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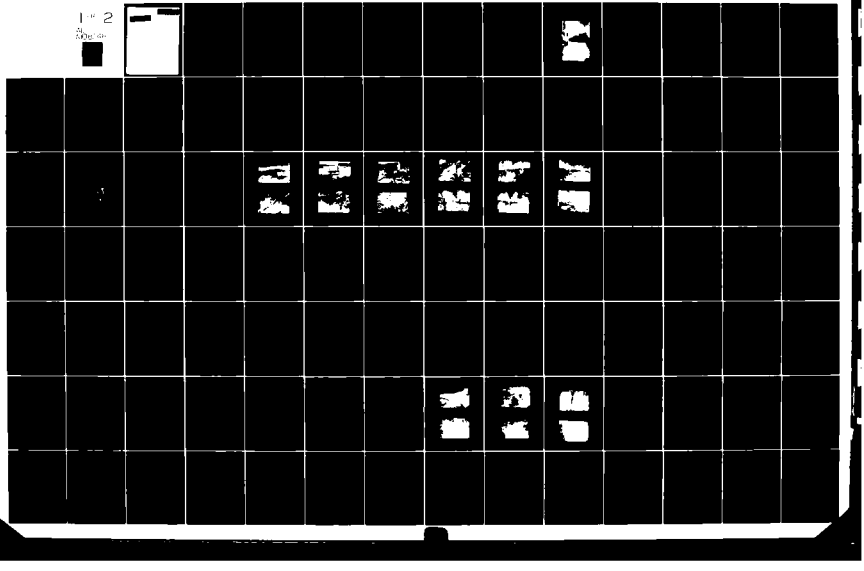

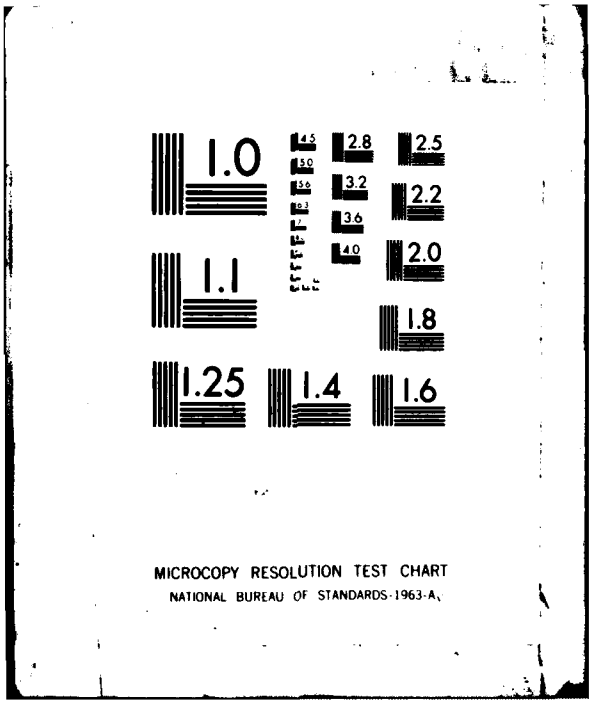
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LEVEL II

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AD A108248

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD A109248	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) National Program of Inspection of Non-Federal Dams, Tennessee. Crystal Lake Dam (Inventory Number TN 06932) near Saulsbury, Tennessee, Hardeman County, TN., Hatchie River Basin		5. TYPE OF REPORT & PERIOD COVERED Phase 1 Investigation Report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)		8. CONTRACT OR GRANT NUMBER(s) DACW-62-81-C-0056
9. PERFORMING ORGANIZATION NAME AND ADDRESS Tennessee Department of Conservation Division of Water Resources 4721 Trousdale Dr., Nashville, TN 37220		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, Nashville P.O. Box 1070 Nashville, TN 37202		12. REPORT DATE September, 1981 13. NUMBER OF PAGES
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 public release; distribution unlimited

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

18. SUPPLEMENTARY NOTES

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

Dams
Dam Safety
National Dam Safety Program
Crystal Lake Dam, TN
Saulsbury, TN
Hardeman County, TN
Embankments
Visual Inspection
Structural Analysis

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

Report is based on the findings of a Phase I inspection of Crystal Lake Dam in Hardeman County. The zoned earthfill embankment is 27 feet high and 410 feet long with a crest width of 13 feet. The embankment slopes are 1V:4.3H upstream and 1V:3.1H downstream. The dam impounds 63 acre-feet at normal pool level with 36 acre-feet of flood storage. The drainage area is 21 acres. The service spillway is a case in place concrete riser leading to a 12 inch slide gate at the base of the riser. The emergency spillway is a triangular earth channel with a maximum depth of 0.6 feet and a top width of 15 feet.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

The dam is in the small size, high hazard potential category. Erosion on the downstream slope of the embankment and in the emergency spillway is becoming severe. Some indications of dispersive soils were noted. The reservoir has sufficient storage/spillway capacity to pass the 1/2 PMF but the PMF overtops the dam by 0.1 feet for 24 hours. Crystal Lake Dam has been assigned a condition classification of "deficient".

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1070
NASHVILLE, TENNESSEE 37202

IN REPLY REFER TO
ORNED-G

2 SEP 1981

Honorable Lamar Alexander
Governor of Tennessee
Nashville, TN 37219

Dear Governor Alexander:

Furnished herewith is the Phase I Investigation Report on Crystal Lake Dam near Bolivar, Tennessee. The report was prepared under the authority and provisions of PL 92-367, the National Dam Inspection Act, dated 8 August 1972.

The report presents details of the field inspection, background information, technical analyses, findings, and recommendations for improving the condition of the dam.

Based upon the inspection and subsequent evaluation, Crystal Lake Dam is classified as deficient due to minor erosion on the embankment and emergency spillway.

The recommendation concerning repair and stabilization of this erosion, and others contained in this report should be undertaken in the near future.

Public release of the report and initiation of public statements fall within your prerogative. However, under provisions of the Freedom of Information Act, the Corps of Engineers is required to respond fully to inquiries on information contained in the report and to make it accessible for review on request.

Your assistance in keeping me informed of any further developments will be appreciated.

Sincerely,

LEE W. TUCKER
Colonel, Corps of Engineers
Commander

1 Incl
As stated

CF:
Mr. Robert A. Hunt, Director
Division of Water Resources
4721 Trousdale Drive
Nashville, TN 37220

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
TENNESSEE

Name of Dam ..... Crystal Lake

County ..... Hardeman

Stream ..... Trib. of East Fork of Spring Creek

Date of Inspection ..... February 23, 1981

This investigation and evaluation was prepared by the Tennessee Department of Conservation, Division of Water Resources.

Prepared By:

George E. Moore
Regional Engineer

Approved By:

Edmond B. O'Neill
Chief Engineer
Safe Dams Section

Approved By:

Robert A. Hunt, P.E.
Director, Division of
Water Resources
Tennessee Department of
Conservation

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National Dam Safety Program
Tennessee

Name of Dam ..... Crystal Lake

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Stream ..... Trib. of East Fork of Spring Creek

Date of Inspection ..... February 23, 1981

ABSTRACT

This report is based on the findings of a Phase I inspection of Crystal Lake Dam in Hardeman County. The zoned earthfill embankment is 27 feet high and 410 feet long with a crest width of 13 feet. The embankment slopes are 1V:4.3H upstream and 1V:3.1H downstream. The dam impounds 63 acre-feet at normal pool level with 36 acre-feet of flood storage. The drainage area is 21 acres. The service spillway is a cast in place concrete riser leading to a 12 inch concrete pipe. The drawdown drain is a 12 inch slide gate at the base of the riser. The emergency spillway is a triangular earth channel with a maximum depth of 0.6 feet and a top width of 15 feet. The dam is in the small size, high hazard potential category. Erosion on the downstream slope of the embankment and in the emergency spillway is becoming severe. Some indications of dispersive soils were noted. The reservoir has sufficient storage/spillway capacity to pass the ½ PMF but the PMF overtops the dam by 0.1 feet for 24 hours. Crystal Lake Dam has been assigned a condition classification of "deficient".

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
CRYSTAL LAKE DAM
HARDEMAN COUNTY, TENNESSEE

SECTION 1 - GENERAL

1.1 Authority - The Phase I inspection of this dam was carried out under the authority of Tennessee Code Annotated, Sections 70-2501 to 70-2530, The Safe Dams Act of 1973, and in cooperation with the U. S. Army Corps of Engineers under the authority of Public Law 92-367, The National Dam Inspection Act.

1.2 Purpose and Scope - The purpose of a Phase I investigation is to develop an engineering assessment of the general condition of a dam with respect to safety and stability. This is accomplished by conducting a visual inspection; reviewing any available design and construction data; and performing appropriate hydraulic, hydrologic, and other analyses. A comprehensive description of the Phase I investigation program is given in Recommended Guidelines for Safety Inspection of Dams, Department of the Army, Chief of Engineers, Washington, D. C. 20314.

1.3 Past Inspections - Past inspections of Crystal Lake Dam include a cursory inspection by George Moore and Troy Wedekind of the Tennessee Division of Water Resources on February 14, 1979. The formation of jug holes indicative of dispersive soils was observed during this inspection. Also noted were the wet area on the right downstream embankment abutment contact and erosion of the emergency spillway. Several inspections were made during the construction of the dam by Ed O'Neill also of the Tennessee Division of Water Resources.

1.4 Miscellaneous Details - The day of the inspection was clear with light breezes and an ambient temperature of about 45°F. A rainfall had occurred on February 20, 1981, three days before the inspection.

1.5 Inspection Team Members - The inspection was conducted by the following State personnel:

Ed O'Neill, Chief Engineer
George Moore, Regional Engineer
Anthony Privett, Engineering Co-op

SECTION 2 - PROJECT DESCRIPTION

2.1 Location - The project is located in Hardeman County, Tennessee, about 4 miles east of Saulsbury, Tennessee. The dam is located on the Saulsbury topographic quadrangle at 89°01'29" west longitude and 35°02'39" north latitude. Location maps are provided in Appendix B of this report. The dam is located near an unnamed tributary of the east fork of Spring Creek about 21.6 miles from its confluence with the Hatchie River.

2.2 Description

2.2.1 Embankment (Design data is shown in parenthesis.) - The Crystal Lake Dam is a zoned earth embankment dam with a straight alignment. The maximum height is 26.9' (27') and the length is 410' (400'). The crest width is 13' (12'). The upstream slope is about 1V:4.3H (1V:3H) from the water surface to the top of the dam. The downstream slope is 1V:3.1H (1V:3H). The dam has a poor cover of sage grass and no upstream wave protection. Sketches are provided in Appendix B.

The embankment is designed with an impervious core and cutoff trench constructed of material in group CL in the Unified Classification System. The core has side slopes of 1V:0.5H. The cutoff trench has a 10 foot wide base and 1V:2H side slopes and a minimum bottom elevation of about 486' msl. The upstream zone and the inner zone downstream of the core are specified as "random fill" with no other material classifications. The outer portion of the downstream zone is constructed of SP and SC material.

2.2.2 Service Spillway/Drawdown Drain - The service spillway is a 2½' x 4' concrete riser with two 1' x 4' inlets at the water surface and a 12" concrete conduit through the dam. The inlet elevation is 524.0' msl. The drawdown drain is a 12" slide gate at the base of the riser.

2.2.3 Emergency Spillway - The emergency spillway is an uncontrolled earth saddle located on the north abutment of the dam. The spillway is triangular in shape with a maximum depth of 0.6 feet and a top width at the low point of the dam of 15 feet. The maximum outflow is estimated to be 37 cfs. The emergency spillway has no vegetative

cover. The design plans call for a trapezoidal channel with a base width of 10' and 1V:3H side slopes.

2.2.4 Reservoir and Drainage Area - The reservoir has a surface area of 6.3 acres at normal pool elevation with a fetch of 800'. The normal impounding capacity of the reservoir is estimated to be 63 acre-feet with about 36 acre-feet of flood storage. The drainage area is 20.8 acres and the predominant soils are Ruston, Lexington, and Providence. Watershed land use is being developed as a medium density residential development.

2.2.5 Miscellaneous - The dam is currently owned by the Candlewood Lakes Property Owner's Association (W. J. Arnold, President). The dam was built in 1976 as a recreational lake for the Candlewood Subdivision being developed by Terra Aqua Corporation. The dam was designed by Ragon Engineering Company with soils testing subcontracted to Construction Materials Lab, Inc. The construction was performed by S & W Construction Company. Other than filling in erosion gullies, no major repairs have been reported since construction. A Certificate of operation was issued by the State in 1977. Ownership of the dam was turned over to the Homeowner's Association in 1979. No instrumentation was found on the dam.

SECTION 3 - INSPECTION FINDINGS

3.1 Specific Findings

3.1.1 The downstream slope is eroding in a manner which is indicative of dispersive clays. A past inspection report (Appendix F) shows that jug holes have occurred before and have been repaired. The problem is now recurring (photo nos. 7 & 8).

3.1.2 A seep or spring is emerging on the right downstream embankment abutment contact about one foot below the pool elevation the day of the inspection. A slight flow (less than 1 gpm) is coming from the seep, but there is no indication of the transport of embankment material. The flow is beginning to erode a gully along the right downstream embankment abutment contact (photo nos. 9 & 10).

3.1.3 The emergency spillway is undergoing an excessive amount of erosion. Material washed from the side slopes has filled the control section to the point that the effective depth of the channel is only 0.6'. Gullies have formed in both the entrance and exit channels (photo nos. 11 & 12).

3.1.4 The upstream slope of the dam has no wave protection other than vegetative cover and some minor erosion is occurring at the water surface (photo no. 2).

3.1.5 According to OCE guidelines, the dam is in the small size and high hazard potential classifications. As such, the structure is required to pass the one-half to full probable maximum flood (PMF). The volume of inflow during the PMF is 47.6 acre-feet using Antecedent Moisture Condition II. Analysis indicates that the PMF will overtop the dam for about 2.4 hours with a maximum depth of about 0.1 feet. The ½ PMF passes with no flow in the emergency spillway. Analysis of the 1-10 day 100-year storm indicates that this storm will pass with no flow in the emergency spillway.

3.1.6 A sample of the embankment material is a silty sandy clay of group CL in the Unified Classification System. The sample is a shallow depth (0.5 to 2.0 feet) hand auger sample taken

near the crest and is not necessarily indicative of the overall composition of the dam.

3.1.7 The dam is located in seismic zone 2.

3.1.8 This dam is in the high hazard potential classification as outlined in the OCE guidelines. Failure of the dam could cause loss of life in the residential subdivision being developed downstream of the dam. A railroad and Hwy 57 which are about 0.5 miles downstream could also be damaged.

3.1.9 A 6-8" vertical drop was found near the toe of the embankment above the service spillway pipe. The drop appears to be a mechanical cut possibly due to the use of earthmoving equipment near the toe.

3.1.10 Design plans and specifications for this project were developed by James Ragon of Bolivar, Tennessee. Copies of the plans, the soils test, and the hydrologic calculations have been included in Appendix G. Except for the emergency spillway, the dam appears to be in substantial compliance of the emergency spillway and the deposition of material in the base of the channel appear to be the cause of the descrepancies between the designed and actual spillway. A freeboard designed storm of 0.8 PMF was used.

3.2 Conclusions and Recommendations

3.2.1 Conclusions

a. The Crystal Lake Dam was determined to be in a deficient condition due to the suspected presence of dispersive soils on the downstream slope and the deteriorated condition of the emergency spillway.

b. The structure appears to be adequate with respect to hydraulic and hydrologic considerations.

c. There were no observable signs of instability on the embankment. Side slopes appear adequate.

d. The seismic stability of this dam is unknown; however, dams in seismic zone 2 are assumed to be adequate against seismic loading if judged adequate in static stability requirements.

e. The seep or spring on the dam appears to be groundwater and does not appear to present any immediate hazard to the structure.

3.2.2 Recommendations

a. The downstream slope should be checked by a qualified engineer to determine if dispersive clays are present in the embankment and make recommendations if necessary to repair and stabilize the slopes against further erosion and jugging.

b. The emergency spillway should be regraded to the design configuration and a soil binding grass cover established to stabilize the channel.

c. The erosion on the upstream slope should be repaired and stabilized.

d. Minor surface irregularities on the embankment should be repaired and the grass cover should be improved.

e. An emergency action plan should be developed for notifying downstream residents in the event potentially serious situations arise.

f. A program of routine maintenance and periodic inspection should be developed for the dam.

SECTION 4 REVIEW BOARD FINDINGS

The Interagency Review Board for the National Program of Inspection of Non - Federal Dams met in Nashville on 18 June 1981 to examine the technical data contained in the Phase I investigation report for Crystal Lake Dam. The Review Board considered the information and recommended that (1) the owner should establish a regular program of inspection and maintenance to provide detection and timely correction of problem areas, (2) an emergency action plan should be developed, including a warning system to alert downstream residents, in the event a serious condition develops with the project, and (3) flood routings using Antecedent Moisture Condition III should also be computed and included in the report. They agreed with other report conclusions and recommendations. A copy of the letter report presented by the Review Board is included in Appendix F.

APPENDIX A

DATA SUMMARY

APPENDIX A
DATA SUMMARY

A.1 Dam

A.1.1 Type - Zoned earthfill, linear alignment dam with a concrete pipe service spillway and drawdown drain and a vegetated earth emergency spillway.

A.1.2 Dimensions and Elevations - (Elevations are taken from design plans. Field measurements are shown in parenthesis if different from design plans. A TBM, elevation 539.3, in oak tree on left abutment was used for field measurements. This marker was reportedly used for construction.)

a. Crest length - 400' (410')
b. Crest width - 12' (13')
c. Height (from service spillway outlet) - 27' (26.9')
d. Crest elevation - 530' msl (529.8')
e. Service spillway elevation - 524' msl (523.7')
f. Emergency spillway elevation - 525.4' msl (529.2')
g. Embankment slope, U/S - 1V:3H (1V:4.3H)
h. Embankment slope, D/S - 1V:3H (1V:3.1H)
i. Size classification - Small

A.1.3 Zones, Cutoffs, Grout Curtains

A.1.3.1 Zones (Fill material given as per Unified Classification System)

a. Core material - CL
b. Side slopes (max.) - 1V:½H
c. U/S zone material - random fill
d. D/S zone (1) material - random fill
e. D/S zone (1) slope (max.) - 1V:1.5H
f. D/S zone (2) material - SP-SC

A.1.3.2 Cutoff Trench (Filled as part of core)

a. Base width - 10'
b. Side slopes - 1V:2H
c. Bottom elevation - 486' msl (approx.)

