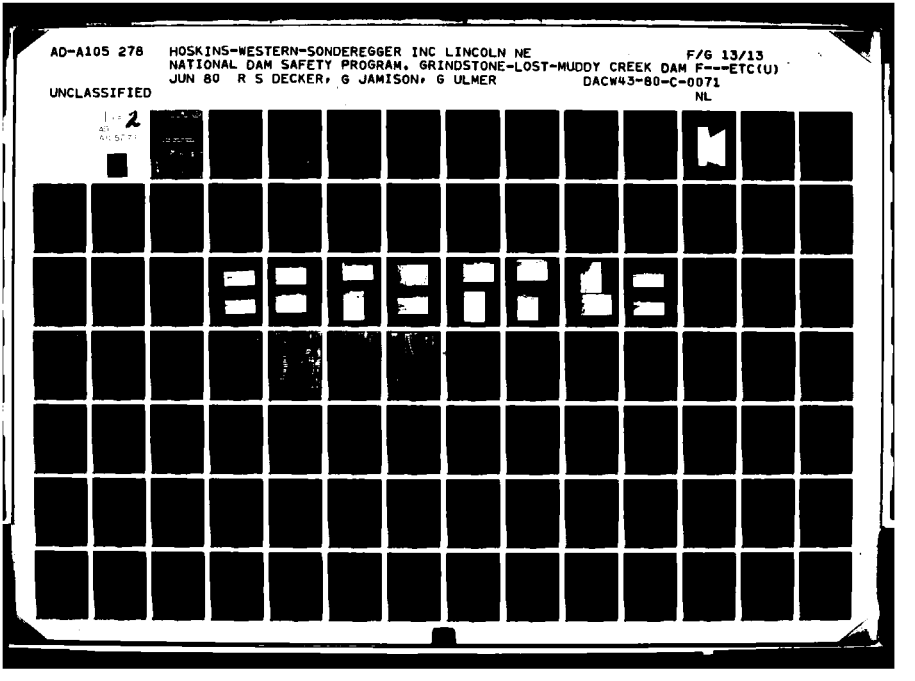
AD-A105 278 HOSKINS-WESTERN-SONDEREGGER INC LINCOLN NE F/G 13/13
NATIONAL DAM SAFETY PROGRAM. GRINDSTONE-LOST-MUDDY CREEK DAM F---ETC(U)
JUN 80 R S DECKER, G JAMISON, G ULMER DACW43-80-C-0071
UNCLASSIFIED NL



LEVEL II

GRAND-CHARITON BASIN

AD A105278

GRINDSTONE-LOST-MUDDY CREEK DAM F-20

DAVIESS COUNTY, MISSOURI

MO. 11220

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

DTIC
ELECTE
OCT 9 1981
S D
D

FILE COPY

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

FOR: STATE OF MISSOURI

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

JUNE, 1980

81 10 7 085

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-A105	3. RECIPIENT'S CATALOG NUMBER 278
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Grindstone-Lost Muddy Creek Dam F-20 (MO 11220) Daviess County, Missouri		5. TYPE OF REPORT & PERIOD COVERED Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Hoskins-Western-Sonderegger, Inc.		8. CONTRACT OR GRANT NUMBER(s) DACW43-80-C-0071
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
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 June 1980
		13. NUMBER OF PAGES Approximately 90
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)

Approved for release; distribution unlimited.

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

18. SUPPLEMENTARY NOTES

National Dam Safety Program. Grindstone-Lost-Muddy Creek Dam F-20 (MO 11220) Grand-Chariton Basin, Daviess 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.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

GRINDSTONE-LOST-MUDDY CREEK DAM F-20
DAVIESS COUNTY, MISSOURI
MISSOURI INVENTORY NO. 11220

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, 1980

Accession For
NTIS GRA&I
DTIC TAB
Unannounced
Justification
By
Distribution/
Availability Codes
Dist | Avail and/or Special
A

DTIC
ELECTE
OCT 9 1981
S
D

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

REPLY TO ATTENTION OF

SUBJECT: Grindstone-Lost-Muddy Creek Dam F-20

This report presents the results of field inspection and evaluation of the Grindstone-Lost-Muddy Creek Dam F-20 (MO 11220).

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:

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED
Chief, Engineering Division
29 SEP 1980
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer
30 SEP 1980
Date

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

TABLE OF CONTENTS

PARAGRAPH NO.	TITLE	PAGE NO.
	Assessment Summary	
	Overview Photograph	
	SECTION 1 - PROJECT INFORMATION	
1.1	General	1
1.2	Description of Project	1
1.3	Pertinent Data	2
	SECTION 2 - ENGINEERING DATA	
2.1	Design	6
2.2	Construction	6
2.3	Operation	6
2.4	Evaluation	6
	SECTION 3 - VISUAL INSPECTION	
3.1	Findings	7
3.2	Evaluation	8
	SECTION 4 - OPERATIONAL PROCEDURES	
4.1	Procedures	9
4.2	Maintenance of Dam	9
4.3	Maintenance of Operating Facilities	9
4.4	Description of Any Warning System in Effect	9
4.5	Evaluation	9
	SECTION 5 - HYDRAULIC/HYDROLOGIC	
5.1	Evaluation of Features	10
	SECTION 6 - STRUCTURAL STABILITY	
6.1	Evaluation of Structural Stability	12
	SECTION 7 - ASSESSMENT/REMEDIAL MEASURES	
7.1	Dam Assessment	13
7.2	Remedial Measures	13

APPENDIX A - MAPS

Plate A-1		Vicinity Topography
Plate A-2		Location Map

APPENDIX B - PHOTOGRAPHS

Plate B-1	Photo Index	
Plate B-2	Photo No. 2	Upstream Face From Left Abutment
	Photo No. 3	Crest From Left Abutment
Plate B-3	Photo No. 4	Downstream Slope From Left End
	PhotoeNo. 5	View Upstream in Emergency Spillway
Plate B-4	Photo No. 6	View Downstream in Emergency Spillway
	Photo No. 7	Principal Spillway Riser
Plate B-5	Photo No. 8	Principal Spillway Riser
	Photo No. 9	View Upstream Across Principal Spillway Riser
Plate B-6	Photo No. 10	View Downstream at Exit Channel for Principal Spillway
	Photo No. 11	Transverse Crack in Crest of Dam. (Immediately to Left of Auger)
Plate B-7	Photo No. 12	Seep Area on Right Downstream Toe
	Photo No. 13	Seep Area Near Right Downstream Trough
Plate B-8	Photo No. 14	View Downstream at End of Principal Spillway Conduit
	Photo No. 15	View Upstream at Principal Spillway Outlet
Plate B-9	Photo No. 16	Home One-Half Mile Downstream
	Photo No. 17	Home and Barn One-Half Mile Downstream

APPENDIX C - PROJECT PLATES

Plates C-1 through C-9	Soil Conservation Service Plans
Plate C-10	Phase I - Plan of Dam and Profile Along Centerline of Dam
Plate C-11	Phase I - Maximum Cross-Section of Dam at Sta 5+30 and Profile Along Centerline of Emergency Spillway

APPENDIX D - HYDRAULIC AND HYDROLOGIC DATA

Plates D-1 and D-2	Hydrologic Computations
Plate D-3	Principal Spillway Rating Curve
Plate D-4	Emergency Spillway Rating Curve
Plate D-5	Ratio-Discharge Curves
Plates D-6 through D-29	Computer Input and Output for Ratios of the PMF

APPENDIX E - GEOLOGICAL INVESTIGATION, SOIL REPORT AND ENGINEER'S REPORT, USDA-SCS, 1968

Division I	Detailed Geologic Investigation of Dam Sites, USDA-SCS, November, 1968
Division II	Soils Report, USDA-SCS, April, 1968
Division III	Engineer's Report, USDA-SCS, November, 1968

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

Name of Dam	Grindstone-Lost-Muddy Creek Dam F-20
State Located	Missouri
County Located	Daviess County
Stream	Tributary to Smith Branch
Date of Inspection	June 30, 1980

Grindstone-Lost-Muddy Creek Dam F-20 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 conditions 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.

Grindstone-Lost-Muddy Creek Dam F-20 has a height of twenty-seven (27) feet and a storage capacity at the minimum top elevation of the dam of one hundred (100+) acre-feet. In accordance with the guidelines, a small size dam has a height greater than or equal to twenty-five (25) feet but less than forty (40) feet and a storage capacity greater than or equal to fifty (50) acre-feet but less than one thousand (1,000) acre-feet. The size classification is determined by either the storage capacity or height, whichever gives the larger size category. Grindstone-Lost-Muddy Creek Dam F-20 is classified as a small size dam.

In accordance with the guidelines and based on visual observation, the dam is classified as having a high potential for damage and loss of life. Failure would threaten life and property. The estimated damage zone extends approximately two (2) miles downstream of the dam. Within the damage zone are three dwellings, a garage, and a barn.

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 small volume of water impounded and the downstream channel from the dam, one-half of the Probable Maximum Flood is the appropriate spillway design flood. The spillways will not pass the 100-year flood (1% probability flood, a flood having a one percent chance of being exceeded in any year) without overtopping the dam. The spillways will pass 24% 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.

Based on available data and on the field inspection of the dam, the following remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams:

a. Alternatives.

(1) The emergency spillway size and/or the height of dam should be increased to pass 50% of the Probable Maximum Flood without overtopping.

b. Operating and Maintenance Procedures.

(1) The vegetative growth around the principal spillway entrance should be removed and the area should be kept clear to prevent a reduction in the principal spillway capacity.

(2) The willows in the principal spillway outlet channel should be removed and measures taken to prevent their recurrence.

(3) The dam should be inspected at regular intervals and records of the inspections made a part of the project file on this dam.

Rey S. Decker
E-3703

Gordon Jamison

Garold Ulmer
E-19246

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

FORM 1

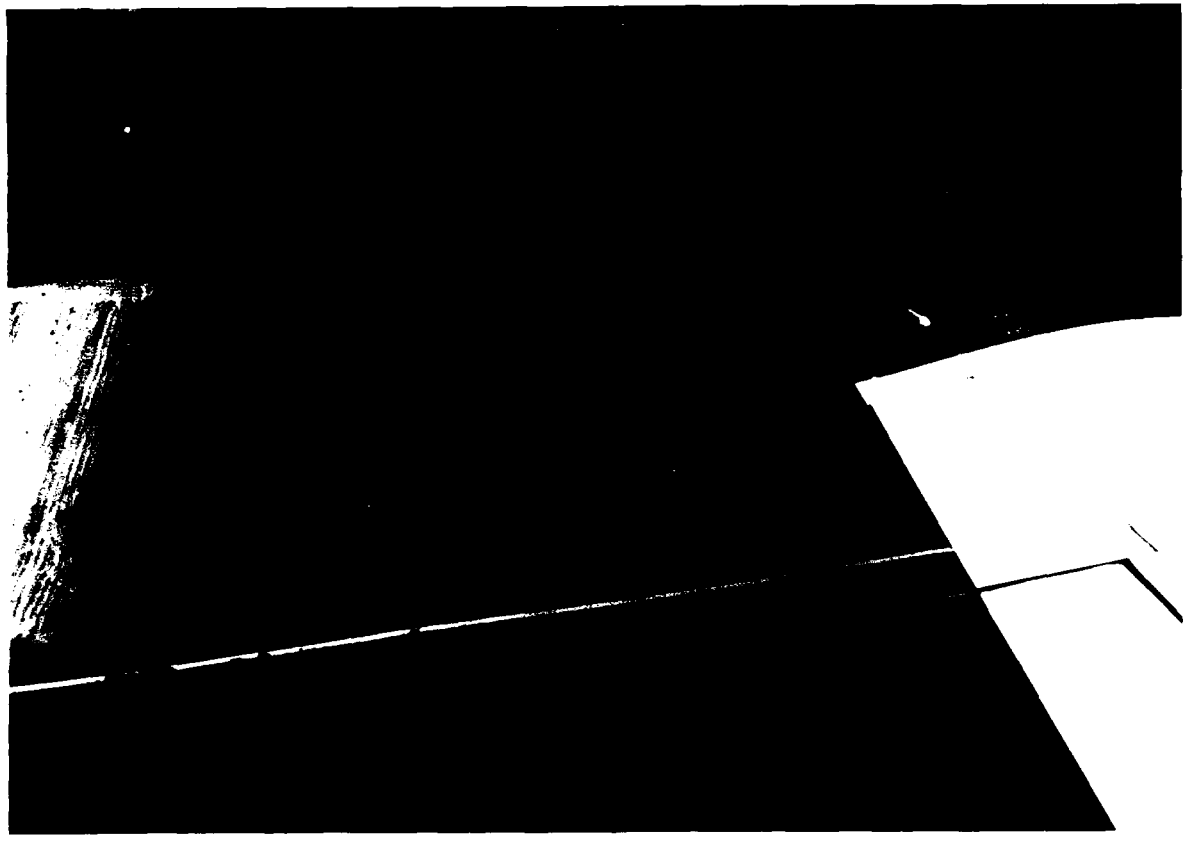


PHOTO NO. 1 - OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
GRINDSTONE-LOST-MUDDY CREEK DAM F-20 - MO 11220
DAVIESS 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 Grindstone-Lost-Muddy Creek Dam F-20 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 earthen flood control dam about 725 feet in length and 27 feet in height, with a storage capacity at the minimum top of dam of 100± acre-feet. It is located in the Iowa-Missouri Heavy Till Plain Resource area of the Central Lowlands Physiographic area about 5.5 miles west of Altamont, Missouri.

(2) The principal spillway consists of a 30-inch corrugated metal pipe drop inlet (riser) with trash rack and antivortex device and a 24-inch corrugated metal pipe conduit passing through the base of the dam.

(3) A vegetated earth emergency spillway is cut through the left abutment.

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

b. Location. The dam is located in the extreme western portion of Daviess County about 5.5 miles west of Altamont. It is located in the SW 1/4, Sec. 30, T59N, R29W as shown on Plate A-1.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. This dam has a height of 27 feet and a storage capacity at the minimum top elevation of the dam of 100 acre-feet. This dam is classified as a small dam. A small dam has a height greater than or equal to 25 feet but less than 40 feet and a storage capacity greater than or equal to fifty acre-feet but less than 1,000 acre-feet. The size classification is determined by either the storage capacity or height, whichever gives the larger 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 and on visual observation, this dam is in the High Hazard Classification. The estimated damage zone extends about two miles downstream of the dam. Within the damage zone are three dwellings, a garage and a barn at 0.6 miles.

e. Ownership. The dam is owned by the Grindstone-Lost-Muddy Creek Watershed Subdistrict, P.O. Box 117, Maysville, Missouri 64469. It is on property owned by Mrs. Gertie Lee, c/o Wesley Lee, Jr., Route 1, Box B-146, Weatherby, Missouri 64497.

f. Purpose of Dam. The dam was constructed for grade stabilization with flood control features under the Watershed Protection Act, P.L. 566.

g. Design and Construction History. The dam was designed by the Soil Conservation Service (SCS), Columbia, Missouri. It was constructed in 1975 with the SCS providing technical supervision and quality control during construction.

h. Normal Operating Procedure. There are no controlled outlet facilities for this dam except the 8-inch diameter drawdown pipe.

1.3 PERTINENT DATA

a. Drainage Area. 162.0 acres (0.253 square miles).

b. Discharge at Damsite.

(1) All discharges at the damsite are through an uncontrolled 30-inch diameter corrugated metal pipe drop inlet (riser) which is connected to a 24-inch diameter corrugated metal pipe conduit and through an uncontrolled, vegetated earth emergency spillway.

(2) Estimated maximum flood at damsite - Mr. Wesley Lee reported that the highest water he had seen was approximately 4 inches over the riser.

(3) The principal spillway capacity varies from 0 c.f.s. at elevation 56.0 feet to 36 c.f.s. at the crest of the emergency spillway (elevation 58.4 feet) to 45 c.f.s. at the minimum top of dam (elevation 60.2 feet).

(4) The emergency spillway capacity varies from 0 c.f.s. at its crest elevation 58.4 feet to 265 c.f.s. at elevation 60.2 feet (minimum top of dam).

(5) Total spillway capacity at the minimum top of dam is 310 c.f.s. ±.

c. Elevations (feet-assumed).

(1) Observed pool - 55.4

(2) Normal pool - 56.0

(3) Spillway crests

Principal - 56.0

Emergency - 58.4

(4) Maximum experienced pool - 56.4 ±

(5) Top of dam (minimum) - 60.2

d. Reservoir. Length (feet) of pool

(1) At principal spillway crest - 800 ±

(2) At emergency spillway crest - 900 ±

(3) At top of dam (minimum) - 1,000 ±

e. Storage (Acre-feet).

(1) Observed pool - 50 ±

(2) Normal pool - 55 ±

(3) Spillway crests

Principal - 55 ±

Emergency - 77 ±

(4) Maximum experienced pool - 56 ±

(5) Top of dam (minimum) - 100 ±

f. Reservoir Surface (Acres).

(1) Observed pool - 7.5 ±

(2) Normal pool - 8.3 ±

(3) Spillway crests

Principal - 8.3 ±

Emergency - 10.1 ±

(4) Maximum experienced pool - 11.5 ±

(5) Top of dam (minimum) - 12 ±

g. Dam.

(1) Type - Rolled earth fill

(2) Length - 725 feet ±

(3) Height - 27 feet ±

(4) Top width - 14 feet

(5) Side slopes.

(a) Downstream - 1V on 2.5H with 10 foot wide berm

(b) Upstream - 1V on 2.5H with 10 foot wide berm

(6) Zoning - Homogeneous

(7) Impervious core - Homogeneous

(8) Cutoff - Depth varies from 4 to 8 feet, 12 foot bottom width, 1V on 1H side slopes

(9) Grout curtain - None

(10) Wave protection - Vegetated earth berm

(11) Drains - None

h. Diversion Channel and Regulating Tunnel. None

i. Spillway.

(1) Principal

(a) Type - Uncontrolled drop inlet with a 30-inch diameter corrugated metal pipe riser and a 24-inch diameter corrugated metal pipe conduit.

(b) Crest (invert) elevation - 56.0

Outlet - 34.0

(c) Length - 124 feet

(2) Emergency

(a) Type - vegetated earth, uncontrolled cut through the left abutment. Bottom width - 40 feet; side slopes - 1V on 3H; exit channel slope - 0.065 ft./ft.

(b) Control section - A level section 30 ft. long near the centerline of the dam.

(c) Crest elevation - 58.3

(d) Upstream Channel - Open and clear

(e) Downstream Channel - Vegetated, slope - 0.065 ft./ft., discharging about 200 feet downstream from the dam.

j. Regulating Outlets. None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

This structure was designed by the Soil Conservation Service, Columbia, Missouri. Copies of the Geologic and Soil Mechanics Reports are included in Appendix E. The plans are included in Appendix C.

2.2 CONSTRUCTION

The dam was constructed in 1975. The SCS provided technical supervision and quality control for the construction.

2.3 OPERATION

No data were available on spillway operation. It was reported by Mr. Wesley Lee that the emergency spillway has never operated.

2.4 EVALUATION

a. Availability. The data in Appendix C and Appendix E were readily available from the S.C.S.

b. Adequacy. The design reports, plans, 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" presented in the SCS report in Appendix E are considered adequate.

c. Validity. The data and analyses are considered valid and adequate.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Grindstone-Lost-Muddy Creek Dam F-20 was made on June 30, 1980. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska making the inspection were: Rey S. Decker, Geotechnical; Garold Ulmer and Gordon Jamison, Hydrology and Hydraulics. Mr. Wesley Lee accompanied the inspection team.

b. Dam.

(1) Geology and Soils (Abutment and Embankment). This site is located in the Iowa-Missouri Heavy Till Plains area. Abutments consist of stiff clay till (Kansan) CL-CH. The alluvial valley material consists of stiff silty clay (CL) underlain at shallow depths by siltstone, shale and/or limestone bedrock. Bedrock is exposed in the scour hole at the end of the pipe spillway. Materials in the dam consist of CL-CH material borrowed from the reservoir area and upstream abutments.

(2) Upstream Slope. The upstream slope is well vegetated with grass and cattails along the waterline. No slumps or slides were observed, nor was there any erosion. Photo No. 2 shows the upstream slope.

(3) Crest. The crest is well vegetated with adapted grasses. Measurements show the crest elevations to be very uniform and according to the plans. No slumps or deformations were observed. A number of drying cracks, up to 1/4 inch wide, were observed on the crest, as shown in Photo No. 11. The same cracking pattern was observed in the emergency spillway which is cut through natural material. The crest is shown in Photo No. 3 and Plate C-10 of Appendix C.

(4) Downstream Slope. The downstream slope is well vegetated with adapted grasses. No cracks, slumps or deformations were observed on the slope. Measurements indicate that it was constructed according to the plans. Evidence of an old seep area (dead cattails) was observed downstream from centerline station 6+50. Borings in this area showed no free water to depths of 2 feet. Another seep area occurs downstream from centerline station 5+00 to 6+00. Free water was ponded in this area with no observable flow. Both of these seep areas occur on the berm. Another seep area is located downstream from the berm at about centerline station 5+50. Mr. Lee reported that this seep (spring) was there when the dam was constructed and results

from seepage through the bedrock. Photo No. 4 shows the downstream slope. Photos 12 and 13 show the seeps on the berm.

c. Appurtenant Structures.

(1) The principal spillway is uncontrolled and consists of a 30-inch corrugated metal pipe riser shown in Photo No. 8 and a 24-inch corrugated metal pipe conduit shown in Photos 14 and 15. The pipe appears to be in good condition. Cattails and grass block part of the entrance to the riser. Cathodic protection measures were installed on the pipe conduit. The activity of the protective measures is monitored by SCS through the "test station" shown on the plans.

(2) The emergency spillway is an uncontrolled earth channel cut through the left abutment. The spillway is very well vegetated. No slumps or slides were observed in the spillway. There was no evidence of flow through the spillway and no erosion was evident (except for vehicular tracks). Drying cracks similar to those on the crest of the dam were observed in the natural soil in the spillway bottom. Photos 5 and 6 show the spillway.

(3) Drawdown Facility. The drawdown facility consists of an 8-inch corrugated metal pipe into the 30-inch corrugated metal pipe riser located 4 feet below the crest of the riser.

d. Reservoir Area. The area around the reservoir is well grassed. No slumps or slides were observed. No significant erosion was evident around the shoreline. Photo No. 9 shows a portion of the reservoir.

e. Downstream Channel. The channel downstream from the principal spillway appears to be stable (rock is exposed in the plunge pool). A number of willows are growing in the downstream channel.

3.2 EVALUATION

This dam appears to be in good shape with no serious deficiencies nor potential of failure. Measurements indicate that it was constructed in accordance with the plans. Seepage along the downstream slope does not appear to adversely affect the integrity of the structure. Some minor deficiencies in maintenance (heavy growth of cattails around the entrance to the principal spillway, trees in the outlet channel) should be corrected.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

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

4.2 MAINTENANCE OF DAM

Maintenance appears to be reasonably good. Vegetative growth around the inlet of the principal spillway and in the outlet channel should be controlled.

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

The maintenance of the dam appears to be good with the exception of the vegetation which has been allowed to grow around the principal spillway inlet and the uncontrolled growth of willow trees in the principal spillway outlet channel.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. "As built" plans for this dam were furnished by the Soil Conservation Service and are shown in Appendix C. Pertinent hydraulic and hydrologic data used in evaluating the dam are shown in Appendix C, Plate C-9.

b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the SCS plans. 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 and information taken from the "as built" plans.

c. Visual Observations.

(1) The drop inlet pipe, trash rack, and anti-vortex plate appear in excellent condition. However, entrance conditions to the riser are becoming blocked with heavy grass and cattails. The outlet end of the pipe was also in excellent condition.

(2) The emergency spillway is very well vegetated with adapted grasses. There is no indication that the emergency spillway has ever operated.

d. Overtopping Potential. The spillways are too small to pass 50% of the probable maximum flood without overtopping. The spillways will pass the 1% probability flood as well as 24% of the probable maximum flood without overtopping the dam. Overtopping is dangerous because the flow of water over the crest will erode the face of the dam and, if continued long enough, will breach the dam with sudden release of all of the impounded water into the downstream floodplain.

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

Frequency	Inflow Discharge c.f.s.	Outflow Discharge c.f.s.	Maximum Pool Elevation	*Maximum Depth Over Dam Feet	Duration Over Top Hours
1 %	800	150	59.4	0	---
1/2 PMF	1410	1270	60.9	0.7	2
PMF	2820	2780	61.4	1.2	5
0.2+ PMF	690	310	60.2	0	---

* Minimum top of dam elevation - 60.2

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 PMF is the test for the adequacy of the dam and its spillway.

The estimated damage zone is described in paragraph 1.2 d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation. Measurements indicate that the dam was constructed according to the plans. It is considered to be structurally stable. Stability analyses provided by the SCS show adequate safety factors with phreatic surface developed from emergency spillway elevation and no downstream drainage measures. Therefore, seepage observed in the lower section of the downstream slope should not endanger the safety of the dam from the standpoint of strength. The nature of materials in the dam and foundation indicate that seepage at the toe would not endanger the stability of the dam from the standpoint of internal erosion and piping.

b. Design and Construction Data. Design data and "As Built" plans were available from the Soil Conservation Service and are included as Appendix C and Appendix E of this report. Seepage and stability analyses presented in the SCS reports are considered adequate for this structure.

c. Operating Records. There are no controlled operating facilities for this dam.

d. Post Construction Changes. There have been no post construction changes for this structure.

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.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. The dam appears to be in excellent structural condition with little likely potential of failure. The flood from one-half the Probable Maximum Flood will overtop the dam by 0.7 feet for a period of 2+ hours. Overtopping is dangerous because the flow of water over the crest will erode the face of the dam and, if continued long enough, will breach the dam with sudden release of all of the impounded water into the downstream floodplain. The few minor deficiencies in maintenance should not seriously affect the safety of the structure.

b. Adequacy of Information. The design data and the "As Built" plans furnished by the SCS and included as Appendix C and Appendix E of this report and the visual observations made during the inspection are considered adequate to support the conclusions and recommendations presented in this report. Seepage and stability analyses presented in the SCS reports are considered adequate for this structure.

c. Urgency. There does not appear to be an immediate urgency to accomplish the remedial measure recommended in paragraph 7.2a.

d. Necessity for Further Investigations. Prior to any action being taken on the remedial measure recommended in paragraph 7.2a, the owner should conduct a breach routing of the dam to determine the downstream effects of the failure of the dam.

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.

7.2 REMEDIAL MEASURES

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

a. Alternatives.

(1) The emergency spillway size and/or the height of dam should be increased to pass 50% of the Probable Maximum Flood without overtopping.

