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NATIONAL DAM SAFETY PROGRAM. DOVE LAKE DAM (MO 30494), MISSOURI--ETC(U)
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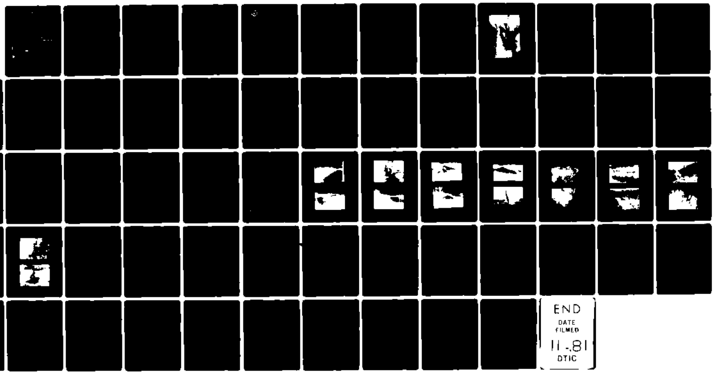

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DOVE LAKE DAM

COLE COUNTY, MISSOURI

MO 30494

PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM

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

St. Louis District

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

FOR: STATE OF MISSOURI

JULY 1980

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National Dam Safety Program
Dove Lake Dam (MO 30494)
Cole County, Missouri

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This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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

FOR: STATE OF MISSOURI

JULY 1980

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

REPLY TO
ATTENTION OF

SUBJECT: Dove Lake Dam, Mo. ID No. 30494
Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Dove Lake Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

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 — 27 OCT 1980 Date

APPROVED BY : SIGNED — Colonel, CE, District Engineer — 27 OCT 1980 Date

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DOVE LAKE DAM

COLE COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30494

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

JULY 1980

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Dove Lake Dam
State Located	Missouri
County Located	Cole County
Stream	Tributary of Rising Creek
Date of Inspection	16 July 1980

Dove Lake Dam was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and state agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers, failure would threaten lives and property. The estimated damage zone extends approximately four miles downstream of the dam. Within the estimated damage zone are three dwellings and three highway bridges.

Our inspection and evaluation indicates the spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillways will pass neither 50 nor 100 percent of the probable maximum flood without overtopping but will pass 15 percent of the probable maximum flood. The spillways will pass the flood which has a one percent chance of occurrence in any given year (100-year flood). The spillway design flood recommended by the guidelines is 50 to 100 percent of the probable maximum flood. Considering the volume of water impounded behind the dam and the hazard below the dam, the spillway design flood should be 50 percent of the probable maximum flood. The probable maximum flood is defined as the flood discharge which may be expected from the most severe combination of critical meteorologic and hydrologic conditions which are reasonably possible in the region.

Based on visual observations, this dam appears to be in good condition. Deficiencies visually observed by the inspection team were the absence of adequate slope protection on the very steep upstream slope, several sink holes on the crest of the dam, animal burrows on the downstream slope, and erosion at the embankment-abutment interfaces. Seepage and stability analyses required by the guidelines were not available.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action and regular maintenance will be required to correct or control the described deficiencies. In addition, detailed seepage and stability analyses of the existing dam, as required by the guidelines, should be performed. A detailed report discussing each of these deficiencies is attached.

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Edwin R. Burton

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Harry L. Callahan

Harry L. Callahan, Partner
Black & Veatch

OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
DOVE LAKE DAM

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APPENDIX

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 District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Dove Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure located in the valley of a tributary of Rising Creek (see Plate 1). The watershed is an area of low hills with moderately steep slopes consisting of about 50% crop land, 35% grassland, 10% timber, and 5% urban development. The area surrounding the lake is predominately timber. Although the lake was constructed for residential development, no significant development has taken place (see Plate 2). The dam is approximately 670 feet long along the crest and 31 feet high. The dam crest is 20 feet wide. The downstream face of the dam slopes from the crest to the valley floor below.