A.1.3.3 Grout Curtains - None

A.2 Reservoir and Drainage Area

A.2.1 Reservoir - (Normal pool elevation 524' msl, 6' below the effective crest of the dam.)

a. Surface area (normal) - 6.3 acres
b. Fetch - 800'
c. Capacity (normal) - 63 acre-feet
d. Capacity (top of dam) - 99 acre-feet

A.2.2 Drainage Area

a. Size - 21 acres
b. Maximum relief - 80'
c. Soil - Ruston (HSG B), Lexington (HSG B), Providence (HSG C)
d. Cover - Medium density residential
e. Runoff (PMF) - 47.6 acre-feet
f. Runoff (P_{100}) - 8.2 acre-feet

A.3 Outlet Structures

A.3.1 Drawdown Drain - (Slide valve at base of service spillway riser.)

a. Valve diameter - 12"
b. Invert elevation - 513' msl

A.3.2 Service Spillway - (Skirted concrete riser connected to concrete pipe with concrete antiseep collars.)

a. Inlet size (2) - 1' x 4'
b. Pipe diameter - 12"
c. Pipe length - 150'
d. Pipe slope - 6% min.
e. Antiseep collars (size) - 8' x 8'
f. Antiseep collars (number & spacing) - 5 @ 12'
g. Capacity - 15 cfs

A.3.3 Emergency Spillway - (Vegetated earth trapezoidal channel curving around right end of dam.)

a. Base width - 10'
b. Control section length - 30'
c. Control section elevation - 529' msl
d. Side slopes - 1V:3H
e. Maximum head - 1'
f. Capacity design - 37.2 cfs

The existing spillway is a bare earth triangular channel with the following dimensions:

g. Elevation - 529.2' msl
h. Maximum head - .6'
i. Top width - 15'
j. Capacity - 8 cfs

A.4 Historical Data

A.4.1 Construction Date - 1976

A.4.2 Designer - Ragon Engineering Company
Bolivar, Tennessee

A.4.3 Soil Testing - Construction Materials Lab, Inc.
Jackson, Tennessee

A.4.4 Builder - S & W Construction Company
Memphis, Tennessee

A.4.5 Developer - Terra Aqua Corporation

A.4.6 Owner - Candlewood Lakes Property Owner's Asso., W. T. Arnold, President

A.4.7 Previous Inspections - February 1979

A.4.8 Seismic Zone - 2

A.5 Downstream Hazard Data

A.5.1 Downstream Hazard Potential Classification

a. Corps of Engineers - High
b. State of Tennessee - 1

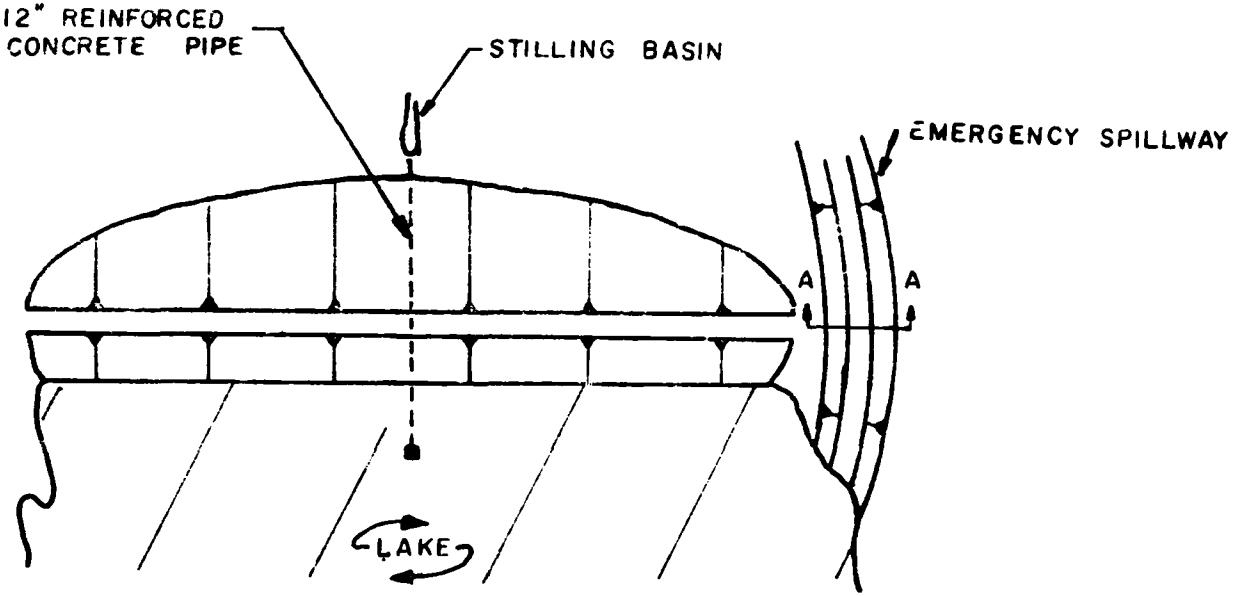
A.5.2 Persons in Probable Flood Path - Undetermined (D/S area being developed into residential lots.)

A.5.3 Downstream Property - Residential lots; Hwy 57; main line Southern Railroad

A.5.4 Warning Systems - None

APPENDIX B

SKETCHES AND LOCATION MAP



GENERAL PLAN

SCALE: 1" = 100'

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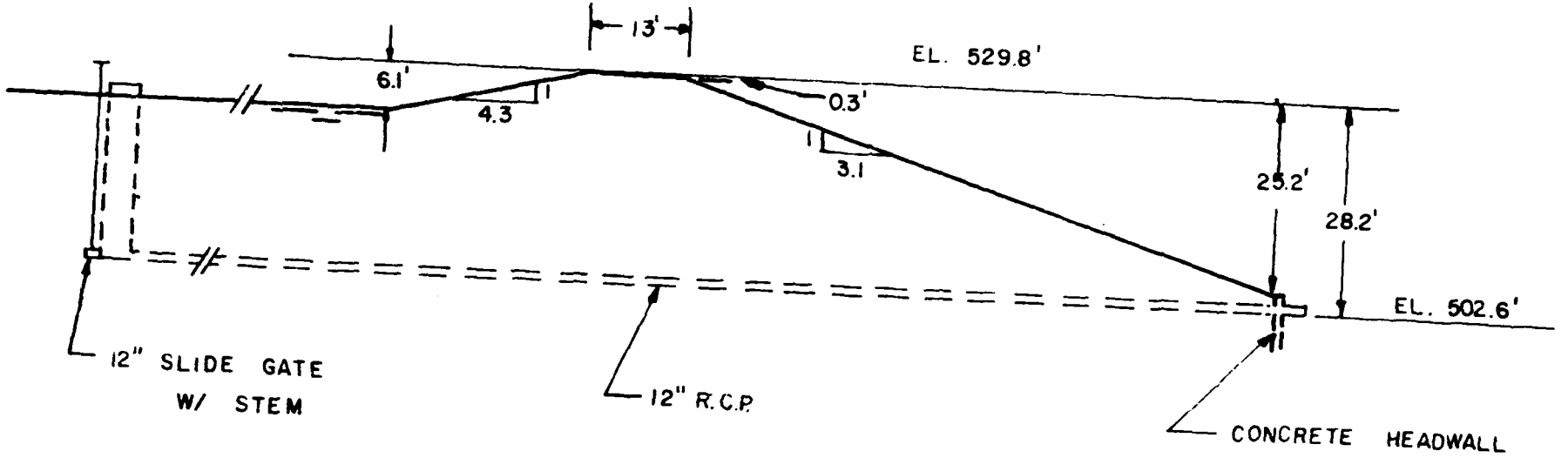
DATE: 13 MAY 81
SHEET: 1 OF 4



MAXIMUM SECTION

SCALE: 1" = 20'

CRYSTAL DAM
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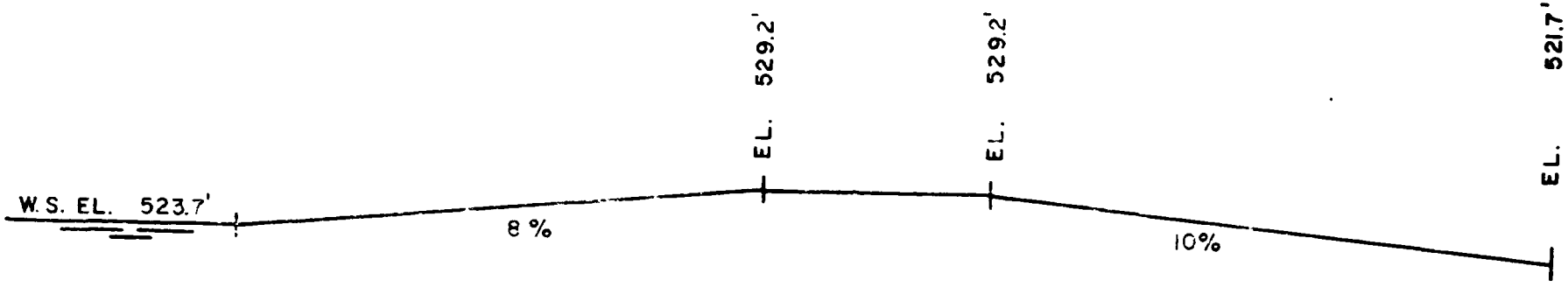
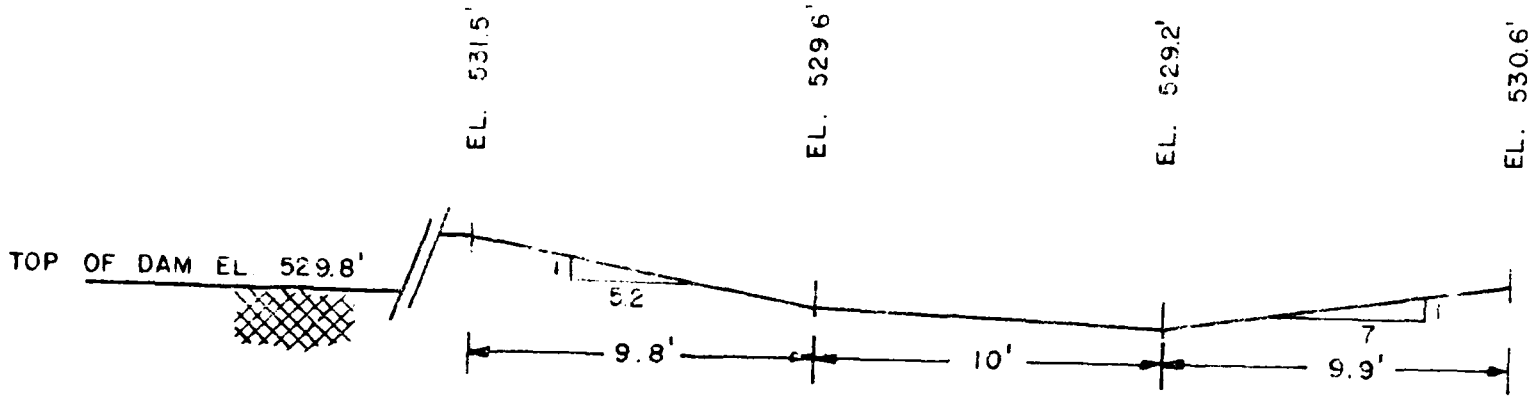
DATE: 13 MAY 81
SHEET: 2 OF 4



EMERGENCY SPILLWAY PROFILE

SCALE: 1"= 20'

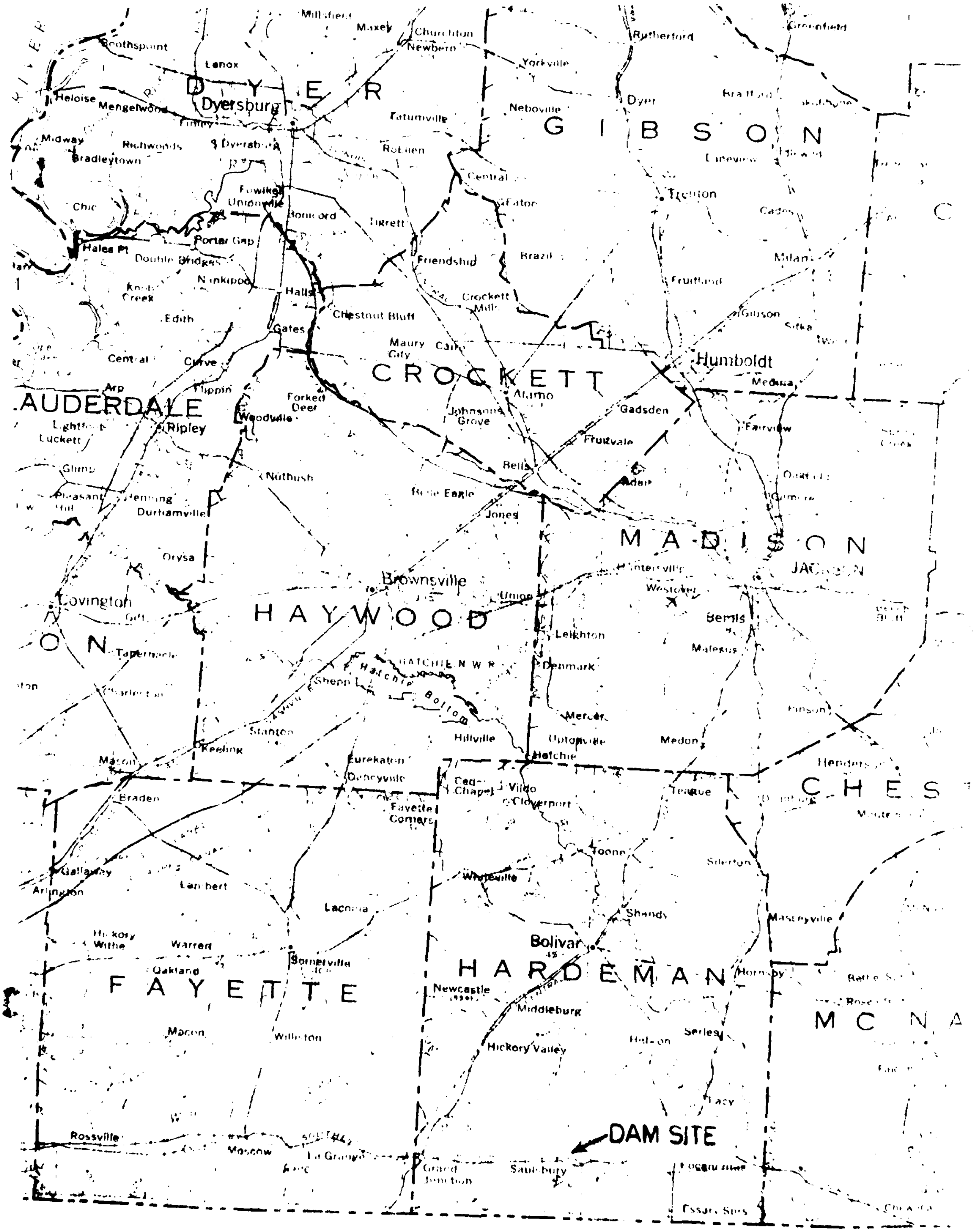
CRYSTAL DAM	
DRAWN BY:	J. G.
DATE:	13 MAY 81
SHEET:	4 OF 4



EMERGENCY SPILLWAY CONTROL SECTION A–A

SCALE: 1" = 5'

CRYSTAL DAM
DRAWN BY: J. G.
DATE: 13 MAY 81
SHEET: 3 OF 4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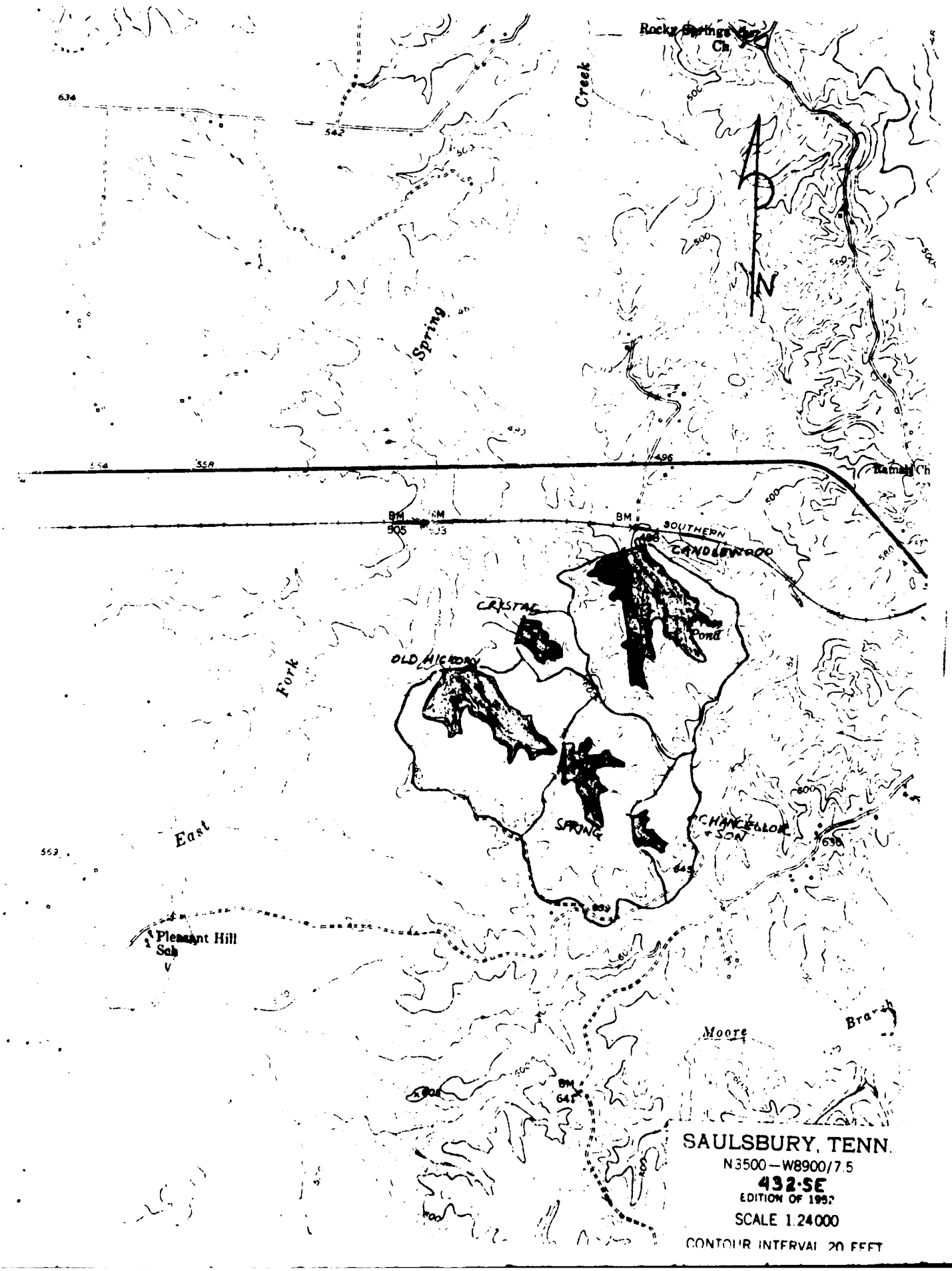
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Creek
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CANDLEWOOD
CRYSTAL
Pond
OLD HICKORY
Fork
East
SPRING
CHANCELLOR
SON
Pleasant Hill
Sch
Moore
Branch
BM
641
SAULSBURY, TENN.
N3500—W8900/7.5
432-SE
EDITION OF 1957
SCALE 1:24000
CONTOUR INTERVAL 20 FEET

APPENDIX C

PHOTOGRAPHIC RECORD

Photographic Record

Photo No. 1 - The upstream slope of the dam from the left abutment.

Photo No. 2 - Erosion occurring near the water surface on the upstream slope.

Photo No. 3 - The service spillway riser.

Photo No. 4 - The outlets of the service spillways and toe drains.

Photo No. 5 - A discontinuity on the downstream slope near the toe and slightly to the right of the service spillway outlet. The feature was apparently produced by earth moving equipment.

Photo No. 6 - A closeup view of the feature in photo no. 5 showing the layering of soil in the embankment.

Photo Nos. 7 & 8 - Holes on the downstream slope due to erosion and/or dispersive clays.

Photo Nos. 9 & 10 - A seep or spring on the right embankment abutment contact starting about one foot below the pool elevation.

Photo Nos. 11 & 12 - The emergency spillway channel showing the sparse vegetation and excessive erosion of the side slopes.