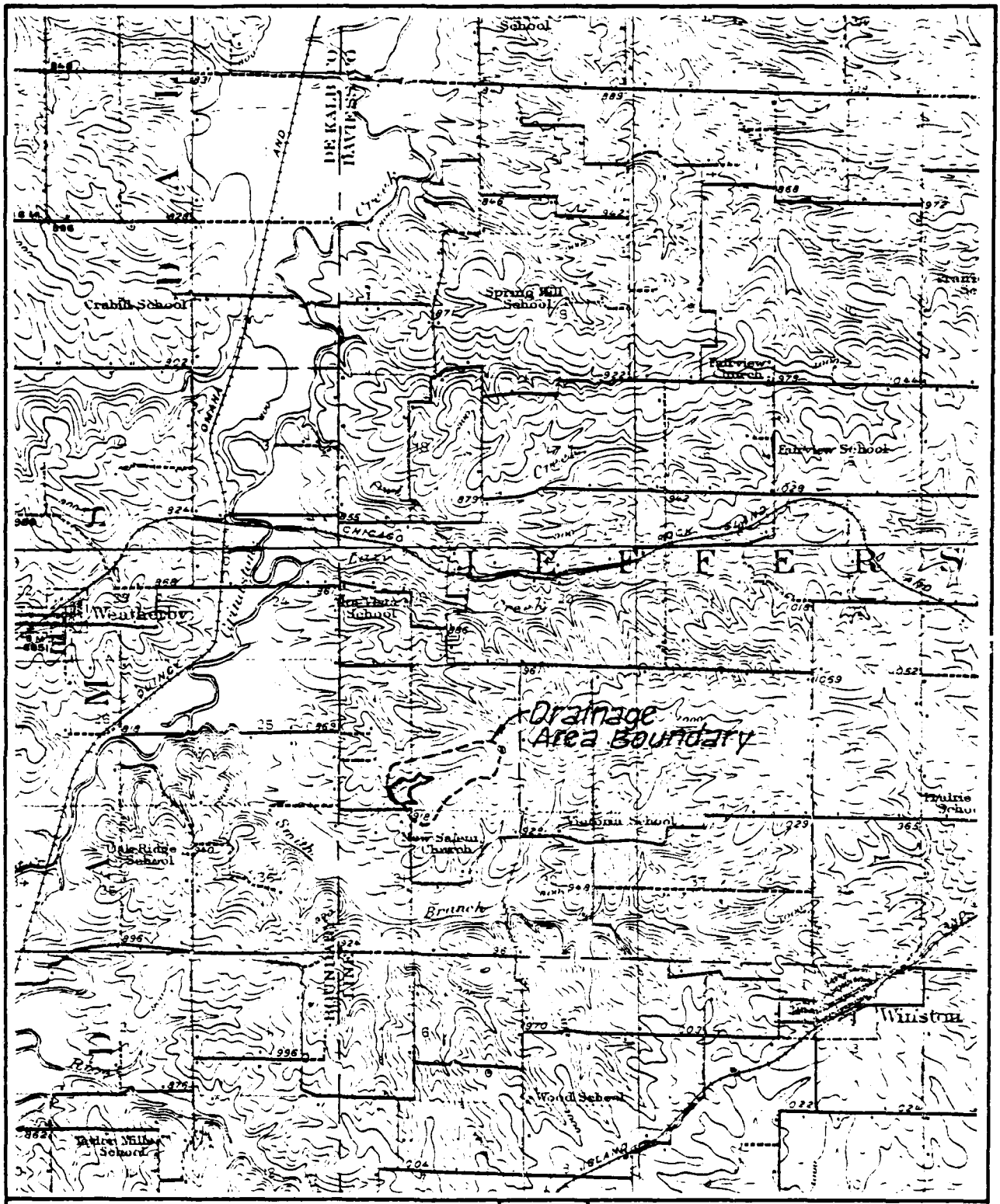
b. Operating and Maintenance Procedures.

(1) The vegetative growth around the principal spillway entrance should be removed and the area should be kept clear to prevent a reduction in the principal spillway capacity.

(2) The willows in the principal spillway outlet channel should be removed and measures taken to prevent their recurrence.

(3) The dam should be inspected at regular intervals and records of the inspections made a part of the project file on this dam.

APPENDIX A
MAPS



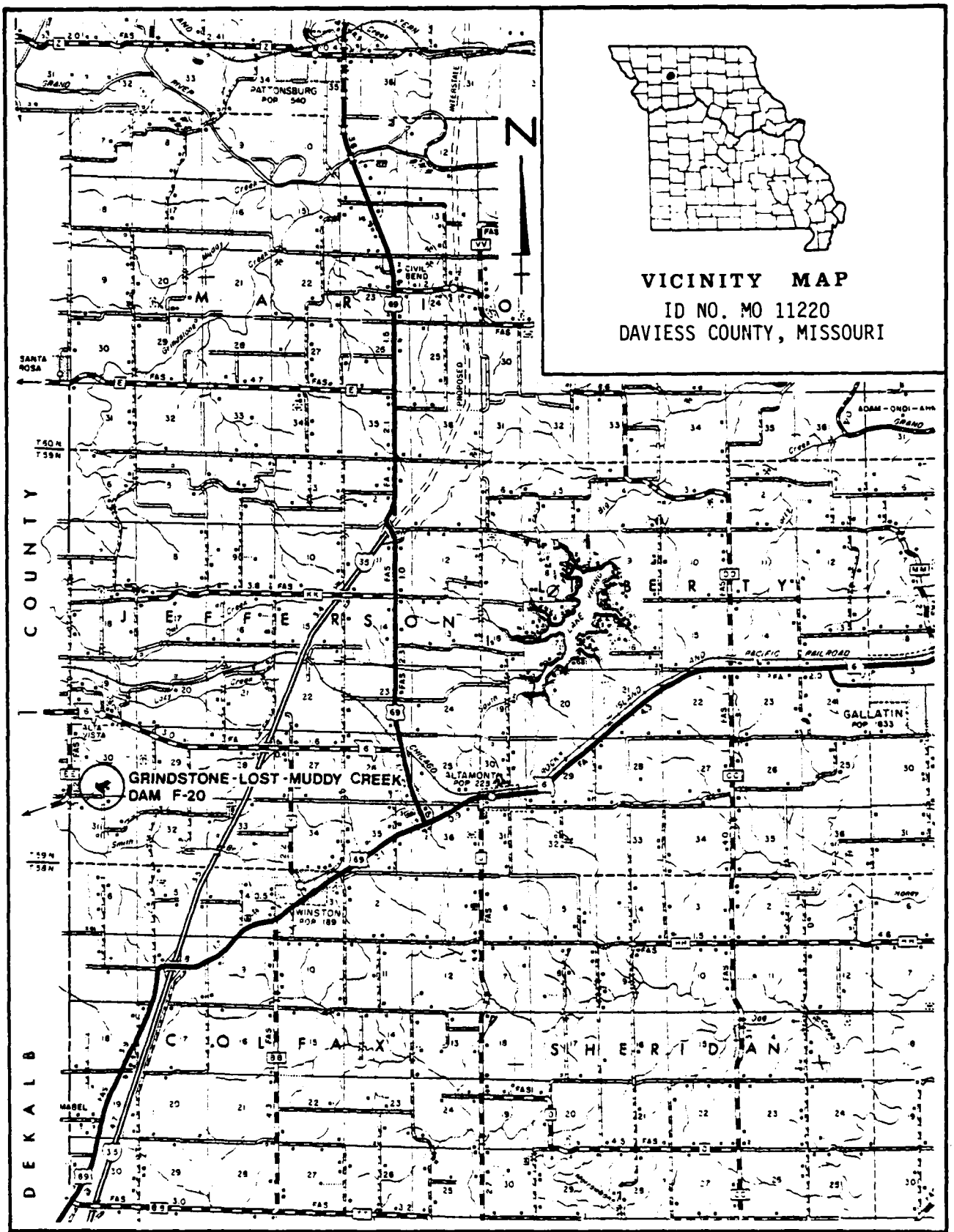
VICINITY TOPOGRAPHY

GRINDSTONE-LOST-MUDDY CREEK DAM F-20

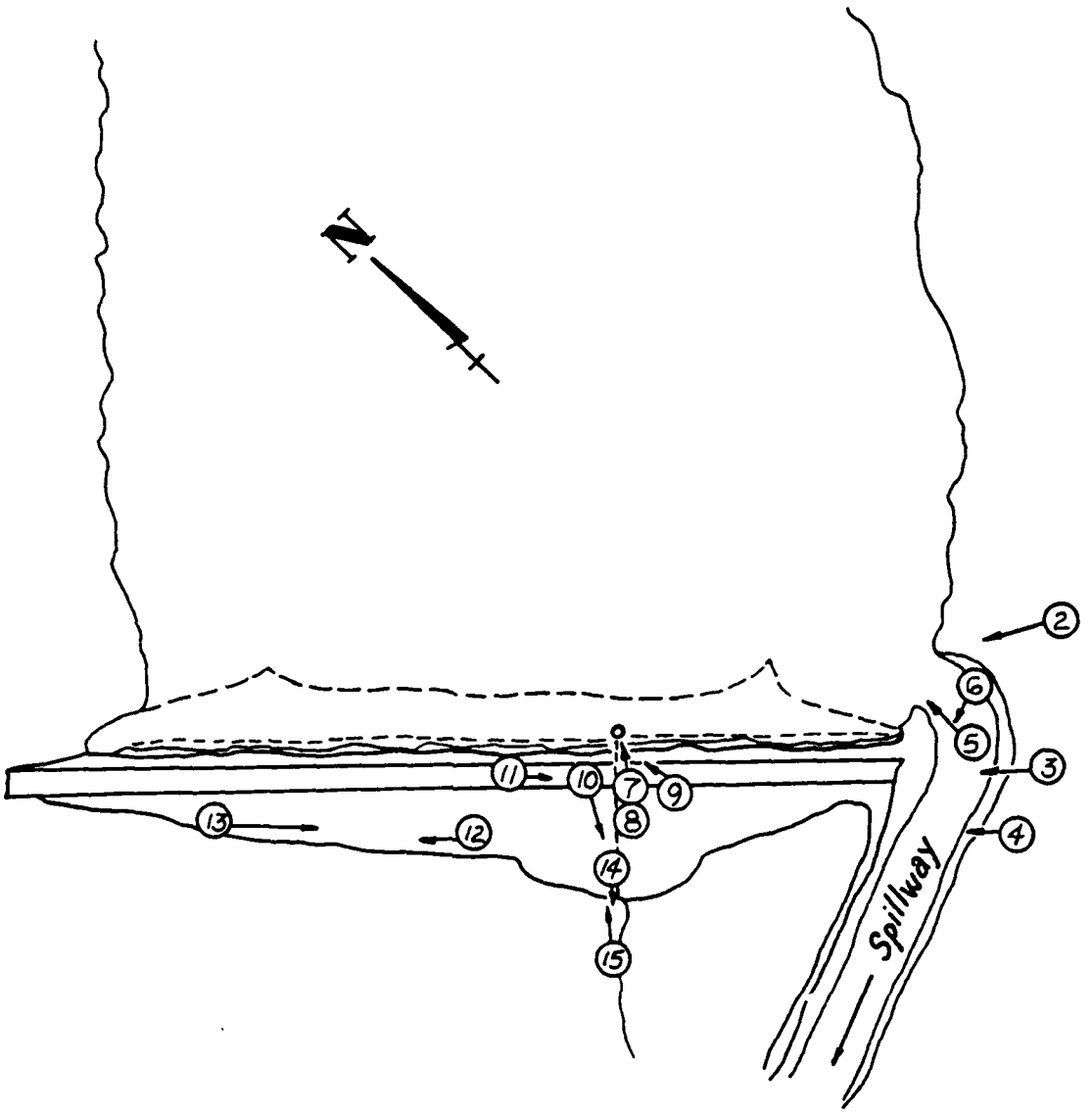
DAVIESS COUNTY, MISSOURI

MO. 11220

PLATE A-1


VICINITY MAP
ID NO. MO 11220
DAVIESS COUNTY, MISSOURI
N
PATTONSBURG
POP 540
CIVIL BEND
SANTA ROSA
PROPOSED
GRINDSTONE-LOST-MUDDY CREEK-
DAM F-20
GALLATIN
POP 1833
ALTAMONT
POP 225
WINSTON
POP 189
MABEL
COUNTY
DEKALB
Scale in miles
0 1 2 3 4 5
LOCATION MAP
PLATE A-2

APPENDIX B
PHOTOGRAPHS



GRINDSTONE-LOST-MUDDY CREEK DAM F-20

DAVIESS COUNTY, MISSOURI

MO. 11220

PHOTO INDEX

PLATE B-1

PHOTO NO. 2 - UPSTREAM FACE FROM LEFT ABUTMENT

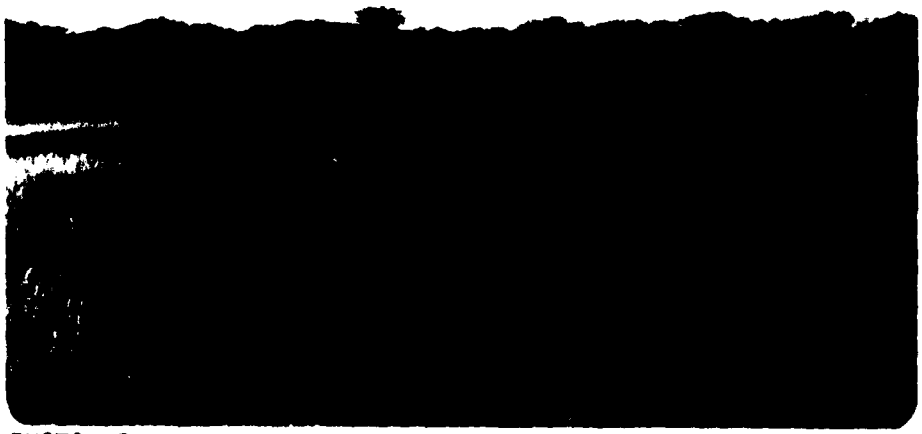


PHOTO NO. 3 - CREST FROM LEFT ABUTMENT

PHOTO NO. 4 - DOWNSTREAM SLOPE FROM LEFT END

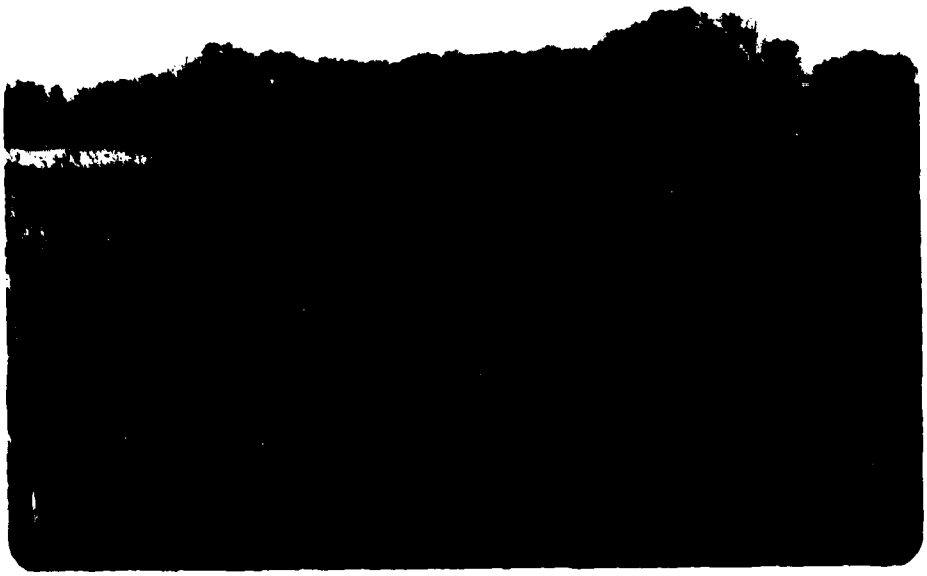


PHOTO NO. 5 - VIEW UPSTREAM IN EMERGENCY SPILLWAY

PHOTO NO. 6 - VIEW DOWNSTREAM IN EMERGENCY SPILLWAY

PHOTO NO. 7 - PRINCIPAL SPILLWAY RISER

PHOTO NO. 8 - PRINCIPAL SPILLWAY RISER

PHOTO NO. 9 - VIEW UPSTREAM ACROSS PRINCIPAL SPILLWAY RISER

PHOTO NO. 10 - VIEW DOWNSTREAM AT EXIT CHANNEL FOR PRINCIPAL SPILLWAY

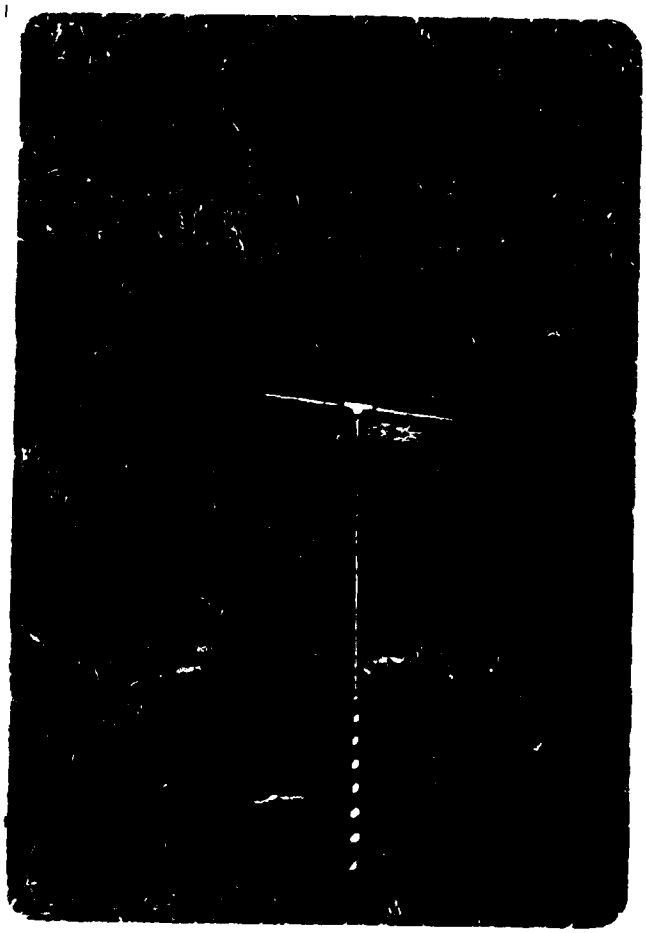


PHOTO NO. 11 - TRANSVERSE CRACK IN CREST OF DAM. (IMMEDIATELY TO LEFT OF AUGER)

PHOTO NO. 12 - SEEP AREA ON RIGHT DOWNSTREAM TOE

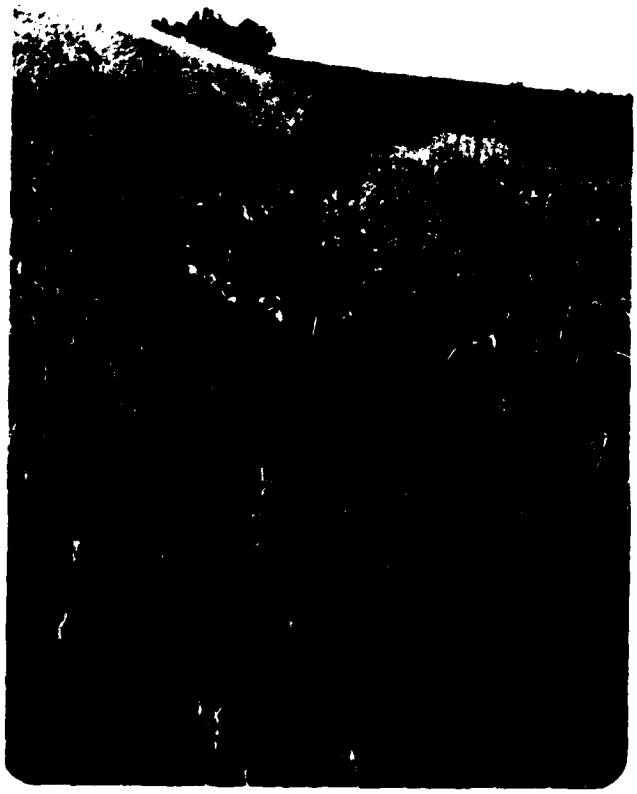


PHOTO NO. 13 - SEEP AREA NEAR RIGHT DOWNSTREAM TROUGH

PHOTO NO. 14 - VIEW DOWNSTREAM AT END OF PRINCIPAL SPILLWAY CONDUIT

PHOTO NO. 15 - VIEW UPSTREAM AT PRINCIPAL SPILLWAY OUTLET

PHOTO NO. 16 - HOME ONE-HALF MILE DOWNSTREAM

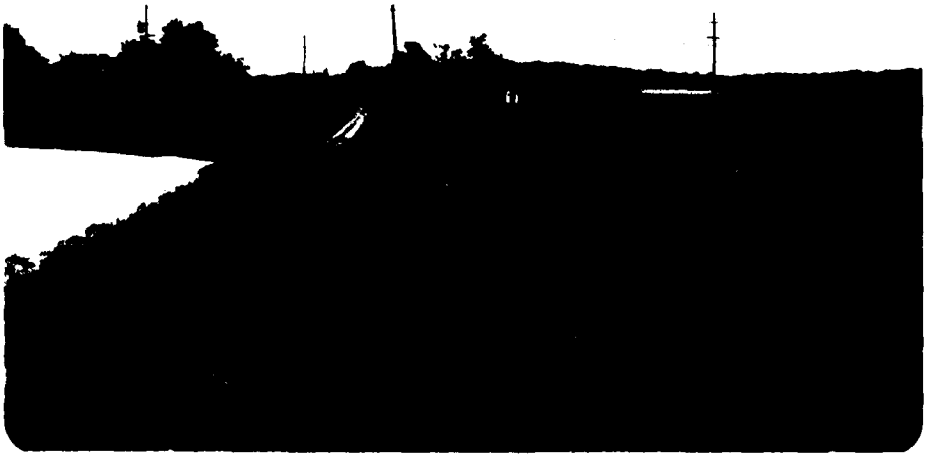
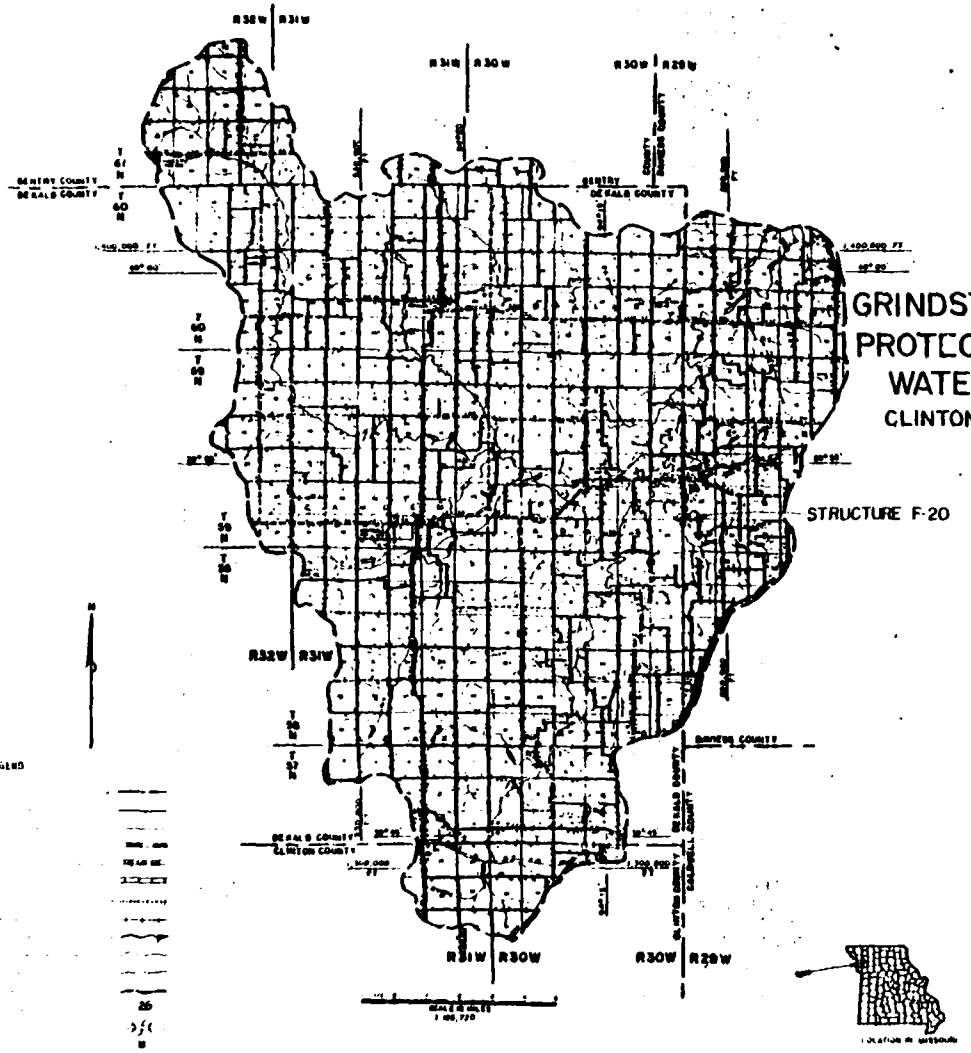


PHOTO NO. 17 - HOME AND BARN ONE-HALF MILE DOWNSTREAM

APPENDIX C
PROJECT PLATES

Details, Outlet Support & Antiseeps	5
Details, Vertical Inlet & Trash Rack	6
Fence Details	7
Plan, Geologic Investigation	8
Profile, Geologic Investigation	9
Cross Section, Geologic Investigation	10



U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DETAIL PLANS FOR GRINDSTONE-LOST-MUDDY CREEK WATERSHED PROTECTION AND FLOOD PREVENTION, MUNICIPAL WATER SUPPLY AND RECREATION PROJECT

CLINTON, DAVIESS, DEKALB AND GENTRY COUNTIES MISSOURI

IN COOPERATION WITH
SOIL AND WATER CONSERVATION DISTRICTS OF DAVIESS, DEKALB AND GENTRY COUNTIES; COUNTY COURTS OF DAVIESS, DEKALB AND GENTRY COUNTIES AND CITY OF MAYSVILLE, MISSOURI

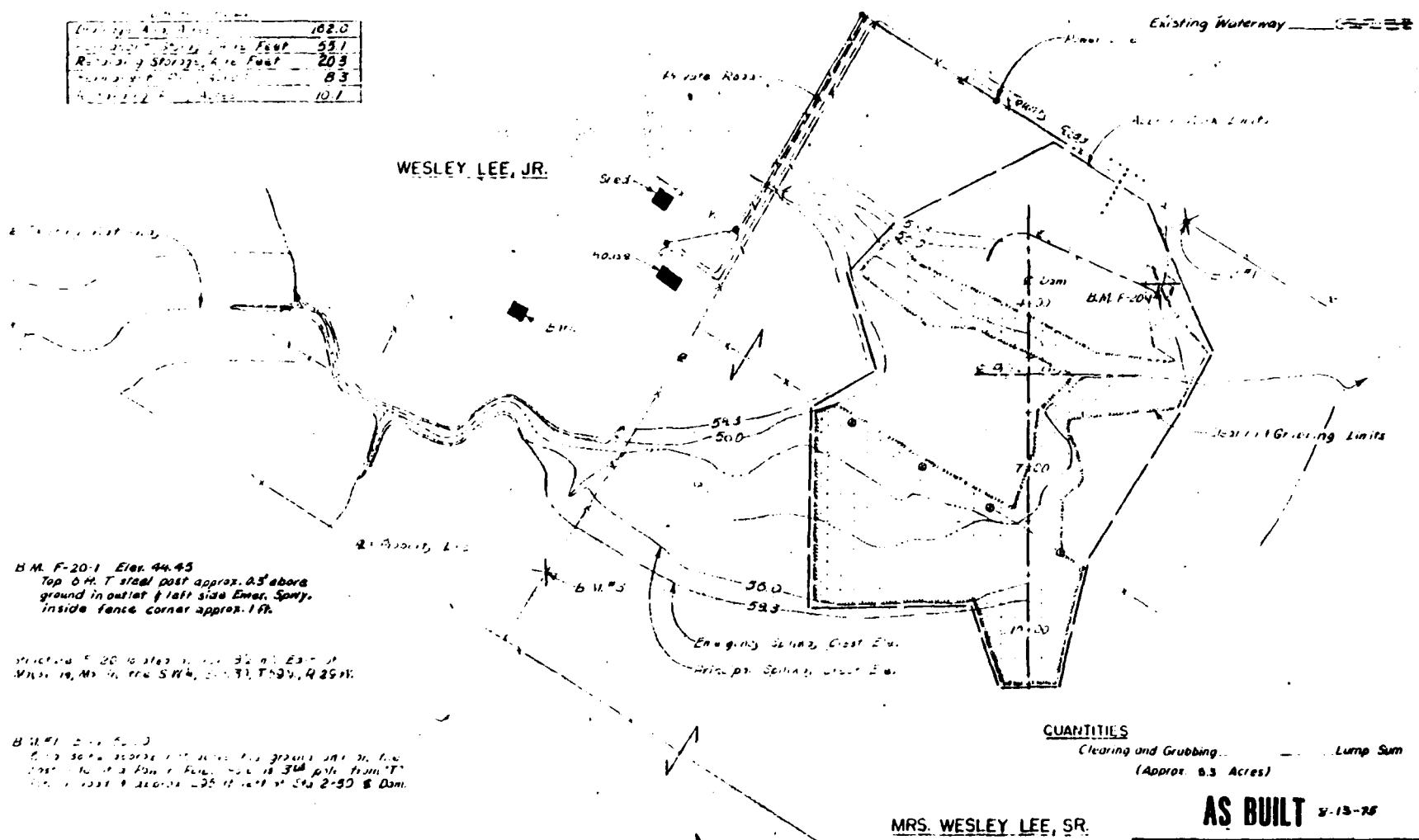
STRUCTURE F-20

AS BUILT 8-18-75

APPROVED BY	DATE
[signature] STATE CONSERVATION ENGINEER	11/30/71

PLATE C-1

[illegible]	162.0
[illegible] Feet	55.1
Retarding Storage, Acre Feet	20.3
[illegible]	8.3
[illegible]	10.1



B.M. F-20-1 Elev. 44.45
Top 6 H. T steel post approx. 0.3' above ground in outlet & left side Emer. Spwy. inside fence corner approx. 1 ft.