(2) The principal spillway from the lake is an uncontrolled 24-inch steel pipe drop inlet connected to a 12-inch steel outlet pipe with anti-seep collars installed in the embankment. The drop inlet is protected by a cone shaped trash rack constructed of 1/2-inch steel bars and an anti-vortex plate. The principal spillway discharges to the original streambed. The emergency spillway consists of a 24-inch corrugated-metal pipe set in the embankment near the left abutment. This 24-inch corrugated-metal pipe replaces a trapezoidal emergency spillway channel at the same location which has been backfilled. The original emergency spillway, as described on the design drawings, was a

trapezoidal channel with a 70-foot bottom width, 3-horizontal to 1-vertical side slopes, and a depth of 4 feet. The emergency spillway discharges into a natural channel to the original streambed.

(3) The low-level outlet consists of a 6-inch plastic pipe with anti-seep collars installed in the dam. Flow enters the pipe through a 5-foot riser. Flow is controlled by a 6-inch gate valve set in a valve box at the downstream toe of the embankment.

(4) A 2-inch plastic water line crosses the dam along its crest to run across the entire crest of the embankment. Although the water line was not observed, a valve riser and service connection to the house near the dam were observed. A sewer line crosses the left abutment and discharges along the interface of the downstream slope and the left abutment.

(5) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located in eastern Cole County, Missouri, as indicated on Plate 1. The lake formed by the dam is shown on the United States Geological Survey 7.5 minute series quadrangle map for Osage City, Missouri in Section 2 of T43N, R11W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, the dam and impoundment are in the small size category.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Dove Lake Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, agricultural, industrial and commercial facilities, and to important public utilities, main highways, or railroads. For the Dove Lake Dam the estimated flood damage zone extends approximately four miles downstream of the dam. Within the estimated damage zone are three dwellings and three highway bridges. Contents of the estimated damage zone were verified by the inspection team.

e. Ownership. The dam is owned by Mr. Marven Talken, Route 3, Jefferson City, Missouri 65101.

f. Purpose of Dam. The dam forms a 20-acre lake used for recreation. The lake was originally planned for residential development but to date only one house has been built.

g. Design and Construction History. The dam was designed by Groner & Picker Consulting Engineers & Land Surveyors, 209 W. Miller, Jefferson City, Missouri. The dam was constructed in 1969. Data relating to construction of the dam were not available.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation and overflow through the uncontrolled outlet pipes all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 190 acres

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through an uncontrolled 24-inch drop inlet and 12-inch outlet pipe through the embankment.

(2) Estimated experienced maximum flood at damsite - Unknown.

(3) Estimated ungated spillway capacity at maximum pool elevation 40 cfs (50 Percent Probable Maximum Flood Pool El.726.1).

c. Elevation (Feet above m.s.l.).

(1) Top of dam - 724.2 (see Plate 3)

(2) Emergency spillway pipe invert - 722.1

(3) Principal spillway crest - 720.7

(4) Streambed at toe of dam - 693 ±

(5) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 2,300 feet ± (50 Percent probable maximum flood pool level)

(2) Length of normal pool - 2,100 feet ± (Principal spillway crest)

e. Storage (Acre-feet).

(1) Top of dam - 284

(2) Emergency spillway pipe invert - 238

(3) Principal spillway crest - 210

(4) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 23.2

(2) Emergency spillway pipe invert - 21.0

(3) Principal spillway pipe invert - 19.6

g. Dam.

(1) Type - Earth embankment

(2) Length - 670 feet

(3) Height - 31 feet ±

(4) Top width - 20 feet

(5) Side slopes - upstream face varies from 1.0 V on 1.6 H to 1.0 V on 3.3 H, downstream face varies between 1.0 V on 2.8 H and 1.0 V on 2.9 H (see Plate 4)

(6) Zoning - None.

(7) Impervious core - None.

(8) Cutoff - Core Trench.

(9) Grout curtain - None.

h. Diversion and Regulating Tunnel - None.

i. Principal Spillway.

(1) Type - 12-inch steel pipe with a 24-inch steel pipe drop inlet.

(2) Inlet crest elevation - 720.7

(3) Outlet invert elevation - 690.6

(4) Gates - None.

(5) Upstream channel - None

(6) Downstream channel - Natural stream channel.

j. Emergency Spillway.

(1) Type - 24-inch corrugated-metal pipe.

(2) Inlet invert elevation - 722.1

(3) Outlet invert elevation - 721.6

(4) Gates - None.

(5) Upstream channel - Trees and light brush.