PHOTO NO.1

PHOTO NO.2

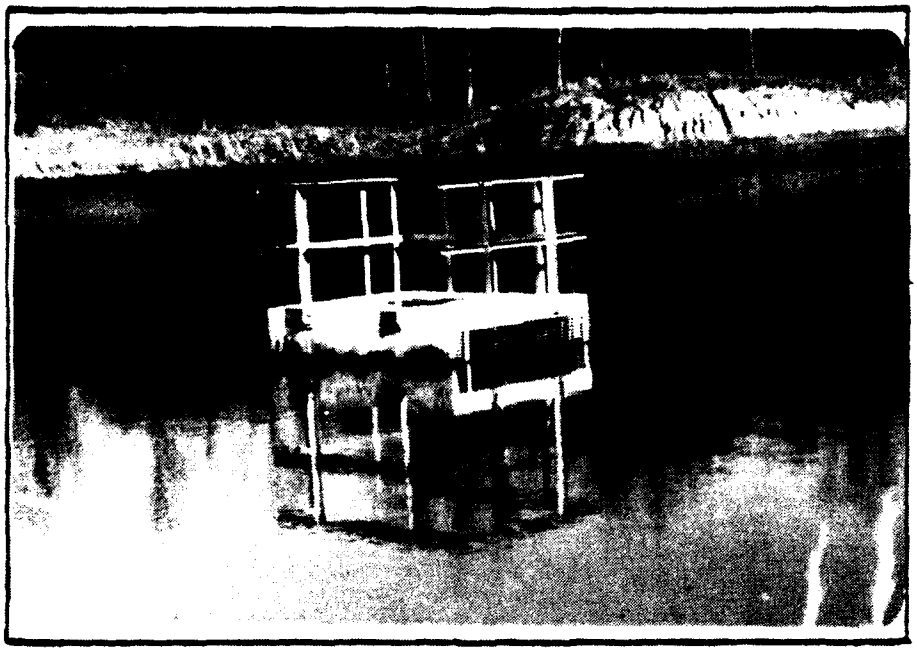


PHOTO NO.3

PHOTO NO.4

PHOTO NO.5

PHOTO NO.6

PHOTO NO.7

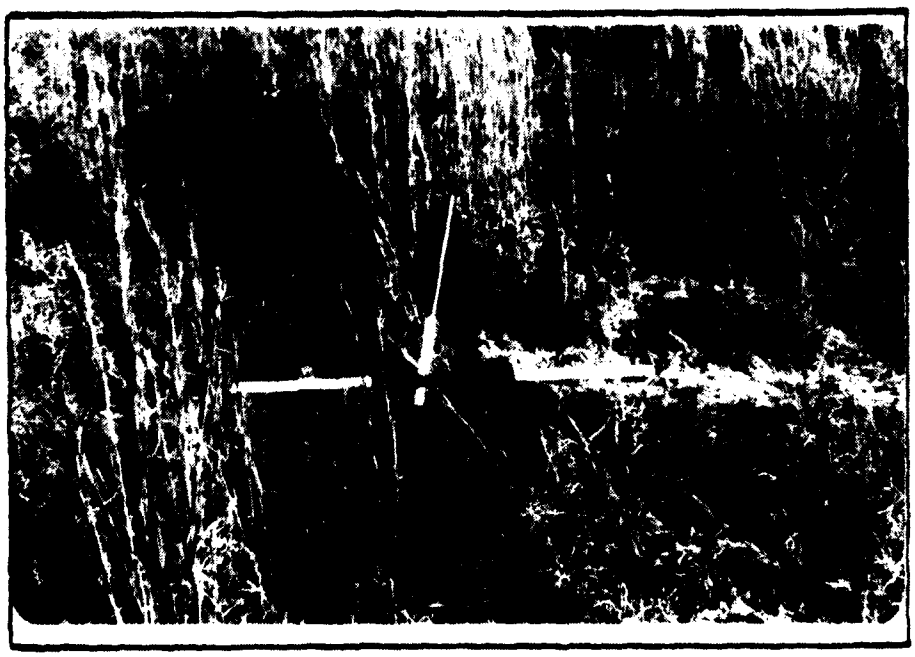


PHOTO NO.8

PHOTO NO.9

PHOTO NO.10

PHOTO NO.11

PHOTO NO.12

APPENDIX D

CHECKLISTS - VISUAL INSPECTION, ENGINEERING DATA, SOIL TESTS

Check List
Visual Inspection of Earth Dams
Department of Conservation
Division of Water Resources

Name of Dam Crystal

County Hardeman Date of Inspection 1/23/81

ID # - State 35-7031 Federal TN-06031

Type of Dam Zoned earthfill

Hazard Category-Federal High State 1

Weather Clear Temperature 45°

Pool at Time of Inspection about NPL (distance from crest)

Tailwater at Time of Inspection None (distance from stream bed)

Design/As Built Drawings Available: Yes X No ____

Location: TDWR

Copy Obtained: Yes X No ____

Reviewed: Yes X No ____

Construction History Available: Yes X No ____

Location: TDWR

Copy Obtained: Yes X No ____

Reviewed: Yes X No ____

Other Records and Reports Available: Yes ____ No ____

Location: ____

Copy Obtained: Yes ____ No ____

Reviewed: Yes ____ No ____

Prior Incidents or Failures: Yes ____ No X

Inspection Personnel and Affiliation:

Ed O'Neill - TDWR

George Moore - TDWR

Anthony Privett - TDWR

I. Embankment

A. Crest

Description (1st inspection) Straight alignment; north-south orientation.

1. Longitudinal Alignment O.K.

2. Longitudinal Surface Cracks None

3. Transverse Surface Cracks None

4. General Condition of Surface Good

5. Miscellaneous Crest is covered by sage grass with little other cover.

B. Upstream Slope

1. Undesirable Growth or Debris Sage grass; entire dam should be regrassed.

2. **Sloughing, Subsidence, or Depressions** None

3. **Slope Protection** None apparent, only sage brush; some minor erosion at water surface.

a. **Condition of Riprap** None

b. **Durability of Individual Stones** N/A

c. **Adequacy of Slope Protection Against Waves and Runoff** O.K. at present time.

d. **Gradation of Slope Protection - Localized Areas of Fine Material** N/A

4. **Surface Cracks** None

C. **Downstream Slope**

1. **Undesirable Growth or Debris** Sage grass cover, only needs more protective cover.

2. **Sloughing, Subsidence, or Depressions; Abnormal Bulges or Non-Uniformity** Some holes and collapsed holes; shallow, generally less than 1' deep. What appears to be a cut area is located just above the spillway pipe. Minor sloughing is occurring at the edge of the crest.

3. **Surface Cracks on Face of Slope** None

4. **Surface Cracks or Evidence of Heaving at Embankment Toe** None

5. **Wet or Saturated Areas or Other Evidence of Seepage on Face of Slope; Evidence of "Piping" or "Boils"** None

6. **Drainage System** Clear, no flow.

7. **Fill Contact with Outlet Structure** O.K.

8. **Condition of Grass Slope Protection** Poor although erosion is minimal.

D. Abutments

1. Erosion of Contact of Embankment with Abutment from Surface Water Runoff, Upstream or Downstream _____

2. Springs or Indications of Seepage Along Contact of Embankment with the Abutments See below.

3. Springs or Indications of Seepage in Areas a Short Distance Downstream of Embankment - Abutment Tie-in

None

Right embankment abutment tie in is wet. Could not be surface runoff. The wet area begins about 1 foot below the normal pool elevation. The flow is clear. There is little wetland vegetation in the area. The wet area is possibly due to spring flow although the emergency spillway should have intercepted any ground water flow. The flow passes along the toe to the outlet channel. Flow is slight (less than 1 gpm) but definite. The area should be reinspected in dryer weather.

II. Area Downstream of Embankment, Including Channel

A. Localized Subsidence, Depressions, Sinkholes, Etc. None

B. Evidence of "Piping", "Boils", or "Seepage" None

C. Unusual Presence of Lush Growth, such as Swamp Grass, etc. None

D. Unusual Muddy Water in Downstream Channel None

E. Sloughing or Erosion None

F. Surface Cracks or Evidence of Heaving Beyond Embankment Toe None

G. Stability of Channel Sideslopes O.K.

H. Condition of Channel Slope Protection O.K.

I. Adequacy of Slope Protection Against Waves, Currents, and Surface Runoff O.K.

J. Miscellaneous N/A

K. Condition of Relief Wells, Drains, and Other Appurtenances N/A

L. Unusual Increase or Decrease in Discharge from Relief Wells N/A

III. Instrumentation

A. Monumentation/Surveys Found benchmark; see plans.

B. Observation Wells None

C. Weirs None

D. Piezometers None

E. Other None

IV. Spillways

A. Service Spillway (Service/Emergency Combination Yes __ No X)

1. **Intake Structure Condition** O.K.; observed from bank.

2. **Outlet Structure Condition** Good; concrete culvert pipe; observed from outlet.

3. **Pipe Condition** Good; end chipped.

4. **Evidence of Leakage or Piping** None

5. **General Remarks**

B. Emergency Spillway

1. **General Condition** No cover

2. **Entrance Channel** Some siltation occurring.

3. **Control Section** Moderate to severe siltation; will eventually raise crest of spillway to crest of dam.

3. **Exit Channel** Moderate erosion occurring; not well defined.

4. **Vegetative/Woody Cover** None

5. **Other Observations** Right spillway bank is not stabilized and is eroding into the channel.

V. Emergency Drawdown Facilities (if part of service spillway so state) Part of service spillway.

Are Facilities Operable: Yes _____ No _____ Unknown

Were Facilities Operated During Inspection: Yes _____ No X

Date Facilities Were Last Used Unknown

VI. **Reservoir**

A. **Slopes** The slopes in some areas are almost vertical but appear stable.

B. **Sedimentation** Minor

C. **Turbidity** Clear, grayish green; 2' visibility.

VII. **Drainage Area**

Description (for hydrologic analysis) Low density residential with wooded lots.

A. **Changes in Land Use**

VIII. **Downstream Area (Stream)**

A. **Condition (obstructions, debris, etc.)** O.K.

B. **Slopes** Flat

C. **Approximate No. Homes, Population, and Distance D/S**

Area immediately D/S of dam is being developed for residential lots.

D. **Other Hazards** Hwy 57 and main line Southern Railroad about .5 miles D/S.

OHIO RIVER DIVISION, NASHVILLE DISTRICT
SOIL TEST DATA SUMMARY

PROJECT CRYSTAL LAKE DAM HOLE 1 ELEV. TOP _____ SHEET 1 OF 1 SHEETS

SAMPLE NO.	DEPTH OF SAMPLE	LABORATORY CLASSIFICATION	NAT. WATER CONT.	ATTERBERG LIMITS		MECHANICAL ANAL.		
				LL	PL	Gravel %	Sand %	Fines %
1	SURFACE	LIGHT YELLOWISH BROWN SILTY	*1.0	27.2	15.9			
		SANDY CLAY (CL) * DRY, HARD						
		TRACE ORGANIC, TRACE MICA,						
		TRACE FE STAIN.				→	P.I.	11.5
		* SAMPLE APPEARS TO HAVE						
		DRIED OUT SINCE IT WAS						
		TAKEN.						

ORH 944
SEPT 67

ORNED-D

IX. Miscellaneous

Incidents/Failures None

Observed Geology of Area Sandy clay soils. A road cut near base of dam revealed a layered fill (2 sandy layers alternating with a clay layer). Soil sample taken on crest 1' deep.

X. Conclusions

Dam appears in good condition except for inadequate vegetative cover.

XI. Recommendations

Renovate grass cover.

Regrade and stabilize spillway and banks.

Monitor seepage.

Regional Engineer

Chief Engineer

APPENDIX E

HYDRAULIC AND HYDROLOGIC DATA

Hydraulic and Hydrologic Calculations

Crystal Lake Dam is located in Hardeman County, Tennessee. The primary land use is medium density residential development with about 30% of the area under water. The predominant soil types are Ruston (HSG B), Lexington (HSG B), and Providence (HSG C). The runoff curve number was calculated to be 84 AMC II.

The Crystal Lake Dam is a small size, high hazard potential dam. As such, it is required to pass the ½ Probable Maximum Flood (½ PMF). The PMF is derived from the Probable Maximum Precipitation. Using the U. S. Weather Service TP-40, the 6-hour PMP was estimated to be 29.7 inches yielding 27.5 inches of runoff during the PMF and 13.8 inches during the ½ PMF.

The total inflow into the reservoir during the ½ PMF is about 20.8 acre-feet with a peak rate of 251 cfs. Crystal Lake has a maximum storage above normal pool of 36 acre-feet and maximum spillway discharge rate of 23 cfs. The impoundment is sufficient to pass the ½ PMF with no flow in the emergency spillway. The PMF overtops the dam by about 0.1 feet.

Routing of a 1-10 day, 100-year storm indicated that the storm would pass with no flow in the emergency spillway.

The inflow hydrograph was calculated by methods contained in Chapter 21, Section 4, of the SCS National Engineering Handbook. Hydraulic calculations were performed in accordance with King & Braters' Handbook of Hydraulics. The routings were taken from NEH-4, Chapter 17. Equation 17-11 was rearranged to the following form:

$$I_1 + I_2 + \left(\frac{2S_1}{\Delta t} - O_1\right) = \frac{2S_2}{\Delta t} + O_2$$

EVENT	ANTECEDENT MOISTURE CONDITION	
	II	III
PMF	Overtops 0.1' for 2.4 hours	Not routed
½ PMF	Passes about 2.5' freeboard	Passes with no flow in the emergency spillway
100 - YEAR	Not routed	Not routed
1-10 day, 100 year	Passed with no flow in emergency spillway	Not routed

CRYSTAL LAKE INFLOW HYDROGRAPH GEM

LOCATED ON TRIBUTARY of SPRING CREEK
DRAINAGE AREA = 20.8 Ac = .0325 Mi^2
MAJOR SOIL TYPES - RUSTON, LEXINGTON, PROVIDENCE
MAJOR LAND USE - MEDIUM DENSITY RESIDENTIAL DEVELOPEMENT.
CN = 84 AMC II, 93 AMC III
NORMAL POOL AREA = 6.3 Ac
D/S HAZARD - HIGH
6-HOUR PMP = 29.7 IN
6 HOUR P_{100} = 5.5 IN
Y = 18.5%
ℓ = 800 ft

AMC II

L = .054 hr
T_c = .090 hr
T_p = .063 hr

PMP = 29.7 IN
Q = 27.5 IN
HYDROGRAPH FAMILY #1
T_o = 5.81 hr
T_o/T_p = 92.2
REV T_o/T_p = 75
REV T_p = .077 hr
q_p = 203 cfs/IN
Q_{qp} = 5584 cfs
q_{max} = 502 cfs @ 2.08 hr

P_{100} = 5.5 IN
Q = 3.7 IN
HYDROGRAPH FAMILY # 2
T_o = 5.1 hr
T_o/T_p = 81
REV T_o/T_p = 75
REV T_p = .068 hr
q_p = 231 cfs/IN
Q_{qp} = 856 cfs
q_{max} = 68 cfs @ 1.43 hr

AMC III

L = .021 hr
T_c = .035 hr
T_p = .025 hr

PMP = 29.7 IN
Q = 28.8 IN
HYDROGRAPH FAMILY #1
T_o = 5.9 hr
T_o/T_p = 236
REV T_o/T_p = 75
REV T_p = .079 hr
q_p = 200 cfs
Q_{qp} = 5759 cfs.
q_{max} = 518 cfs @ 2.13 hr

P_{100} = 5.5 IN
Q = 4.7 IN
HYDROGRAPH FAMILY # 1
T_o = 5.55 hr
T_o/T_p = 222
REV T_o/T_p = 75
REV T_p = .074
q_p = 213 cfs/IN
Q_{qp} = 999 cfs
q_{max} = 90 cfs @ 2.00 hr

CRYSTAL LAKE AMC II PMF HYDROGRAPH 2 sq. mi.

HYDROGRAPH FAMILY # 1 $T_0/T_p = 75$

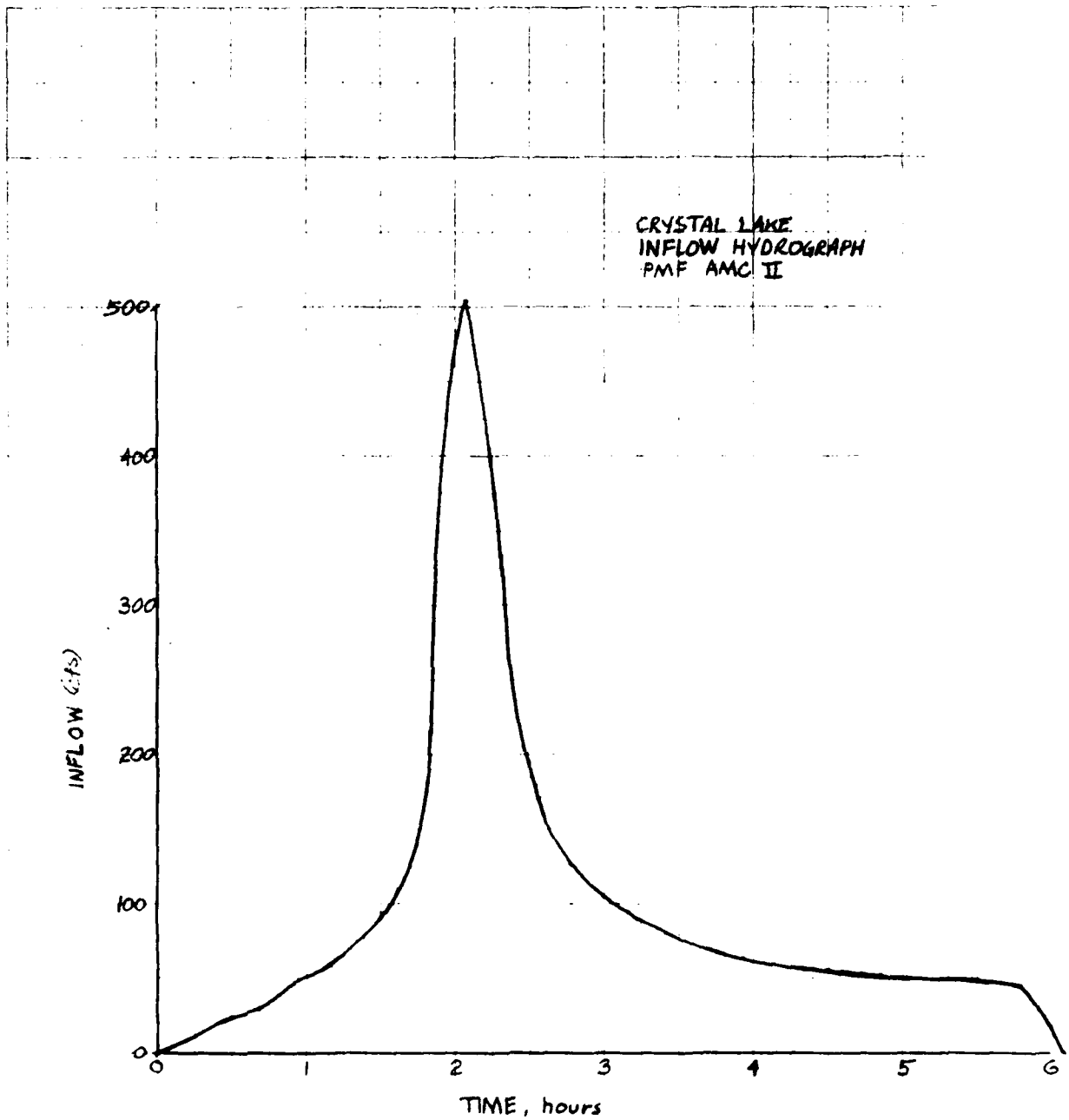
$T_p = .077$ hr $Q_{gp} = 5584$ cfs

LINE No	t/T_p	t (hrs)	q_c/q_p	q_c (cfs)
1	0	0	0	0
2	3.00	.23	.0017	10
3	6.00	.46	.0039	22
4	9.00	.69	.0054	30
5	12.00	.92	.0084	47
6	15.00	1.16	.0106	59
7	18.00	1.39	.0137	77
8	21.00	1.62	.0197	110
9	24.00	1.85	.0516	288
10	27.00	2.08	.0900	503
11	30.00	2.31	.0593	331
12	33.00	2.54	.0321	179
13	36.00	2.77	.0226	126
14	39.00	3.00	.0188	105
15	42.00	3.23	.0161	90
16	45.00	3.47	.0142	79
17	48.00	3.70	.0125	70
18	51.00	3.93	.0112	63
19	54.00	4.16	.0105	59
20	57.00	4.39	.0100	56
21	60.00	4.62	.0097	54
22	63.00	4.85	.0094	52
23	66.00	5.08	.0090	50
24	69.00	5.31	.0087	49
25	72.00	5.54	.0084	45
26	75.00	5.78	.0081	45
27	78.00	6.01	.0002	1
28	81.00	6.24	0	0

2600

49.44 cfs

ACTUAL 47.6 Acft ERROR 3.8%


CRYSTAL LAKE
INFLOW HYDROGRAPH
PMF AMC II
500
400
300
200
100
0
INFLOW (cfs)
0
1
2
3
4
5
6
TIME, hours

CRYSTAL LAKE ROUTING PMF AMC II GEM

t (hrs)	INFLOW (cfs)	2S/Δt - O	2S/Δt + O	OUTFLOW (cfs)	
0	0	0	0	0	
.24	10	10	10	0	
.48	22	54	42	6	
.72	30	90	106	8	
.96	47	147	167	10	
1.20	59	231	253	11	
1.44	77	343	367	12	
1.68	110	504	530	13	
1.92	288	874	902	14	
2.16	502	1636	1664	14	
2.40	331	2441	2469	14	
2.64	179	2923	2951	14	
2.88	126	3198	3228	15	
3.12	105	3397	3429	16	
3.36	90	3552	3592	20	
3.60	79	3609	3721	56	OVERTOPS.
3.84	70	3608	3758	75	
4.08	63	3607	3741	67	PEAK PASSES. N.1 ft ABOVE CREST
4.32	59	3609	3729	60	
4.56	56	3610	3724	57	
4.80	54	3608	3720	56	
5.04	52	3608	3719	53	
5.28	50	3610	3710	50	
5.52	49	3609	3709	50	
5.76	47	3609	3705	48	
6.00	45	3609	3701	46	
6.24	1		3655	23	Below crest
6.48					

CRYSTAL LAKE ROUTING ½ PMF AMCII

GEM1

t (hours)	INFLOW (cfs)	2S/Δt − O	2S/Δt + O	OUTFLOW (cfs)
0	0	0	0	0
.24	5	5	5	0
.48	11	11	21	5
.72	15	25	37	6
.96	23	49	63	7
1.20	30	86	102	8
1.44	38	136	154	9
1.68	55	207	229	11
1.92	149	382	406	12
2.16	251	751	777	13
2.40	166	1140	1168	14
2.64	90	1368	1396	14
2.88	63	1493	1521	14
3.12	53	1581	1609	14
3.36	45	1651	1679	14
3.60	40	1708	1736	14
3.84	35	1755	1783	14
4.08	31	1793	1821	14
4.32	29	1825	1853	14
4.56	28	1854	1882	14
4.80	27	1881	1909	14
5.04	26	1906	1934	14
5.28	25	1929	1957	14
5.52	24	1950	1978	14
5.76	23	1969	1997	14
6.00	23	1987	2015	14
6.24	1	1983	2011	14
6.48	0		1984	14

peak outflow with no flow in ES.