Structure F-20 located [illegible] East of [illegible] in the S.W.¼, [illegible] T 59 N., R 29 W.

B.M. #1 [illegible]
[illegible] ground and on the [illegible] 3rd pole from "T" [illegible] approx. 295 ft. left of Sta 2+50 ℄ Dam.

B.M. #3 Elev. 63.52
[illegible] above the ground and on the South side of a 16 [illegible] tree. Tree is located 3 ft. East of [illegible] fence and approx. 145 ft. South of fence corner.

GENERAL PLAN OF RESERVOIR

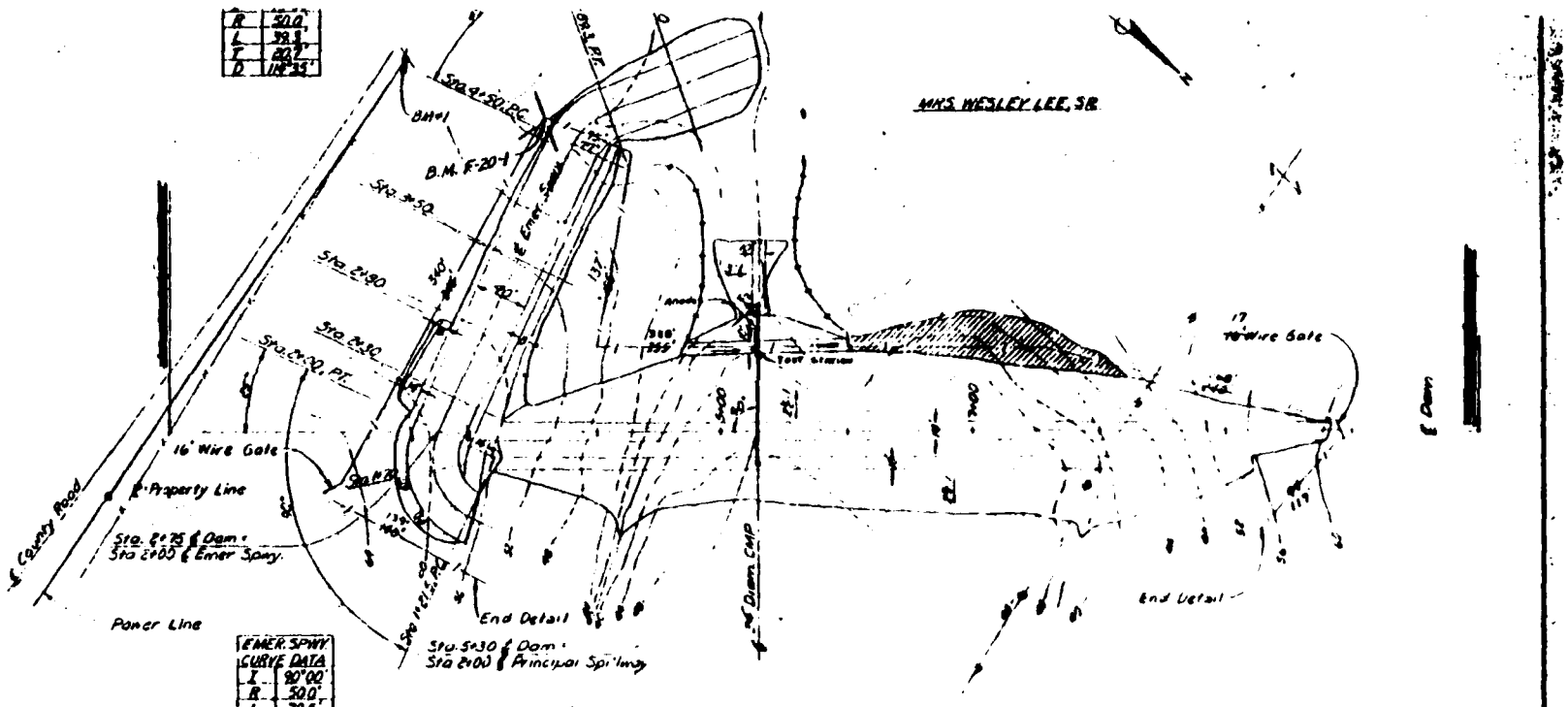
100 50 0 100 200

CUANTITIES
Clearing and Grubbing ..... Lump Sum
(Approx. 6.3 Acres)

AS BUILT 8-13-75

STRUCTURE F-20
GRINDSTONE-LOST-MUDDY CREEK WATERSHED
P. L. 566 DAVIESS CO., MO.
U. S. DEPARTMENT OF AGRICULTURE

PLATE C-2



R	50.0'
L	39.3'
T	20.7'
D	114°35'

EMER. SPWY. CURVE	DATA
I	90°00'
R	50.0'
L	78.5'
T	50.0'
D	114°35'

PLAN OF EMBANKMENT & SPILLWAYS

50 25 0 50 100

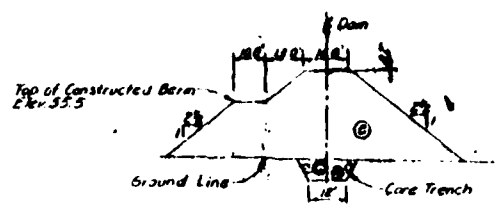
Scale in Feet

NOTES:

Diversion
Protective Dike dimensions: 18" effective height, 3:1 side slopes, minimum base width 9'.

Topsoil
A minimum of six (6) inches topsoil to be placed on all compacted earth fill slopes and in the emergency spillway.

Waste Areas
Waste Areas will be as shown or as designated by the Engineer.

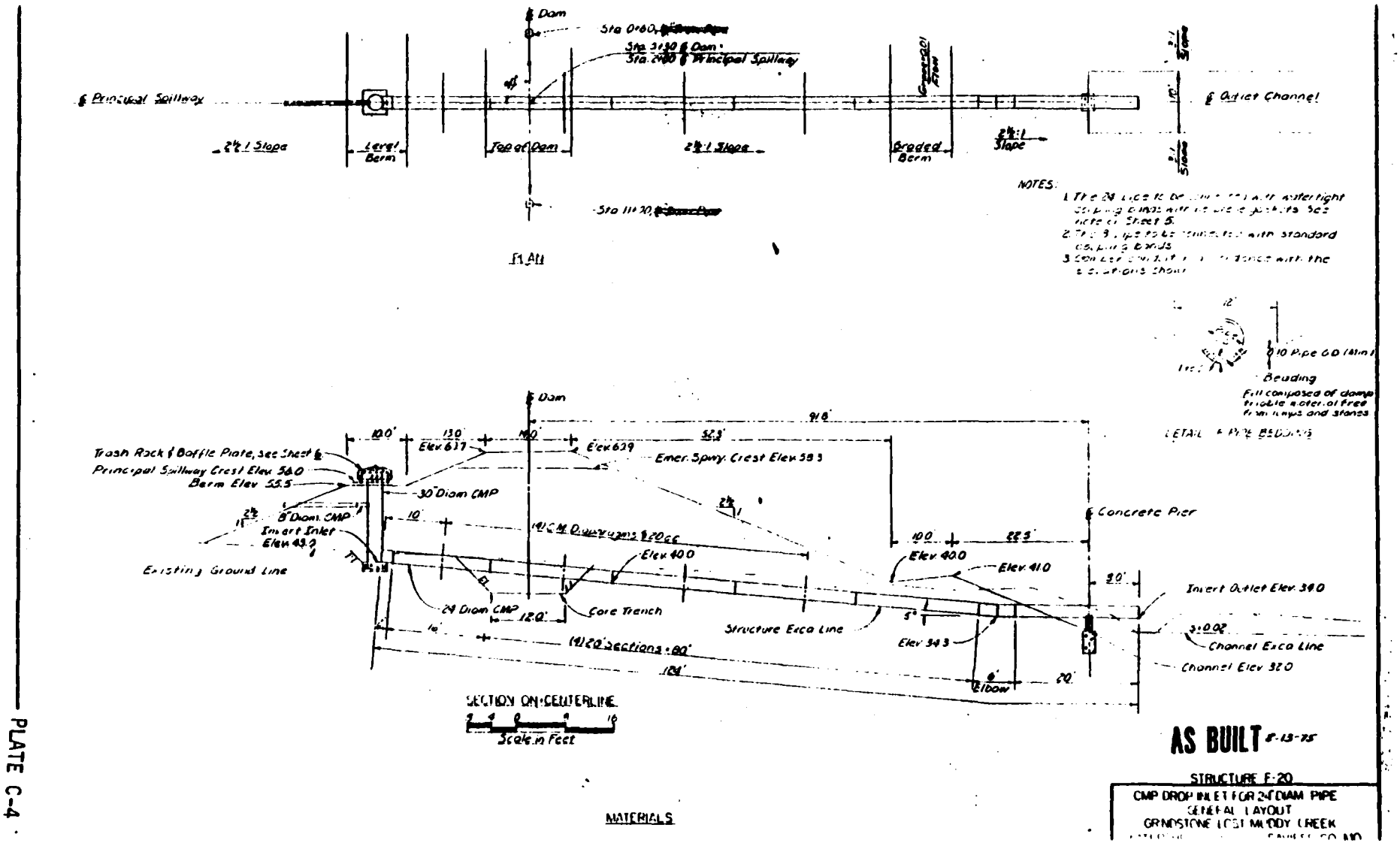


QUANTITIES		
Excavation, Common @		
Core Trench	1902	Cu. Yds.
Structure	175	Cu. Yds.
Outlet Channel	62	Cu. Yds.
Stream Channel	293	Cu. Yds.
Total	2432	Cu. Yds.
Earth Fill		
Class @	29,100	Cu. Yds.
Topsoil	2457	Sq. Yds.
Fence, Barbed Wire	[illegible]	Lin. Ft.

AS BUILT 8-13-75

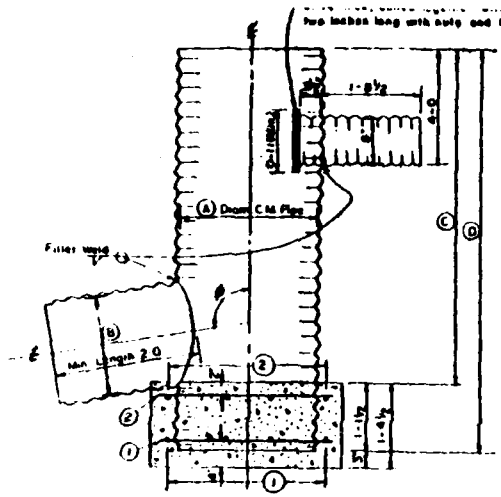
STRUCTURE F-20
GRINDSTONE-LOST-MUDDY CREEK
WATERSHED PL 566 DAVIESS CO., MO.

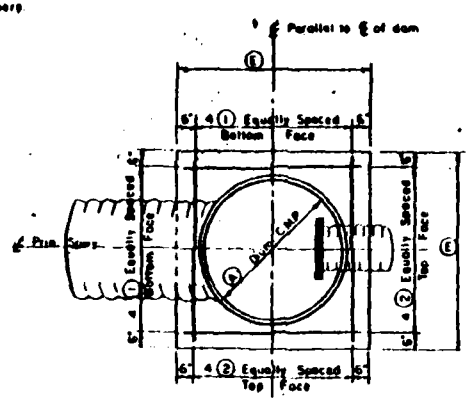
PLATE C-3



℄ Dam
Sta 0+60
Sta 3+30 ℄ Dam
Sta 2+00 ℄ Principal Spillway
℄ Principal Spillway
℄ Outlet Channel
2½:1 Slope
Level Berm
Top of Dam
2½:1 Slope
Graded Berm
2½:1 Slope
Sta 11+20
PLAN
NOTES:
1. The 24 pipe to be connected with watertight coupling bands with no pipe gaskets. See note on Sheet 5.
2. The 8 pipe to be connected with standard coupling bands.
3. Contractor [illegible] with the elevations shown.
0.10 Pipe O.D. (Min.)
Bedding
Fill composed of damp friable material free from lumps and stones
DETAIL OF PIPE BEDDING
℄ Dam
91.8'
10.0'
13.0'
14.0'
52.3'
Elev. 61.7
Elev. 62.9
Emer. Spwy. Crest Elev. 58.3
Trash Rack & Baffle Plate, see Sheet 6
Principal Spillway Crest Elev. 56.0
Berm Elev. 55.5
30" Diam CMP
8" Diam. CMP
Invert Inlet Elev. 43.0
Existing Ground Line
(4) C.M. Diaphragms @ 20 cc
Elev. 40.0
Elev. 40.0
Elev. 41.0
℄ Concrete Pier
10.0
22.5'
9.0'
Invert Outlet Elev. 34.0
24 Diam CMP
12.0'
Core Trench
Structure Exca Line
Elev. 34.3
Channel Exca Line
Channel Elev. 32.0
(4) 20' Sections = 80'
124'
Elbow
20'
SECTION ON CENTERLINE
Scale in Feet
MATERIALS
AS BUILT 8-13-75
STRUCTURE F-20
CMP DROP INLET FOR 24" DIAM PIPE
GENERAL LAYOUT
GRINDSTONE LOST MUDDY CREEK

PLATE C-4





Station on ℄ Dam		1+30
Ⓐ	-24-	30"
Ⓑ	-30-	24"
Ⓒ		13-0
Ⓓ		14-11½
Ⓔ	2-6	6-0
CM Pipe Gage for Ⓐ Diam		14
CM Pipe Gage for Ⓑ Diam		14
∅ Degrees - Angle		99°
Weight of Steel Bar Reinforcement, Lbs	332.0	374
Volume of Concrete, Class 3000M, Cu Yds	0.62	0.81

STEEL SCHEDULE FOR Ⓐ - 24"

Mark	Size	Type	Quan	Length	Total Length	Weight (pounds)
1	#4	Straight	8	3-0	24-0	16.0
2	#4	"	8	3-0	24-0	16.0

STEEL SCHEDULE FOR Ⓐ - 30"

Mark	Size	Type	Quan	Length	Total Length	Weight (pounds)
1	#4	Straight	8	3-6	28-0	18.7
2	#4	"	8	3-6	28-0	18.7

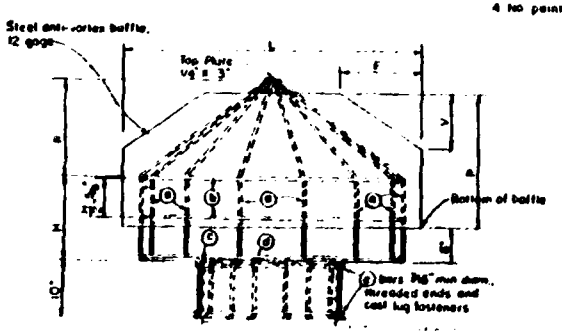
Notes:
1. Drill ⅜" diam holes in the C.M.P. Vertical Inlet as required to clear the reinforcing bars. To be done by manufacturer
2. Sufficient blocks shall be provided to support the vertical inlet as shown. The required size and number to be determined by the Contractor. Footing blocks are incidental to the Vertical Inlet.
3. Vertical inlet to be shop fabricated. Materials and fabrication to be in accordance with Federal Specification WW-P-405

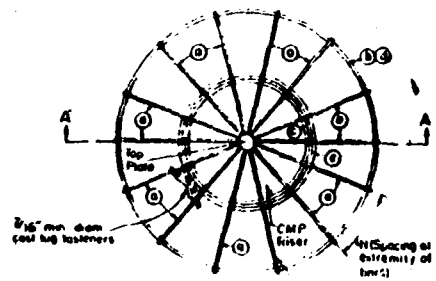
DETAILS OF VERTICAL INLET
NOT TO SCALE

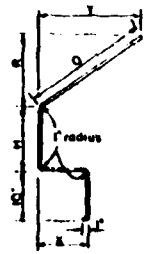
TABLE OF DIMENSIONS AND MATERIALS FOR TRASH RACK

Ⓐ Diam inches	H inches	Ⓐ Bars ⅜⌀ B inches	E inches	Y inches	Q inches	Total Length	No Req'd	W inches	Baffle Plate L inches	F inches	F' inches	V inches	Ⓑ Bars ⅜⌀ No Req'd	r inches	Diam Length inches	Ⓒ Bars ⅜⌀ No Req'd	r inches	Diam Length inches	Ⓓ Bars ⅜⌀ No Req'd	r inches	Diam Length inches	Ⓔ Bars ⅝⌀ No Req'd	r inches	Diam Length inches
24	25	19	42	24	29½	6-7½	14	11	64	24	15	10	4	23½	24	1	12	72½	1	23½	148	2	13⅜	9-1½
30	31	25½	49	29	32½	6-3½	14	13½	67	24	16½	7½	4	29½	93	1	15	96	1	29½	186	2	16½	111

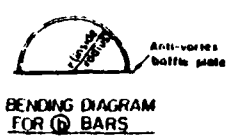
NOTES: 1. Weld 2 Ⓔ bars to baffle plate. Weld Ⓑ Ⓒ and Ⓓ bars to Ⓔ bars and weld Ⓐ bars to top plate.
2. The trash rack and baffle plate to be fabricated as a unit.
3. Trash rack to be fabricated from steel bars conforming to A.S.T.M. Designation A-36
4. No painting or galvanizing required



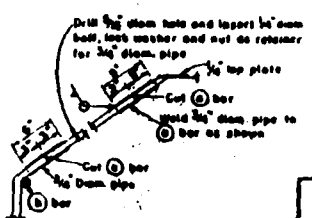


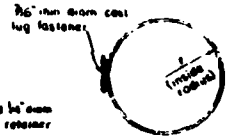


BENDING DIAGRAM FOR Ⓒ AND Ⓓ BARS



BENDING DIAGRAM FOR Ⓓ BARS





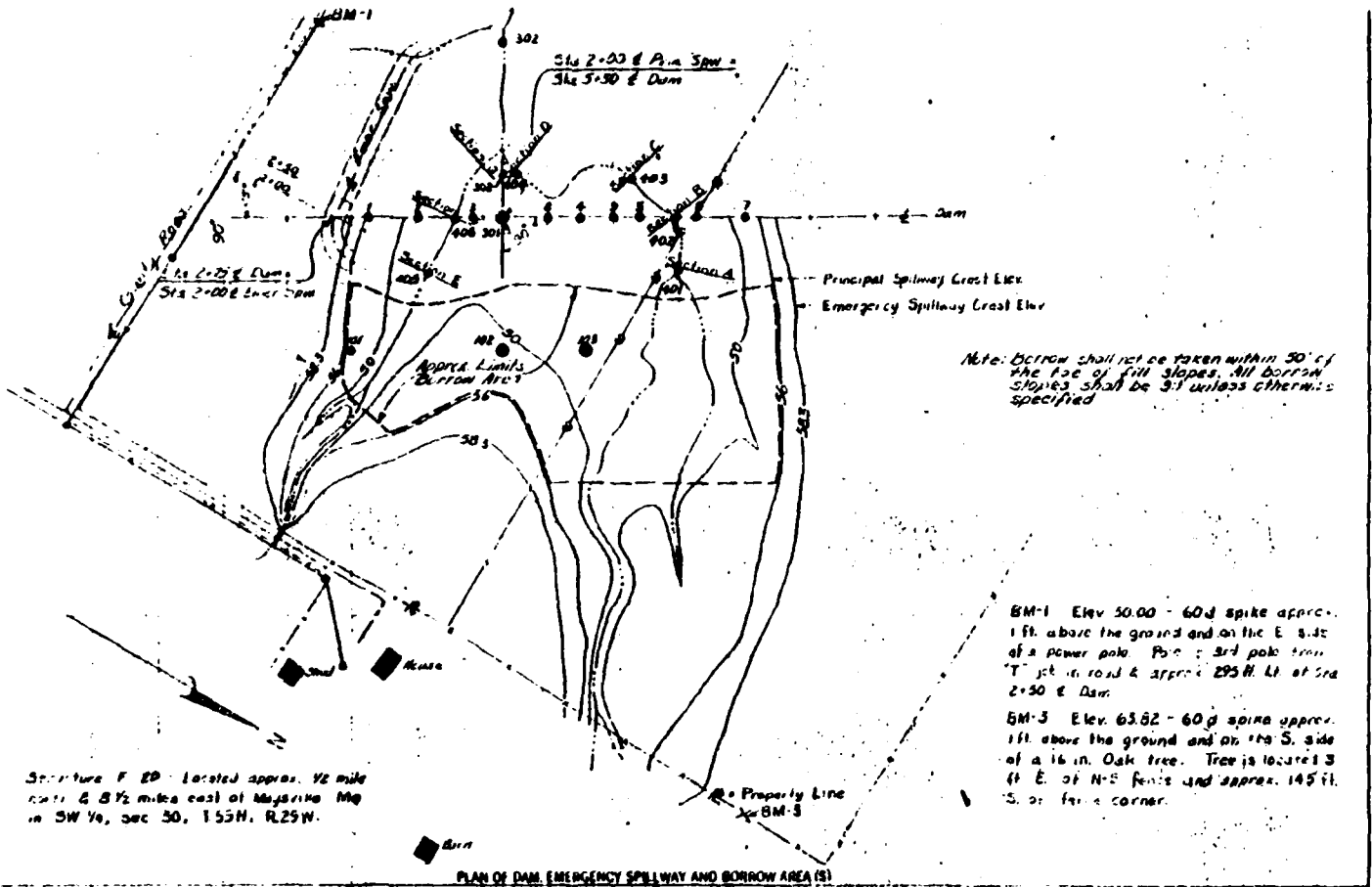
BENDING DIAGRAM FOR Ⓔ BARS

AS BUILT 8-19-75

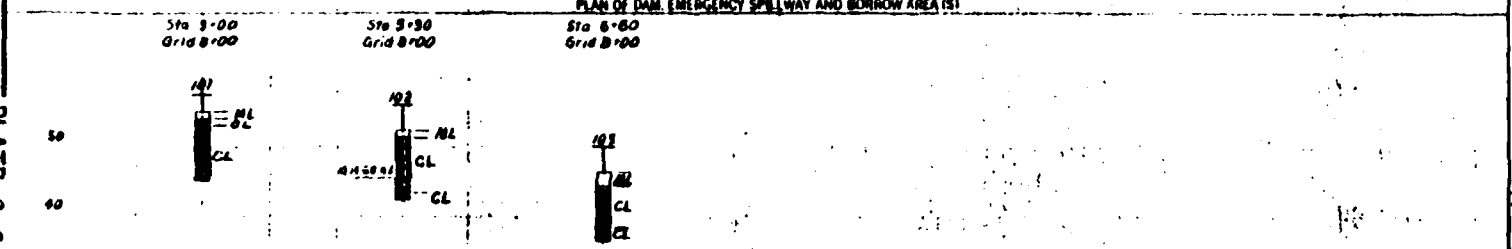
STRUCTURE F-20

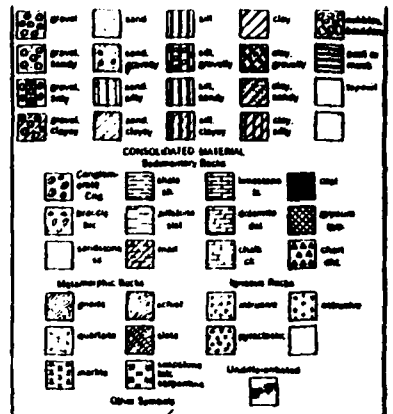
DETAILS OF CORRUGATED METAL PIPE VERTICAL INLET AND TRASH RACK
GRINDSTONE-LOST-MUDDY CREEK WATERSHED PL 566 DAVIESS CO., MO

PLATE C-5



PLAN OF DAM, EMERGENCY SPILLWAY AND BORROW AREA (S)





ABBREVIATIONS

ang	angular	lam	laminated	G	gravel, gravelly
bld	boulders (> 12")	lse	loose	S	sand, sandy
calc	calcareous	mas	massive	M	silt, silty
cab	caliche	med	medium	C	clay, clayey
cav	cavities	mic	micaceous	O	organic
cmt	cemented	mod	moderately	W	well graded
csa	coarse	n.r.	no recovery	P	poorly graded
cbl	cobbles (3" 12")	per	permeable		
cpt	Compact	po	poorly		
con	concretions	rdd	rounded		
cry	crystalline	sl	slightly		
ds	dense	sft	soft		
dip	dipping	sl	some		
d.s.	downstream	sls	slowly		
fn	fine	stf	stiff		
fm	firm	t.b.	thin bedded		
frac	fractured	tuff	tuffaceous		
frg	fragments	u.s.	upstream		
fri	friable	ver	variable		
gm	grain	v	very		
gyp	gypsiferous	w/	with		
hd	hard	wea	weathered		
h	highly	w.l.	idolar static water level		

