56.	57.	58.	59.	60.	61.	62.	64.	65.	65.
65.	65.	65.	65.	65.	65.	65.	65.	65.	65.
66.	66.	66.	66.	66.	66.	66.	66.	66.	66.
66.	66.	66.	66.	66.	66.	66.	66.	66.	66.
66.	66.	66.	66.	66.	66.	66.	66.	66.	66.
66.	66.	66.	66.	66.	66.	66.	66.	66.	66.
66.	66.	66.	66.	66.	66.	66.	66.	66.	66.

PLATE D-8

STATION 000302, PLAN 1, RATIO 4

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	2.	2.	2.	2.	3.	3.	3.
4.	5.	5.	6.	7.	7.	8.	9.	10.	11.
11.	12.	13.	14.	15.	16.	17.	18.	20.	22.
23.	25.	27.	29.	31.	32.	34.	36.	38.	39.
41.	43.	45.	47.	48.	50.	51.	51.	52.	53.
54.	55.	55.	56.	57.	58.	59.	60.	61.	61.
62.	63.	64.	64.	64.	64.	64.	65.	65.	65.
65.	65.	65.	65.	65.	65.	65.	65.	65.	65.
65.	65.	65.	65.	66.	66.	66.	66.	66.	73.
82.	90.	99.	116.	135.	155.	174.	196.	219.	242.
265.	288.	316.	345.	375.	404.	440.	550.	678.	779.
901.	991.	1040.	1087.	1140.	1227.	1411.	1771.	2340.	3018.
3532.	3883.	3862.	3610.	3250.	2878.	2544.	2256.	2018.	1827.
1677.	1560.	1469.	1400.	1345.	1301.	1261.	1220.	1178.	1136.
1098.	1065.	1036.	1013.	994.	979.	965.	945.	910.	855.
783.	702.	623.	552.	494.	449.	425.	414.	403.	392.
381.	370.	360.	350.	340.	330.	321.	312.	304.	295.
288.	282.	276.	270.	264.	258.	253.	248.	243.	238.
233.	228.	223.	219.	215.	211.	207.	203.	199.	195.
192.	188.	185.	182.	179.	177.	174.	172.	169.	167.
165.	163.	161.	159.	157.	155.	153.	151.	149.	147.
146.	144.	142.	141.	139.	138.	136.	135.		

STORAGE

520.	520.	520.	520.	520.	520.	520.	520.	520.	520.
520.	520.	520.	520.	520.	520.	520.	520.	520.	520.
520.	520.	520.	520.	520.	520.	520.	520.	520.	520.
520.	520.	520.	520.	520.	520.	520.	520.	520.	520.
520.	520.	520.	520.	520.	520.	520.	520.	520.	520.
520.	520.	520.	520.	520.	520.	520.	520.	520.	520.
520.	520.	520.	520.	520.	520.	521.	521.	521.	521.
521.	521.	521.	521.	521.	521.	521.	521.	521.	521.
522.	522.	522.	522.	522.	522.	523.	523.	524.	524.
525.	526.	526.	527.	528.	529.	530.	531.	532.	533.
534.	535.	536.	537.	538.	539.	540.	541.	541.	544.
545.	546.	547.	548.	550.	551.	552.	553.	554.	555.
557.	558.	559.	560.	561.	562.	563.	565.	566.	567.
569.	569.	571.	571.	573.	574.	575.	576.	577.	578.
580.	581.	582.	583.	584.	585.	586.	588.	590.	590.
591.	592.	594.	595.	596.	597.	599.	601.	604.	608.
611.	616.	620.	624.	627.	634.	639.	644.	649.	655.
666.	666.	671.	677.	683.	688.	694.	699.	704.	710.
715.	721.	726.	731.	737.	742.	748.	753.	757.	763.
763.	765.	766.	767.	768.	770.	774.	786.	790.	800.
807.	811.	811.	808.	803.	798.	793.	788.	784.	781.
779.	776.	774.	773.	772.	772.	771.	770.	769.	768.
767.	766.	766.	765.	765.	765.	764.	764.	763.	762.
761.	757.	755.	754.	752.	750.	748.	746.	744.	742.
741.	736.	734.	732.	731.	728.	727.	725.	723.	722.

PLATE D-9

72[illegible].	719.	717.	716.	715.	714.	712.	711.	710.	709.
70[illegible].	707.	706.	704.	704.	703.	702.	701.	700.	699.
69[illegible].	697.	697.	696.	695.	694.	694.	693.	692.	692.
691.	691.	690.	689.	689.	688.	688.	687.	687.	686.
686.	685.	685.	684.	684.	683.	683.	682.		