CRYSTAL LAKE AMC III P_{100} HYDROGRAPH

2 pm.

HYDROGRAPH FAMILY #1 $T_o/T_p = 7.5$

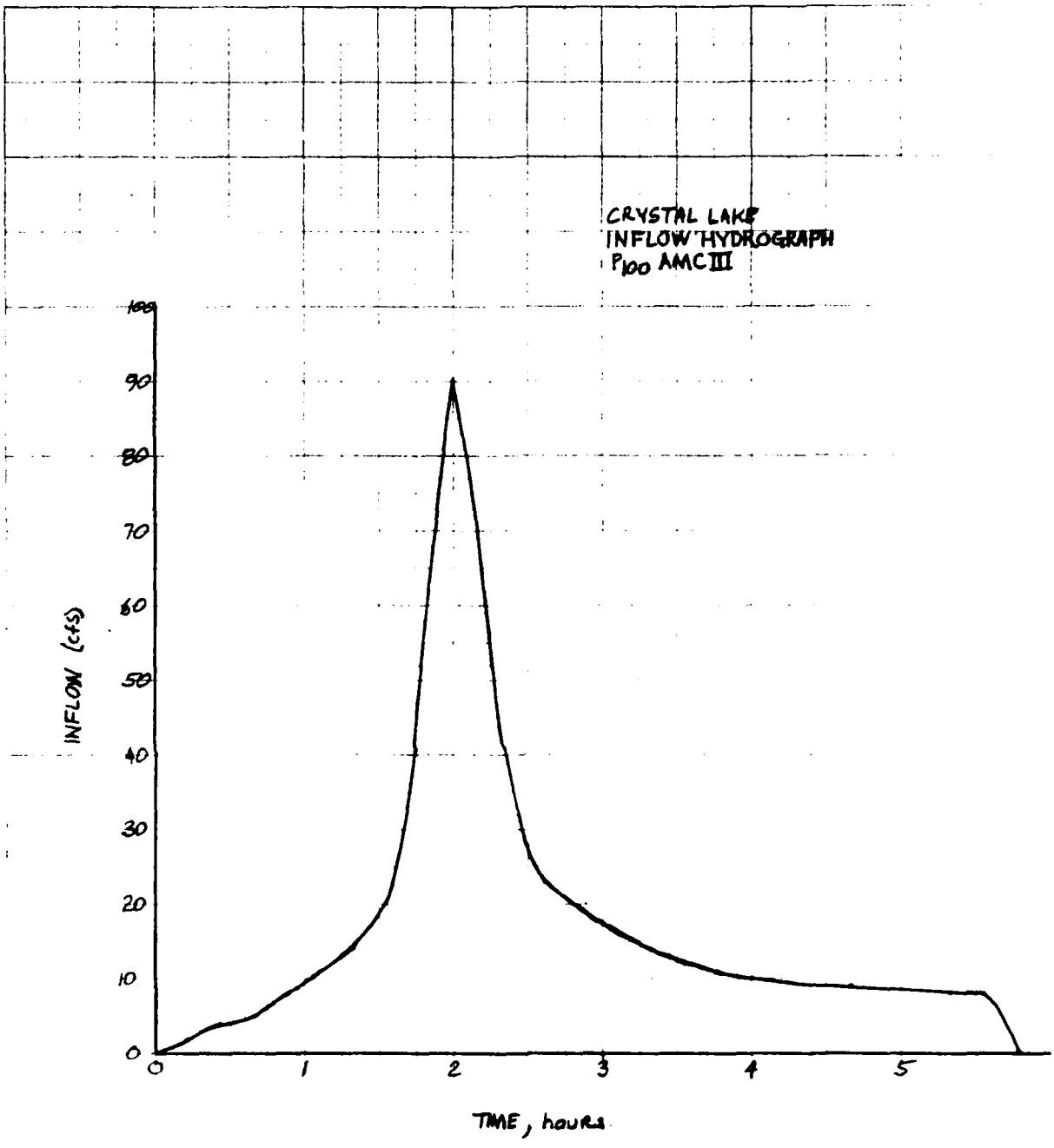
$T_p = .074$ $Q_{gp} = 999$ cfs

LINE NO	t/T_p	t (hours)	q_c/q_p	q_c (cfs)
1	0	0	0	0
2	3.00	.22	.0017	2
3	6.00	.44	.0039	4
4	9.00	.66	.0054	5
5	12.00	.89	.0084	8
6	15.00	1.11	.0106	11
7	18.00	1.33	.0137	14
8	21.00	1.55	.0197	20
9	24.00	1.78	.0516	52
10	27.00	2.00	.0900	90
11	30.00	2.22	.0593	59
12	33.00	2.44	.0321	32
13	36.00	2.66	.0226	23
14	39.00	2.89	.0188	19
15	42.00	3.11	.0161	16
16	45.00	3.33	.0142	14
17	48.00	3.55	.0125	12
18	51.00	3.77	.0112	11
19	54.00	4.00	.0105	10
20	57.00	4.22	.0100	10
21	60.00	4.44	.0097	10
22	63.00	4.66	.0094	9
23	66.00	4.88	.0090	9
24	69.00	5.11	.0087	9
25	72.00	5.33	.0084	8
26	75.00	5.55	.0081	8
27	78.00	5.77	.0002	0
28	81.00	5.99	0	0

442 cfs

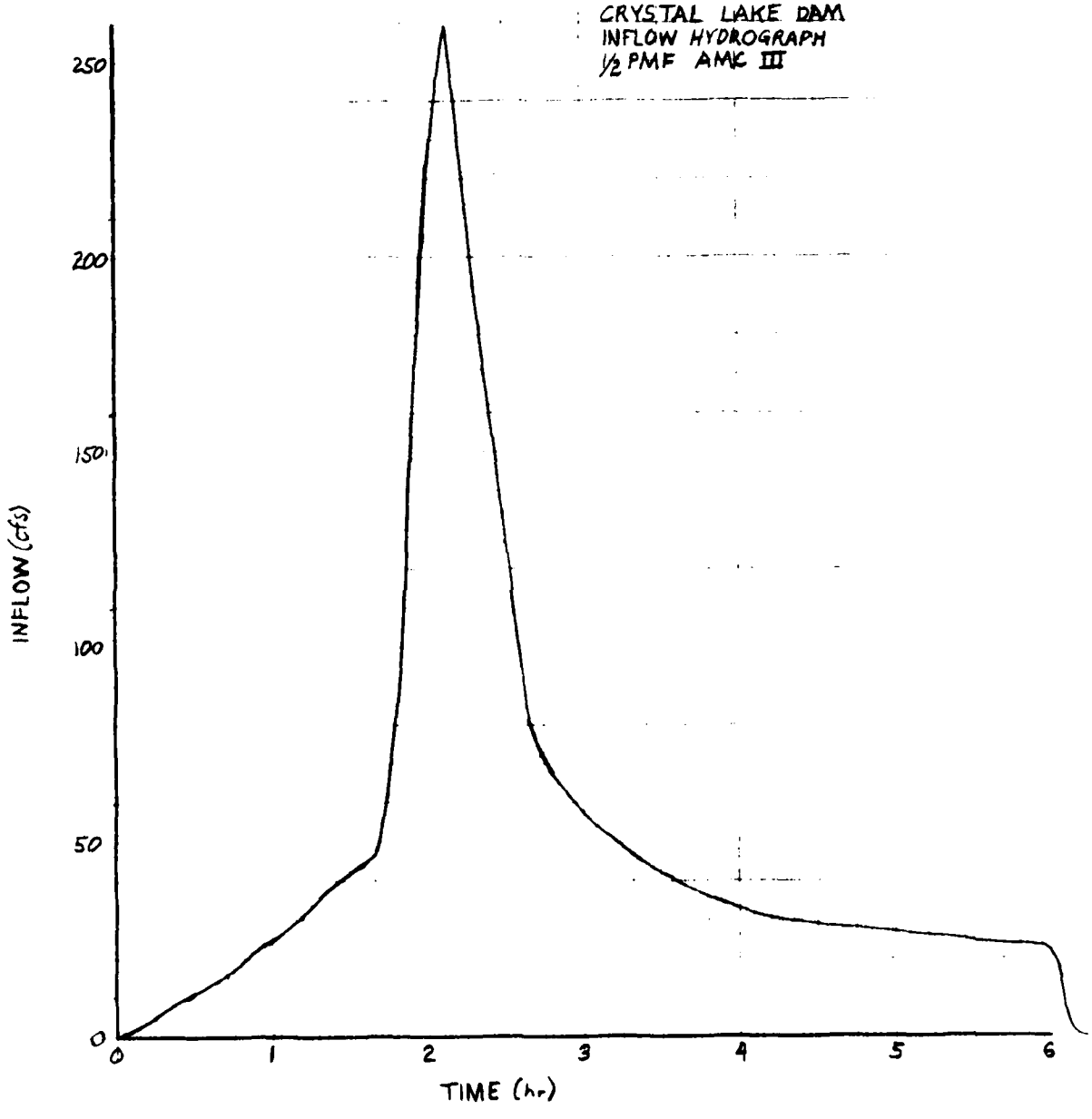
SUMMATION 8.11 Ac ft

ACTUAL 8.15 Ac ft OK


CRYSTAL LAKE
INFLOW HYDROGRAPH
P100 AMC III
INFLOW (cfs)
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
TIME, hours

CRYSTAL LAKE PMF + ½ PMF AMC III Gem

t (hours)	PMF INFLOW (cfs)	½ PMF INFLOW cfs.
0	0	0
.24	10	5
.47	22	11
.71	31	15.5
.95	48	24
1.19	61	30.5
1.42	79	39.5
1.66	113	56.5
1.90	297	148.5
2.13	518	259
2.37	342	171
2.61	185	92.5
2.84	130	65
3.08	108	54
3.32	93	46.5
3.56	82	41
3.79	72	36
4.03	65	32.5
4.27	60	30
4.50	58	29
4.74	56	28
4.98	54	27
5.21	52	26
5.45	50	25
5.69	48	24
5.93	47	23.5
6.16	1	0.5
6.40	0	0


CRYSTAL LAKE DAM
INFLOW HYDROGRAPH
½ PMF AMC III
INFLOW (cfs)
250
200
150
100
50
0
0
1
2
3
4
5
6
TIME (hr)

CRYSTAL LAKE DAM ROUTING ½ PMF AMC III GCM

TIME (hr)	INFLOW (cfs)	2S/Δt − O	2S/Δt + O	OUTFLOW(cfs)
0	0	0	0	0
.24	5	5	5	0
.48	11	11	21	5
.72	16	26	38	6
.96	24	52	66	7
1.20	31	91	107	8
1.44	40	142	162	10
1.68	50	210	232	11
1.92	164	400	424	12
2.16	259	795	823	14
2.40	162	1188	1216	14
2.64	85	1407	1435	14
2.88	63	1527	1555	14
3.12	53	1615	1643	14
3.36	46	1686	1714	14
3.60	40	1744	1772	14
3.84	35	1791	1819	14
4.08	32	1830	1858	14
4.32	30	1864	1892	14
4.56	28	1894	1922	14
4.80	28	1922	1950	14
5.04	27	1949	1977	14
5.28	26	1974	2002	14
5.52	25	1997	2025	14
5.76	24	2018	2046	14
6.00	21	2035	2063	14
6.24	0	2028	2056	14
6.48	0		2028	

PEAK PMF INFLOW IN C.S.

CRYSTAL LAKE — SPILLWAY RATING — GEM

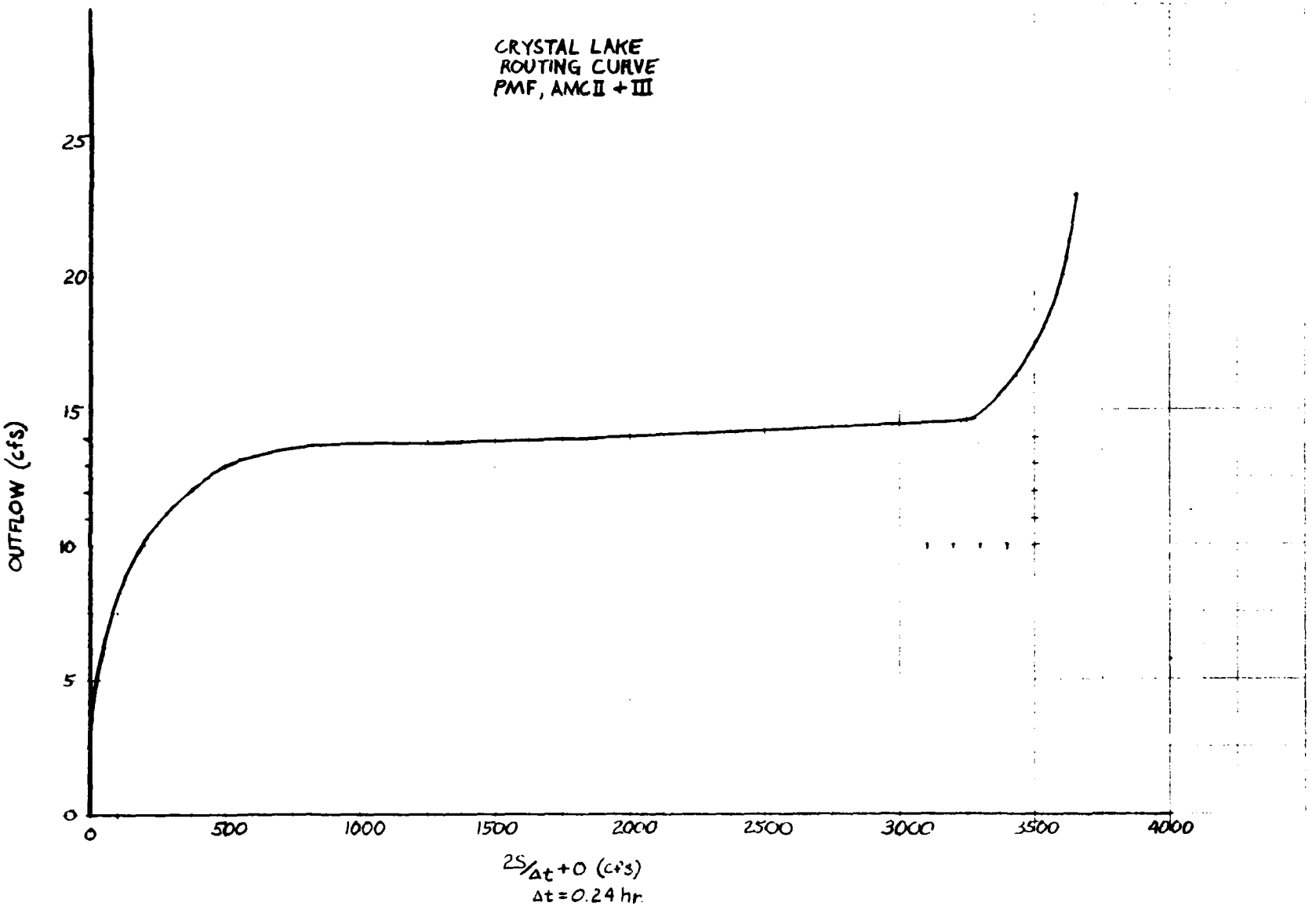
	SERVICE SPILLWAY				EMERGENCY SPILLWAY		TOTAL OUTFLOW
	WEIR FLOW		PIPE FLOW				
ELEV	h (Ft)	Q (cfs)	h(Ft)	Q(cfs)	Hm (Ft)	Q (cfs)	Q_T (cfs)
523.7	0	0					0
524.7	1	~~24.2~~	22.1	13.3			13.3
525.7	2	~~68.3~~	23.1	13.6			13.6
527.7			25.1	14.2			14.2
529.2			26.6	14.6			14.6
529.8	TOP of DAM		27.2	14.8	0.6	8.0	23.0
	h (Ft)	Q cfs					
330.05	.25	166	27.45	14.8	0.85	19.1	200
530.3	.50	470	27.7	14.9	1.10	36.4	521

SERVICE SPILLWAY
WEIR FLOW $Q = CLH^{3/2}$ $C = 3.02$ $L = 8$ Ft
PIPE FLOW $Q = Ca\sqrt{2gh}$ $C = .45$ $a = \pi(.5)^2$
EMERGENCY SPILLWAY
OPEN CHANNEL $Q = 2.295 Z H_m^{5/2}$ $Z_{AVG} = 12.5$
TOP of DAM
WEIR FLOW - $Q = CLH^{3/2}$ $C = 3.02$ $L = 440$ ft