TEST HOLE NUMBERING SYSTEM

Centerline of dam	1	99	Stream channel	401	499
Borrow area	101	199	Relief wells	501	599
Emergency spillway	201	299		601	699
Centerline of outlet structure	301	399		701	799

UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOLS

GW	Well graded gravels, gravel sand mixtures
GP	Poorly graded gravels
GM	Silty gravels, gravel sand silt mixtures
GC	Clayey gravels, gravel sand clay mixtures
SW	Well graded sands, sand gravel mixtures
SP	Poorly graded sands
SM	Silty sand
SC	Clayey sands, sand clay mixtures
ML	Silts with liquid limit of 50 or less
MH	Silts with liquid limit above 50
CL	Clays with liquid limit of 50 or less
CH	Clays with liquid limit above 50
OL	Organic silts and clays with liquid limit of 50 or less
OH	Organic silts and clays with liquid limit above 50

Revised February 1963

AS BUILT 8-13-75

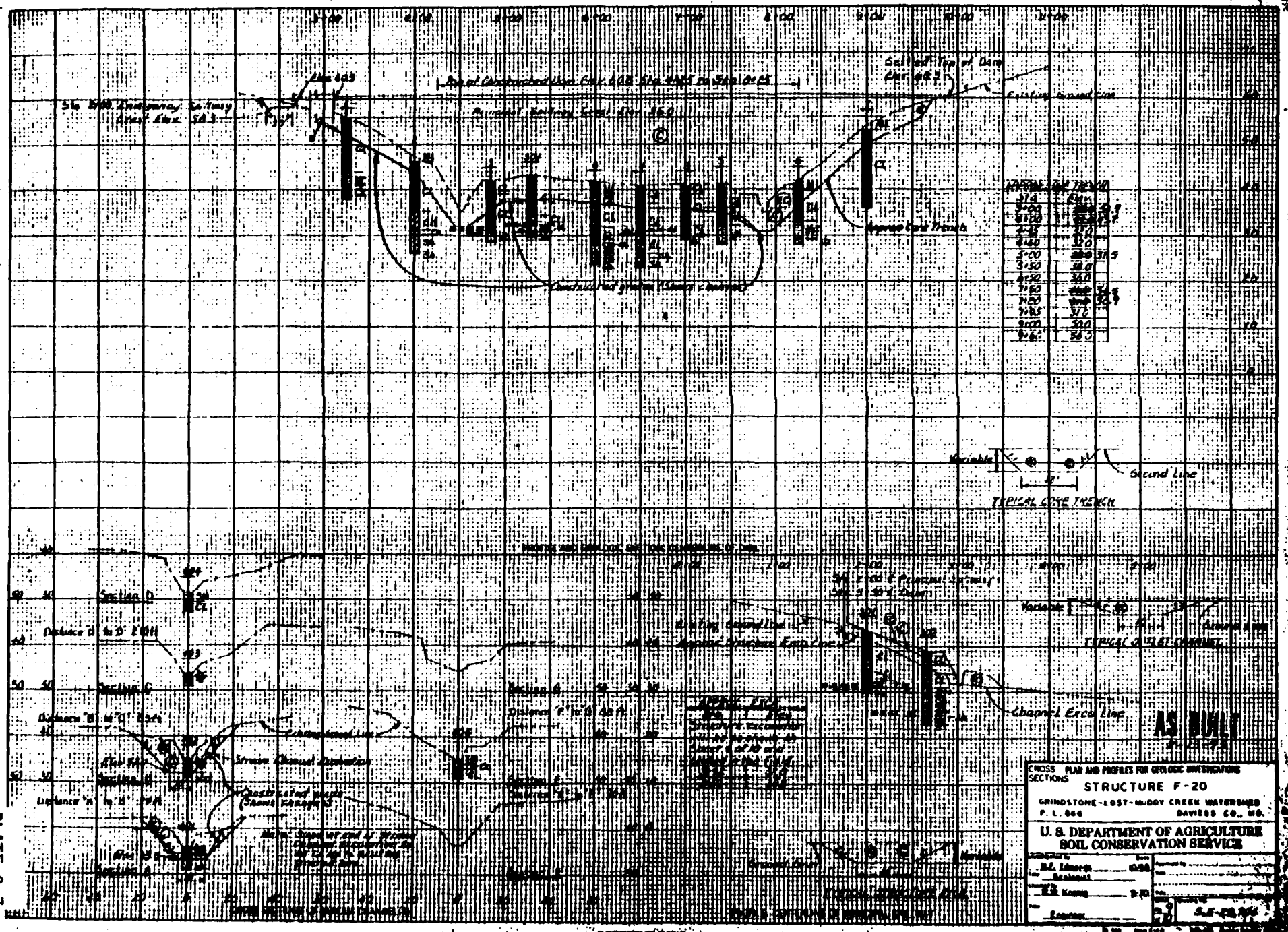
CROSS SECTIONS PLAN AND PROFILES FOR GEOLOGIC INVESTIGATIONS

STRUCTURE F-20

GRINDSTONE-LOST MUDDY CREEK WATERSHED

DAVIESS CO., MO

PLATE C-6



CROSS SECTIONS PLAN AND PROFILES FOR GEOLOGIC INVESTIGATIONS

STRUCTURE F-20

GRINDSTONE-LOST-MUDDY CREEK WATERSHED
P. L. 566 DAVIESS CO., MO.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PLATE C-7

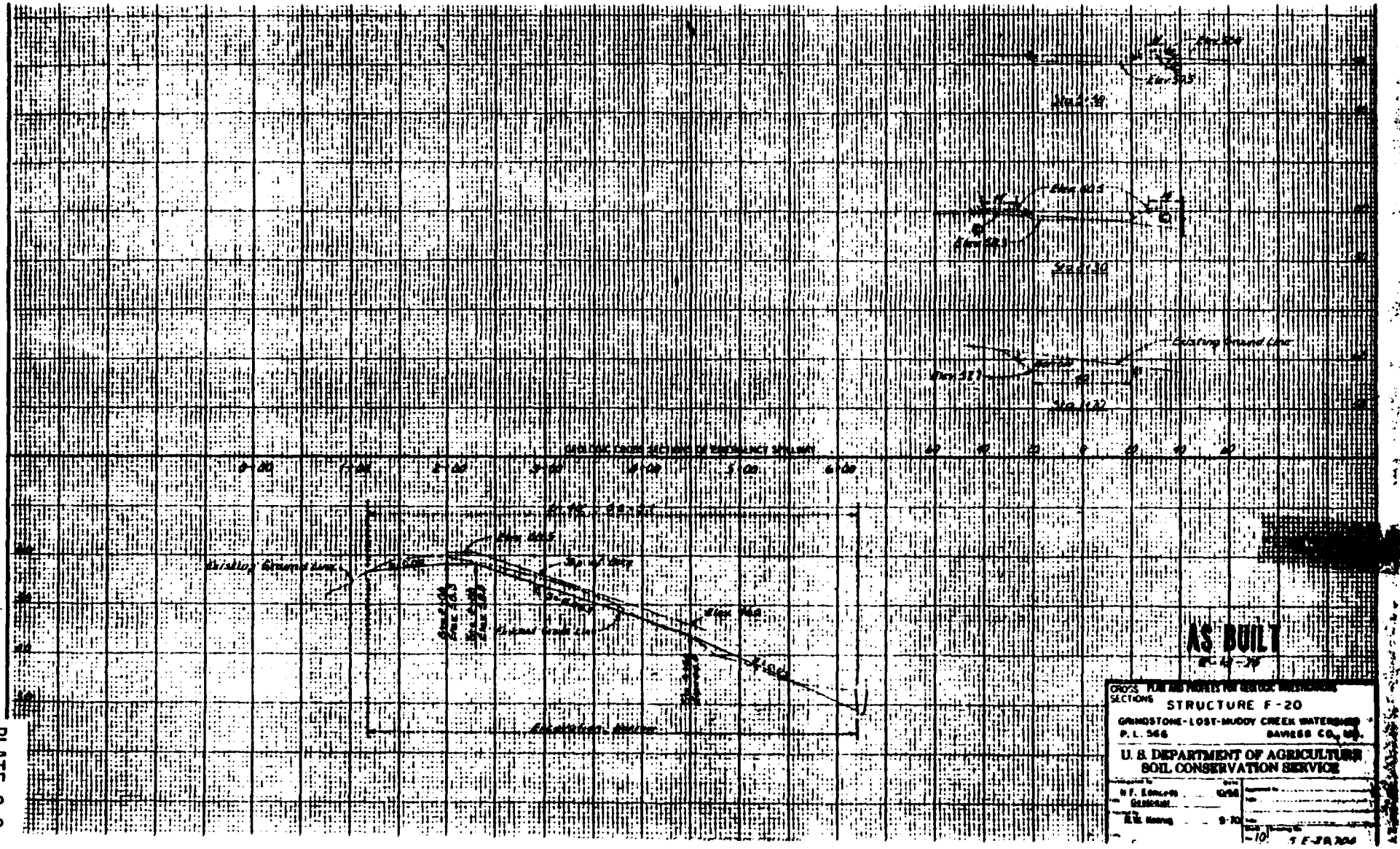

AS BUILT
CROSS SECTIONS
STRUCTURE F-20
GRINDSTONE-LOST-MUDDY CREEK WATERSHED
P. L. 566
DAVIESS CO., IND.
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PLATE C-8

STRUCTURE DATA

Class of Structure "a" Grade Stabilization

Drainage Area (total) 162 Ac. 0.253 Sq.Mi.

(uncontrolled) 162 Ac. 0.253 Sq.Mi.

Time of Concentration 0.25 Hours

Soil Cover Complex Number 80 For A.M.C. II

Sediment Capacity Available 55.1 Ac.Ft. below Elev. 56.0

Total Sediment Capacity Available 55.1 Ac.Ft.

Capacity Equivalents (Vol.) 4.08 In.

Retarding Capacity Provided 20.3 Ac.Ft.

Capacity Equivalents (Vol.) 1.50 In.

Water Supply Provided _____ Ac.Ft.-Identify Uses

Principal Spillway:

Maximum Capacity ~~(low stage)~~ 43 c.f.s.

~~Maximum Capacity (high stage) _____ c.f.s.~~

10 Day Drawdown Elev. 56.0

Emergency Spillway:

Percent Chance Use 4 Storm Duration 6 Hours

Type Vegetated Earth "n" Value Used 0.04

Emergency Spillway Hydrograph for Class "a" Structures

Rainfall 5.50 in.

Runoff 3.33 in.

Peak Inflow 498 c.f.s.

Maximum Discharge - Emergency Spillway 36 c.f.s.

Maximum Water Surface Elev. 58.86

Velocity of Flow (Ve) 3.7 f.p.s.

Supplementary Data and Special Design Features:

Principal Spillway Crest Elev. = 56.0
Emergency Spillway Crest Elev. = 58.9
Emergency Spillway Bottom Width = 40'
Settled Top of Dam Elev. = 60.3
H x S = 23.7 x 75.4 = 1749

Freeboard Hydrograph for Class "a" Structures

Rainfall 8.01 in.

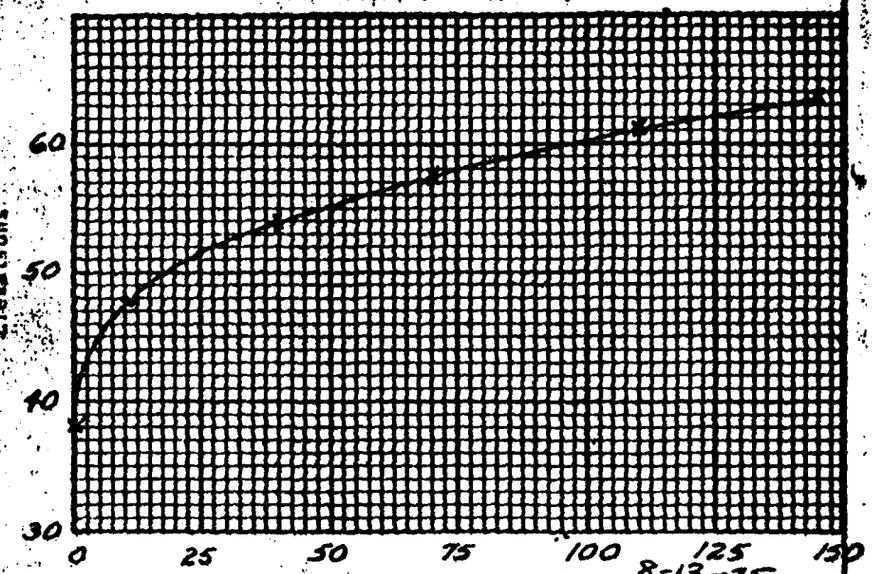
Runoff 5.63 in.

Peak Inflow 697 c.f.s.

Maximum Discharge - Emergency Spillway 163 c.f.s.

Maximum Water Surface Elev. 59.76

Reservoir Capacity



8-13-75

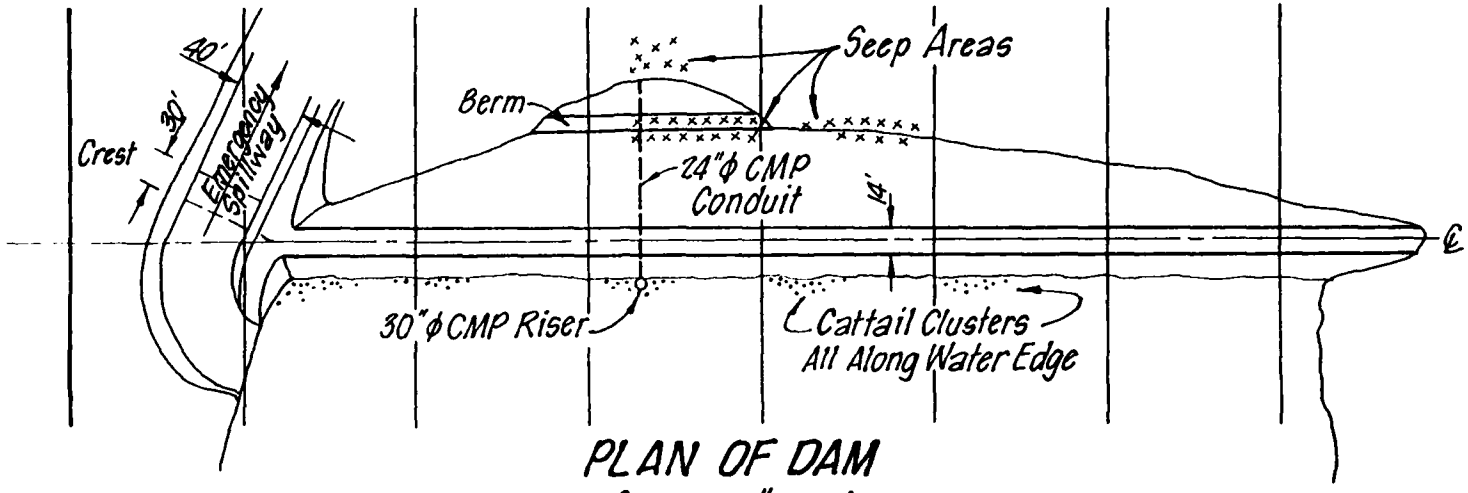
AS BUILT

Supplementary Data and Special Design Features:

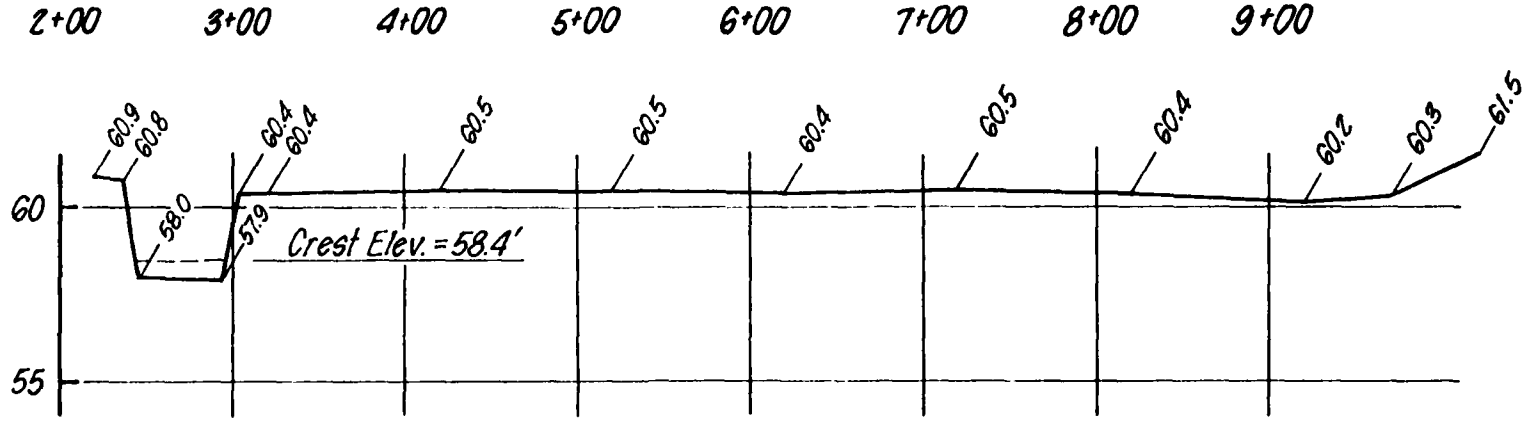
STRUCTURE F-20
GRINDSTONE-LOST-MUDDY CREEK WATERSHED P.L.566 DAVIESS CO., MO.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PLATE C-9

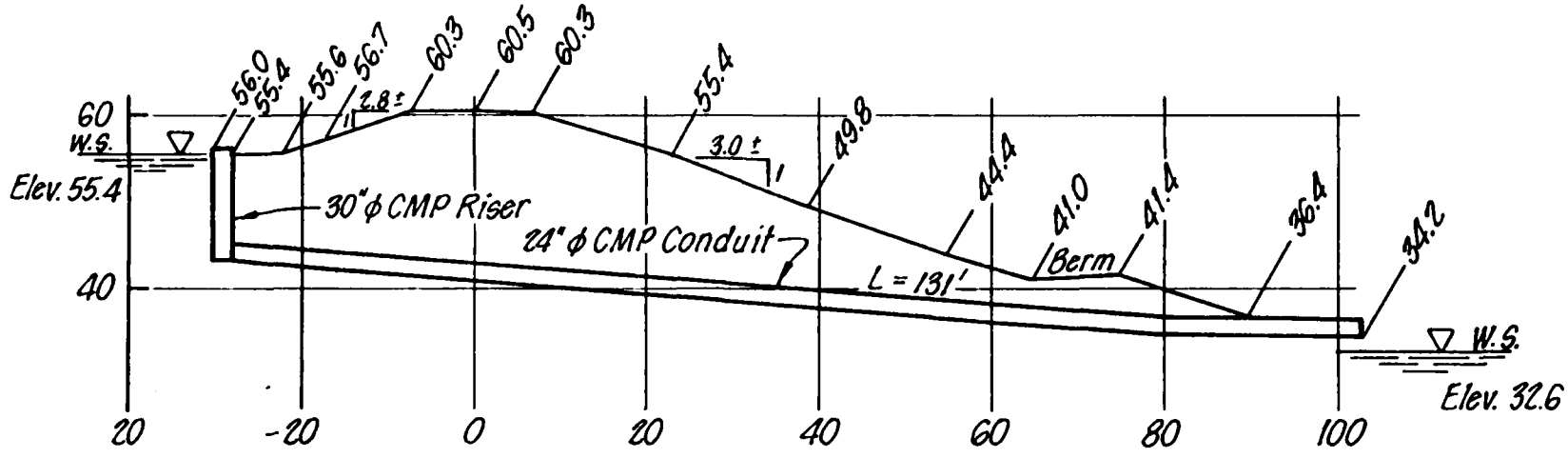


PLAN OF DAM
Scale: 1"=100'



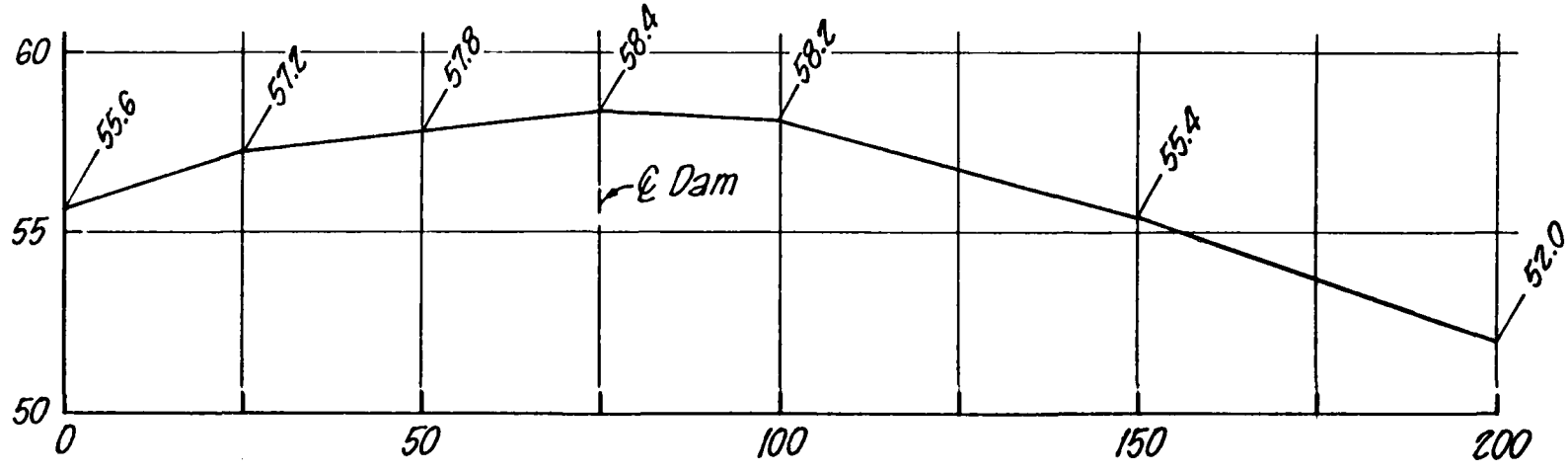
PROFILE ALONG CENTERLINE OF DAM
Scale: 1" = 100' H
1" = 5' V.

PLATE C-10



MAXIMUM CROSS-SECTION OF DAM AT STA. 5+30

Scale: 1" = 20'



PROFILE ALONG CENTERLINE OF EMERGENCY SPILLWAY

Scale: 1" = 25' H.
1" = 5' V.

PLATE C-11

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 (See this Appendix).

   a. Twenty-four hour, one percent probabilistic rainfall for the dam location was taken from the data for the rainfall station at Chillicothe, MO. as supplied by the St. Louis District, Corps of Engineers per their letter dated 4 March 1980. The twenty-four hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and guidance for hydraulics and hydrology. The rainfall distribution is inherent in the HEC-1 (Dam Safety Version) computer program and is distributed according to EM 1110-2-1411 (See Section 4a).

   b. Drainage area = 0.253 square miles (162.0 acres).

   c. Time of concentration of runoff = 15 minutes (taken from the SCS "as-built" plans, and compared to 18 minutes as computed by the 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 one percent probabilistic 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 invert of the principal spillway.

   e. The total twenty-four hour storm duration losses for the one percent probabilistic storm were 2.33 inches. The total losses for the PMF storm were 1.16 inches. These data are based on SCS runoff curve No. 80 and No. 91 for antecedent moisture conditions SCS AMC II and AMC III respectively. The watershed is composed of primarily SCS soil groups C and D (Lamoni-Shelby-Zook soil association) with approximately 75% in grass and woods and the remainder under cultivation in legumes. Almost the entire watershed is contoured.

   f. Average soil loss rates = 0.05 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, orifice and full conduit flow equations.

(1) Weir Flow equation ($Q = CLH^{1.5}$)
where C = weir coefficient = 3.4 (from USGS TWRI, Bk. 3, Ch. A5)
L = effective weir length, ft. = 7.8
H = total head, ft.

(2) Orifice equation - $Q = CA\sqrt{2gh}$
where C = orifice coefficient = 0.6
A = area of riser, sq. ft. = 4.9
h = total head, ft.

(3) Full conduit flow equation

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

where a = cross-sectional area of pipe, ft^2 = 3.14
H = total head, ft.
K_r = coefficient for riser = 1.0
K_p = coefficient for pipe friction loss = 0.0459
(ES-42, SCS NEH, Section 5)
L = length of pipe, ft. = 131 (field measurement)

b. The emergency spillway rating curve was developed using the Corps of Engineers, Water Surface Profile HEC-2 computer program. The slope-area method was used assuming an estimated energy slope of 0.033 ft/ft.

c. The flows over the dam were determined by using the dam overtopping analyses (irregular top of dam) 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 input, output and plotted hydrographs are attached in this Section.