STAGE

773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0
773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0
773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0
773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0
773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0
773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0
773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0	773.0
773.0	773.0	773.0	773.0	773.0	773.1	773.1	773.1	773.1	773.1
773.1	773.1	773.2	773.2	773.2	773.2	773.2	773.3	773.3	773.3
773.3	773.4	773.4	773.4	773.4	773.5	773.5	773.5	773.5	773.6
773.6	773.6	773.6	773.7	773.7	773.7	773.8	773.8	773.8	773.8
773.9	773.9	773.9	774.0	774.0	774.0	774.0	774.1	774.1	774.1
774.1	774.2	774.2	774.2	774.3	774.3	774.3	774.3	774.4	774.4
774.4	774.4	774.5	774.5	774.5	774.6	774.6	774.6	774.6	774.7
774.7	774.7	774.9	774.8	774.8	774.8	774.9	774.9	775.0	775.1
775.2	775.3	775.3	775.4	775.6	775.7	775.8	775.9	776.0	776.1
776.2	776.3	776.5	776.6	776.7	776.8	777.0	777.1	777.2	777.3
777.4	777.5	777.6	777.7	777.8	777.9	778.0	778.1	778.2	778.3
778.3	778.4	778.4	778.4	778.4	778.5	778.5	778.7	778.8	779.0
779.2	779.3	779.3	779.2	779.1	779.0	778.9	778.8	778.7	778.7
778.6	778.6	778.6	778.5	778.5	778.5	778.5	778.5	778.4	778.4
778.4	778.4	778.4	778.4	778.4	778.4	778.3	778.3	778.3	778.3
778.3	778.2	778.2	778.1	778.1	778.0	778.0	777.9	777.9	777.9
777.8	777.8	777.7	777.7	777.7	777.6	777.6	777.6	777.5	777.5
777.5	777.5	777.4	777.4	777.4	777.3	777.3	777.3	777.3	777.3
777.2	777.2	777.2	777.2	777.1	777.1	777.1	777.1	777.1	777.1
777.0	777.0	777.0	777.0	777.0	777.0	777.0	776.9	776.9	776.9
776.9	776.9	776.9	776.9	776.8	776.8	776.8	776.8	776.8	776.8
776.8	776.8	776.8	776.7	776.7	776.7	776.7	776.7		

PEAK OUTFLOW IS 3883. AT TIME 16.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3883.	1134.	331.	331.	95341.
CMS	110.	32.	9.	9.	2700.
INCHES		10.41	12.15	12.15	12.15
MM		264.33	308.56	308.56	308.56
AC-FT		563.	657.	657.	657.
THOUS CU M		694.	810.	810.	81[illegible].