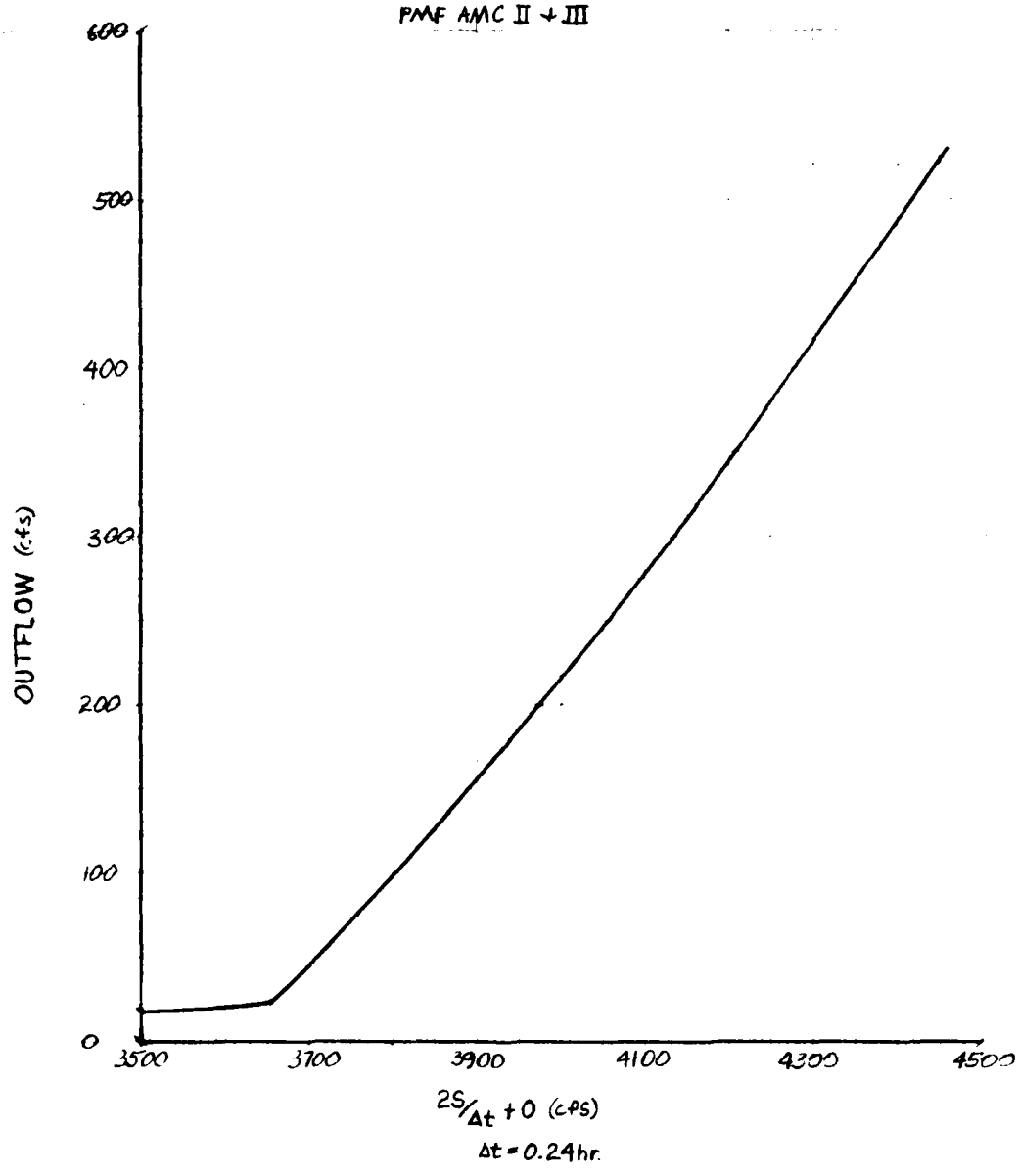
REF: KING'S HANDBOOK §4, §5, §8

ROUTING CURVE COMPUTATION (PMP AMC II + III)

h (Ft)	STORAGE (Aft)	STORAGE (DSF)	$S/\Delta t$ (.24hr CFS)	OUTFLOW (CFS)	$2S/\Delta t + O$ (cfs)
1	5.9	3.0	297	13.3	608
2	11.8	6.0	595	136	1204
4	23.6	11.9	1190	142	2394
5.5	32.5	16.4	1636	14.6	3287
6.1	36.0	18.1	1815	23	3653
6.35	37.5	18.9	1889	200	3978
6.6	39.0	19.6	1964	521	4449


CRYSTAL LAKE
ROUTING CURVE
PMF, AMC II + III
OUTFLOW (cfs)
0
5
10
15
20
25
0
500
1000
1500
2000
2500
3000
3500
4000
2S/Δt+O (cfs)
Δt = 0.24 hr

CRYSTAL LAKE
ROUTING CURVE
ABOVE TOP OF DAM
PMF AMC II → III



CRYSTAL LAKE PSH AND PSMC 100YR 9EM

DA = 20.8 Ac
T_c = .09 Hr
AVERAGE ANNUAL PRECIPITATION 49 IN
AVERAGE ANNUAL TEMPERATURE 52 °F
RUNOFF CN = 84
10DAY - P_{100} = 7.7 IN
10DAY P_{100} = 14.0 IN
10DAY CN = 71
Q_1 = 5.8 IN
Q_{10} = 10.1 IN

Q_1/Q_{10} = .574

SERIAL # 5

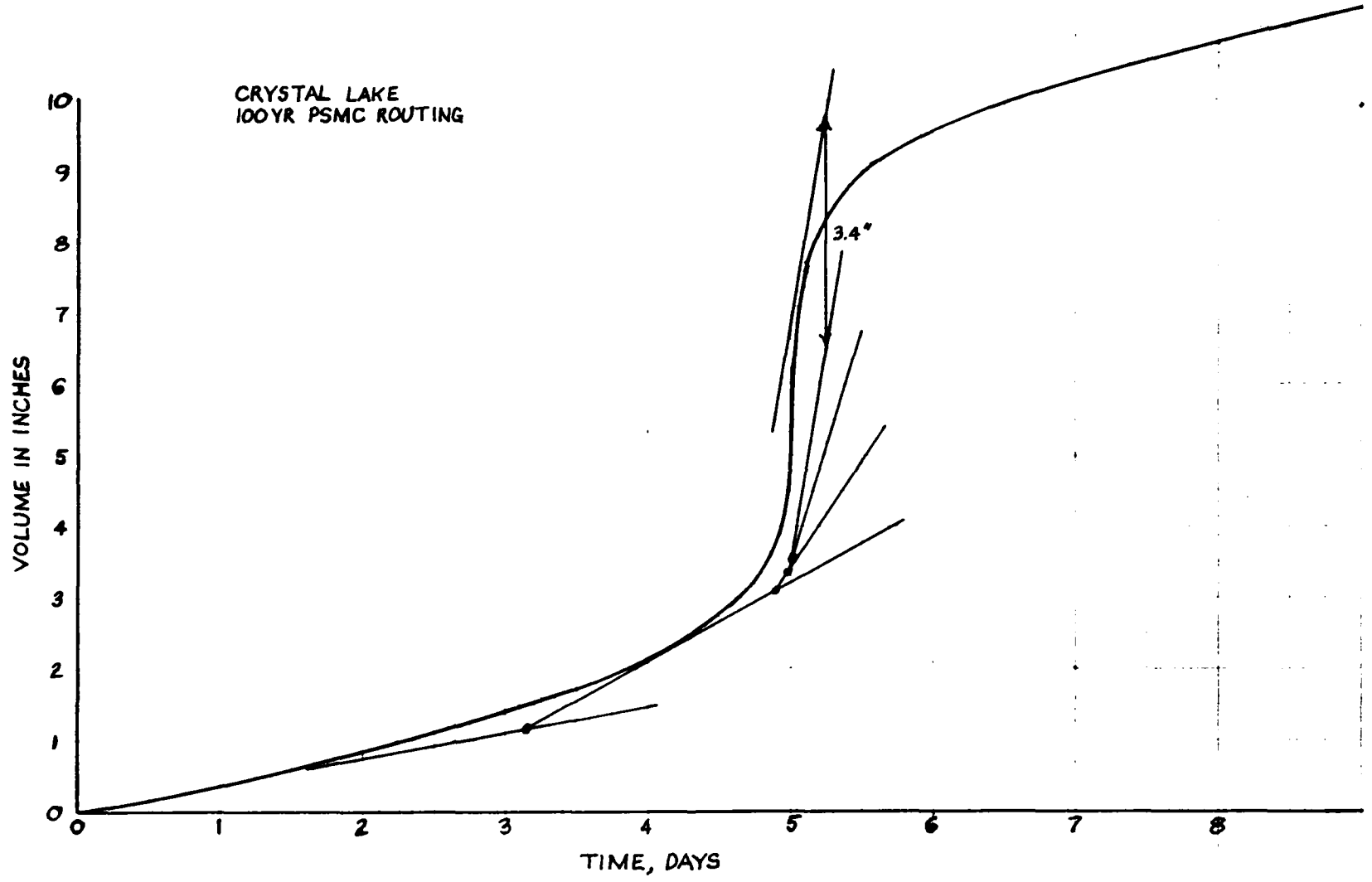
$C_a = \frac{100\ P_a}{(T_a)^2} = \frac{100\ (49)}{(6.2)^2} = 1.275$

min QRF = .153 IN/DAY or 4.11 CSM = .13 cfs

TIME (DAYS)	PRELIMINARY PSH (cfs)	QRF (cfs)	PSH (cfs)	PRELIMINARY PSMC (INCHES)	ACC QRF (INCHES)	(illegible) (INCHES)
0	0	.13	.13	0	0	0
.1	.17	.13	.30	.01	.02	.03
.5	.22	.13	.35	.10	.08	.18
1.0	.25	.13	.38	.23	.15	.33
2.0	.30	.13	.43	.54	.31	.85
3.0	.40	.13	.53	.94	.46	1.40
3.5	.49	.13	.62	1.20	.54	1.74
4.0	.66	.13	.79	1.55	.61	2.16
4.2	.92	.13	1.05	1.72	.64	2.36
4.4	1.11	.13	1.24	1.94	.67	2.61
4.6	1.36	.13	1.49	2.21	.70	2.91
4.7	1.63	.13	1.76	2.38	.72	3.10
4.8	2.16	.13	2.29	2.59	.73	3.32
4.9	3.33	.13	3.46	2.89	.75	3.64
5.0	26.71	.13	26.84	4.55	.77	5.32
5.1	10.30	.13	10.43	6.59	.78	7.37
5.2	4.23	.13	4.36	7.39	.80	8.19
5.3	2.35	.13	2.48	7.75	.81	8.56
5.4	1.66	.13	1.79	7.97	.82	8.80
5.5	1.35	.13	1.48	8.13	.84	8.97
5.6	.98	.13	1.11	8.26	.86	9.12
5.8	.84	.13	.97	8.46	.89	9.35
6.0	.67	.13	.80	8.63	.92	9.55
6.5	.55	.13	.68	8.94	.95	9.88
7.0	.44	.13	.57	9.19	1.07	10.26
8.0	.30	.13	.43	9.56	1.22	10.78
9.0	.34	.13	.47	9.87	1.38	11.25
10.0	.19	.13	.32	10.08	1.53	11.61
10.1	.01	.13	.14	10.10	1.55	11.65

CRYSTAL LAKE WORKING TABLE, PSAAC ROUTING gom.

ELEV. (Ft MSL)	SPILLWAY DISCHARGE (IN/day) INST	AVG	STORAGE (IN)
523.7	0		0
		.37	
523.79	.75		.33
		1.1	
523.84	1.45		.51
		3.0	
524.0	4.59		1.09
		6.5	
524.2	8.59		1.82
		11.9	
524.7	15.2		3.4


CRYSTAL LAKE
100YR PSMC ROUTING
3.4"
VOLUME IN INCHES
TIME, DAYS
0
1
2
3
4
5
6
7
8
9
10

APPENDIX F

CORRESPONDENCE

Date 2/14/79 Region West

INSPECTION REPORT

Name of Dam: Crystal County: Hardeman

Owner's Name: Quad: 432SE

Type Project: Application No.

Existing	X
New Construction	
Repair/Alteration	
Removal	

Type Inspection:

Phase I	
Phase II	
Certificate	X
Cursory	
Preliminary Site Review	

Phase I Reconnaissance

Damage Potential Category: One X Two ___ Three ___ Undetermined ___

Inspection by: George Moore and Troy Wedekind

Inspection Results:

Several holes, apparently due to subsurface erosion, were observed in an area along the D/S slope and about 30 to 50 feet either side of the service spillway. The holes are of a configuration normally associated with dispersive clay. Further evaluation, including dispersive clay tests, should be performed to determine the cause and possible solutions to this problem. Several areas along the U/S face near the water surface have eroded and should be repaired. A large erosion gully is in the emergency spillway. This should be repaired and the area reseeded. A possible wet area along the right abutment about 3' below the water surface should be reinspected during dry weather to determine if it could be seepage or leakage. A large

INSPECTION REPORT (cont.)

area on both sides of the service spillway outlet has eroded and need to be repaired. Leakage was apparently coming from the last section of conduit. Repair and evaluation of the conduit should be made to insure its integrity. This report is accompanied by photos.

Photographic Log

Photo No. 1 - Erosion gully in inlet of emergency spillway.

Photo No. 2 - Possible wet area right abutment about 3 feet below water surface.

Photo No. 3 - Erosion on upstream face near left abutment at the water surface.

Photo No. 4 - Erosion pit on downstream slope.

Photo No. 5 - Looking down downstream slope toward service spillway outlet.

Photo No. 6 - Erosion pits on downstream slope.

PHOTO NO.1

PHOTO NO.2

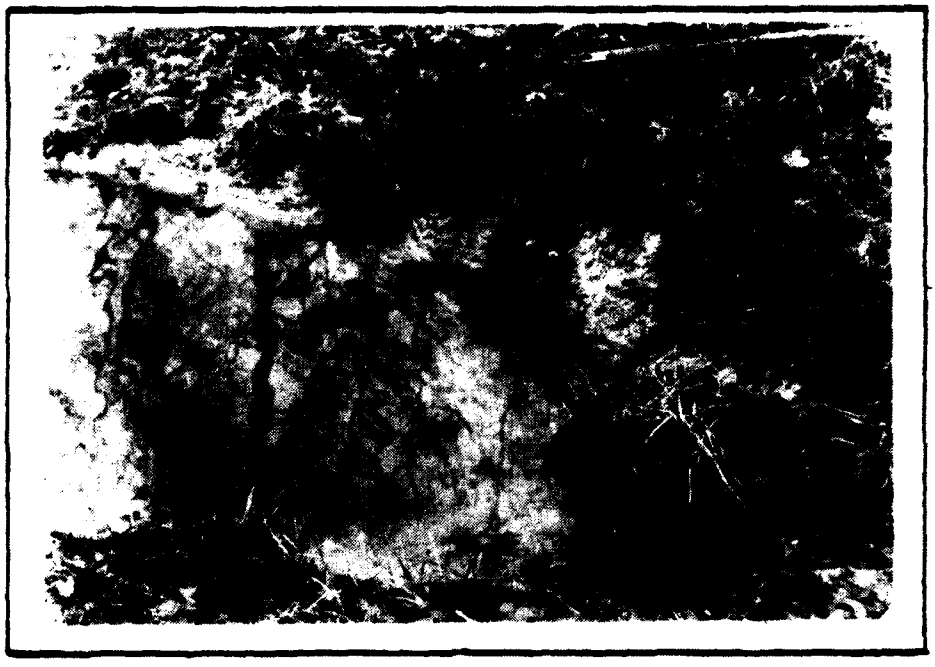


PHOTO NO.3

PHOTO NO.4

PHOTO NO.5

PHOTO NO.6

RAM
Send copy to Glover
File

CANDLEWOOD LAKES PROPERTY

OWNERS ASSOC.,INC.

P.O. BOX 171321
MEMPHIS,TN. 38117

December 31, 1980

Mr. Robert A. Hunt, Director
Division of Water Resources
Tennessee Department of Conservation
4721 Trousdale Drive
Nashville, Tennessee 37219

Re: Dams at Candlewood Lake, Spring Lake #2, Crystal Lake #4 and Old Hickory Lake located in Hardeman County

Dear Mr. Hunt:

Your letter of December 1, 1980 to Candlewood Lakes Inc., has been forwarded to us.

As of January 1, 1979, the ownership of the above mentioned dams was transferred to Candlewood Lakes Property Owners Association.

We were not aware of the State Safe Dams Act, but we will be glad to cooperate with you in any way possible to keep the dams safe.

Please direct all future correspondence to Candlewood Lak - Property Owners Association, P.O. Box 171321, Memphis, Tennessee 38117. The phone number is 901-685-6968.

Sincerely,

W. J. Arnold, President
Candlewood Lakes Property Owners Assn.

WJA/a

STATE OF TENNESSEE
DEPARTMENT OF CONSERVATION
Division of Water Resources

CERTIFICATE OF APPROVAL & SAFETY

TO SAFEGUARD THE PUBLIC FROM THE DANGERS OF THE FAILURE OF DAMS OR RESERVOIRS AND IN ACCORDANCE WITH THE PROVISIONS OF THE SAFE DAMS ACT OF 1973, TENNESSEE CODE ANNOTATED SECTION 75-2505 AND APPLIED REGULATIONS, SECTION 0400-4-1.05, THIS CERTIFICATE OF APPROVAL AND SAFETY IS HEREBY GRANTED TO:

CANDLEWOOD LAKE SUBDIVISION, INC.

Memphis, Tennessee

for the construction of

Crystal Lake Dam, located in Hardeman County, Tennessee

THE CERTIFIED PROJECT SHALL BE AS DESCRIBED HEREIN AND IN APPLICATION NO. 76-102-OAS FILED IN THE OFFICE OF THE TENNESSEE DEPARTMENT OF CONSERVATION, AND IN CONFORMITY WITH THE APPROVED PLANS AND SPECIFICATIONS AND OTHER DATA SUBMITTED TO THE DEPARTMENT IN SUPPORT OF THE APPLICATION ALL OF WHICH ARE FILED WITH AND CONSIDERED PART OF THIS CERTIFICATE.

Certificate No. 0009-C

Issued this 15 day of April, 1976;

Project Review Fee $40

to expire 15 day of April, 1976.

Paid 1-1-76 Receipt No. 5009

Safety Inspection Fee N/A

Commissioner

Paid _____ Receipt No. _____

Director

NOTICE: This Certificate is not transferrable and whenever legal title to the dam is modified to create real property interests, including leasehold interest, in persons not listed in the Application, the owner shall make application for a new Certificate within ninety (90) days of the date such interests are created.

Special conditions of issuance are listed on back of this certificate.

Conservation
DWR Form 75-02A

Issuance and continuance of this Certificate is contingent upon full compliance with all provisions of THE SAFE DAMS ACT OF 1973, TCA Sections 70-2501 to 70-2530 and RULES AND REGULATIONS applied to said ACT, CHAPTER 0400-4-1. Special conditions of issuance are as follows:

(1) Damage Potential Category 1; Safety Inspection Interval N/A.
(2) Engineering supervision and certification upon completion that project was constructed in accordance with approved plans and specifications to be by Ragon Engineering Company.

DESCRIPTION OF DAM

Type of Dam: Earthen Normal Pool Surface Area: 6 acres

Maximum Height: 32.5ft. Length of Crest: 440 ft. Width of Crest: 12 ft.

Centerline Location: Lattitude: ___o___'___"

Longitude: ___o___'___"

Conservation
DWR Form 75-

RAGON ENGINEERING COMPANY

CONSULTING ENGINEERS
725 WEST MARKET ST.
P. O. Box 267
BOLIVAR, TENNESSEE 38008

JAMES H. RAGON, P. E.

DON R. MOORE, ESCE, EIT
EDMOND B. O'NEILL, BSME
BOBBY L. TULLEY, BSAET

December 7, 1976

Mr. Robert A. Hunt
Tennessee Department of Conservation
Division of Water Resources
6213 Charlotte Ave.
Nashville, Tennessee 37209

Re: Candlewood Subdivision
Crystal Lake (Lake #4)

Dear Mr. Hunt:

The construction of Crystal Lake (Lake #4) has been completed in substantial conformity with the approved plans and specifications as prepared by Ragon Engineering Company.

Yours truly,

James H. Ragon

James H. Ragon, P. E.

JHR/ct

Enc.

cc: Mr. Edmond B. O'Neill
Regional Engineer

S & W Construction Co.
Memphis, Tennessee

NON-FEDERAL DAM INSPECTION REVIEW BOARD
PO BOX 1070
NASHVILLE, TENNESSEE 37202

ORNED-G

Commander, Nashville District
US Army, Corps of Engineers
PO Box 1070
Nashville, TN 37202

1. The Interagency Review Board, appointed by the Commander on 8 October 1980, presents the following recommendations after meeting on 18 June 1981 to consider the Phase I investigation report on Crystal Lake Dam inspected by the Tennessee Department of Conservation.

2. The owner should establish a regular program of inspection and maintenance to provide detection and timely correction of problem areas.

3. An emergency action plan should be developed, including a warning system to alert downstream residents, in the event a serious condition develops with the project.