GRINDSTONE-LOST-MUDDY CREEK
DAM F-20
MO. ID. NO. 11220
PRINCIPAL SPILLWAY
RATING CURVE

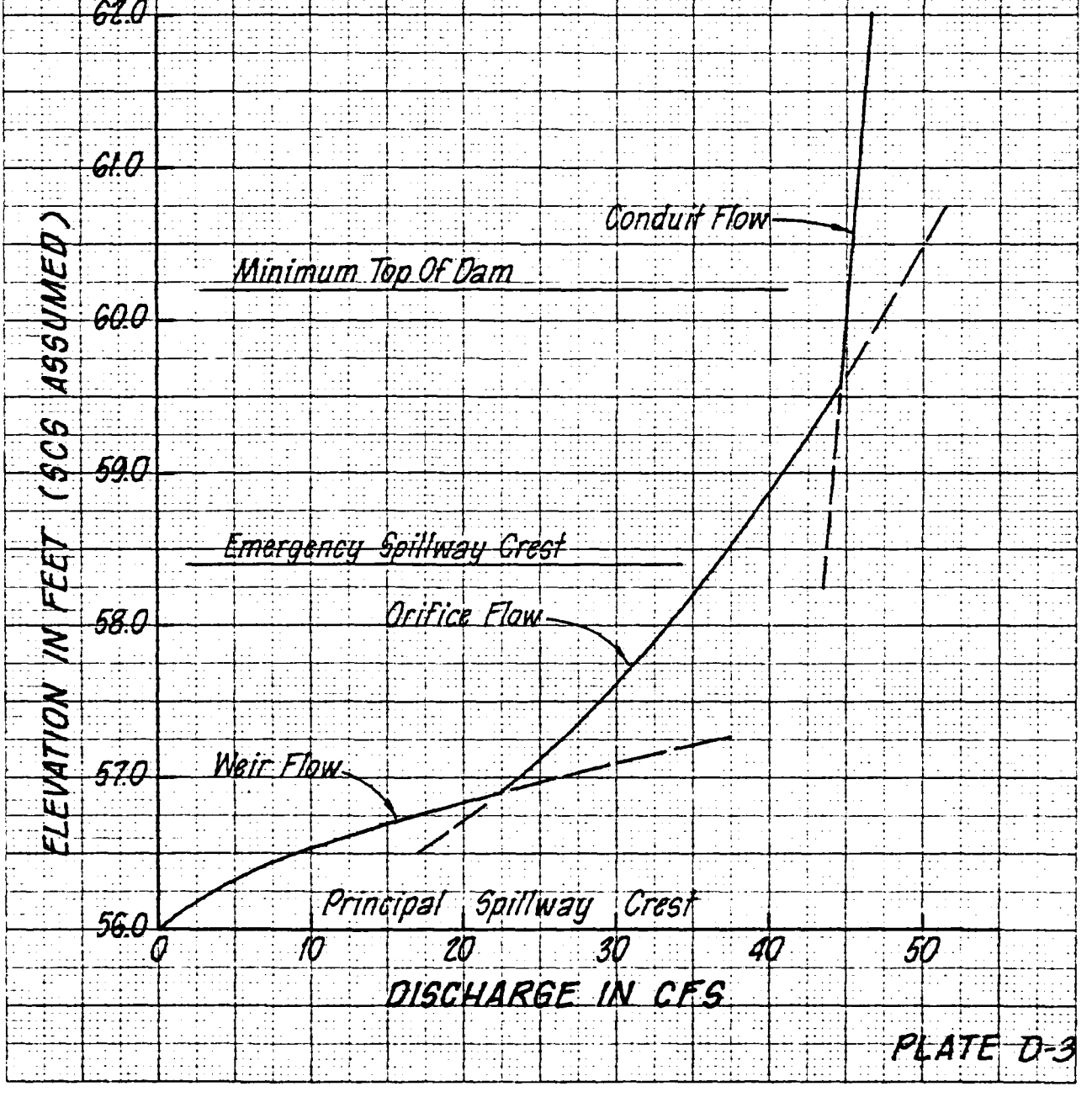


PLATE D-3

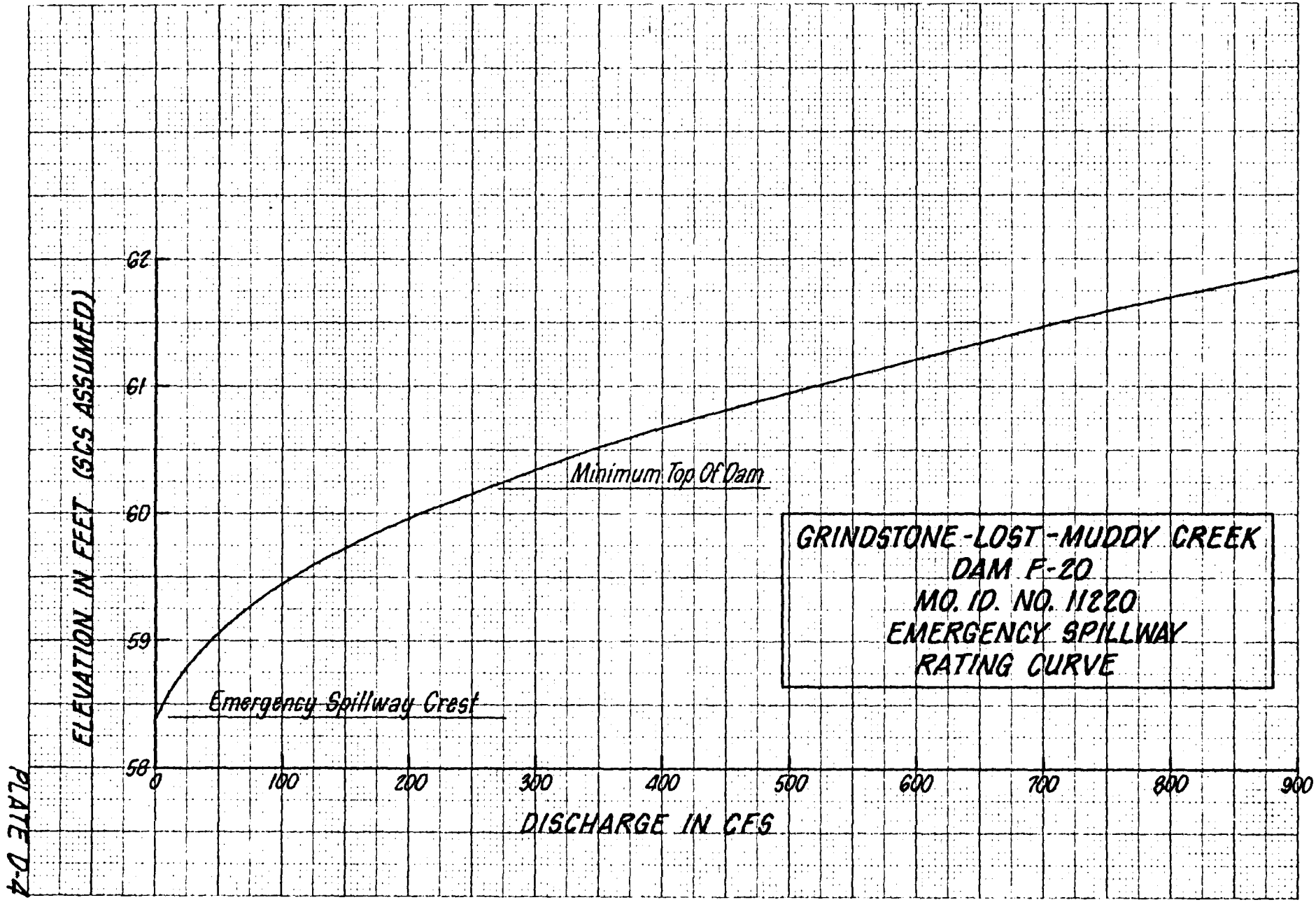

ELEVATION IN FEET (SCS ASSUMED)
62
61
60
59
58
Minimum Top Of Dam
Emergency Spillway Crest
0
100
200
300
400
500
600
700
800
900
DISCHARGE IN CFS
GRINDSTONE-LOST-MUDDY CREEK
DAM F-20
MO. ID. NO. 11220
EMERGENCY SPILLWAY
RATING CURVE

PLATE D-4

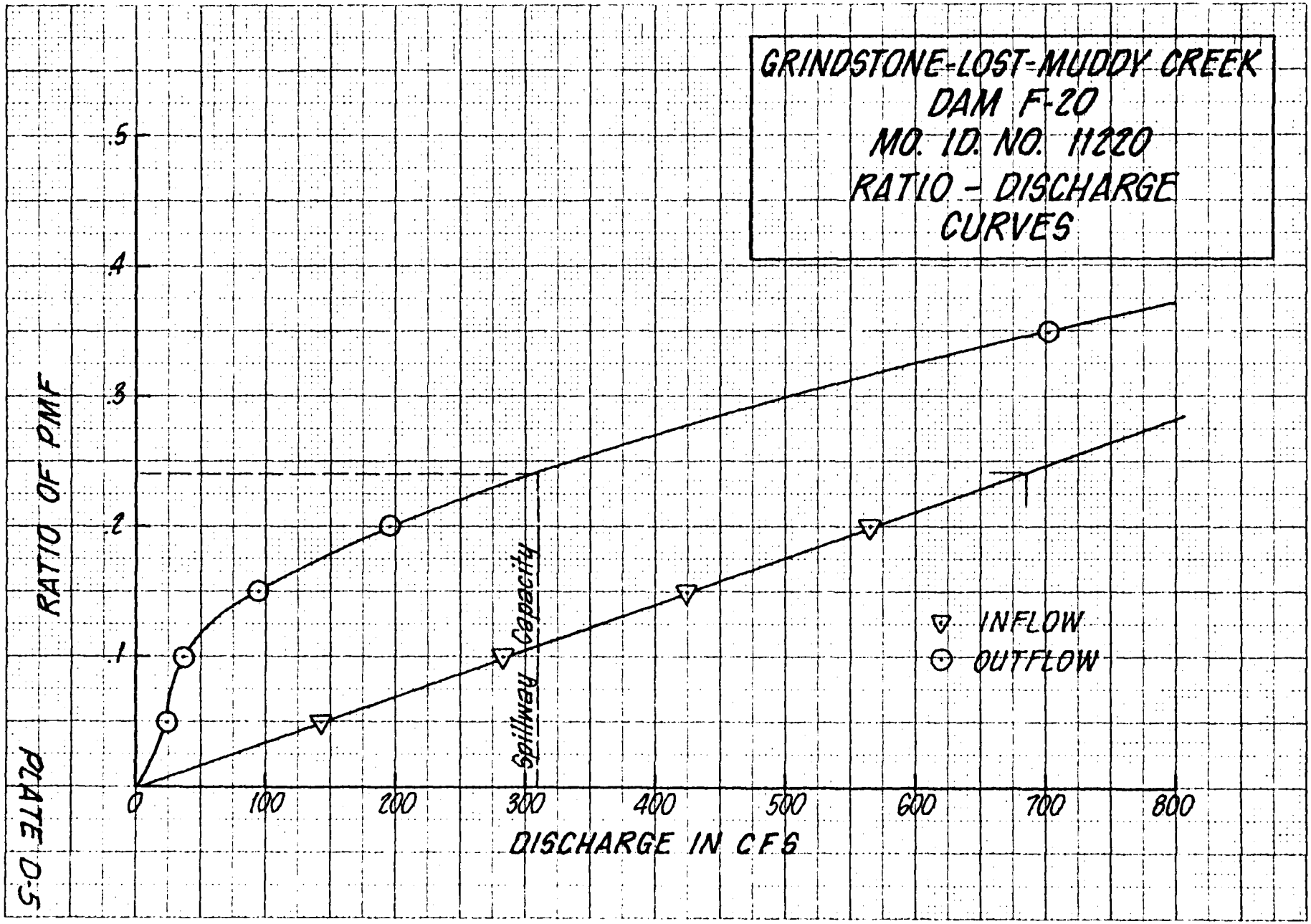

GRINDSTONE-LOST-MUDDY CREEK
DAM F-20
MO. ID. NO. 11220
RATIO - DISCHARGE
CURVES
RATIO OF PMF
.5
.4
.3
.2
.1
0
100
200
300
400
500
600
700
800
DISCHARGE IN CFS
Adopted Permits
INFLOW
OUTFLOW

PLATE D-5

LISTING OF CARD INPUT DATA

```
A1                          GRINDSTONE-LOST-MUDDY CR DAM F-20-MO ID NO 11220
A2        SAFETY ANALYSIS OF DAM OVERTOPPING USING ASSIGNED FLOOD FREQUENCIES
A3                H & H ANALYSIS BY ROUTING PMF RATIOS THRU THE RESERVOIR
B      2880000000000000005                                 000000000000000000000003
B1       5
J        10000000800000001
J1     .0500000.1000000.1500000.2000000.3500000.5000000.75000001.0
K        000000001                  000000000000000000000001
K1        CALCULATION OF INFLOW HYDRO TO F-20 RESERVOIR
M        1000000020000.253          0000.253000001.0                  00000001
P        0000024.1000001020000012100000130
T                                                          -1.0    -91.0
W2        00000.17
X        0     -.0100000001
K        100000002                  000000020000000000000001
K1        ROUTED FLOWS THRU F-20 RESERVOIR
Y                          0000000100000001
Y1       1                                                -56.0       -1
Y4    56.0000056.3000056.5000056.9000057.0000057.5000058.0000058.4000059.0000059.6
Y4    60.0000060.2000061.0000062.0
Y5       0000004.4000009.4000022.5000023.6000028.9000033.4000036.5000084.0000173.0
Y5   257.0    310.0    566.0    987.0
$S       0000005.0000018.0000047.0000055.1000074.0000098.0000125.0
$E      38000000450000005000000055000000560000005800000060000000062
$$    56.0
$D    60.2000002.8000001.500000674
$L       00000010500000153000001690000057400000674000006940000071600000724
$V    60.2000060.3000060.4000060.4000060.5000060.5000061.0000061.5000062.0
K       99
A
A
A
A
A
```