LEVEL

STATION000002

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

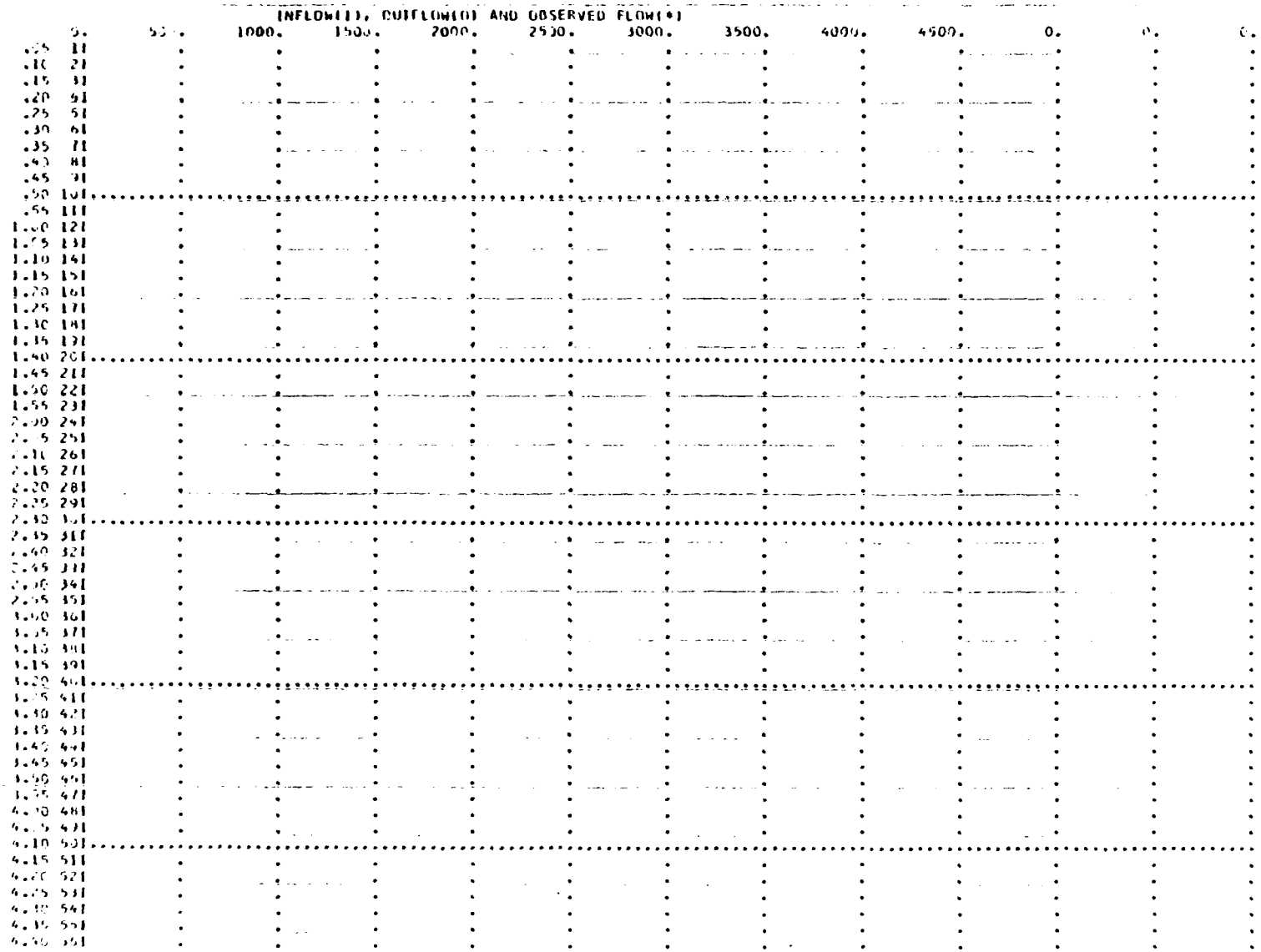


PLATE D-11

PLATE D-12

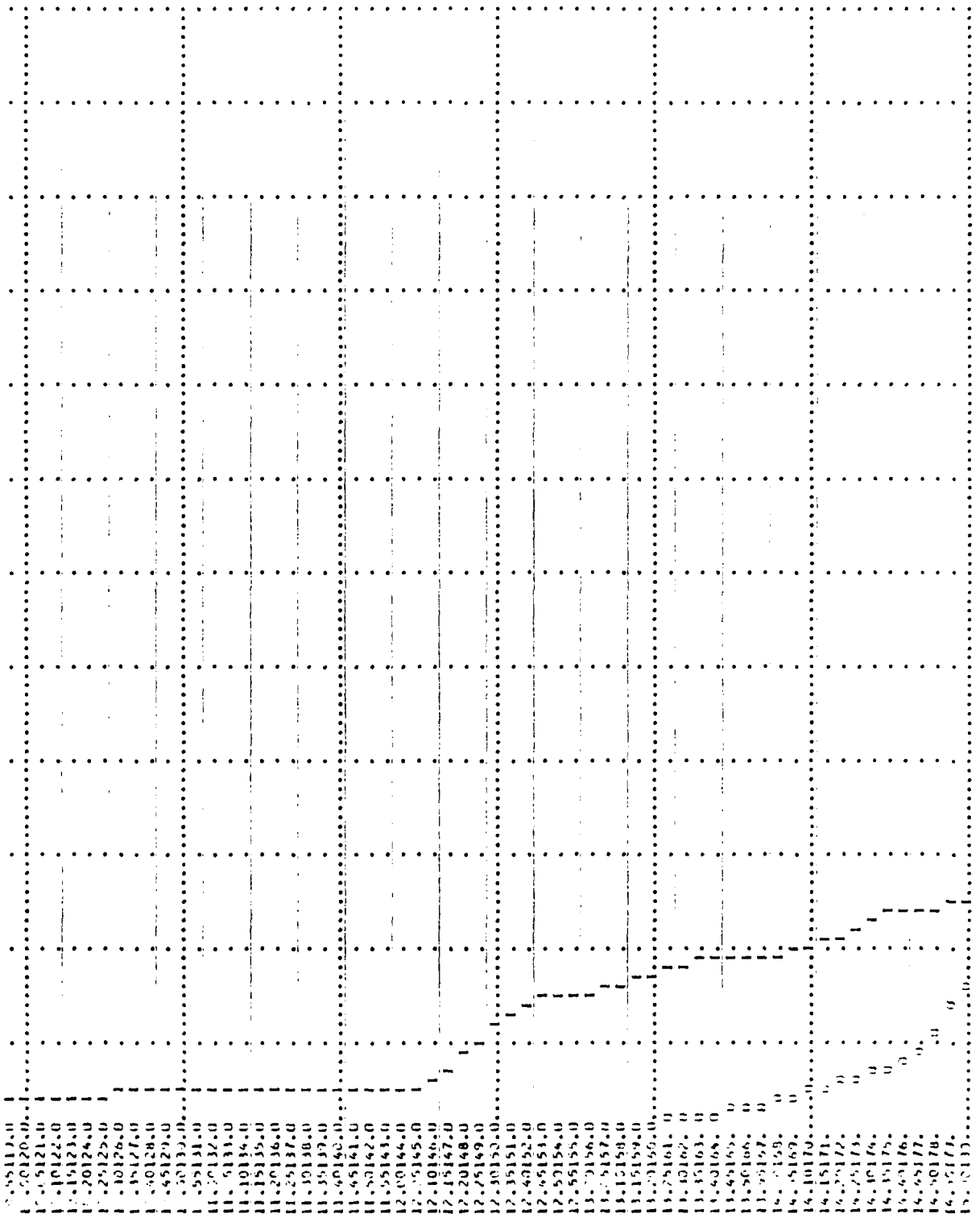


PLATE D-13

PLATE D-14

PLATE D-15

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

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .20	RATIO 3 .35	RATIO 4 .50	RATIO 5 .65	RATIO 6 .80	RATIO 7 1.00
HYDROGRAPH AT	000001	1.01	1	891.	1782.	3119.	4456.	5793.	7130.	8912.
		(2.63)		(25.24)(	50.47)(	88.33)(	126.19)(	164.04)(	201.90)(	252.37)(
ROUTED TO	000002	1.01	1	66.	380.	2366.	3883.	5171.	6460.	7938.