4. Flood routings using Antecedent Moisture Condition III should also be computed and included in the report.

5. The Board is in agreement with other report conclusions and recommendations following minor revisions.

Herman Gray
HERMAN GRAY
Chief, Design Branch
Alternate Chairman

Bobby G. Moore
BOBBY G. MOORE
Assistant State Conservation Engineer
Alternate, Soil Conservation Service

Robert A. Hunt
ROBERT A. HUNT
Director, Division of Water Resources
State of Tennessee

Thomas N. Porter
THOMAS N. PORTER
Hydraulic Engineer
Alternate, Hydrology and Hydraulics Branch

Edward B. Boyd
EDWARD B. BOYD
Hydrologic Technician
Alternate, US Geological Survey

Timothy McCleskey
TIMOTHY McCLESKEY
Chief, Instrumentation and Inspection Section
Alternate, Geotechnical Branch

APPENDIX G

DESIGN AND CONSTRUCTION DATA

PLANS

FOR

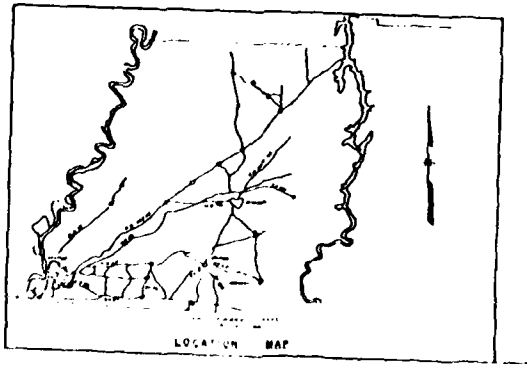
CRYSTAL LAKE (LAKE NO 4)

HARDEMAN COUNTY, TENNESSEE

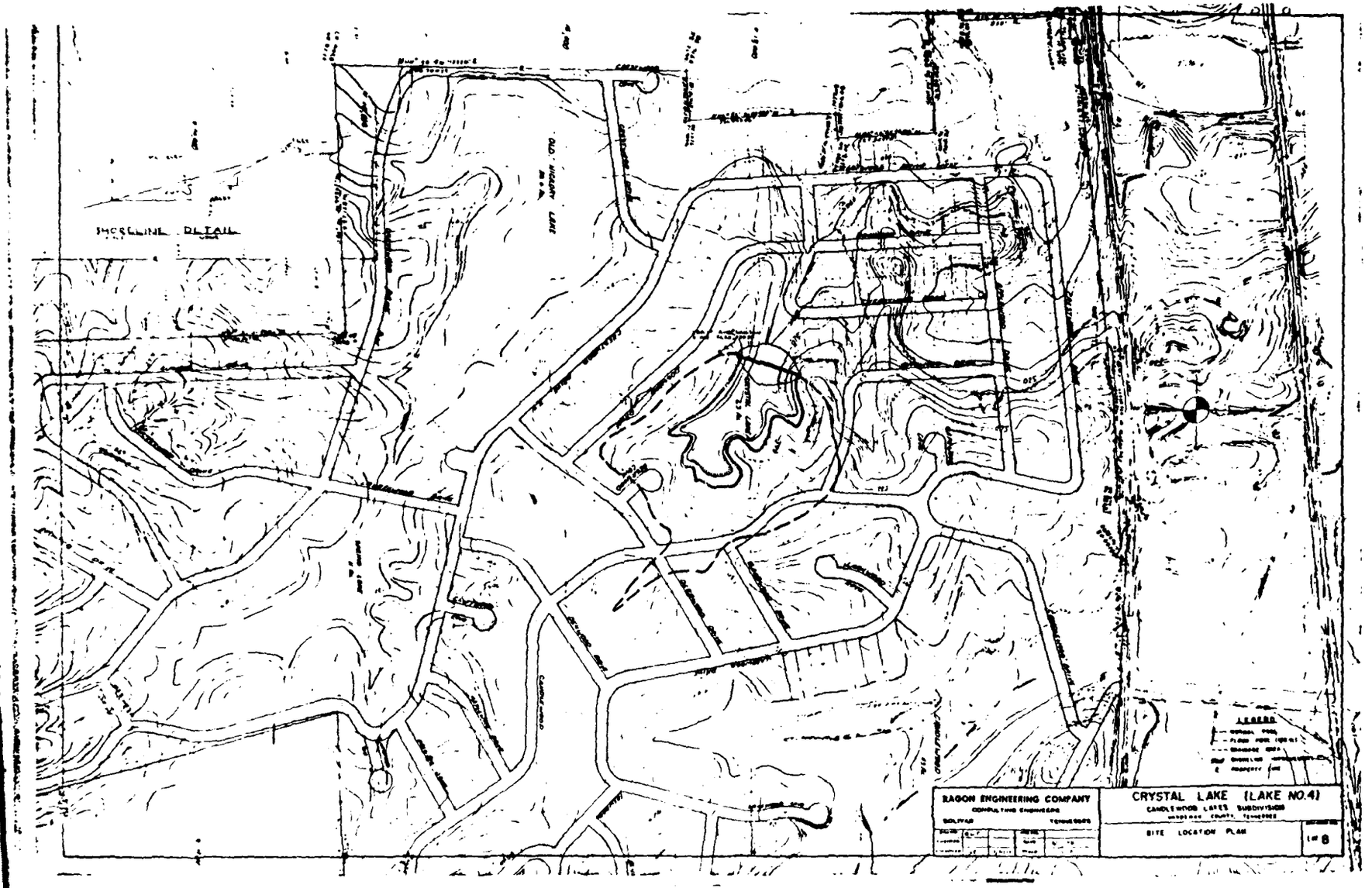
CANDLEWOOD LAKES INCORPORATED

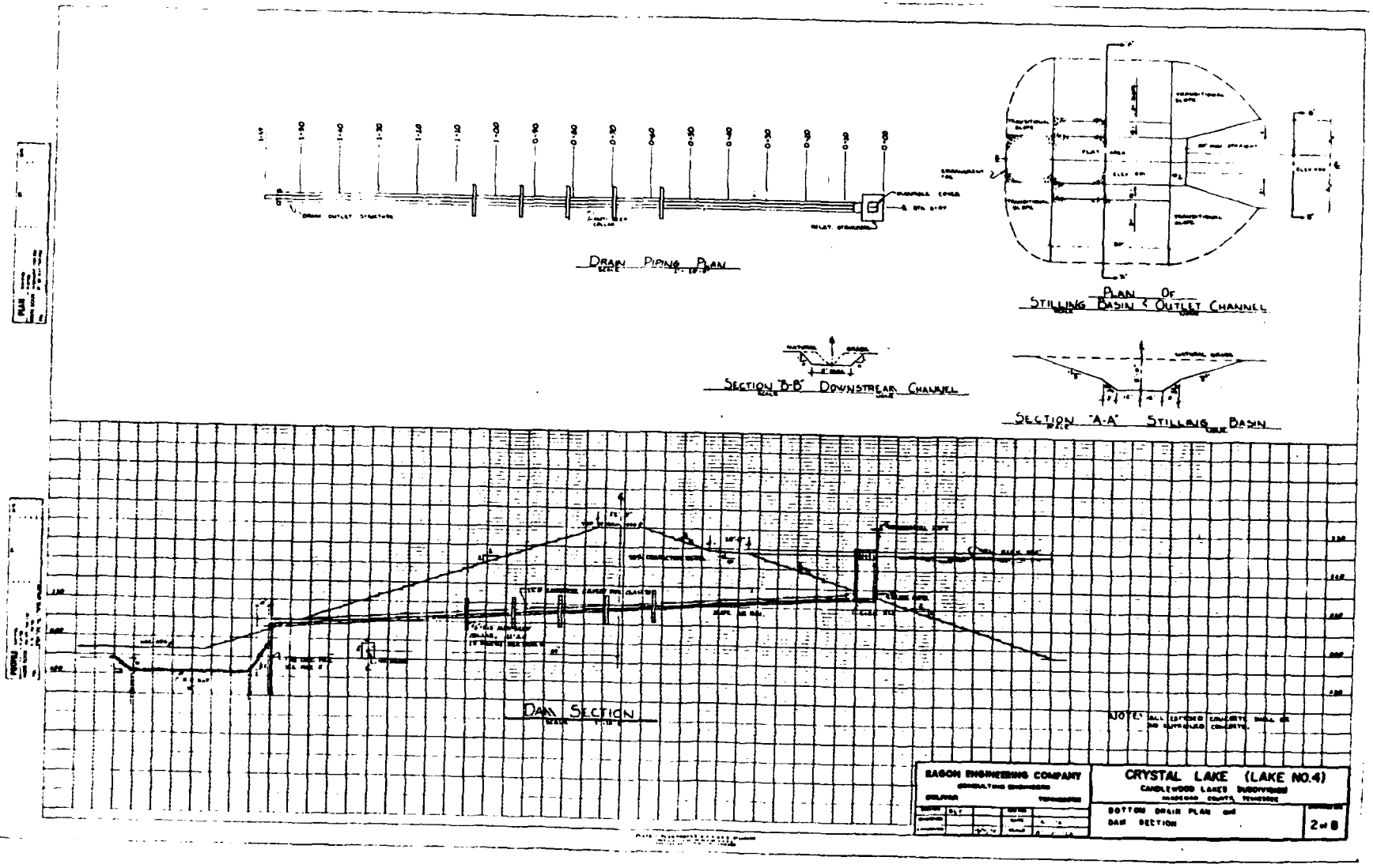
RAGAN ENGINEERING COMPANY

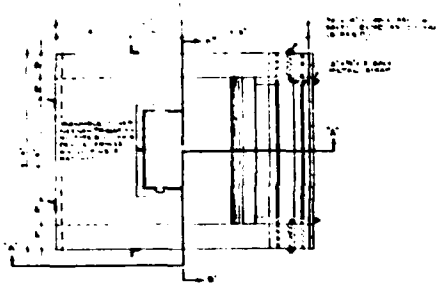
BOLIVAR, TENNESSEE



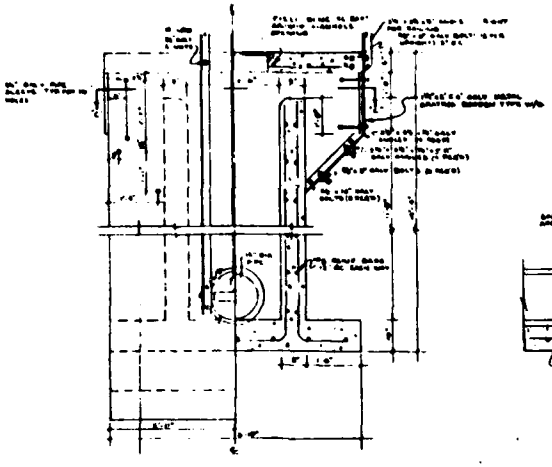
LOCATION MAP


HORSELINE RETAIL
OLD HICKORY LAKE
RAGON ENGINEERING COMPANY
CONSULTING ENGINEERS
DICKSON TENNESSEE
CRYSTAL LAKE (LAKE NO.4)
CANDLEWOOD LAKES SUBDIVISION
DICKSON COUNTY, TENNESSEE
SITE LOCATION PLAN
1" = 8

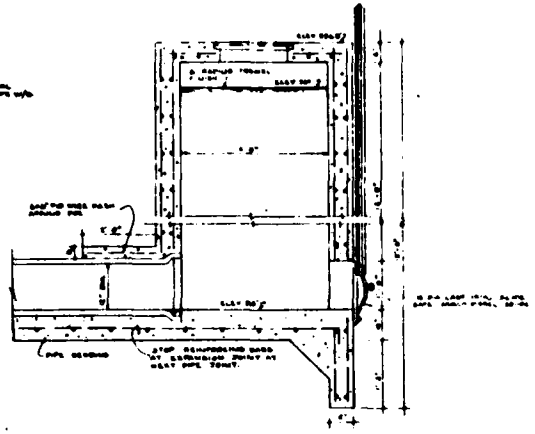

DRAIN PIPING PLAN
PLAN OF STILLING BASIN & OUTLET CHANNEL
SECTION "B-B" DOWNSTREAM CHANNEL
SECTION "A-A" STILLING BASIN
DAM SECTION
NOTE: ALL EXPOSED CONCRETE SHALL BE
BAGON ENGINEERING COMPANY
CRYSTAL LAKE (LAKE NO.4)
CANDLEWOOD LAKES SUBDIVISION
BOTTOM DRAIN PLAN AND
DAM SECTION
2 of 8



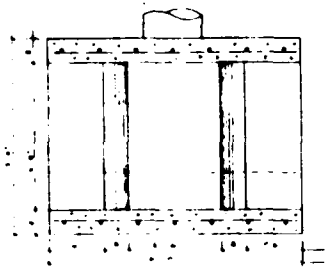
DROP INLET PLAN



SECTION "A-A"



SECTION "B-B"

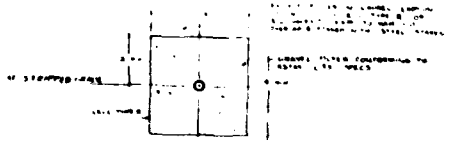


SECTION C-C

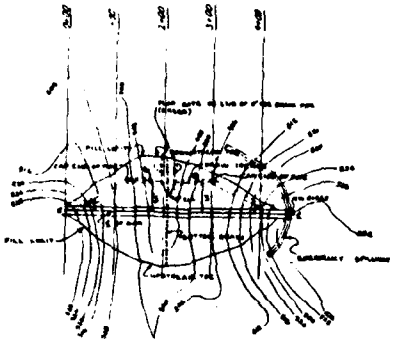
GENERAL NOTES

1. CONCRETE ALL EXPOSED CONCRETE EDGES 3/4"
2. ALL THREADED PARTS SHALL BE HOT-DIPPED GALVANIZED
3. ALL STANDARD BOLTS SHALL BE CUT OFF FLUSH WITH NUTS AFTER TIGHTENED
4. ALL CONCRETE SHALL BE 3000 PSI

	BASON ENGINEERING COMPANY CONSULTING ENGINEERS BOLIVAR TENNESSEE	CRYSTAL LAKE (LAKE NO.4) CANDLEWOOD LAKES SUBDIVISION HARDEMAN COUNTY, TENNESSEE
		CONCRETE RISER DETAILS — 3 of 8