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

RUN  DATE# 80/07/28.
     TIME# 09.10.55.
```

GRINDSTONE-LOST-MUDDY CR DAM F-20-MO ID NO 11220
SAFETY ANALYSIS OF DAM OVERTOPPING USING ASSIGNED FLOOD FREQUENCIES
H & H ANALYSIS BY ROUTING PMF RATIOS THRU 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= 8 LRTIO= 1

RTIOS= .05 .10 .15 .20 .35 .50 .75 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDRO TO F-20 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000001	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.25	0.00	.25	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.10	102.00	121.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-91.00	0.00	0.00

CURVE NO = -91.00 WETNESS = -1.00 EFFECT CN = 91.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .17

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

UNIT HYDROGRAPH 12 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .17 VOL= 1.00

175.	531.	546.	342.	171.	92.	48.	25.	13.	7.
4.	2.								

0 END-OF-PERIOD FLOW

PLATE D-7

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.05	145	.20	.20	.00	145.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.10	146	.20	.20	.00	219.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.15	147	.20	.20	.00	294.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.20	148	.20	.20	.00	342.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.25	149	.20	.20	.00	366.
1.01	.30	6	.01	0.00	.01	0.	1.01	12.30	150	.20	.20	.00	379.
1.01	.35	7	.01	0.00	.01	0.	1.01	12.35	151	.20	.20	.00	386.
1.01	.40	8	.01	0.00	.01	0.	1.01	12.40	152	.20	.20	.00	390.
1.01	.45	9	.01	0.00	.01	0.	1.01	12.45	153	.20	.20	.00	392.
1.01	.50	10	.01	0.00	.01	0.	1.01	12.50	154	.20	.20	.00	394.
1.01	.55	11	.01	0.00	.01	0.	1.01	12.55	155	.20	.20	.00	395.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.00	156	.20	.20	.00	395.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.05	157	.25	.24	.00	403.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.10	158	.25	.24	.00	424.
1.01	1.15	15	.01	0.00	.01	0.	1.01	13.15	159	.25	.24	.00	447.
1.01	1.20	16	.01	0.00	.01	0.	1.01	13.20	160	.25	.24	.00	461.
1.01	1.25	17	.01	.00	.01	0.	1.01	13.25	161	.25	.24	.00	468.
1.01	1.30	18	.01	.00	.01	0.	1.01	13.30	162	.25	.24	.00	472.
1.01	1.35	19	.01	.00	.01	0.	1.01	13.35	163	.25	.24	.00	474.
1.01	1.40	20	.01	.00	.01	1.	1.01	13.40	164	.25	.24	.00	476.
1.01	1.45	21	.01	.00	.01	1.	1.01	13.45	165	.25	.24	.00	476.
1.01	1.50	22	.01	.00	.01	2.	1.01	13.50	166	.25	.24	.00	477.
1.01	1.55	23	.01	.00	.01	2.	1.01	13.55	167	.25	.24	.00	477.
1.01	2.00	24	.01	.00	.01	3.	1.01	14.00	168	.25	.24	.00	477.
1.01	2.05	25	.01	.00	.01	3.	1.01	14.05	169	.31	.31	.00	488.
1.01	2.10	26	.01	.00	.01	3.	1.01	14.10	170	.31	.31	.00	521.
1.01	2.15	27	.01	.00	.01	4.	1.01	14.15	171	.31	.31	.00	554.
1.01	2.20	28	.01	.00	.01	4.	1.01	14.20	172	.31	.31	.00	575.
1.01	2.25	29	.01	.00	.01	5.	1.01	14.25	173	.31	.31	.00	586.
1.01	2.30	30	.01	.00	.01	5.	1.01	14.30	174	.31	.31	.00	592.
1.01	2.35	31	.01	.00	.01	6.	1.01	14.35	175	.31	.31	.00	595.
1.01	2.40	32	.01	.00	.01	6.	1.01	14.40	176	.31	.31	.00	597.
1.01	2.45	33	.01	.00	.01	6.	1.01	14.45	177	.31	.31	.00	598.
1.01	2.50	34	.01	.00	.01	7.	1.01	14.50	178	.31	.31	.00	598.
1.01	2.55	35	.01	.00	.01	7.	1.01	14.55	179	.31	.31	.00	599.
1.01	3.00	36	.01	.00	.01	7.	1.01	15.00	180	.31	.31	.00	599.
1.01	3.05	37	.01	.00	.01	8.	1.01	15.05	181	.19	.19	.00	578.
1.01	3.10	38	.01	.00	.01	8.	1.01	15.10	182	.37	.37	.00	547.
1.01	3.15	39	.01	.00	.01	8.	1.01	15.15	183	.37	.37	.00	580.
1.01	3.20	40	.01	.00	.01	9.	1.01	15.20	184	.56	.56	.00	674.
1.01	3.25	41	.01	.00	.01	9.	1.01	15.25	185	.65	.65	.00	832.
1.01	3.30	42	.01	.00	.01	9.	1.01	15.30	186	1.59	1.58	.00	1168.
1.01	3.35	43	.01	.01	.01	9.	1.01	15.35	187	2.62	2.61	.01	1968.
1.01	3.40	44	.01	.01	.01	10.	1.01	15.40	188	1.03	1.03	.00	2814.
1.01	3.45	45	.01	.01	.01	10.	1.01	15.45	189	.65	.65	.00	2022.
1.01	3.50	46	.01	.01	.01	10.	1.01	15.50	190	.56	.56	.00	2274.
1.01	3.55	47	.01	.01	.01	10.	1.01	15.55	191	.37	.37	.00	1717.
1.01	4.00	48	.01	.01	.01	11.	1.01	16.00	192	.37	.37	.00	1313.
1.01	4.05	49	.01	.01	.01	11.	1.01	16.05	193	.29	.29	.00	1031.
1.01	4.10	50	.01	.01	.01	11.	1.01	16.10	194	.29	.29	.00	834.
1.01	4.15	51	.01	.01	.01	11.	1.01	16.15	195	.29	.29	.00	709.
1.01	4.20	52	.01	.01	.01	12.	1.01	16.20	196	.29	.29	.00	638.
1.01	4.25	53	.01	.01	.01	12.	1.01	16.25	197	.29	.29	.00	602.
1.01	4.30	54	.01	.01	.01	12.	1.01	16.30	198	.29	.29	.00	580.
1.01	4.35	55	.01	.01	.01	12.	1.01	16.35	199	.29	.29	.00	569.
1.01	4.40	56	.01	.01	.01	12.	1.01	16.40	200	.29	.29	.00	564.
1.01	4.45	57	.01	.01	.01	13.	1.01	16.45	201	.29	.29	.00	562.
1.01	4.50	58	.01	.01	.01	13.	1.01	16.50	202	.29	.29	.00	561.
1.01	4.55	59	.01	.01	.01	13.	1.01	16.55	203	.29	.29	.00	561.
1.01	5.00	60	.01	.01	.01	13.	1.01	17.00	204	.29	.29	.00	561.

PLATE D-8

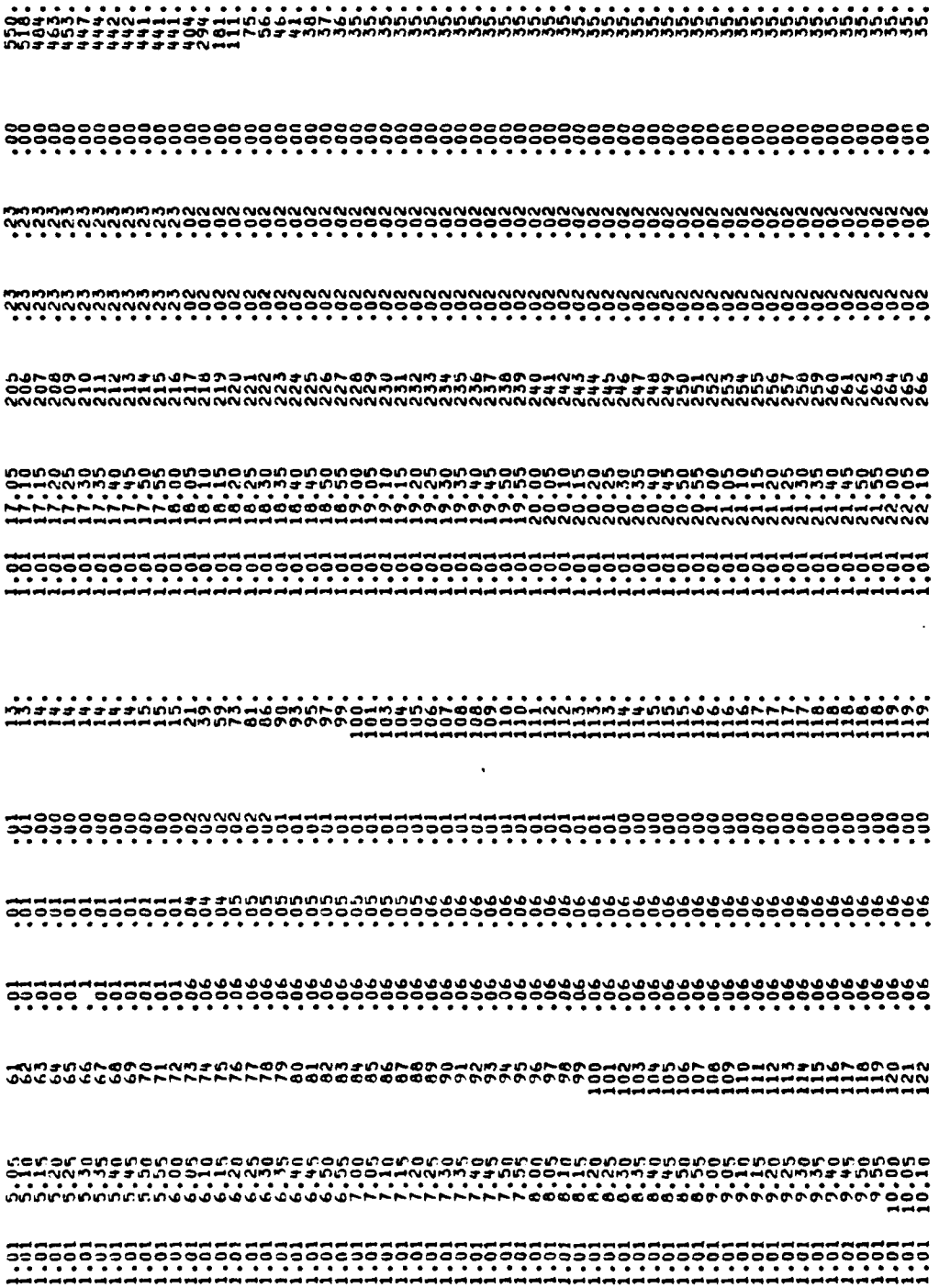


PLATE D-9

1.01	10.15	123	.06	.06	.00	119.	1.01	22.15	267	.02	.02	.00	35.
1.01	10.20	124	.06	.06	.00	119.	1.01	22.20	268	.02	.02	.00	35.
1.01	10.25	125	.06	.06	.00	119.	1.01	22.25	269	.02	.02	.00	35.
1.01	10.30	126	.06	.06	.00	119.	1.01	22.30	270	.02	.02	.00	35.
1.01	10.35	127	.06	.06	.00	120.	1.01	22.35	271	.02	.02	.00	35.
1.01	10.40	128	.06	.06	.00	120.	1.01	22.40	272	.02	.02	.00	35.
1.01	10.45	129	.06	.06	.00	120.	1.01	22.45	273	.02	.02	.00	35.
1.01	10.50	130	.06	.06	.00	120.	1.01	22.50	274	.02	.02	.00	35.
1.01	10.55	131	.06	.06	.00	120.	1.01	22.55	275	.02	.02	.00	35.
1.01	11.00	132	.06	.06	.00	120.	1.01	23.00	276	.02	.02	.00	35.
1.01	11.05	133	.06	.06	.00	120.	1.01	23.05	277	.02	.02	.00	35.
1.01	11.10	134	.06	.06	.00	120.	1.01	23.10	278	.02	.02	.00	35.
1.01	11.15	135	.06	.06	.00	120.	1.01	23.15	279	.02	.02	.00	35.
1.01	11.20	136	.06	.06	.00	121.	1.01	23.20	280	.02	.02	.00	35.
1.01	11.25	137	.06	.06	.00	121.	1.01	23.25	281	.02	.02	.00	35.
1.01	11.30	138	.06	.06	.00	121.	1.01	23.30	282	.02	.02	.00	35.
1.01	11.35	139	.06	.06	.00	121.	1.01	23.35	283	.02	.02	.00	35.
1.01	11.40	140	.06	.06	.00	121.	1.01	23.40	284	.02	.02	.00	35.
1.01	11.45	141	.06	.06	.00	121.	1.01	23.45	285	.02	.02	.00	35.
1.01	11.50	142	.06	.06	.00	121.	1.01	23.50	286	.02	.02	.00	35.
1.01	11.55	143	.06	.06	.00	121.	1.01	23.55	287	.02	.02	.00	35.
1.01	12.00	144	.06	.06	.00	121.	1.02	0.00	288	.02	.02	.00	35.
									SUM	31.33	30.17	1.16	58982.
										(796.)	(766.)	(29.)	(1670.18)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2822.	659.	205.	205.	58988.
CMS	80.	19.	6.	6.	1670.
INCHES		24.23	30.12	30.12	30.12
MM		615.55	765.13	765.13	765.13
AC-FT		327.	406.	406.	406.
THOUS CU M		403.	501.	501.	501.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	141.	33.	10.	10.	2949.
CMS	4.	1.	0.	0.	84.
INCHES		1.21	1.51	1.51	1.51
MM		30.78	38.26	38.26	38.26
AC-FT		16.	20.	20.	20.
THOUS CU M		20.	25.	25.	25.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	282.	66.	20.	20.	5899.
CMS	8.	2.	1.	1.	167.
INCHES		2.42	3.01	3.01	3.01
MM		61.55	76.51	76.51	76.51
AC-FT		33.	41.	41.	41.
THOUS CU M		40.	50.	50.	50.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 3

PLATE D-10

1.01	10.15	123	.06	.06	.00	119.	1.01	22.15	267	.02	.02	.00	35.
1.01	10.20	124	.06	.06	.00	119.	1.01	22.20	268	.02	.02	.00	35.
1.01	10.25	125	.06	.06	.00	119.	1.01	22.25	269	.02	.02	.00	35.
1.01	10.30	126	.06	.06	.00	119.	1.01	22.30	270	.02	.02	.00	35.
1.01	10.35	127	.06	.06	.00	120.	1.01	22.35	271	.02	.02	.00	35.
1.01	10.40	128	.06	.06	.00	120.	1.01	22.40	272	.02	.02	.00	35.
1.01	10.45	129	.06	.06	.00	120.	1.01	22.45	273	.02	.02	.00	35.
1.01	10.50	130	.06	.06	.00	120.	1.01	22.50	274	.02	.02	.00	35.
1.01	10.55	131	.06	.06	.00	120.	1.01	22.55	275	.02	.02	.00	35.
1.01	11.00	132	.06	.06	.00	120.	1.01	23.00	276	.02	.02	.00	35.
1.01	11.05	133	.06	.06	.00	120.	1.01	23.05	277	.02	.02	.00	35.
1.01	11.10	134	.06	.06	.00	120.	1.01	23.10	278	.02	.02	.00	35.
1.01	11.15	135	.06	.06	.00	120.	1.01	23.15	279	.02	.02	.00	35.
1.01	11.20	136	.06	.06	.00	121.	1.01	23.20	280	.02	.02	.00	35.
1.01	11.25	137	.06	.06	.00	121.	1.01	23.25	281	.02	.02	.00	35.
1.01	11.30	138	.06	.06	.00	121.	1.01	23.30	282	.02	.02	.00	35.
1.01	11.35	139	.06	.06	.00	121.	1.01	23.35	283	.02	.02	.00	35.
1.01	11.40	140	.06	.06	.00	121.	1.01	23.40	284	.02	.02	.00	35.
1.01	11.45	141	.06	.06	.00	121.	1.01	23.45	285	.02	.02	.00	35.
1.01	11.50	142	.06	.06	.00	121.	1.01	23.50	286	.02	.02	.00	35.
1.01	11.55	143	.06	.06	.00	121.	1.01	23.55	287	.02	.02	.00	35.
1.01	12.00	144	.06	.06	.00	121.	1.02	0.00	288	.02	.02	.00	35.
									SUM	31.33	30.17	1.16	58982.
										(796.)	(766.)	(29.)	(1670.18)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2822.	659.	205.	205.	58988.
CMS	80.	19.	6.	6.	1670.
INCHES		24.23	30.12	30.12	30.12
MM		615.55	765.13	765.13	765.13
AC-FT		327.	406.	406.	406.
THOUS CU M		403.	501.	501.	501.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	141.	33.	10.	10.	2949.
CMS	4.	1.	0.	0.	84.
INCHES		1.21	1.51	1.51	1.51
MM		30.78	38.26	38.26	38.26
AC-FT		16.	20.	20.	20.
THOUS CU M		20.	25.	25.	25.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	282.	66.	20.	20.	5899.
CMS	8.	2.	1.	1.	167.
INCHES		2.42	3.01	3.01	3.01
MM		61.55	76.51	76.51	76.51
AC-FT		33.	41.	41.	41.
THOUS CU M		40.	50.	50.	50.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	423.	99.	31.	31.	8848.
CMS	12.	3.	1.	1.	251.
INCHES		3.64	4.52	4.52	4.52
MM		92.33	114.77	114.77	114.77
AC-FT		49.	61.	61.	61.
THOUS CU M		60.	75.	75.	75.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	564.	132.	41.	41.	11798.
CMS	16.	4.	1.	1.	334.
INCHES		4.85	6.02	6.02	6.02
MM		123.11	153.03	153.03	153.03
AC-FT		65.	81.	81.	81.
THOUS CU M		81.	100.	100.	100.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	988.	231.	72.	72.	20646.
CMS	28.	7.	2.	2.	585.
INCHES		8.48	10.54	10.54	10.54
MM		215.44	267.79	267.79	267.79
AC-FT		114.	142.	142.	142.
THOUS CU M		141.	175.	175.	175.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 6 [1/2 PMF]

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1411.	330.	102.	102.	29494.
CMS	40.	9.	3.	3.	835.
INCHES		12.12	15.06	15.06	15.06
MM		307.77	382.56	382.56	382.56
AC-FT		163.	203.	203.	203.
THOUS CU M		202.	251.	251.	251.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 7

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2117.	494.	154.	154.	44241.
CMS	60.	14.	4.	4.	1253.
INCHES		18.18	22.59	22.59	22.59
MM		461.66	573.85	573.85	573.85
AC-FT		245.	305.	305.	305.
THOUS CU M		302.	376.	376.	376.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 8 [PMF]

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2822.	659.	205.	205.	58988.

CMS	80.	19.	6.	6.	1670.
INCHES		24.23	30.12	30.12	30.12
MM		615.55	765.13	765.13	765.13
AC-FT		327.	406.	406.	406.
THOUS CU M		403.	501.	501.	501.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTED FLOWS THRU F-20 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	-56.	-1

STAGE	56.00	56.30	56.50	56.90	57.00	57.50	58.00	58.40	59.00	59.60
	60.00	60.20	61.00	62.00						
FLOW	0.00	4.40	9.40	22.50	23.60	28.90	33.40	36.50	84.00	173.00
	257.00	310.00	566.00	987.00						

CAPACITY=	0.	5.	18.	47.	55.	74.	98.	125.
ELEVATION=	38.	45.	50.	55.	56.	58.	60.	62.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
56.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
60.2	2.8	1.5	674.

CREST LENGTH	0.	105.	153.	169.	574.	674.	694.	716.	724.	
AT OR BELOW ELEVATION	60.2	60.3	60.4	60.4	60.5	60.5	61.0	61.5	62.0	

~~STATION 000002, PLAN 1, RATIO 1~~

~~END-OF-PERIOD HYDROGRAPH ORDINATES~~

OUTFLOW

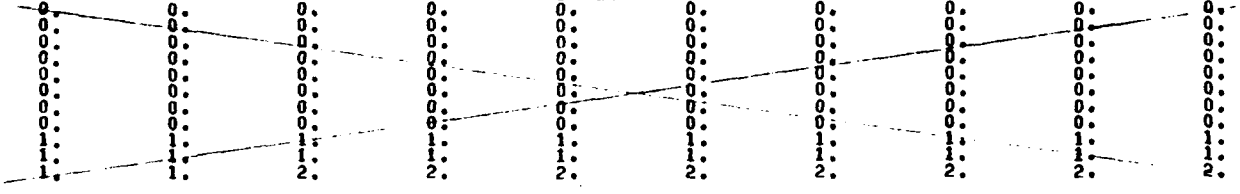


PLATE D-13

OVN

STATION 000002, PLAN 1, RATIO 6 [½ PMF]

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.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
2.	2.	2.	2.	3.	3.	3.	4.	4.	5.
5.	6.	7.	8.	9.	9.	10.	11.	12.	13.
14.	15.	16.	17.	18.	19.	20.	20.	21.	22.
23.	23.	23.	23.	24.	24.	24.	25.	25.	25.
25.	26.	26.	26.	26.	27.	27.	27.	27.	28.
28.	28.	28.	28.	29.	29.	29.	29.	30.	30.
30.	30.	30.	31.	31.	31.	31.	31.	31.	32.
32.	32.	32.	32.	33.	33.	34.	34.	35.	35.
36.	39.	46.	53.	59.	65.	71.	77.	84.	95.
106.	117.	126.	135.	144.	151.	159.	165.	171.	180.
190.	200.	210.	220.	229.	237.	244.	250.	256.	261.
265.	267.	269.	274.	287.	315.	412.	834.	1258.	1270.
1062.	844.	675.	553.	470.	422.	391.	369.	352.	339.
329.	321.	315.	311.	307.	302.	296.	288.	281.	274.
268.	262.	257.	253.	250.	247.	243.	235.	222.	205.
187.	171.	159.	147.	137.	127.	119.	110.	103.	96.