		(2.63)		(1.87)(	10.76)(	66.99)(	109.95)(	146.43)(	182.93)(	224.79)(

PLATE D-16

X

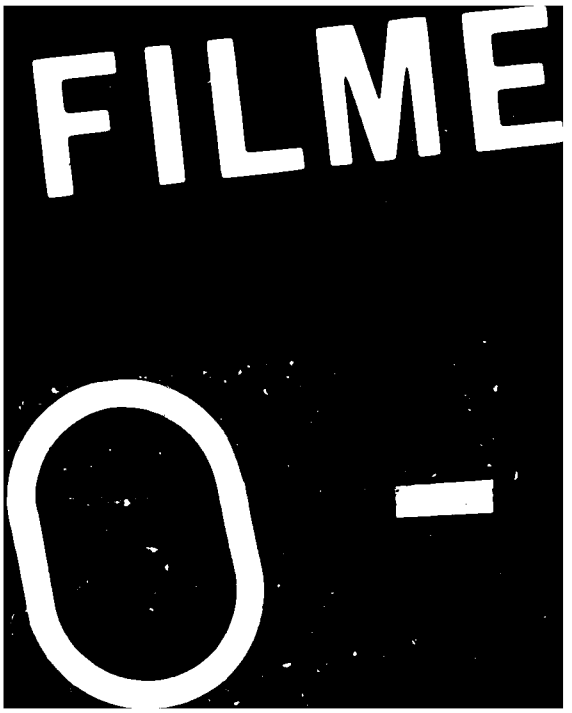
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	773.00	773.00	778.00
STORAGE	520.	520.	747.
OUTFLOW	0.	0.	428.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	775.93	0.00	647.	66.	0.00	18.50	0.00
.20	777.82	0.00	738.	380.	0.00	17.75	0.00
.35	778.85	.82	790.	2366.	3.00	16.08	0.00
.50	779.27	1.27	811.	3883.	4.17	16.00	0.00
.65	779.58	1.58	827.	5171.	5.08	16.00	0.00
.80	779.86	1.86	841.	6460.	5.67	16.00	0.00
1.00	780.16	2.16	861.	7938.	6.25	16.00	0.00

PLATE D-17


FILME
0 -