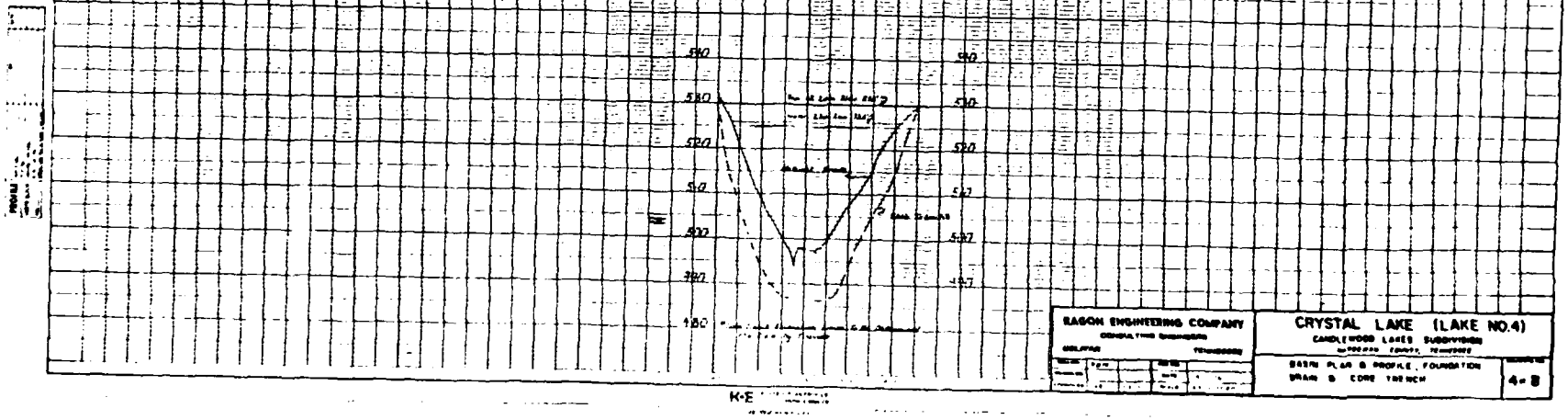


FOUNDATION DRAIN FILTER DETAIL



FOUNDATION DRAIN PLAN

NOTES



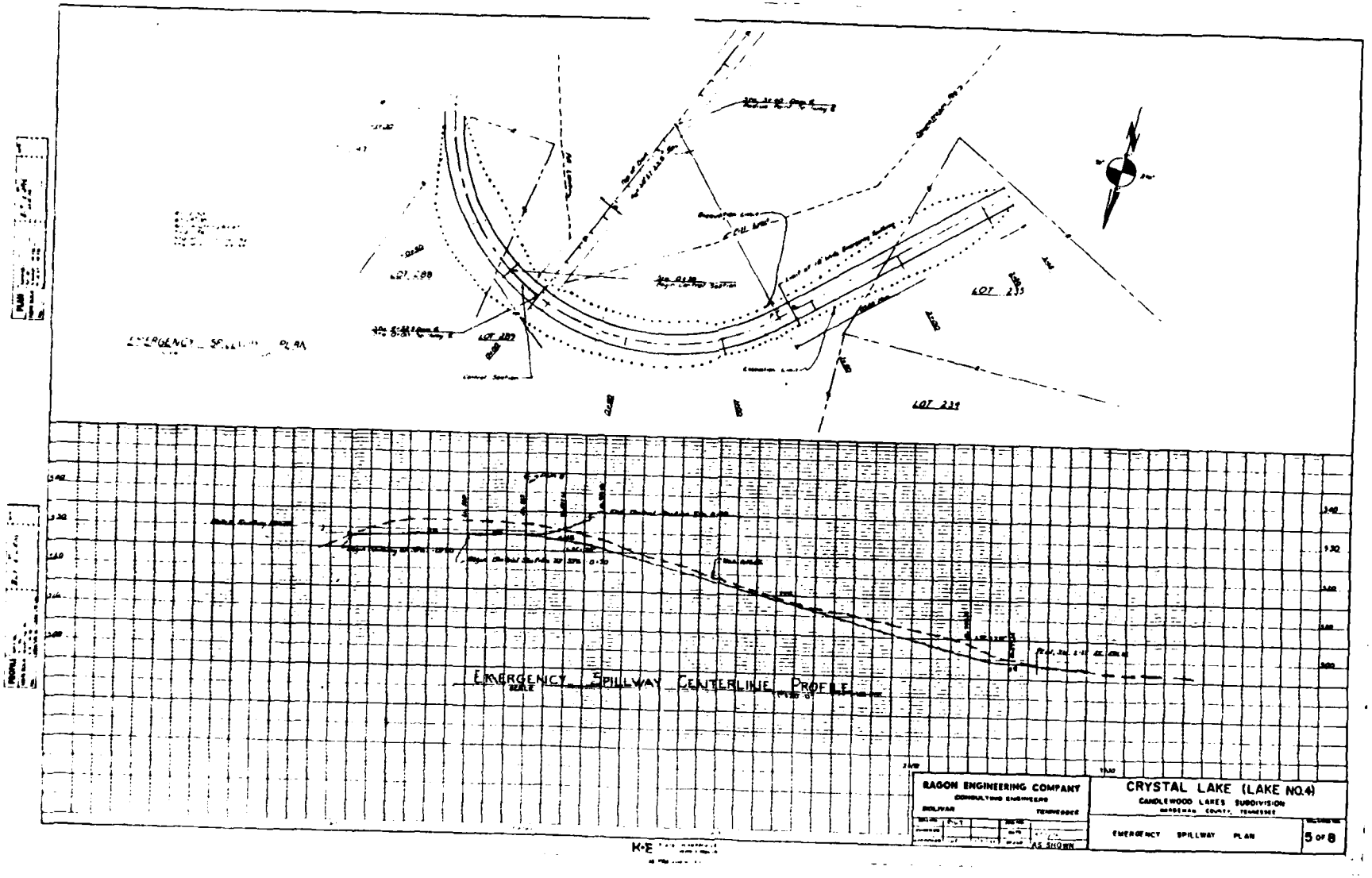
K-E

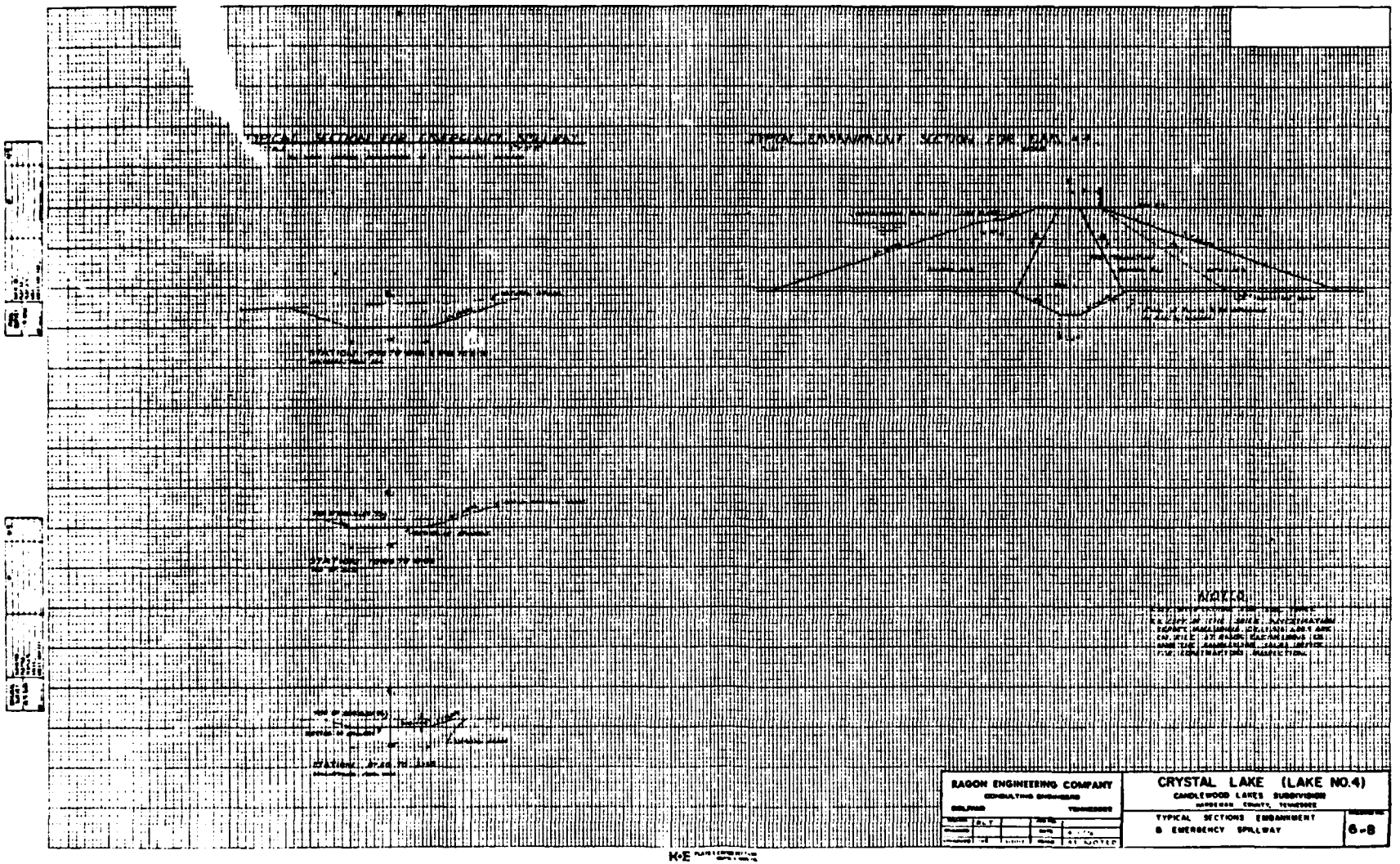
BASON ENGINEERING COMPANY
CONSULTING ENGINEERS
MILLINGTON TENNESSEE

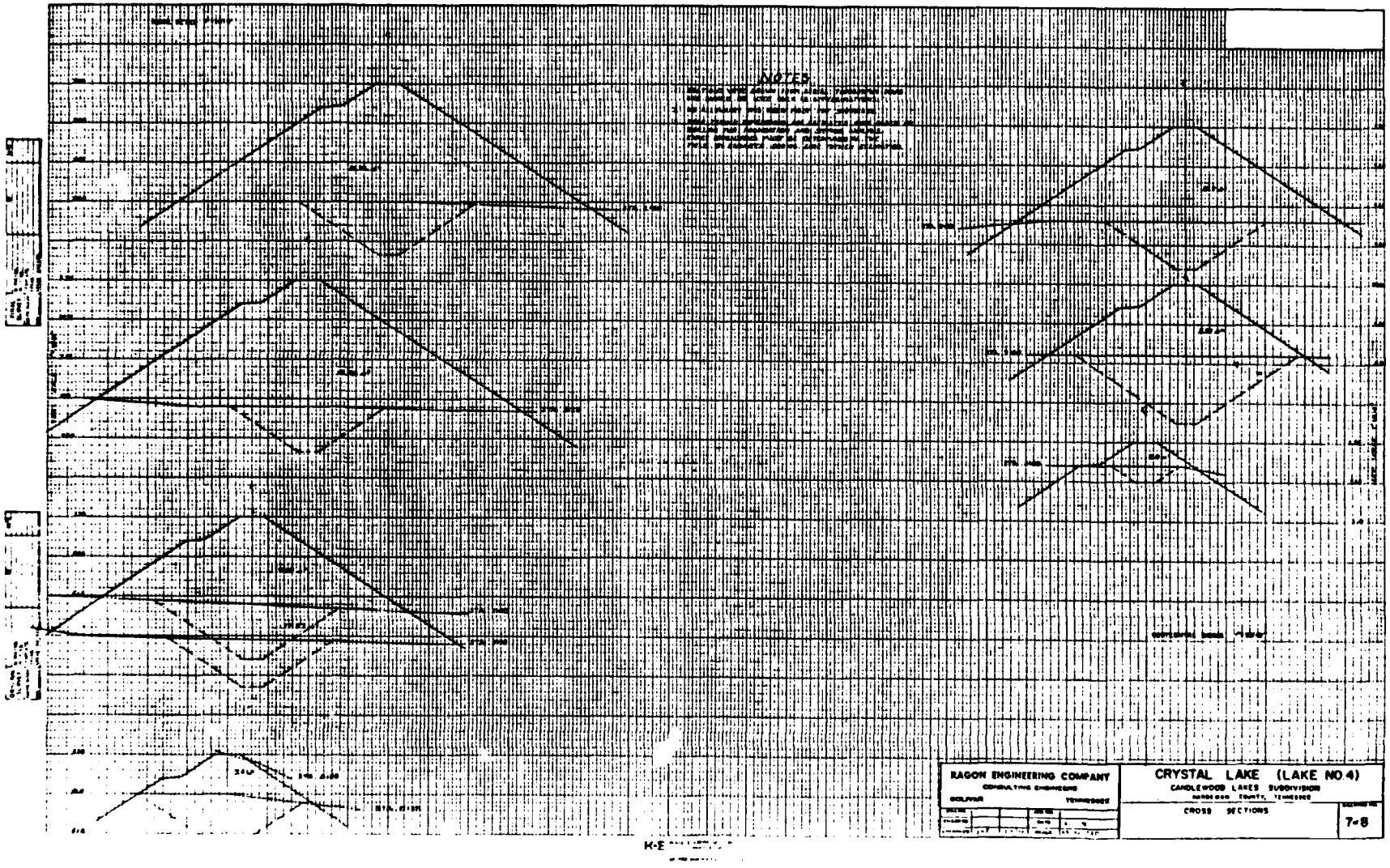
CRYSTAL LAKE (LAKE NO.4)
CANDLEWOOD LAKES SUBDIVISION
MILLINGTON SHELBY TENNESSEE

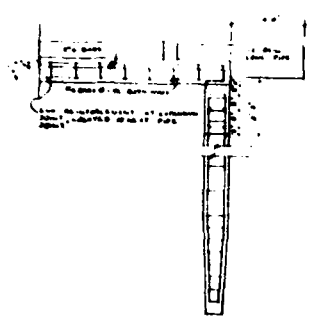
BASIN PLAN & PROFILE FOUNDATION DRAIN & CORE TRENCH

4-8

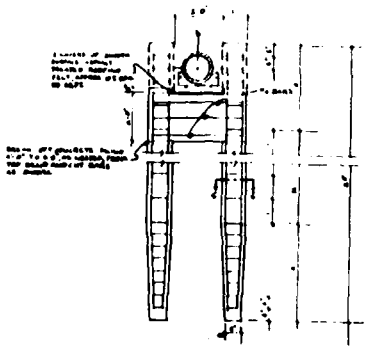

LOT 233
LOT 234
EMERGENCY SPILLWAY CENTERLINE PROFILE
RAGON ENGINEERING COMPANY
CONSULTING ENGINEERS
BOLIVAR TENNESSEE
CRYSTAL LAKE (LAKE NO.4)
CANDLEWOOD LAKES SUBDIVISION
AS SHOWN
EMERGENCY SPILLWAY PLAN
5 OF 8


NOTES
RAGON ENGINEERING COMPANY
CONSULTING ENGINEERS
CRYSTAL LAKE (LAKE NO.4)
CANDLEWOOD LAKES SUBDIVISION
TYPICAL SECTIONS EMBANKMENT & EMERGENCY SPILLWAY
6-8


NOTES
RAGON ENGINEERING COMPANY
CONSULTING ENGINEERS
DICKSON TENNESSEE
CRYSTAL LAKE (LAKE NO 4)
CANDLEWOOD LAKES SUBDIVISION
DICKSON COUNTY, TENNESSEE
CROSS SECTIONS
7-8

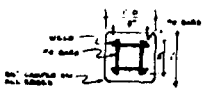


LONGITUDINAL SECTION

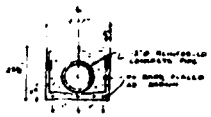


ELEVATION

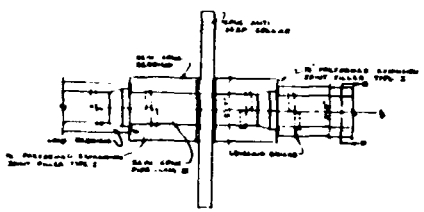
BOTTOM DRAIN OUTLET STRUCTURE DETAIL



SECTION C-C

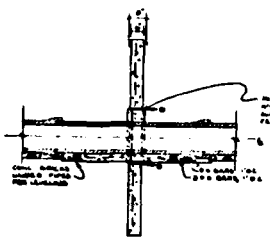


SECTION B-B

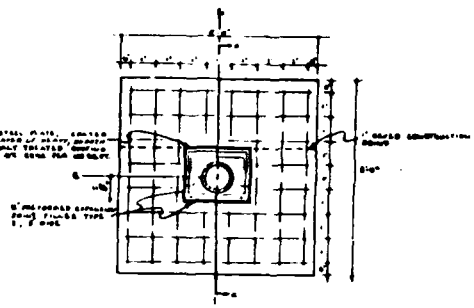


PLAN

SECTION D-D



SECTION A-A



ELEVATION OF ANTI-SEEP COLLAR

NOTES:

BASON ENGINEERING COMPANY
CONSULTING ENGINEERS
BOLIVAR TENNESSEE

CRYSTAL LAKE (LAKE NO.4)
CANDLEWOOD LAKES SUBDIVISION
HARDEMAN COUNTY, TENNESSEE

DETAILS ON ANTI-SEEP COLLAR, PIPE BEDDING & OUTLET STRUCTURE

8 of 8

CML

ANALYSES OF MOISTURE DENSITY TEST OF COMPACTED FILL

Contractor S & W Construction Company Project CANDLEWOOD (CYRSTAL LAKE)

Report to S & W Construction(2); Ragon Engineering Date May 24, 1976

Lab. No. 30512

Test No.	1	2	3	4		
Density of Sand (lbs./cu ft.)	98.0	98.0	98.0	98.0		
Wgt of Jar & Sand (before test)	7.78	7.81	7.89	7.80		
Wgt of Jar & Sand (after test)	3.55	3.62	3.80	3.74		
Wgt. of Sand in Hole & Funnel	4.23	4.19	4.09	4.06		
Wgt. of Sand in Funnel	1.98	1.98	1.98	1.98		
Wgt. of Sand in Hole	2.25	2.21	2.11	2.08		
Volume of Hole (cu. ft.)	.0230	.0226	.0215	.0212		
Wgt. of Wet Soil	2.91	3.15	3.03	3.09		
Wgt. of Dry Soil	2.53	2.73	2.69	2.74		
Wgt. of Water	.38	.42	.34	.35		
Moisture Content (% of Dry Wgt.)	15.0	15.4	12.6	12.8		
Density, Dry Soil (lbs./cu. ft.)	110.0	120.8	125.1	129.2		
% Required Density	95.6	104.9	103.8	107.2		
Required Density (lbs /cu. ft.)	115.1	115.1	120.5	120.5		
Optimum Moisture (% of Dry Wgt.)	14.6	14.6	11.2	11.2		
Stone, % by Wgt.						

Location of Tests

1 At Station 2+20 25' S. off Center of Dam Elevation 503.5
2 At Station 3+00 15' S. off Center of Dam Elevation 503.5
3 At Station 2+50 30' N. off Center of Dam Elevation 503.5
4 At Station 2+50 45' S. off Center of Dam Elevation 503.5

NEW ADDRESS
CONSTRUCTION MATERIALS LAB, INC.
41 [illegible] SQUARE
JACKSON, TENNESSEE 38301
PHONE 423-2062

40 OLD HICKORY COVE
JACKSON, TENNESSEE 38301
(901) 668-7274

CML

ANALYSES OF MOISTURE DENSITY TEST OF COMPACTED FILL

Contractor S & W Construction — Project CANDLEWOOD LAKES (CRYSTAL LAKE)

Report to S & W Construction(2); Dixon Engineering — Date July 26, 1976

Lab. No 31153

Test No.	1	2	3	4		
Density of Sand (lbs./cu. ft.)	98.0	98.0	98.0	98.0		
Wgt. of Jar & Sand (before test)	7.80	7.66	7.52	7.82		
Wgt. of Jar & Sand (after test)	3.79	3.47	3.32	3.44		
Wgt. of Sand in Hole & Funnel	4.01	4.19	4.20	4.38		
Wgt. of Sand in Funnel	1.68	1.68	1.68	1.68		
Wgt. of Sand in Hole	2.33	2.51	2.52	2.70		
Volume of Hole (cu. ft.)	.0238	.0256	.0257	.0276		
Wgt. of Wet Soil	2.96	3.47	3.40	3.41		
Wgt. of Dry Soil	2.44	2.95	2.83	2.98		
Wgt. of Water	.52	.52	.57	.43		
Moisture Content (% of Dry Wgt.)	21.3	17.6	20.1	14.4		
Density, Dry Soil (lbs./cu. ft.)	102.5	115.2	110.1	108.0		
% Required Density	91.1	102.4	97.9	96.0		
Required Density (lbs./cu. ft.)	112.5	112.5	112.5	112.5		
Optimum Moisture (% of Dry Wgt.)	14.6	14.6	14.6	14.6		
Stone, % by Wgt.						

Location of Tests

1 Centerline of Crystal Lake Dam, Sta. 4+00—15' Below Grade
2 E. Side of Dam, Sta. 4+00—15' Below Grade
3 Centerline of Dam, 20' Below Grade—Sta. 2+00
4 W. Side of Dam, 20' Below Grade—Sta. 2+00

40 OLD HICKORY COVE JACKSON, TENNESSEE 38301
(901) 668-7274

CVL

ANALYSES OF MOISTURE DENSITY TEST OF COMPACTED FILL

(CRYSTAL)

Contractor [illegible] Project [illegible]

Report to [illegible] Date [illegible]

Lab. No [illegible]

Test No.	1	2	3	4		
Density of Sand (lbs /cu ft)	93.0	99.0	99.0	91.9		
Wgt of Jar & Sand (before test)	7.72	7.68	7.90	7.61		
Wgt of Jar & Sand (after test)	3.[illegible]	3.69	3.97	3.95		
Wgt of Sand in Hole & Funnel	3.9[illegible]	3.99	3.93	3.66		
Wgt of Sand in Funnel	1.[illegible]3	1.[illegible]3	1.83	1.83		
Wgt of Sand in Hole	2.1[illegible]	2.16	2.10	2.03		
Volume of Hole (cu ft)	.02[illegible]	.0[illegible]	.0211	.0207		
Wgt of Wet Soil	2.6[illegible]	2.85	2 77	2.56		
Wgt of Dry Soil	2.2[illegible]	2.[illegible]	2.31	2.[illegible]		
Wgt of Water	.46	.47	.46	.3[illegible]		
Moisture Content (% of Dry Wgt.)	20.[illegible]	1[illegible]	1[illegible]	17.[illegible]		
Density, Dry Soil (lbs./cu. ft.)	1[illegible].2	1[illegible].2	[illegible]7.6	[illegible].4		
% Required Density	82.6	96.6	96.4	91.4		
Required Density (lbs /cu ft)	112.6	112.6	112.6	112.6		
Optimum Moisture (% of Dry Wgt.)	1[illegible].6	1[illegible].6	14.6	14.6		
Stone, % by Wgt.						

Location of Tests

1 At Station 4+00--35' L. off center of dam--11' below grade
2 Re-check 4+00--centerline of dam
3 At Station 2+[illegible]--2[illegible]' L. off center of dam--15' below grade
4 At Station 2+[illegible]--25' L. off center of dam--15' below grade

CONSTR[illegible]

40 OLD HICKORY COVE JACKSON, TENNESSEE 38301
(901) 668-7274 PHONE 423-2032

AD-A108 248 TENNESSEE STATE DEPT OF CONSERVATION NASHVILLE DIV O--ETC F/G 13/13
NATIONAL PROGRAM OF INSPECTION OF NON-FEDERAL DAMS, TENNESSEE, --ETC(U)
SEP 81 G E MOORE
DACW62-81-C-0056

UNCLASSIFIED

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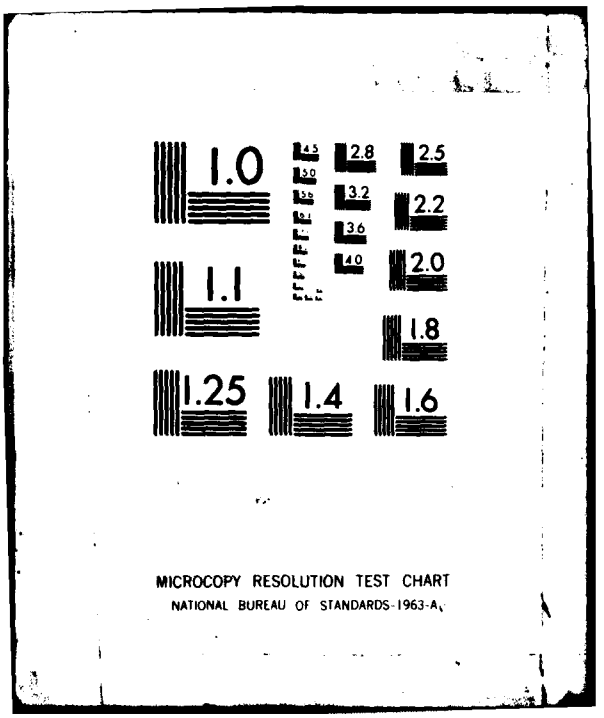
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4.5
5.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

CML

ANALYSES OF MOISTURE DENSITY TEST OF COMPACTED FILL

Contractor [illegible]   Project (CRYSTAL) [illegible]

Report to [illegible] Engineering   Date [illegible] 1976

Lab. No. [illegible]

Test No.	1	2	3	4	5	6
Density of Sand (lbs./cu. ft.)	[illegible]	[illegible]	98.0	[illegible]	98.0	98.0
Wgt. of Jar & Sand (before test)	[illegible]	7.76	[illegible]	7.78	7.77	7.74
Wgt. of Jar & Sand (after test)	[illegible]	4.06	3.61	3.77	3.70	3.83
Wgt. of Sand in Hole & Funnel	3.70	3.70	4.27	[illegible]	4.07	[illegible]
Wgt. of Sand in Funnel	[illegible]	[illegible]	1.83	1.83	1.83	[illegible]
Wgt. of Sand in Hole	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Volume of Hole (cu. ft.)	[illegible]	[illegible]	.0249	[illegible]	.0229	.0212
Wgt. of Wet Soil	2.52	2.64	2.87	2.7[illegible]	2.91	2.71
Wgt. of Dry Soil	[illegible]	[illegible]	2.45	[illegible]	2.49	2.34
Wgt. of Water	.35	.37	.42	.37	.42	.37
Moisture Content (% of Dry Wgt.)	[illegible]	16.5	17.1	15.4	16.9	15.8
Density, Dry Soil (lbs./cu. ft.)	[illegible]	[illegible]	[illegible]	108.6	108.7	110.4
% Required Density	97.7	100.1	87.9	97.0	[illegible].1	[illegible]
Required Density (lbs./cu. ft.)	112.0	112.0	112.0	112.0	112.0	112.0
Optimum Moisture (% of Dry Wgt.)	14.6	14.6	14.6	14.6	14.6	14.6
Stone, % by Wgt.						