89.	84.	81.	78.	75.	73.	70.	68.	66.	64.
62.	60.	58.	56.	54.	53.	51.	50.	48.	47.
46.	44.	43.	42.	41.	40.	39.	38.	37.	36.
36.	36.	36.	36.	36.	36.	36.	36.	36.	36.
36.	35.	35.	35.	35.	35.	35.	35.	35.	35.
35.	35.	35.	35.	34.	34.	34.	34.		

STORAGE

55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	56.	56.	56.	56.	56.	56.	56.
56.	56.	56.	56.	56.	56.	56.	56.	56.	56.
56.	56.	56.	56.	56.	56.	56.	56.	56.	56.
56.	56.	57.	57.	57.	57.	57.	57.	58.	58.
58.	59.	59.	59.	59.	60.	60.	60.	61.	61.
61.	61.	62.	62.	62.	63.	63.	63.	63.	63.
64.	64.	64.	64.	65.	65.	65.	65.	66.	66.
66.	66.	66.	67.	67.	67.	67.	68.	68.	68.
68.	68.	69.	69.	69.	69.	70.	70.	70.	70.
70.	71.	71.	71.	71.	71.	72.	72.	72.	72.
72.	73.	73.	73.	73.	74.	74.	75.	76.	77.
78.	79.	80.	81.	82.	83.	84.	85.	86.	87.
88.	89.	89.	90.	91.	91.	92.	93.	93.	94.
94.	95.	95.	96.	96.	97.	97.	98.	98.	98.
98.	98.	99.	99.	100.	101.	104.	108.	110.	110.
109.	108.	107.	106.	105.	104.	103.	103.	102.	102.
101.	101.	101.	101.	101.	100.	100.	100.	99.	99.
99.	98.	98.	98.	98.	97.	97.	97.	96.	95.
94.	93.	92.	91.	90.	90.	89.	88.	88.	87.
86.	86.	86.	85.	85.	84.	84.	84.	83.	83.

83. 80. 79. 77. 76.	82. 80. 78. 77. 76.	82. 80. 78. 77. 76.	82. 80. 78. 77. 76.	81. 79. 78. 77. 76.	81. 79. 78. 77. 76.	81. 79. 78. 77. 75.	81. 79. 78. 77. 75.	81. 79. 78. 76.	80. 79. 77. 76.

STAGE

56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0
56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0
56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0
56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0
56.0	56.0	56.0	56.0	56.0	56.1	56.1	56.1	56.1	56.1
56.1	56.1	56.1	56.1	56.1	56.1	56.1	56.1	56.1	56.1
56.1	56.1	56.2	56.2	56.2	56.2	56.2	56.3	56.3	56.3
56.3	56.4	56.4	56.4	56.5	56.5	56.5	56.6	56.6	56.6
56.6	56.7	56.7	56.7	56.8	56.8	56.8	56.8	56.9	56.9
56.9	56.9	57.0	57.0	57.0	57.0	57.1	57.1	57.1	57.1
57.2	57.2	57.2	57.2	57.3	57.3	57.3	57.3	57.3	57.4
57.4	57.4	57.4	57.5	57.5	57.5	57.5	57.5	57.6	57.6
57.6	57.6	57.7	57.7	57.7	57.7	57.7	57.8	57.8	57.8
57.8	57.8	57.9	57.9	57.9	57.9	58.0	58.1	58.2	58.3
58.3	58.4	58.5	58.6	58.7	58.8	58.8	58.9	59.0	59.1
59.1	59.2	59.3	59.3	59.4	59.5	59.5	59.5	59.6	59.6
59.7	59.7	59.8	59.8	59.9	59.9	59.9	60.0	60.0	60.0
60.0	60.0	60.0	60.1	60.1	60.2	60.4	60.7	60.9	60.9
60.8	60.7	60.6	60.6	60.5	60.4	60.4	60.4	60.3	60.3
60.3	60.2	60.2	60.2	60.2	60.2	60.1	60.1	60.1	60.1
60.0	60.0	60.0	60.0	60.0	60.0	59.9	59.9	59.8	59.8
59.7	59.6	59.5	59.4	59.4	59.3	59.2	59.2	59.1	59.1
59.0	59.0	59.0	58.9	58.9	58.9	58.8	58.8	58.8	58.7
58.7	58.7	58.7	58.6	58.6	58.6	58.6	58.6	58.5	58.5
58.5	58.5	58.5	58.5	58.5	58.4	58.4	58.4	58.4	58.4
58.4	58.4	58.4	58.4	58.3	58.3	58.3	58.3	58.3	58.3
58.3	58.3	58.3	58.2	58.2	58.2	58.2	58.2	58.2	58.2
58.2	58.2	58.2	58.2	58.1	58.1	58.1	58.1		

PEAK OUTFLOW IS 1270. AT TIME 15.83 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1270.	301.	92.	92.	26561.
CMS	36.	9.	3.	3.	752.
INCHES		11.07	13.56	13.56	13.56
MM		281.20	344.52	344.52	344.52
AC-FT		149.	183.	183.	183.
THOUS CU M		184.	226.	226.	226.

OVF

STATION000002

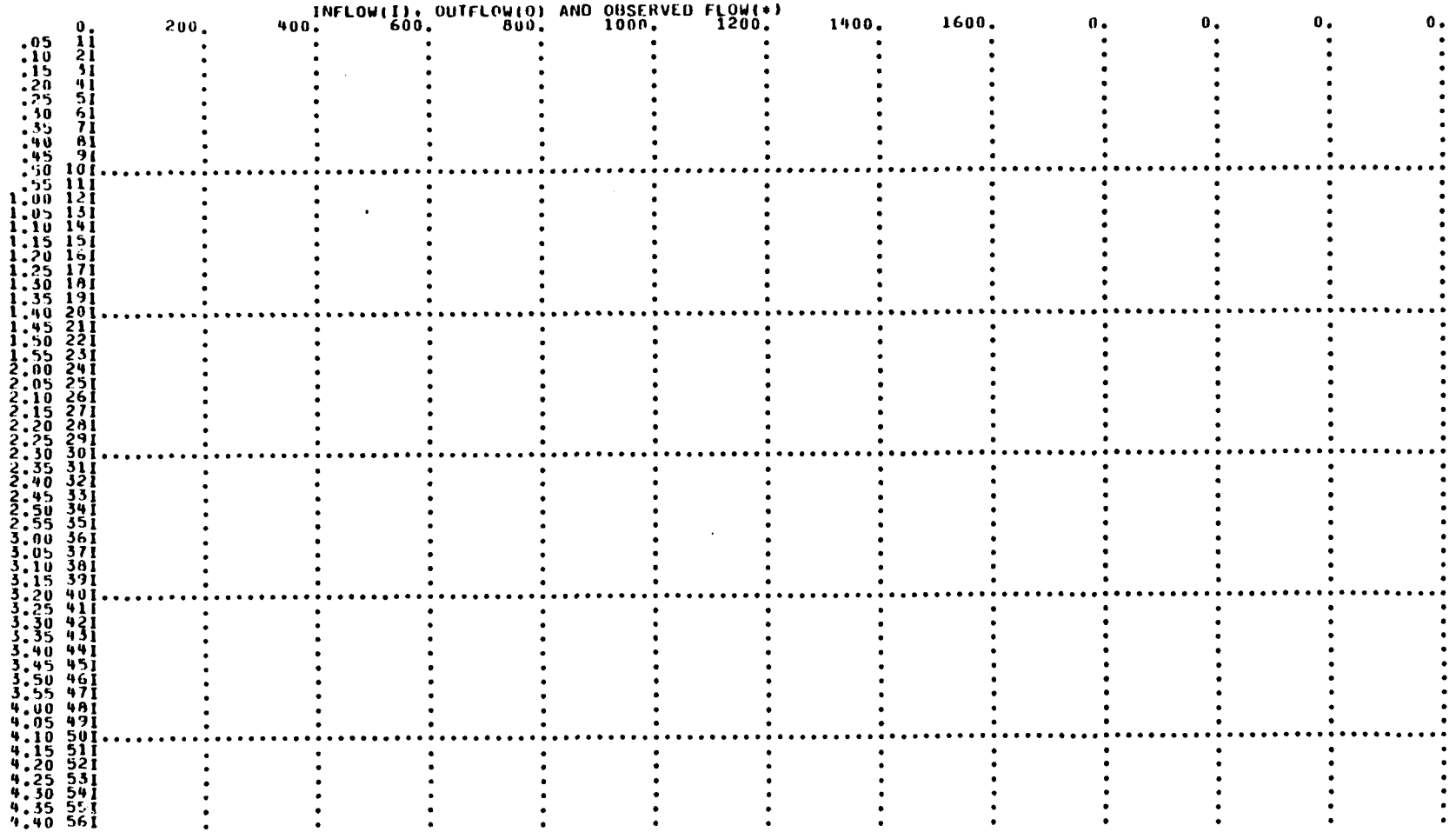


PLATE D-16

4.45 571
4.50 581
4.55 591
5.00 601
5.05 611
5.10 621
5.15 631
5.20 641
5.25 651
5.30 661
5.35 671
5.40 681
5.45 691
5.50 701
5.55 711
6.00 721
6.05 730E
6.10 740E
6.15 750E
6.20 760
6.25 770
6.30 780
6.35 790
6.40 800
6.45 810
6.50 820
6.55 830
7.00 840
7.05 850
7.10 860
7.15 87.00
7.20 88.00
7.25 89.00
7.30 90.00
7.35 91.00
7.40 92.00
7.45 93.00
7.50 94.00
7.55 95.00
8.00 96.00
8.05 97.00
8.10 98.00
8.15 99.00
8.20 100.00
8.25 101.00
8.30 102.00
8.35 103.00
8.40 104.00
8.45 105.00
8.50 106.00
8.55 107.00
9.00 108.00
9.05 109.00
9.10 110.00
9.15 111.00
9.20 112.00
9.25 113.00
9.30 114.00
9.35 115.00
9.40 116.00
9.45 117.00
9.50 118.00

PLATE D-17

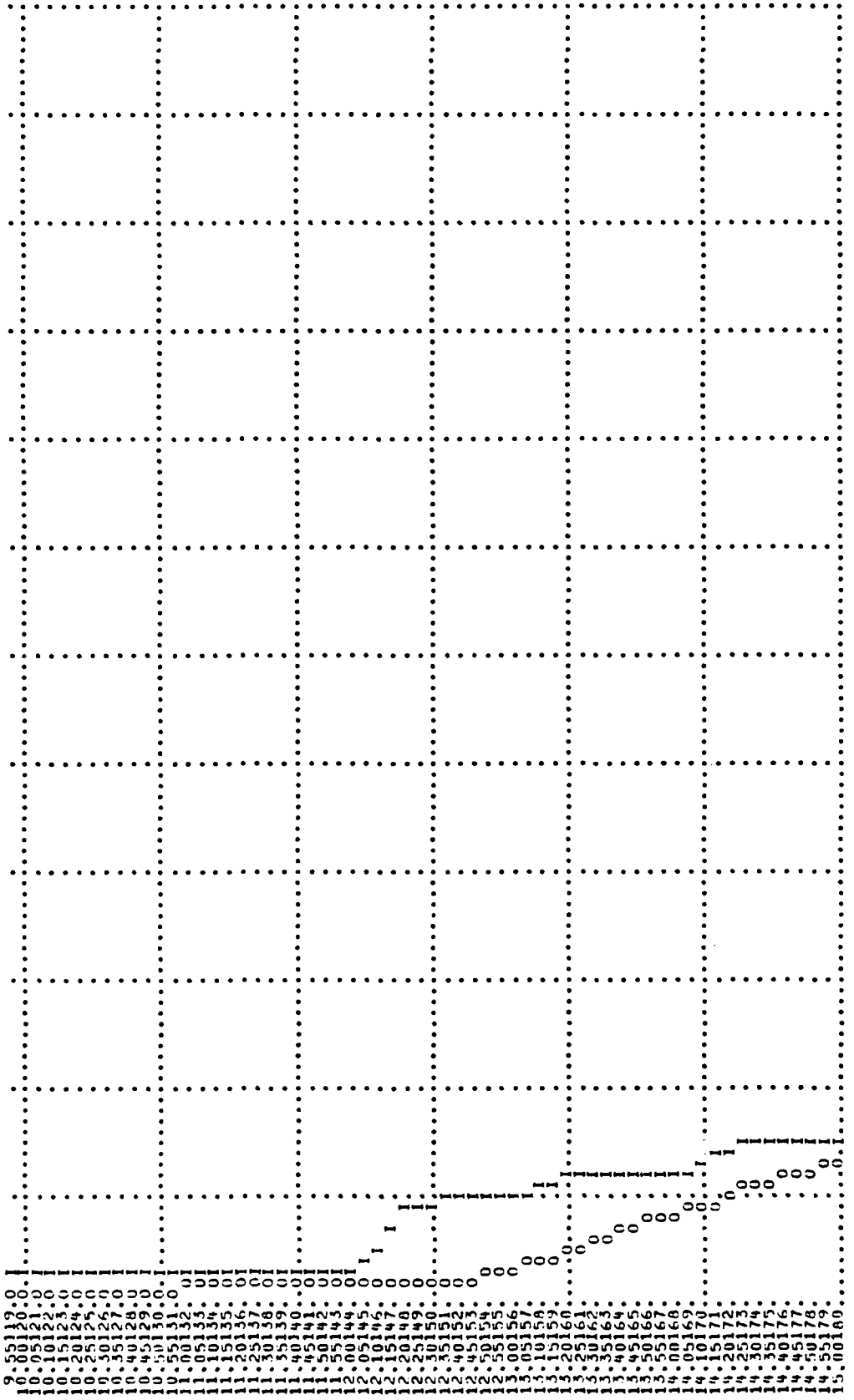


PLATE D-18

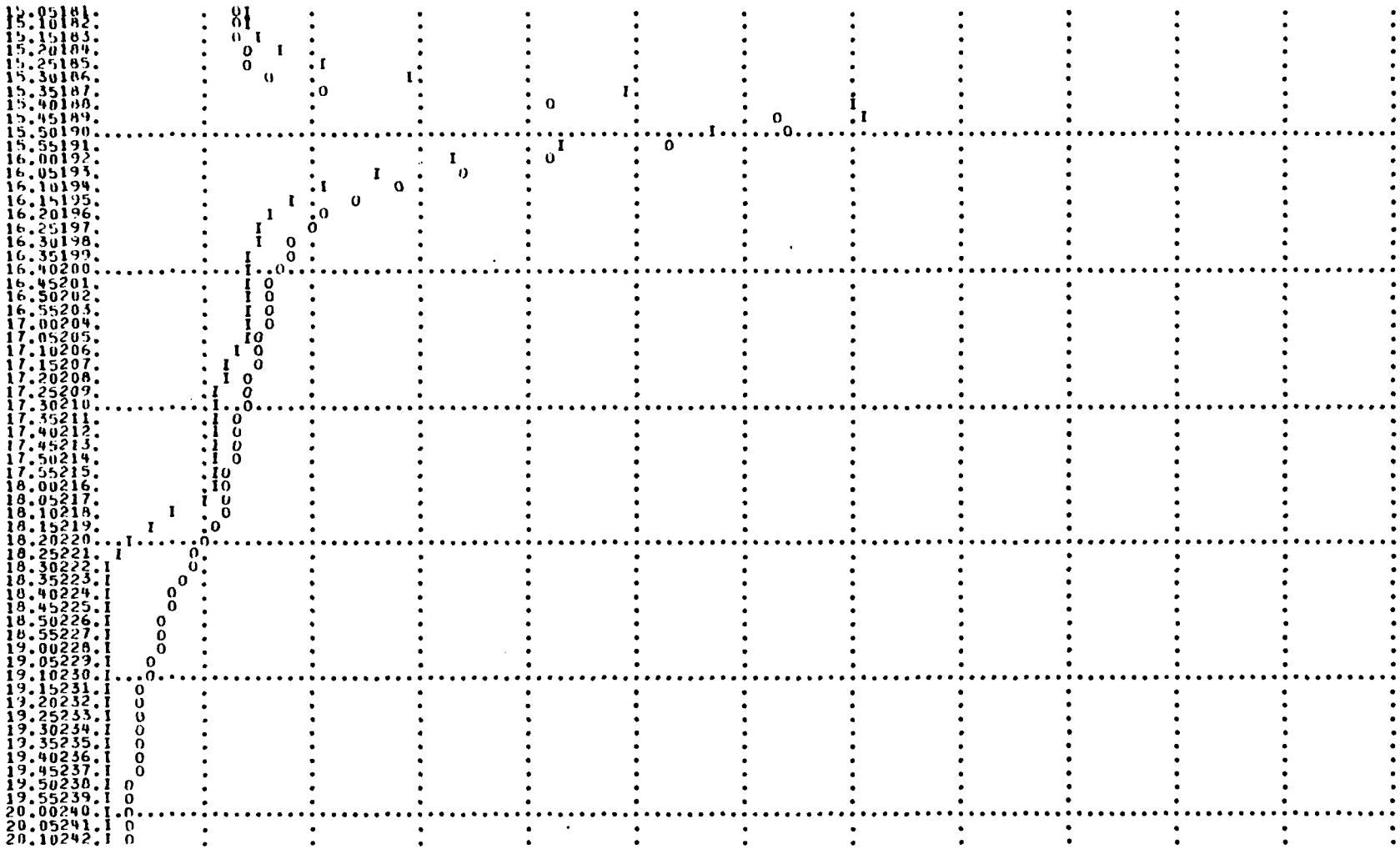


PLATE D-19

PLATE D-20

STATION 000002, PLAN 1, RATIO 8 [PMF]

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.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	2.	2.	2.	2.	2.
2.	2.	2.	2.	2.	3.	3.	3.	3.	3.
3.	3.	3.	3.	3.	4.	4.	4.	4.	4.
4.	4.	4.	5.	6.	7.	8.	9.	11.	13.
15.	17.	19.	21.	23.	24.	24.	25.	26.	26.
26.	27.	28.	28.	29.	29.	30.	30.	31.	32.
32.	33.	33.	34.	34.	34.	35.	35.	36.	36.
36.	36.	39.	43.	46.	49.	52.	55.	58.	61.
63.	66.	68.	71.	73.	75.	77.	79.	80.	82.
84.	87.	90.	92.	94.	96.	98.	100.	102.	103.
105.	106.	107.	109.	111.	116.	128.	143.	161.	180.
203.	224.	243.	260.	277.	292.	306.	321.	341.	364.
387.	408.	428.	443.	454.	462.	468.	472.	476.	488.
511.	538.	560.	576.	585.	591.	595.	596.	598.	598.
593.	576.	569.	601.	693.	899.	1408.	2268.	2785.	2560.
2039.	1580.	1249.	1009.	841.	729.	660.	620.	594.	579.
571.	566.	563.	562.	559.	546.	523.	499.	481.	468.
460.	454.	450.	447.	445.	443.	437.	409.	368.	325.
295.	264.	239.	217.	197.	179.	165.	155.	145.	136.
120.	120.	113.	107.	101.	96.	91.	86.	83.	81.
79.	77.	75.	73.	72.	70.	69.	67.	66.	64.
63.	62.	61.	59.	58.	57.	56.	55.	55.	54.
53.	52.	51.	51.	50.	49.	49.	48.	48.	47.
47.	46.	46.	45.	45.	44.	44.	43.	43.	43.
42.	42.	42.	42.	41.	41.	41.	41.		

STORAGE

55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	56.	56.	56.	56.	56.
56.	56.	56.	56.	56.	56.	56.	56.	56.	56.
56.	56.	57.	57.	57.	57.	57.	57.	57.	57.
57.	57.	57.	57.	57.	57.	57.	58.	58.	58.
58.	58.	58.	58.	58.	59.	59.	60.	60.	61.
61.	62.	63.	63.	64.	64.	65.	65.	66.	66.
67.	68.	68.	69.	69.	70.	70.	71.	71.	72.
73.	73.	74.	74.	75.	75.	76.	76.	77.	78.
78.	79.	79.	80.	80.	81.	81.	82.	82.	82.
83.	83.	84.	84.	84.	85.	85.	85.	85.	86.
86.	86.	86.	87.	87.	87.	87.	87.	87.	88.
88.	88.	88.	88.	88.	89.	90.	91.	92.	94.
95.	96.	97.	98.	99.	100.	100.	101.	102.	103.
103.	104.	104.	104.	105.	105.	105.	105.	105.	105.
105.	105.	106.	106.	106.	106.	106.	106.	106.	106.
106.	106.	106.	106.	107.	108.	111.	115.	117.	116.
114.	112.	110.	109.	108.	107.	106.	106.	106.	106.
106.	106.	106.	106.	106.	106.	105.	105.	105.	105.
105.	105.	104.	104.	104.	104.	104.	104.	103.	101.
100.	98.	97.	96.	95.	94.	93.	92.	91.	90.
90.	89.	88.	88.	87.	87.	87.	86.	86.	86.

PLATE D-21

85.	85.	85.	84.	84.	84.	84.	83.	83.	83.
83.	82.	82.	82.	82.	82.	82.	82.	82.	81.
81.	81.	81.	81.	81.	81.	81.	81.	80.	80.
80.	80.	80.	80.	80.	80.	80.	80.	80.	80.
80.	80.	80.	80.	80.	79.	79.	79.		

STAGE

56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0
56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0
56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0
56.0	56.0	56.0	56.0	56.0	56.0	56.1	56.1	56.1	56.1
56.1	56.1	56.1	56.1	56.1	56.1	56.1	56.1	56.1	56.1
56.1	56.1	56.1	56.2	56.2	56.2	56.2	56.2	56.2	56.2
56.2	56.2	56.2	56.2	56.2	56.2	56.3	56.3	56.3	56.3
56.3	56.3	56.3	56.3	56.4	56.4	56.4	56.5	56.6	56.6
56.7	56.7	56.8	56.8	56.9	57.0	57.0	57.1	57.1	57.2
57.3	57.3	57.4	57.4	57.5	57.6	57.6	57.7	57.7	57.8
57.8	57.9	58.0	58.0	58.1	58.1	58.2	58.2	58.3	58.3
58.3	58.4	58.4	58.5	58.5	58.6	58.6	58.6	58.7	58.7
58.7	58.8	58.8	58.8	58.9	58.9	58.9	58.9	59.0	59.0
59.0	59.0	59.0	59.1	59.1	59.1	59.1	59.1	59.1	59.1
59.1	59.1	59.2	59.2	59.2	59.2	59.3	59.4	59.5	59.6
59.7	59.8	59.9	60.0	60.1	60.1	60.2	60.2	60.3	60.3
60.4	60.4	60.5	60.5	60.5	60.5	60.5	60.5	60.5	60.5
60.5	60.6	60.6	60.6	60.6	60.6	60.6	60.6	60.6	60.6
60.6	60.6	60.6	60.6	60.6	60.8	61.0	61.2	61.4	61.3
61.2	61.0	60.9	60.8	60.7	60.7	60.6	60.6	60.6	60.6
60.6	60.6	60.6	60.6	60.6	60.6	60.5	60.5	60.5	60.5
60.5	60.5	60.5	60.5	60.5	60.5	60.5	60.4	60.3	60.2
60.1	60.0	59.9	59.8	59.7	59.6	59.5	59.5	59.4	59.4
59.3	59.2	59.2	59.2	59.1	59.1	59.0	59.0	59.0	59.0
58.9	58.9	58.9	58.9	58.8	58.8	58.8	58.8	58.8	58.8
58.7	58.7	58.7	58.7	58.7	58.7	58.7	58.6	58.6	58.6
58.6	58.6	58.6	58.6	58.6	58.6	58.6	58.5	58.5	58.5
58.5	58.5	58.5	58.5	58.5	58.5	58.5	58.5	58.5	58.5
58.5	58.5	58.5	58.5	58.5	58.5	58.5	58.5		

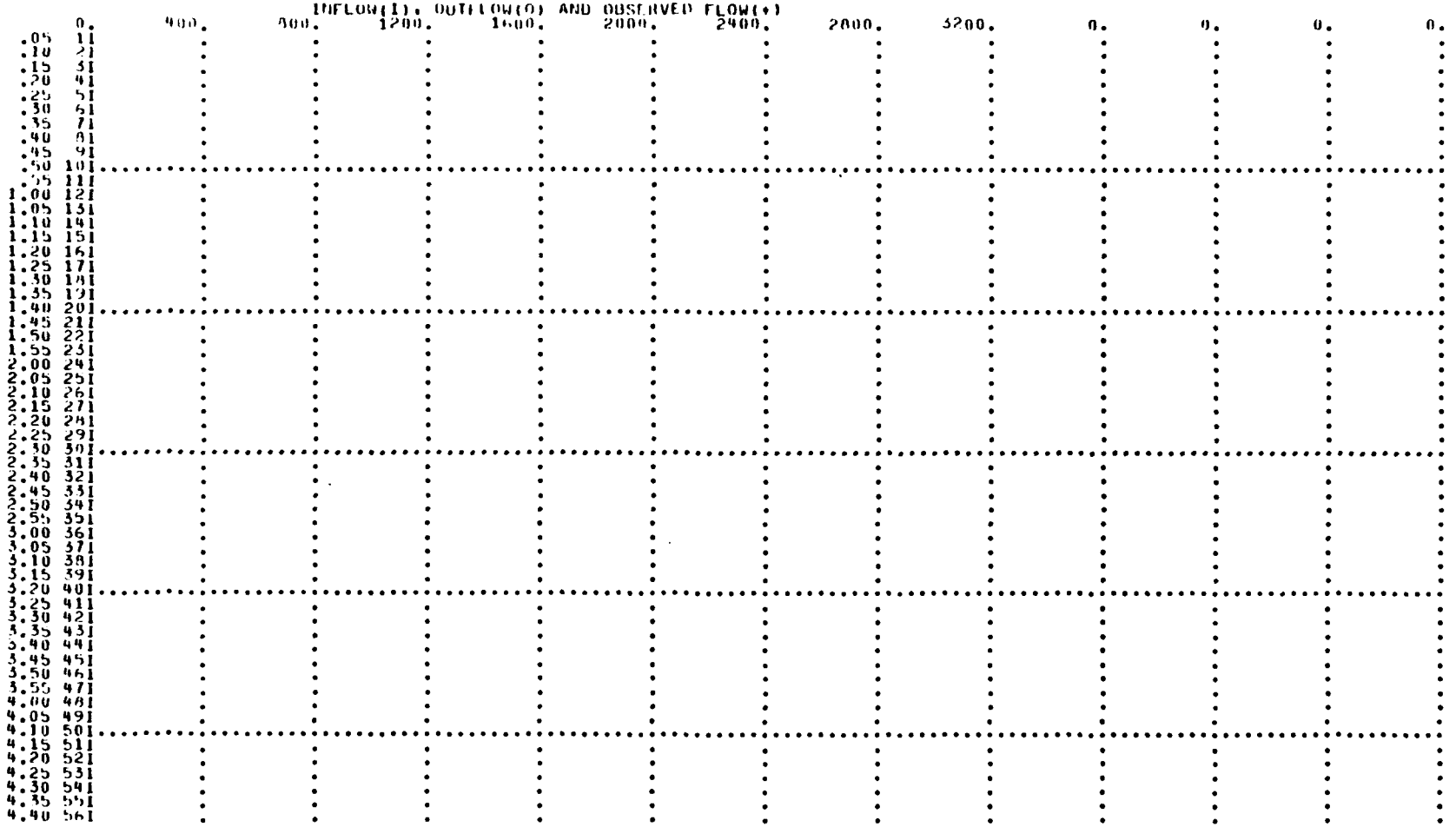
PEAK OUTFLOW IS 2785. AT TIME 15.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2785.	640.	193.	193.	55461.
CMS	79.	18.	5.	5.	1570.
INCHES		23.53	28.32	28.32	28.32
MM		597.73	719.38	719.38	719.38
AC-FT		317.	382.	382.	382.
THOUS CU M		391.	471.	471.	471.

OVF

STATION000002

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



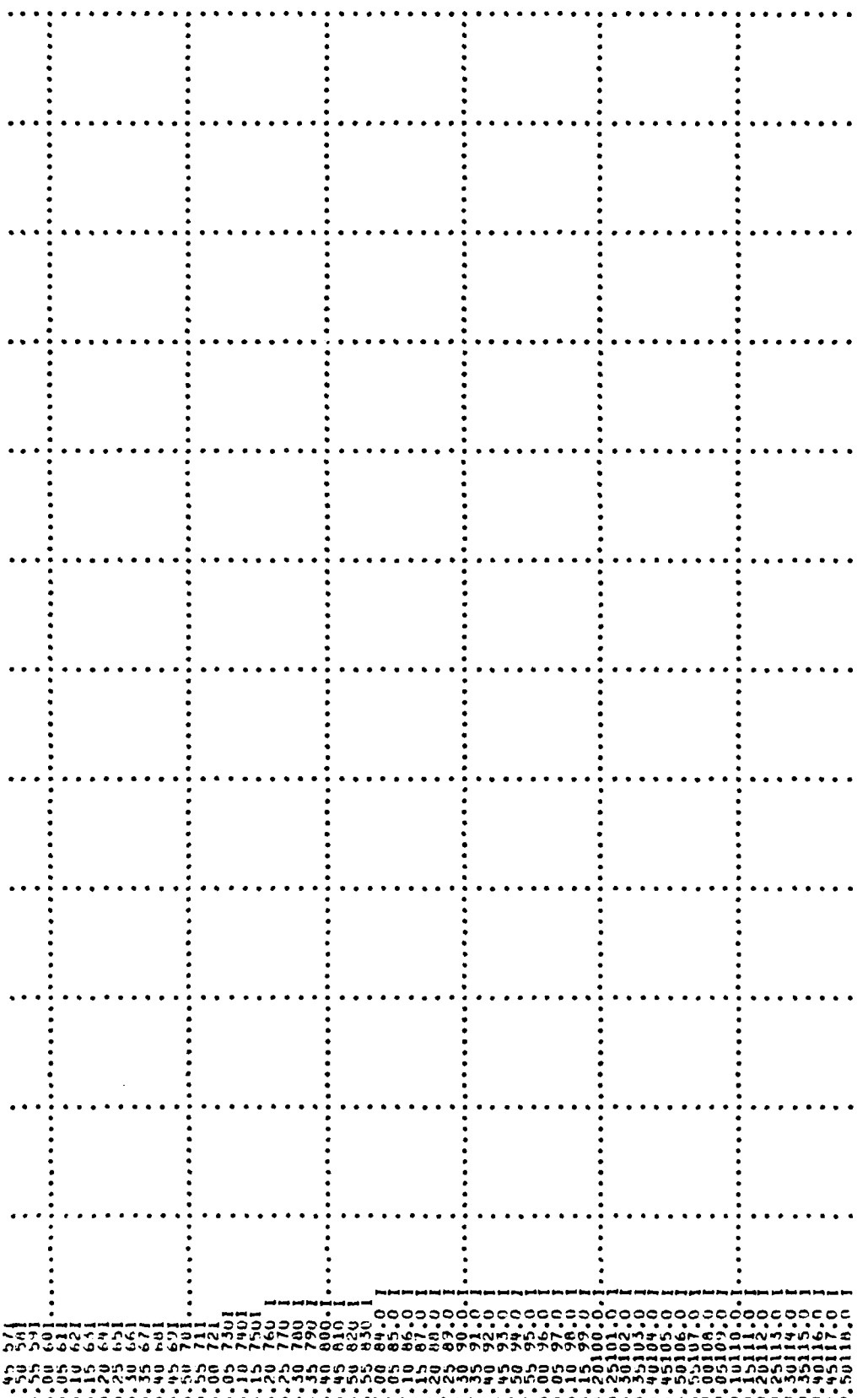


PLATE D-24

PLATE D-25

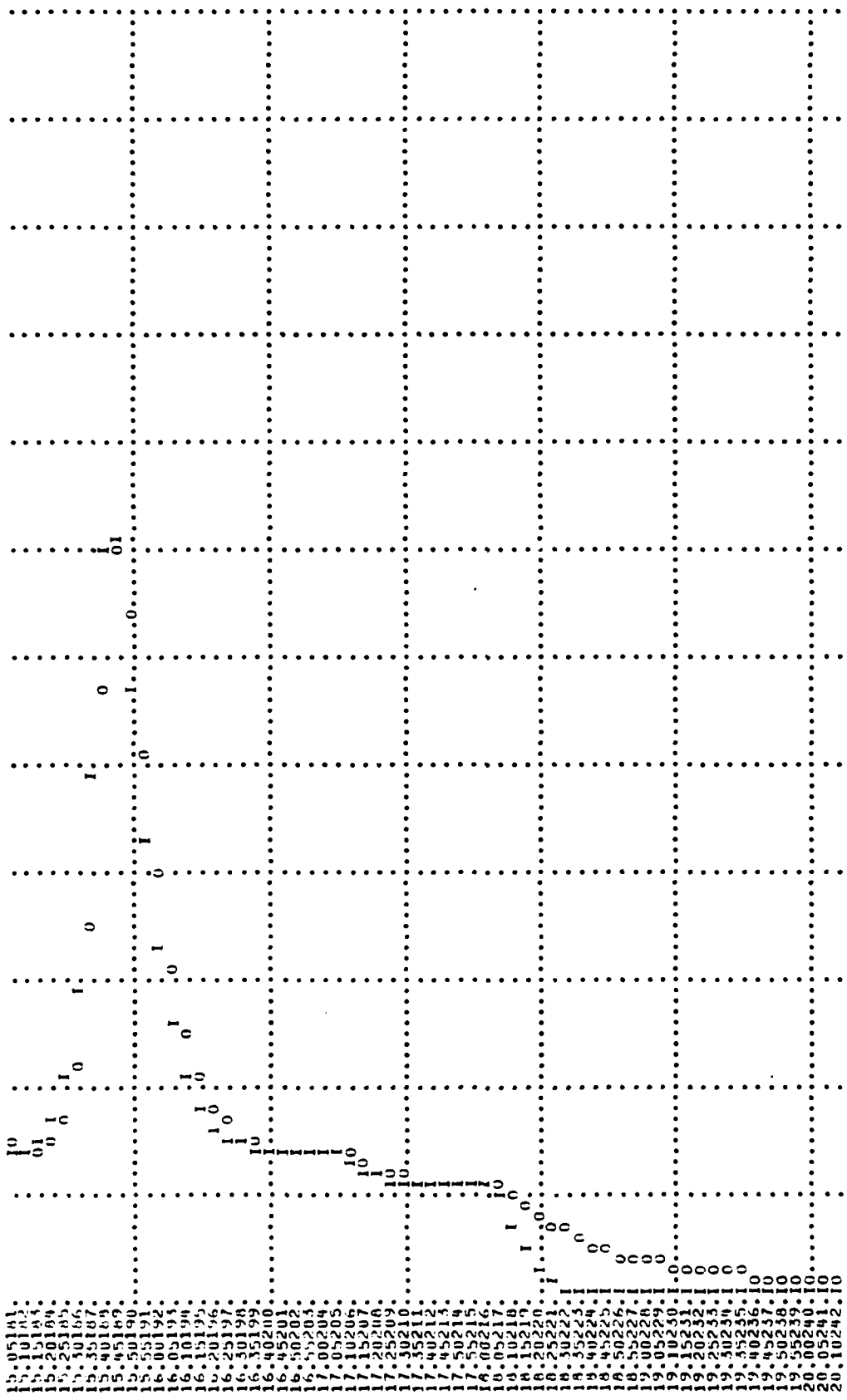


PLATE D-26

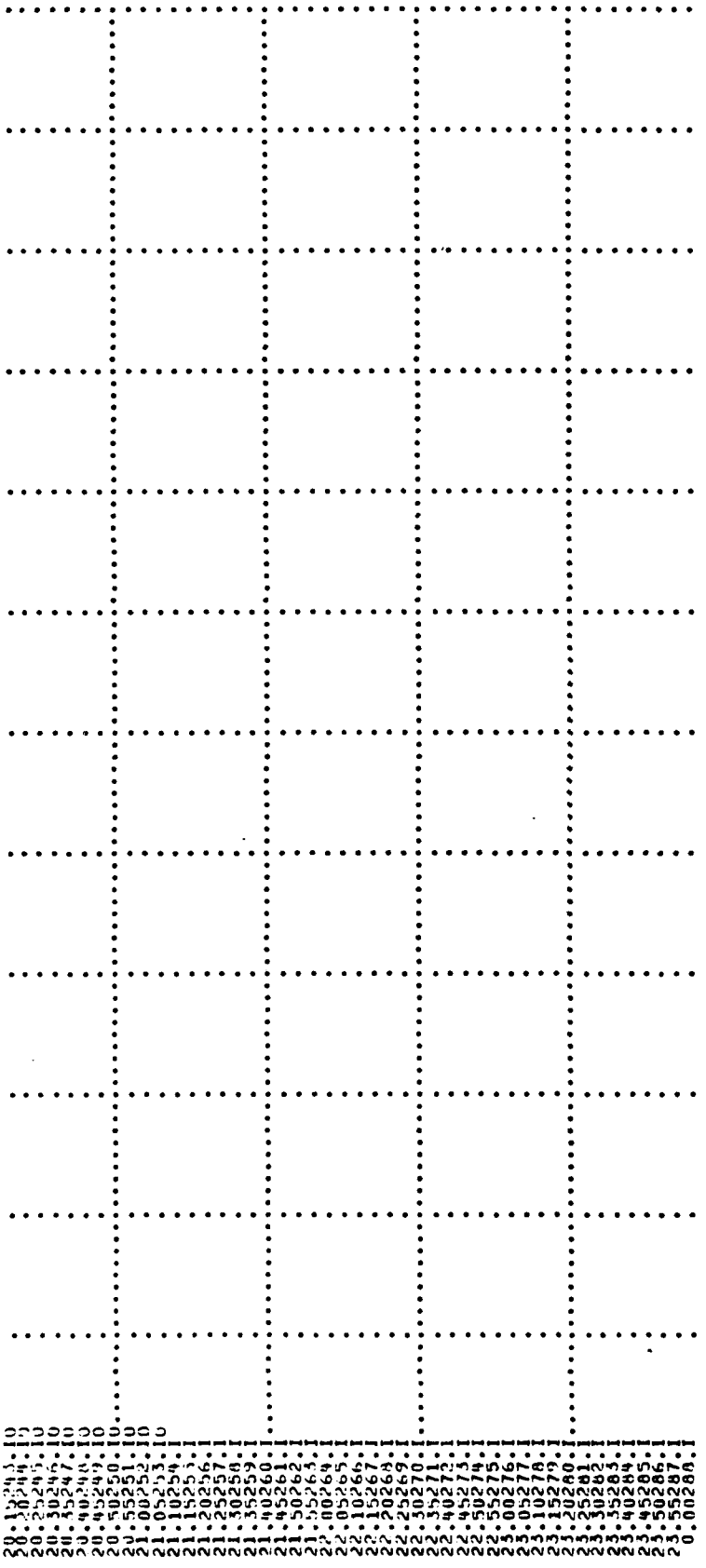


PLATE D-27

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 .05	RATIO 2 .10	RATIO 3 .15	RATIO 4 .20	RATIO 5 .35	RATIO 6 .50	RATIO 7 .75	RATIO 8 1.00
HYDROGRAPH AT	000001	.25 .66	1	141. 4.00	282. 7.99	423. 11.99	564. 15.98	988. 27.97	1411. 39.96	2117. 59.94	2822. 79.92
ROUTED TO	000002	.25 .66	1	25. .72	37. 1.06	94. 2.67	196. 5.55	701. 19.85	1270. 35.98	2055. 58.20	2785. 78.87

PLATE D-28

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	56.00	56.00	60.20
STORAGE	55.	55.	101.
OUTFLOW	0.	0.	310.

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
.05	57.16	0.00	66.	25.	0.00	17.17	0.00
.10	58.41	0.00	79.	37.	0.00	18.08	0.00
.15	59.07	0.00	87.	94.	0.00	16.33	0.00
.20	59.71	0.00	95.	196.	0.00	16.08	0.00
.35	60.65	.45	107.	701.	.75	15.83	0.00
.50	60.91	.71	110.	1270.	1.58	15.83	0.00
.75	61.18	.98	114.	2055.	4.25	15.75	0.00
1.00	61.40	1.20	117.	2785.	5.25	15.75	0.00

APPENDIX E

GEOLOGICAL INVESTIGATION, SOILS REPORT
AND ENGINEER'S REPORT
USDA-SCS
1968

APPENDIX E

DIVISION I

DETAILED GEOLOGIC INVESTIGATION
OF DAM SITES
USDA-SCS
NOVEMBER, 1968

Form SCS-376A
Sheet 1 of [illegible]

10-59

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

GENERAL

State [illegible] County [illegible] ; ___ ¼, [illegible] ¼, Sec. 30, T [illegible] R [illegible] ; Watershed [illegible]

Subwatershed ___ Fund class [illegible] (FP-2, WP-1, etc.) Site number [illegible] Site group [illegible] Structure class [illegible]

Investigated by [illegible] (signature and title) [illegible] Equipment used [illegible] (Type, size, make, model, etc.) Date 11-1-[illegible]

SITE DATA

Drainage area size [illegible] sq. mi., 162 acres. Type of structure DT 24" CMP Purpose [illegible]

Direction of valley trend (downstream) [illegible] Maximum height of fill [illegible] feet. Length of fill [illegible] feet.

Estimated volume of compacted fill required 26,500 yards

STORAGE ALLOCATION

	Volume (ac. ft.)	Surface Area (acres)	Depth at Dam (feet)
Sediment	55.1	9.[illegible]	20.7
Floodwater	20.3	10.1	23.0

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description [illegible] Topography [illegible] Attitude of beds: Dip [illegible] Strike [illegible]

Steepness of abutments: Left 11 percent; Right 13 percent. Width of floodplain at centerline of dam ___ feet

General geology of site: [illegible]

[illegible] There is sufficient borrow [illegible] available within 400 feet [illegible]

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Grindstone - Lost - Muddy
F-20

FORM SCS-376B
REV. 2-64
SHEET 2 OF 3

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FEATURE ℄ Dam, principal spillway, stream channel, borrow area
(CENTERLINE OF DAM, PRINCIPAL SPILLWAY, EMERGENCY SPILLWAY, THE STREAM CHANNEL, INVESTIGATIONS FOR DRAINAGE OF STRUCTURE, BORROW AREA, RESERVOIR BASIN, ETC.)

DRILLING PROGRAM

EQUIPMENT USED	NUMBER OF HOLES		NUMBER OF SAMPLES TAKEN		
			UNDISTURBED	DISTURBED	
	EXPLORATION	SAMPLING	(STATE TYPE)	LARGE	SMALL
6" Slat Auger	12	2		2 L. Bag	
2" Split Spoon		1			1 Jar
2½" HA	4				
TOTAL	16	3		2	1

SUMMARY OF FINDINGS
(INCLUDE ONLY FACTUAL DATA)

The abutments are stiff glacial till. The alluvium of the foundation is predominately stiff silty clay with some sandy clay occurring at depth. Bedrock of shale and siltstone with some interbedded thin limestone beds occurs at shallow depths. The shallow alluvium underlain with shale forms the foundation of the principal spillway. The emergency spillway cuts are shallow and in stiff till. Stream channels are dry with channel deposits less than 3' deep.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-376C
REV. 2-64
SHEET 3 OF 3

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

WATERSHED	SUBWATERSHED	COUNTY	STATE
Grindstone		Davies	ND

SITE NO.	SITE GROUP	STRUCTURE CLASS	INVESTIGATED BY: (SIGNATURE OF GEOLOGIST)	DATE
F-20		a	[illegible]	11-1-65

INTERPRETATIONS AND CONCLUSIONS

No unfavorable geologic conditions were encountered at this site. The emergency spillway cuts will be in the Till soil and was not investigated. Borrow areas 101 & 102 are Till. Depth of borrow may be limited on the lower slopes in area 102 because of the water level. Borrow area 103 is alluvium with soil profile development and classified CL below the topsoil. The channels are narrow and shallow and the shallow channel deposits are subject to seasonal change. Limestone cobbles occur in the channel downstream from sections D & 5.

Estimated cu/yds of compacted fill available below the crest elevation of the principal is Grid D.

Borrow area	101	2000 cu/yds
	102	7000 cu/yds
	103	16000 cu/yds

APPENDIX E

DIVISION II

SOILS REPORT
USDA-SCS
APRIL, 1968

SCS-633 (6-67)

UNITED STATES GOVERNMENT

Memorandum

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TO : James M. Dale, State Conservation Engineer, SCS, Columbia, Missouri

DATE: April 8, 1969

FROM : Lorn P. Dunnigan, Head, Soil Mechanics Laboratory, SCS, Lincoln, Nebraska

SUBJECT: ENG 22-5, Missouri WP-08, Grindstone-Lost-Muddy Creek, Site No. F-20 (Davies County)

ATTACHMENTS

1. Form SCS-354, Soil Mechanics Laboratory Data, 1 sheet.
2. Form SCS-355A, Triaxial Shear Test Data, 1 sheet.
3. Form SCS-352, Compaction and Penetration Resistance, 2 sheets.
4. Form SCS-357, Summary - Slope Stability Analysis, 3 sheets.

DISCUSSION

FOUNDATION

A. Bedrock: The bedrock at the site consists of shale and siltstone with some interbedded thin beds of limestone at shallow depths. The bedrock is reportedly of Pennsylvanian age.

B. Soil Classification: The sample from TH 301 is classified as CL material with a liquid limit of 39 and a PI of 20. Both abutments are logged as CL till.

C. Shear Strength: Undisturbed samples were not submitted from this site. A blow count of 7 from the 7 to 8-foot depth in TH 301 was recorded; and based upon this blow count, design strength parameters of ϕ = 18.5°, c = 1150 psf are suggested. These strength parameters are from site No. D-34 on this watershed.

EMBANKMENT MATERIALS

A. Classification: The borrow samples submitted are from the upstream borrow area (TH's 102 and 103). Both materials are CL's with liquid limits of 40 (Sample 69WL301) and 39 (Sample 69WL302). The samples have PI's of 22 and 20, respectively.

B. Compacted Density: Standard Proctor compaction tests were made. Sample 69WL301 (Field No. 102.1) has a maximum dry density of 109.5 pcf and Sample 69WL302 (Field No. 103.1) has a maximum dry density of 107.0.

C. Shear Strength: A consolidated unlrained shear test was made on Sample 69W1301 (Field No. 102.1) compacted to average density of 101.5 pcf, which is 92.6 percent of standard Proctor. The test is interpreted to yield shear strength parameters of ϕ = 5.5°, c = 625 psf. Sample 69W66, from Site No. B-36 Grindstone-Lost-Muddy, which closely approximates the alluvial materials on this site (F-20) has strength parameters of ϕ = 6.5°, c = 825 psf.

SLOPE STABILITY

A. Maximum Section at Station 7+87. A 27.3-foot high embankment was analyzed considering drying cracks to the phreatic surface in all the modified Swedish circle method trials. In addition, the upstream analysis considers rapid drawdown from the emergency spillway elevation to the base of the embankment, no berm, and embankment shear strength parameters of ϕ = 5.5°, c = 625 psf. Under these conditions a minimum factor of safety of 1.69 was computed. The upstream analysis considered 2 1/2:1 embankment slopes.

The downstream stability analysis considerations are identical to the upstream with the exception that a full phreatic surface (no drain) is considered in place of rapid drawdown. A factor of safety of 1.76 was obtained for the downstream 2 1/2:1 slope.

B. Floodplain Section at Station 6+50. A 19.3-foot upstream embankment was analyzed considering an 11-foot depth of compressible foundation material. Factors of safety above 3.0 were obtained for this analysis and are fully described on the attached Summary - Slope Stability Analysis, Grindstone-Lost-Muddy Site No. F-20.

RECOMMENDATIONS

A. Cutoff Trench: We concur with the engineer's recommended cutoff trench depths. The cutoff trench will bottom in CL till and CL alluvium in the abutments, left channel section, and the floodplain. The trench will bottom in bedrock in the right channel section.

B. Principal Spillway: At the proposed location the foundation consists of about 10 feet of 7-blow-count material overlying bedrock. Based on blow count, foundation consolidation is expected to be low for the proposed fill height.

C. Drain: The trench will bottom in stiff to medium CL (n = 7) and good cutoff is anticipated with the cutoff trench depths recommended in the engineer's report for this site, and a drain is not considered necessary.

3 -- James M. Dale -- 4/8/69
Lorn P. Dunnigan
Subj: EMG 22-5, Missouri WP-08, Grindstone-Lost-Muddy Creek, Site F-20

D. Embankment Design:

1. Placement of Materials: The borrow samples submitted have about the same liquid limits. We concur with the engineer's recommendation that the higher plasticity materials be utilized in the interior portions of the embankment fill and the less plastic materials be utilized as a blanket to reduce the possibility of drying cracks and promote vegetative cover.

   All materials should be placed at a minimum of 90 percent of standard Proctor density with moisture controlled near optimum.

2. Slopes: With the embankment at 90 percent of Proctor and no drain, the proposed 2 1/2:1 slopes are expected to be stable.

3. Settlement: An overfill allowance of 0.5 foot is suggested to compensate for residual consolidation within the foundation and embankment.

Prepared by:

Gerald N. Gibson

Reviewed and Approved by:

Lorn P. Dunnigan

Attachments

cc:
Project Office, Maysville, Missouri (2)
E. D. Butler, Lincoln, Nebraska

2/2/68 Ht. = 25' 26,500 cy Class "A" Stabilization

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

MISSOURI WP-03

Grindstone Lost Muddy, F-20

[illegible]	Field Number	Location and Description	Depth	Field Classification	Mechanical Analysis: Grain Size Distribution Expressed as Percent Finer by Dry Weight — Fines					Sand						Gravel						Atterberg Limits		Unified Classification	Soluble Salts %	Dispersion %	Moisture Density Relationships (20 Standard, ☐ Modified)			Unsaturated Samples	
																3/8"	1/2"	3/4"	1"	1 1/2"	3"	LL	PI				Curve No.	Max γ_d pcf	w_o %	γ_d g/cc	w_o %
300	301.1	¢ Fill, 5+30, Jar	7-8	CL	30	37	58	78	[illegible]	[illegible]	[illegible]	[illegible]	100									39	20	CL							[illegible]
301	102.1	Borrow, B+00, 5+30, L.Bag 102 = 7,000 cy Till	1-8	CL	31	37	52	66	79					100								40	22	CL			①	109.5	12.0		
302	103.1	Borrow, B+00, 6+00, L.Bag 103 = 16,000 cy Alluvium	2-8	CL	29	34	56	74	78					100								39	20	CL			②	107.0	12.5		

Form SCS 355-A
Rev. 6-65

LABORATORY NO. S[illegible]

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	TRIAXIAL SHEAR TEST

PROJECT and STATE: GRANSTONE LOST MUDDY F-20 MISSOURI
SAMPLE LOCATION: BORROW, 6+00, 5+30

FIELD SAMPLE NO: 102.1
DEPTH: 1-8'
GEOLOGIC ORIGIN: TILL

TYPE OF SAMPLE: COMPACTED
TESTED AT: SML LINCOLN
APPROVED BY: M. D. H.
DATE: 3-23-68

INDEX TEST DATA

USCS CL ; LL 40 ; PI 22
% FINER (mm): 0.002 31 ; 0.005 37 ;
0.074 (#200) 79
G_s (-#4) 2.70 ; G_s (+#4) _____
STANDARD: γ_d MAX. 109.5 pcf; w_o 17.0 %
MODIFIED: γ_d MAX. _____ pcf; w_o _____ %

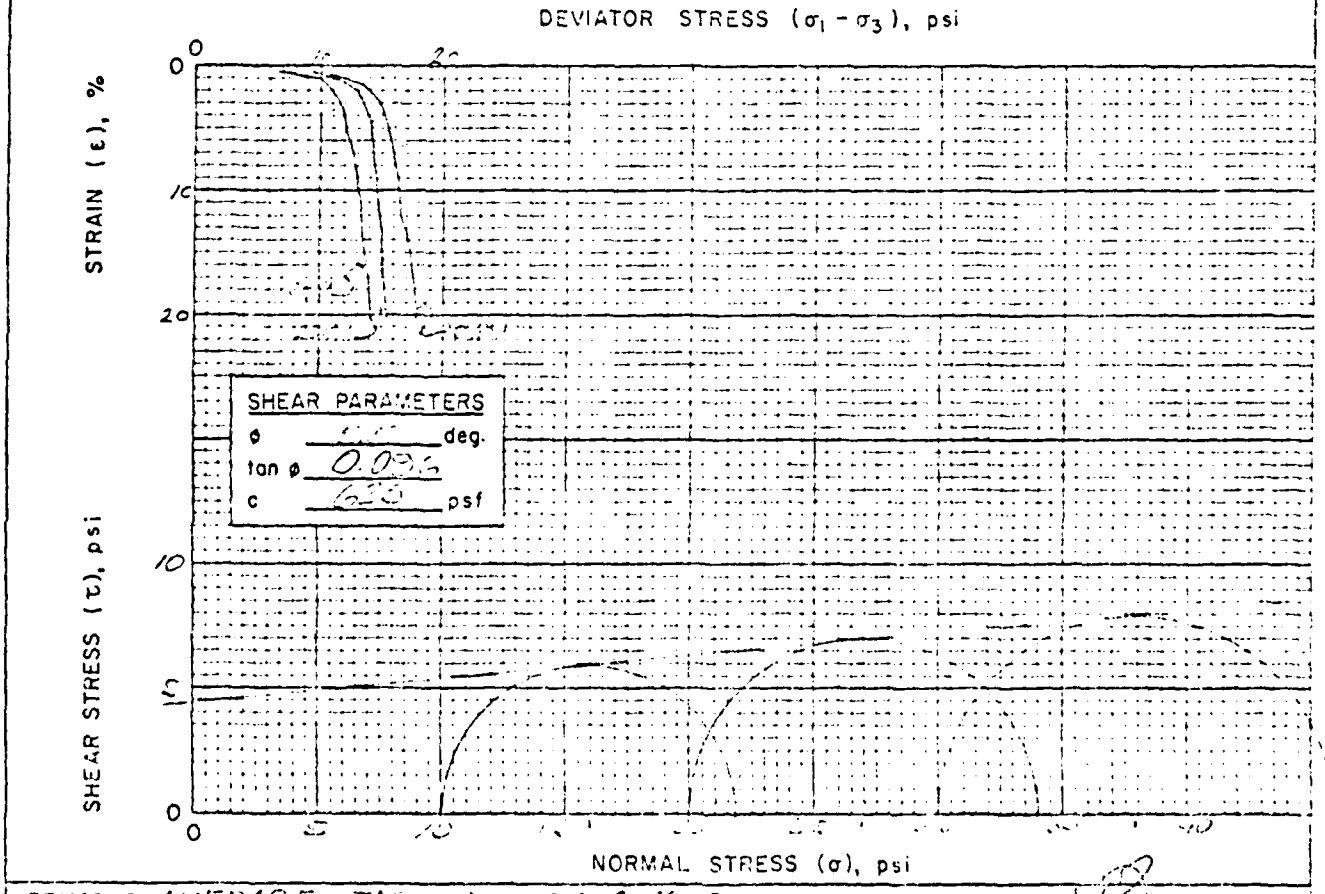
SPECIMEN DATA

HEIGHT 3.0 "; DIAMETER 1.4 "
MATERIALS TESTED PASSED #4 SIEVE
METHOD OF PREPARATION STATIC 3 LAYER COMPACTION AND SOAKED
MOLDING MOISTURE 8.5 %
MOLDED AT 98.0 % OF γ_d MAXIMUM

TYPE OF TEST

- UU ☐
- CU ☒
- $\overline{CU}$ ☐
- CD ☐

DRY DENSITY			MOISTURE CONTENT, %			TIME OF CONSOLIDATION (hrs)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, ε (%)
INITIAL pcf ☒ g/cc ☐	CONSOLIDATED pcf ☒ g/cc ☐		START OF TEST	DEG. OF SAT. AT START OF TEST	END OF TEST				
102.2	102.7		23.0	93.6	22.7	6.63	10	[illegible]	[illegible]
100.5	101.2		23.2	92.4	22.6	5.85	20	[illegible]	[illegible]
101.4	105.0		23.3	94.3	22.9	6.82	30	[illegible]	[illegible]



REMARKS AVERAGE TEST γ_d = 92.6 % STD. [illegible]

Form SCS 352
Rev. 5-55

LABORATORY NO. S-64-1591

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANCE

PROJECT and STATE: Grindstone Lost Muddy # F-20 ; Missouri

FIELD SAMPLE NO.	LOCATION	DEPTH
102.1	Borrow, B+00, 5+30	1.0' - 8.0'

GEOLOGIC ORIGIN	TESTED AT	APPROVED BY	DATE
Till	SML-Lincoln	G. T. L.	5-28-65

CLASSIFICATION CL LL 40 PI 22

MAX. PARTICLE SIZE INCLUDED IN TEST < #4 "

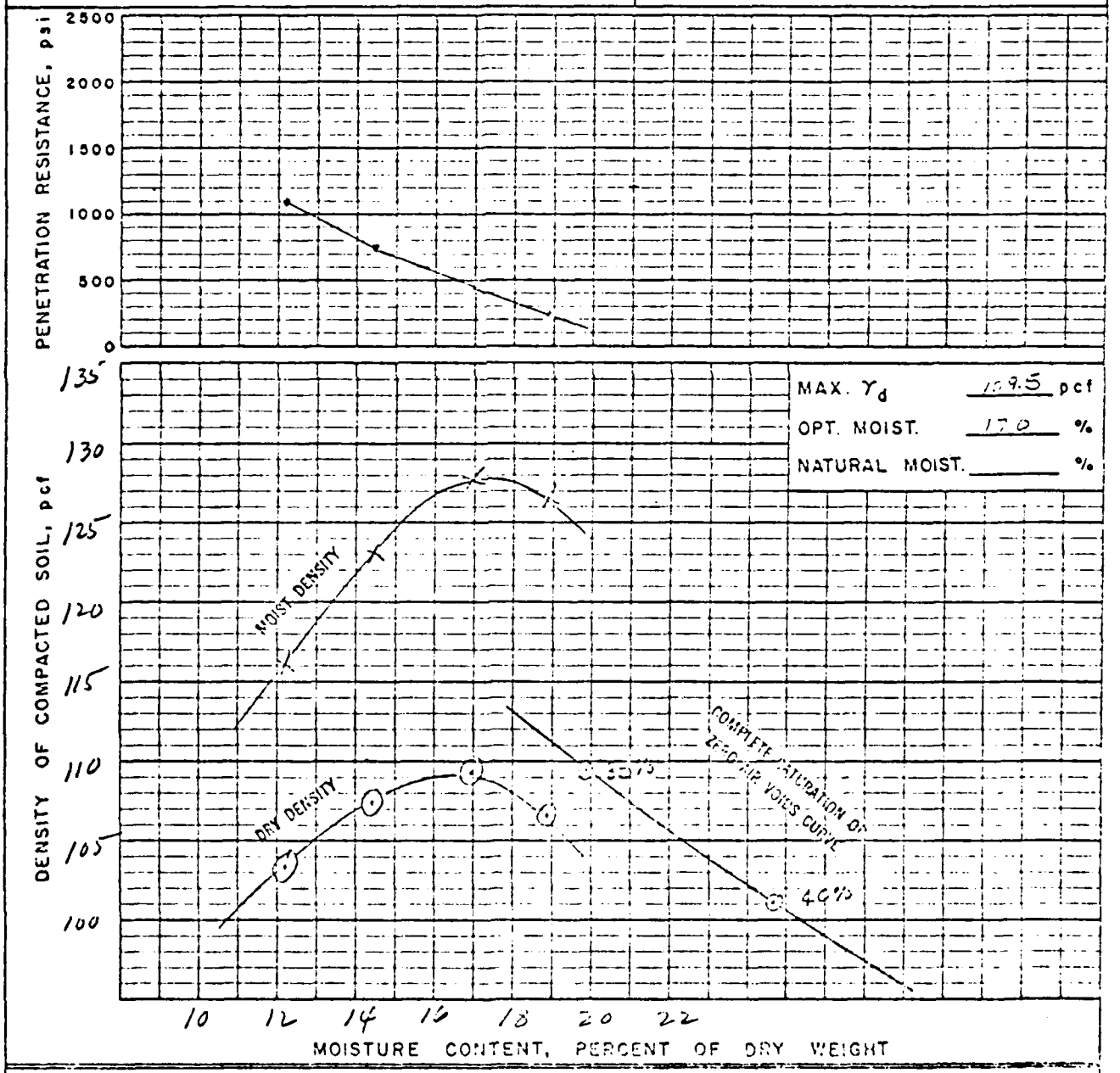
SPECIFIC GRAVITY (G_s) { MINUS NO. 4 2.70 ; PLUS NO. 4 ____

CURVE NO. 1 OF 2

STD (ASTM D-698) ☒; METHOD A

MOD. (ASTM D-1557) ☐; METHOD ____

OTHER TEST ☐ (SEE REMARKS)



REMARKS

Form SCS 356
Rev. 4-65

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANCE

PROJECT and STATE: Grindstone Lost Mudd # E-20 ; Missouri

FIELD SAMPLE NO.	LOCATION	DEPTH
103.1	Borrow, B+00 6+00	-3.5'

GEOLOGIC ORIGIN	TESTED AT	APPROVED BY	DATE
Alluvium	SML-LINCOLN	[illegible]	3-28-69

CLASSIFICATION CL LL 39 PI 20 | CURVE NO. 2 OF 2

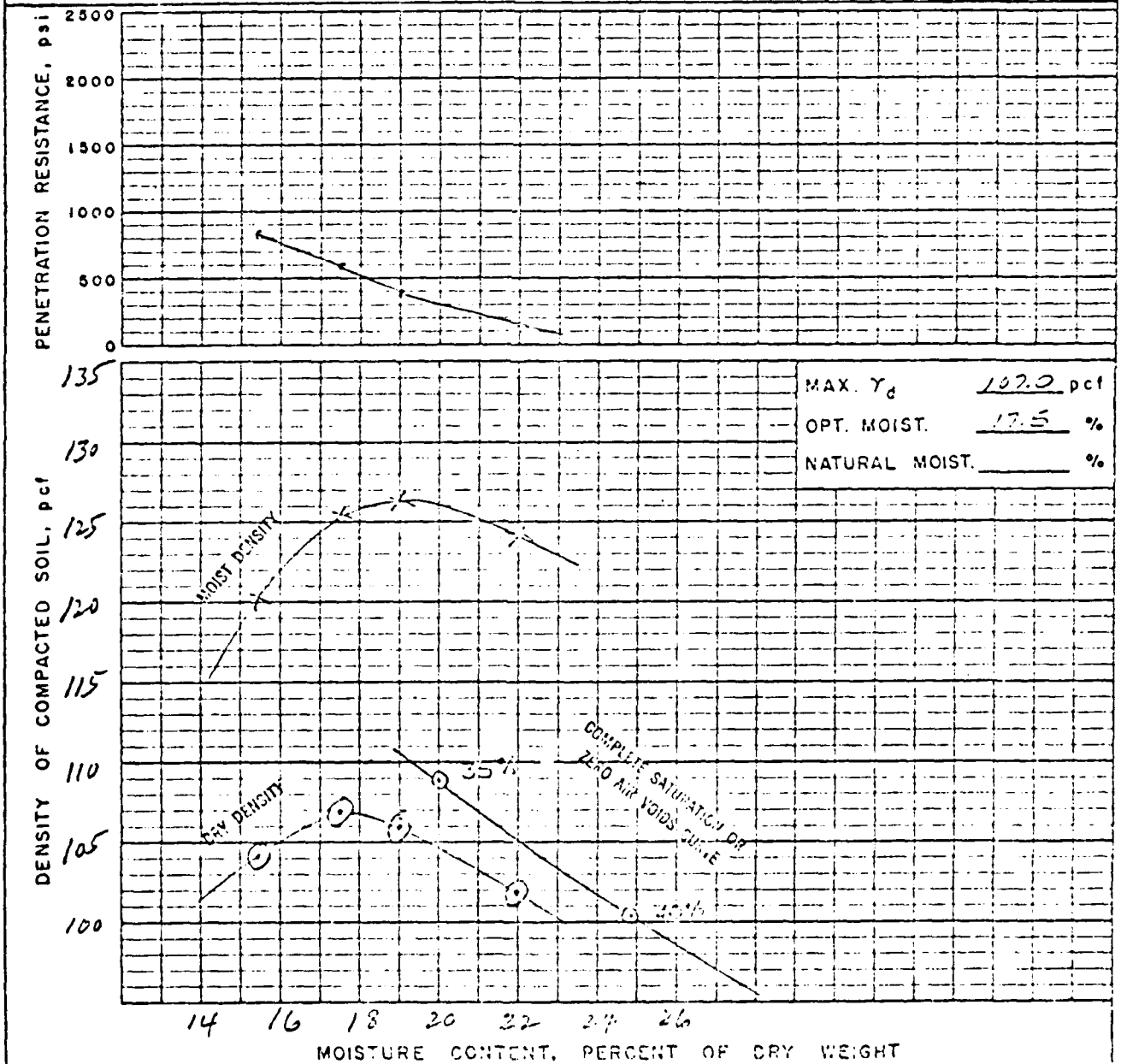
MAX. PARTICLE SIZE INCLUDED IN TEST 4 mm #

SPECIFIC GRAVITY (G_s) { MINUS NO. 4 2.68 ; PLUS NO. 4 ____

STD. (ASTM D-698) ☒; METHOD A

MOD. (ASTM D-1557) ☐; METHOD ____

OTHER TEST ☐ (SEE REMARKS)



REMARKS

Form SCS 357
Rev. 6-65

U.S. DEPARTMENT of AGRICULTURE
SOIL CONSERVATION SERVICE

MATERIALS TESTING REPORT — SUMMARY - SLOPE STABILITY ANALYSIS

PROJECT and STATE

METHOD OF ANALYSIS

ANALYZED BY

APPROVED BY

DATE

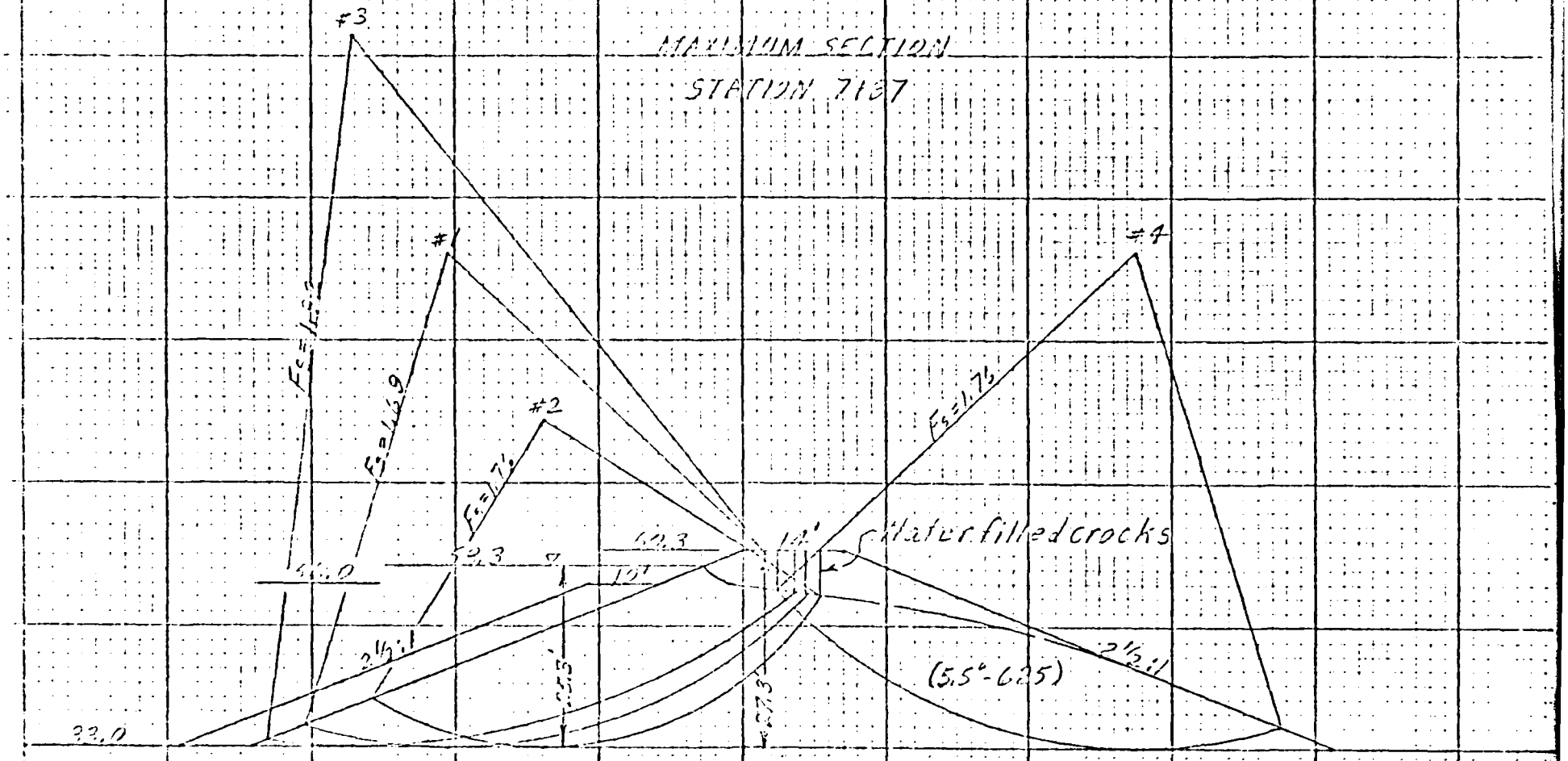
	SOURCE AND USE OF MATERIALS	CLASSIFICATION	ADOPTED DESIGN DATA: γ_d (pcf)	γ_m (pcf)	γ_{sat} (pcf)	γ_{sub} (pcf)	ϕ (deg)	tan ϕ	c (psf)	REMARKS
①	Found.	CL	103.5		125.0	62.5	13.5	0.335	1152	-Site D-34
②	Foundation	CL	104.4	113.5	125.0	62.5	5.5	0.096	425	
③	Foundation	CL	99.7	113.9	122.1	59.5	6.5	0.114	325	-Site B-36
④										
⑤										
⑥										
⑦										
⑧										

TRIAL NO.		SLOPE	CONDITIONS	F_s
			MAXIMUM SECTION @ STATION 7+37	
1	½	2:1	Full drawdown - No Exsm - Arc cut from bottom of crack thru soil (5.5'-32.5') only.	1.69
2	½	2:1	Same conditions as trial #1.	1.71
3	½	2:1	Same conditions as trial #1.	1.38
4	½	2:1	No Drain - No Exsm - Arc cut from bottom of crack thru soil (5.5'-32.5').	1.74
			FLOOD PLAIN SECTION @ STATION 4+50	
5	½	2:1	Full drawdown - No Exsm - Arc cut from bottom of crack thru soil (6.5'-32.5') & 5.5' Found (18.5'-11.5').	2.4
6	½	2:1	Same conditions as trial #5 but + 11' Found (12.5'-11.5').	2.5

Sheet 1 of 2

GRINDSTONE LOST MUDDY #F-20
MISSOURI

MAXIMUM SECTION
STATION 7137



U. S. DEPARTMENT OF AGRIC
SOIL CONSERVATION SE

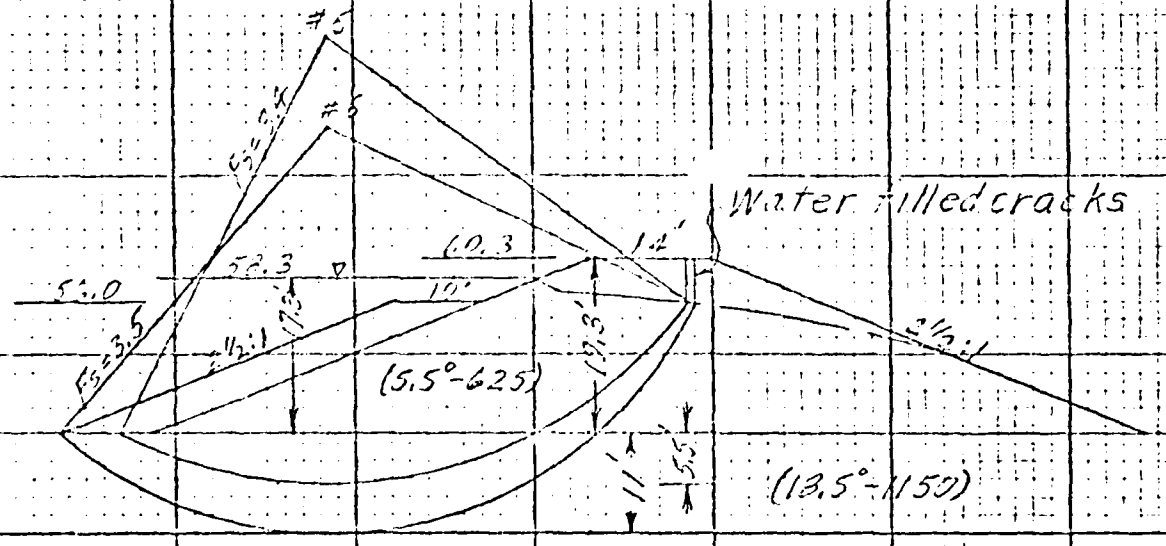
DESIGNED BY A.W.L.	APPROVED
CHECKED BY R.F.H.	DRAWING NO. F

GRINDSTONE LOST MOODY #F-20

MISSOURI

FLOOD PLAIN SECTION

STATION 6+50



SCALE: 1" = 30'

U. S. DEPARTMENT OF AGRIC
SOIL CONSERVATION SE

DESIGNED BY A.W.L.	APPROVED BY
CHECKED BY	DRAWING NO. F-
DATE: 3-1-19	SHEET 5

APPENDIX E

DIVISION III

ENGINEER'S REPORT
USDA-SCS
DECEMBER, 1968

AD-A105 278 HOSKINS-WESTERN-SONDEREGGER INC LINCOLN NE F/G 13/13
NATIONAL DAM SAFETY PROGRAM. GRINDSTONE-LOST-MUDDY CREEK DAM F---ETC(U)
JUN 80 R S DECKER, G JAMISON, G ULMER DACW43-80-C-0071
UNCLASSIFIED NL

Engineer's Report - Investigation of Dam Site F-20
Grindstone-Lost-Muddy Creek

Harold B. Townsend Jr. 12-18-68

Stream channel cleanout is recommended between sections A and B. Cleanout depths of 2.5 ft. to 3 ft., bottom width of 10 ft. and side slopes of 2:1 should be adequate to remove the recent channel fill. Channel cleanout is not recommended for the channel below the centerline of the dam.

Recommended Core:	Stations	Elevations
	3+00	55.0
	4+00	44.0
	4+45	32.0
	4+60	32.0
	5+00	38.0
	5+50	39.0
	6+50	36.0
	7+50	36.0
	7+80	31.0
	7+95	31.0
	9+00	50.0
	9+60	56.0

3:1 End Slopes

Placement of the fill materials from the required excavations and borrows will be controled by the engineer. The more plastic CL material to be placed in the core with the ML or top soil in the outer shell to reduce drying cracks and to improve vegetative cover establishment.

The principal spillway conduit will be 24 inch diameter corrugated metal pipe. A pipe drop inlet and cantilevered outlet will be used.

Foundation drainage should not be required with the recommended core depths.

There does not appear to be any special foundation or fill design problems at this site.