Location of Tests

Re-check at Station 4+00--30' E. off center of dam--11' below grade
Re-check at Station 2+52--25' W. off center of dam--15' below grade
At Station 2+30--10' E. off center of dam--9' below grade
At Station 2+95--12' W. off center of dam--9' below grade
At Station 3+60--in center of dam--9' below grade
At Station 4+10--10' W. off center of dam--9' below grade

NEW ADDRESS
CONSTRU[illegible] S LAB, INC.
JACKSON, [illegible] 38301
PHONE [illegible]

CML

ANALYSES OF MOISTURE DENSITY TEST OF COMPACTED FILL

Contractor S & W Construction Company Project CANDLEWOOD LAKES (CRYSTAL LAKE)

Report to S & W Construction (2); Hagen Engineering Date August 10, 1976

Lab. No. 31287

Test No.	1	2	3	4	5	
Density of Sand (lbs./cu. ft.)	98.0	98.0	98.0	98.0	98.0	
Wgt. of Jar & Sand (before test)	7.81	7.93	7.82	7.72	7.65	
Wgt. of Jar & Sand (after test)	3.68	3.85	3.80	3.70	4.07	
Wgt. of Sand in Hole & Funnel	4.13	4.08	4.02	4.02	3.78	
Wgt. of Sand in Funnel	1.83	1.83	1.83	1.83	1.83	
Wgt. of Sand in Hole	2.30	2.25	2.19	2.19	1.95	
Volume of Hole (cu. ft.)	.0235	.0230	.0223	.0223	.0199	
Wgt. of Wet Soil	3.00	3.00	2.95	3.00	2.75	
Wgt. of Dry Soil	2.63	2.57	2.53	2.61	2.49	
Wgt. of Water	.37	.43	.42	.39	.26	
Moisture Content (% of Dry Wgt.)	14.1	16.7	16.6	14.9	10.4	
Density, Dry Soil (lbs./cu. ft.)	111.9	111.7	113.5	117.0	125.1	
% Required Density	97.2	97.0	98.6	101.7	103.8	
Required Density (lbs./cu. ft.)	115.1	115.1	115.1	115.1	120.5	
Optimum Moisture (% of Dry Wgt.)	14.6	14.6	14.6	14.6	11.2	
Stone, % by Wgt.						

Location of Tests

1 at Sta. 1+50, 25' E. off center of Dam--15' Below Grade
2 at Sta. 1+00, In Center of Dam--15' Below Grade
3 Rockcheck at Sta. 2+30, 10' E. off Center of Dam--9' Below Grade
4 At Sta. 2+75, In Center of Dam--6' Below Grade
5 At Sta. 3+18, 10' E. off Center of Dam--6' Below Grade

NEW ADDRESS
CONCRETE [illegible] LAB, INC.
[illegible]
[illegible] 38301
40 OLD HICKORY COVE JACKSON, TENNESSEE 38301
PHONE [illegible]

CML

ANALYSES OF MOISTURE DENSITY TEST OF COMPACTED FILL

Contractor S & W Construction Company Project CANDLEWOOD LAKES (CRYSTAL LAKE)

Report to S & W Construction Co. (2); Hagon Eng. Date August 12, 1976

Lab. No. 31306

Test No.	1	2	3	4		
Density of Sand (lbs./cu ft)	98.0	98.0	98.0	98.0		
Wgt. of Jar & Sand (before test)	7.91	7.77	7.87	7.87		
Wgt. of Jar & Sand (after test)	4.13	3.65	3.65	3.89		
Wgt. of Sand in Hole & Funnel	3.78	3.92	4.02	3.98		
Wgt. of Sand in Funnel	1.83	1.83	1.83	1.83		
Wgt. of Sand in Hole	1.95	2.09	2.19	2.15		
Volume of Hole (cu. ft.)	.0199	.0213	.0223	.0219		
Wgt. of Wet Soil	2.67	2.90	2.96	2.94		
Wgt. of Dry Soil	2.27	2.48	2.51	2.53		
Wgt. of Water	.40	.42	.45	.41		
Moisture Content (% of Dry Wgt.)	17.6	16.9	17.9	16.2		
Density, Dry Soil (lbs./cu. ft.)	114.1	116.4	112.6	115.5		
% Required Density	99.1	101.1	97.8	100.3		
Required Density (lbs./cu. ft.)	115.1	115.1	115.1	115.1		
Optimum Moisture (% of Dry Wgt.)	14.6	14.6	14.6	14.6		
Stone, % by Wgt.						

Location of Tests

1 At Sta. 1+90, 20' E. off center of Dam--12' Below Grade
2 At Sta. 1+65, In center of Dam--12' Below Grade
3 At Sta. 0+90, 15' E. off Center of Dam--12' Below Grade
4 At Sta. 0+60, 15' W., off Center of Dam--12' Below Grade

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(901) 668-7274

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ANALYSES OF MOISTURE DENSITY TEST OF COMPACTED FILL

Contractor S & W Construction Project CANDLEWOOD LAKES (CYRSTAL LAKE)

Report to S & W Construction(2); Ragon Engineering Date August 13, 1976

Lab. No. 31334

Test No.	1	2	3	4		
Density of Sand (lbs./cu. ft.)	98.0	98.0	98.0	98.0		
Wgt. of Jar & Sand (before test)	7.83	7.77	7.88	7.75		
Wgt. of Jar & Sand (after test)	3.74	3.74	3.92	4.03		
Wgt. of Sand in Hole & Funnel	4.09	4.03	3.96	3.72		
Wgt. of Sand in Funnel	1.83	1.83	1.83	1.83		
Wgt. of Sand in Hole	2.26	2.20	2.13	1.89		
Volume of Hole (cu. ft.)	.0231	.0224	.0217	.0193		
Wgt. of Wet Soil	3.17	3.08	2.98	2.66		
Wgt. of Dry Soil	2.73	2.63	2.64	2.35		
Wgt. of Water	.44	.45	.34	.31		
Moisture Content (% of Dry Wgt.)	16.1	17.1	12.9	13.2		
Density, Dry Soil (lbs./cu. ft.)	118.2	117.4	121.7	121.8		
% Required Density	102.7	102.0	101.0	101.1		
Required Density (lbs./cu. ft.)	115.1	115.1	120.5	120.5		
Optimum Moisture (% of Dry Wgt.)	14.6	14.6	11.2	11.2		
Stone, % by Wgt.						

Location of Tests

1 Sta. 0+15, In Center of Dam—1' Below Grade
2 Sta. 0+90, 20' E. off Center of Dam—9' Below Grade
3 Sta. 1+10, 20' W. off Center of Dam—9' Below Grade
4 Sta. 2+00, In Center of Dam—9' Below Grade

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CML

ANALYSES OF MOISTURE DENSITY TEST OF COMPACTED FILL

Contractor S & W Construction

Project CANDLEWOOD LAKES (CRYSTAL LAKE)

Report to S & W Construction(2); Bacon Engineering

Date August 17, 1976

Lab. No. 31365

Test No.	1	2	3	4		
Density of Sand (lbs /cu ft.)	98.0	98.0	98.0	98.0		
Wgt. of Jar & Sand (before test)	7.76	7.98	7.75	7.88		
Wgt. of Jar & Sand (after test)	3.59	3.85	3.88	3.59		
Wgt. of Sand in Hole & Funnel	4.17	4.03	3.87	4.29		
Wgt. of Sand in Funnel	1.83	1.83	1.83	1.83		
Wgt. of Sand in Hole	2.34	2.20	2.04	2.46		
Volume of Hole (cu. ft.)	.0239	.0224	.0208	.0251		
Wgt. of Wet Soil	3.05	2.82	2.48	3.00		
Wgt. of Dry Soil	2.79	2.57	2.30	2.73		
Wgt. of Water	.26	.25	.18	.27		
Moisture Content (% of Dry Wgt.)	9.3	9.7	7.8	9.9		
Density, Dry Soil (lbs./cu. ft.)	116.7	114.7	110.6	108.8		
% Required Density	101.4	99.7	96.1	97.1		
Required Density (lbs./cu. ft.)	115.1	115.1	115.1	112.0		
Optimum Moisture (% of Dry Wgt.)	14.6	14.6	14.6	14.6		
Stone, % by Wgt.						

Location of Tests

1 Sta. 3+95, In Center of Dam—On Grade
2 Sta. 2+80, In Center of Dam—On Grade
3 Sta. 1+65, In Center of Dam—On Grade
4 Sta. 0+32, In Center of Dam—On Grade

40 OLD HICKORY COVE JACKSON, TENNESSEE 38301
(901) 668-7274

JH
11/16/75

WELCOME TO
6TH ANNUAL MEETING AMERICAN COLLEGE OF SURVEYORS IN TENNESSEE

HUB CITY BLUE PRINT & SUPPLY CO.
301 NORTH ROYAL STR.
PHONE (901) 427-9871

OK
4/14/76
EBO

PRINCIPAL SPILLWAY SIZING

Criteria: Lower Lake to Elev. 516 in 3 Days:

$V_{ip} = 524$

$0.25V_p = 513$

11' > 8'

$V_{524} = 2.75 \times 10^6 ft^3$

$V_{513} = 0.69 \times 10^6$

2.06×10^6

$V_{524} = 2.75 \times 10^6 ft^3$

$V_{516} = 1.05 \times 10^6$

$1.70 \times 10^6 ft^3$

Required Discharge Rate:

$$Q = \frac{1.70 \times 10^6}{3(24)(3600)} = 6.558 \text{ ft}^3/\text{sec.}$$

$$H = \frac{524 + 516}{2} - 516 = 7'$$

Solving Equation:

$$Q = D^2 \left\langle \frac{H + 1.5 S_o - D}{0.0252 \left[1 + K_e + \frac{185 L n^2}{D^{4/3}} \right]} \right\rangle^{1/2}$$

Where:

$H = 7'$
$L = 144'$
$S_o = 0.06$
$n = 0.012$
$K_e = 0.5$
$D = 12''$

$Q = 10.6 \text{ ft}^3/\text{sec}$

10/18/75 JTC

WELCOME TO

6TH ANNUAL MEETING AMERICAN COLLEGE OF SURVEYORS IN TENNESSEE

FLOOD ROUTING.

$A_D = 20.8A = \frac{20.8}{640} = 0.032\ mi^2$

Rainfall = 24" (0.8 PMP)

SCS $C_n = 80$

$T_c = \frac{[11.9(L^3)]^{0.385}}{H} = \frac{[11.9(\frac{4530}{5280})^3]^{0.385}}{82} = 0.028$ Hrs.

1. P = 24" Table 21.91 (ES 1020 Page 5 of 5)
2. 24"
3. $T_c < 6$ hr.
4. Q = 21.3 " (Figure A-4 DESIGN OF SMALL DAMS) Pp. 592
5. Family 1
6. $T_o = 5.71$ hrs. Fig. 24.4
7. $T_p = 0.7\,T_c = 0.7(0.028) = 0.0195$ Hrs.
8. $T_o/T_p = \frac{5.71}{0.0195} = 291$
9. $T_o/T_p(Rev) = 75$
10. $T_p = \frac{T_c}{75} = 0.076$ Hrs.
11. $q_p = \frac{484A}{T_p} = \frac{484(0.032)}{0.076} = 203.8\ ft^3/sec.$
12. $Q_{qp} = Q \times q_p = 21.3(203.8) = 4340.94\ f^3/sec.$
13. $q_{max} = (\frac{q_c}{q_p})Q_{qp} = .4341(0.09) = .391\ ft^3/sec.$ Pp 21.63
14. $V_1 = 53.33(Q)(A) = 53.33(21.3)(0.032) = 36.35$ AF
15. $E_{NP} = 524$ $E_{EE} = 525$
15. $V_{UP} = 63.1$ AF
16. $V_{SP} = V_{EE} - V_{UP} = (2.977^{527} - 2.75^{526})10^6 = 0.227 \times 10^6\ ft^3 = 5.2$ AF
17. $\frac{V_{SP}}{V_1} = \frac{5.2}{36.35} = 0.143$
18. $V_{EW} = 75.7$

$E_{NP} = 524$ $E_{EE} = 529$

15 $V_{SP} = (4.3 - 2.75)10^6 = 1.55 \times 10^6 = 35.58$ AF

16. $\frac{V_{SP}}{V_1} = \frac{35.58}{36.35} = 0.978.$

17. $V_{STA.45} = 99.09 - 63.1 = 35.99$

18 $\frac{V_{SW}}{V_1} = \frac{35.99}{36.35} = 0.99$

19 $\frac{Q_e}{Q_1} = 0.02$

21. $\frac{Q_e}{b} = 1.10$

22 $b = \frac{7.8}{1.10} = 7$ ft.

Crystal Lake (Mem.)
12/10/75 JR

$C_N = 80$ $P = 24''$

Volume 10 yr. Storm $20.8(43560)\left(\frac{3.3}{12}\right) = 2.49 \times 10^5 \text{ ft}^3$

Elev. N_p = 524 $V_{MP} = 2.75 \times 10^6$

$V_{10} = \frac{0.249 \times 10^6}{2.999 \times 10^6}$

Elev. N_{p10} = 525'

Volume 100 yr. Storm $20.8(43560)\frac{5.2}{12} = 0.3926 \times 10^6 \text{ ft}^3$

$V_M = 2.75 \times 10^6 \text{ ft}^3$

$V_{100} = \frac{0.3926 \times 10^6}{3.1426 \times 10^6 \text{ ft}^3}$

Elev. N_{p100} = 525.5'

Volume MPF $20.8(43560)\left(\frac{21.3}{12}\right) = 1.608 \times 10^6 \text{ ft}^3$

$V_M = 2.75 \times 10^6 \text{ ft}^3$

$V_{MPF} = \frac{1.609 \times 10^6}{4.358 \times 10^6 \text{ ft}^3}$

Elev. N_{pMPF} = 529.5.

With E_{SP} = 529' Flood Routing results in a spillway of 10' x 1'; H < 0.5'

$E_{MPF} \leq 529 + 0.25 \leq 529.25'$

12/10/75
$N_p = 524$
$A_o = 0.032\ mi^2$
$C_N = 80$
$P = 24"$
$Q_i = 391\ cfs$

1	2	3	4	5	6	7	8	9	10	11	12
E_v ft	V_{tw} AF	V_{ow} AF	V_{ow}/V_I	V'_{ow}/V_I	Q_o/Q_I	Q_o cfs	Q_a cfs	H_p ft	Q_e/b	b ft	v fps
530	71.9	28.7	0.733		0.1	39.1		2	15.1	7.4	
529.5	97.2	34.1	0.871		0.16	62.6		2.5	17.6	5	
529	99.1	12.5	0.319		0.27	105.6		2	9.78	12	
528.5	79.1	15	0.412		0.45	176		1.5	5.1	3.1	
528	75.1	12.6	0.346		0.6	234.6		1	3.12	95	
527.5	71.2	8.1	0.222		0.84	328.4		.5	1.10	7.99	
530	105.6	42.5	1.17								
529.5	100.05	36.9	1.02								
529	97.57	34.47	0.948								
528.5	95.27	32.17	0.885								
528.25	93.09	35.99	0.99		0.07	7.8		.75	1.10	7	

USE 10'

$E_{sw} = 529$

$E_{sw} = 529.0$

$H_p = \frac{.25}{529.25}$

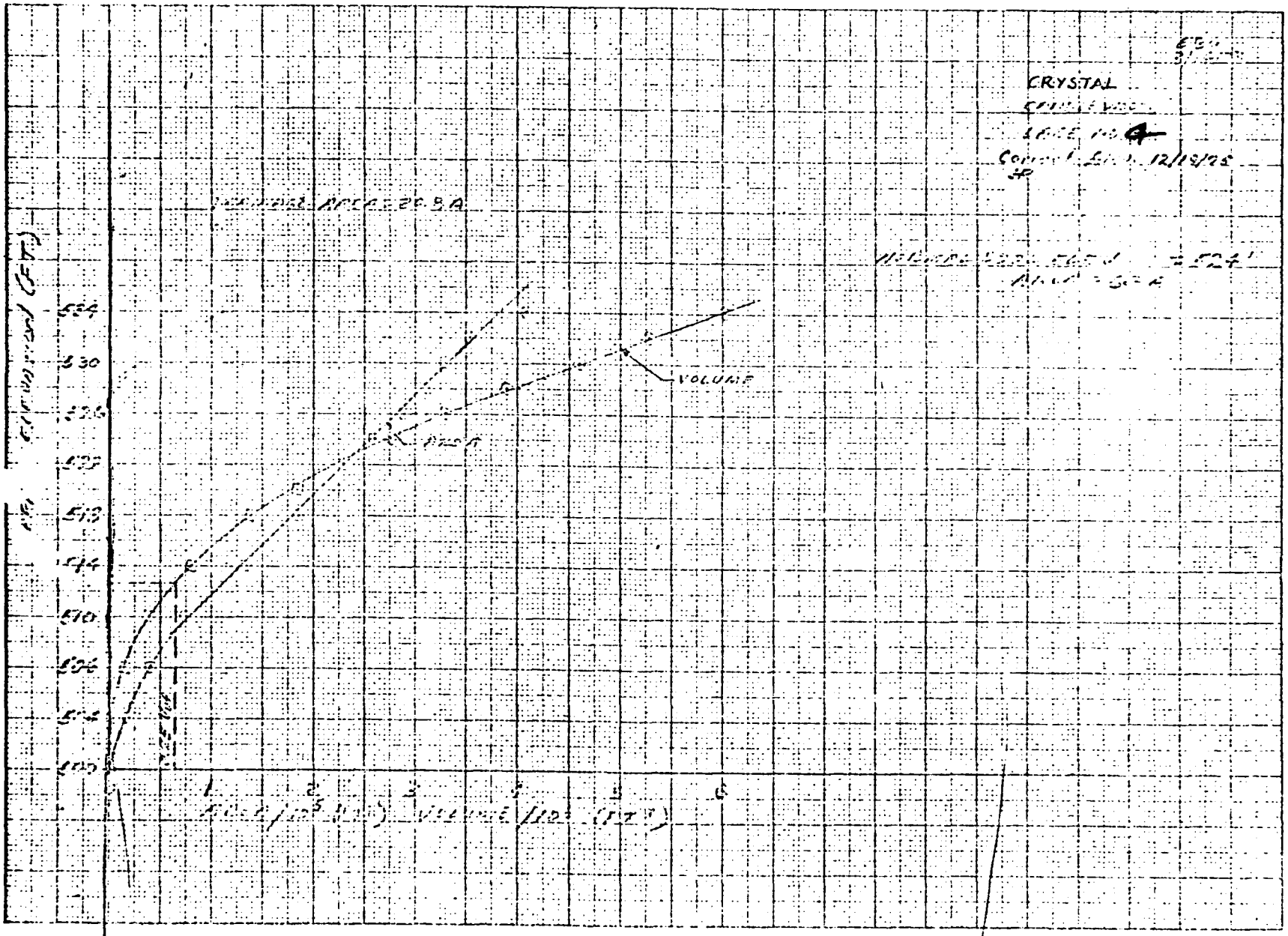
Zero $\frac{.75}{530.0}$

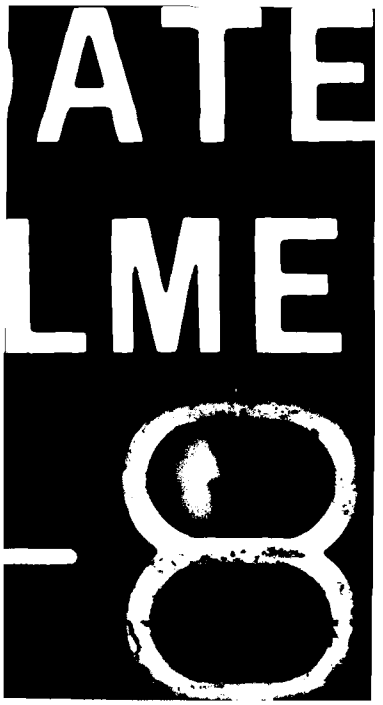
Top of Dam

$E_{sw} = 529$

$V_{sp} = V_{te} - V_{ur} = (4.3 - 2.75)10^6 = 1.55 \times 10^6 = 35.58\ AF$

$\frac{V_{sp}}{V_i} = \frac{35.58}{36.35} = 0.978$

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