(6) Downstream channel - Natural channel to the original streambed.

k. Regulating Outlets -

(1) Type - 6-inch plastic pipe.

(2) Inlet crest elevation - 705.7

(3) Outlet invert elevation - 695.7

(4) Valve - 6-inch gate valve at the downstream end of the pipe.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data in the form of design drawings were provided by Grover and Picker.

2.2 CONSTRUCTION

Construction records were unavailable, however, the dam was constructed in 1969.

2.3 OPERATION

No records of operation or of past floods were available.

2.4 GEOLOGY

The site of the dam and reservoir is located in a shallow, steep-sided valley. The dam impounds an intermittent tributary of Rising Creek.

Information on the soils in the area of the dam and reservoir were not available. The bedrock consists of jointed, fine-grained, silty and cherty dolomite and sandstone of the Jefferson City formation of the Ordovician System. A report on the geology of the site by the Missouri Geological Survey is included in Appendix B.

2.5 EVALUATION

a. Availability. Limited engineering data were available.

b. Adequacy. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. The validity of the design, construction, and operation could not be determined due to the inadequacy of the engineering data.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Dove Lake Dam was made on 16 July 1980. The inspection team consisted of Edwin Burton, team leader; Robert Pinker, geologist; Gary Van Riessen, geotechnical engineer; and Andrew Dywan, Civil engineer. The dam is in good condition. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following conditions at the dam. Sinkholes about 8 inches wide, 12 inches long and several feet deep were observed at several points across the length of the dam on the crest. These holes were located along a line parallel to and near the downstream edge of the dam crest. These holes were possibly caused by improper backfilling following installation of a water line. The embankment has no visible stability problems. No instruments to measure the performance of the dam were located. The dam crest has been graded and was observed to have a fair stand of mowed grass. The downstream slope had a very dense stand of unmowed fescue grass. The upstream slope has some rock protection and weed cover. The upstream slope forms a berm above a steep face. It appears that the upstream face has been redressed recently by excavating material from below the water surface with a backhoe creating the steep slope and berm. This may have been done to correct erosion. There are no trees on the embankment. Some erosion was observed on the downstream slope that probably took place prior to establishment of the grass cover. The dense grass cover has prevented further erosion damage. Some erosion gullies were observed at the interface of the dam embankment and both the left and right abutments. The erosion at the left abutment has been caused by surface runoff and discharge from the sanitary sewer system. The material being eroded is a silty clay (CL). A few animal burrows were observed on the downstream slope. No cracking, sliding, sloughing, settlement or seepage were observed. No evidence was found to indicate that the embankment has ever been overtopped. No toe drains or relief wells were observed.

c. Appurtenant Structures. The inspection team observed the following items pertaining to appurtenant structures. The 12-inch principal spillway pipe was inspected from the outlet end and found to have a short horizontal section before curving upward to the drop inlet. About 3 feet of the exterior of the outlet end of the pipe was inspected and no corrosion was found except surface rust. Some minor undercutting of embankment material at the outlet end was observed. The principal spillway contains no obstructions to flow and is in good condition. An abnormally large spillway discharge would probably not damage the embankment. The emergency spillway pipe appeared to be in good condition with no rust or no obstructions to flow.

There is no development downstream of the spillways that would suffer damage due to flow through the spillway except for a cattle barn and several cattle feeders that are located near the stream channel about 1,000 feet downstream of the dam.

d. Geology. The soil in the area of the dam and reservoir was silty clay with fragments of dolomite and chert. Some loess is present on the upland ridges and slopes. The soils are classified for engineering purposes as low-plastic clay (CL).

One outcrop of dolomite and chert was observed in the downstream channel. The dolomite was medium bedded with closed bedding planes and contained chert layers and nodules. No joints or seeps were observed in the outcrop.

Samples of the embankment were taken near the center of the upstream crest. The material in the samples consisted of low-plastic silty clay classified as (CL). Based on these samples and visual observations, it is anticipated that the embankment consists of low-plastic silty clay.

The abutments and foundation of the dam are anticipated to consist of cherty dolomite overlain by a residual silty-clay soil.

e. Reservoir Area. No slumping or slides of the reservoir banks were observed. The upstream channel to the lake consists of several inlets with trees and light brush as well as a small dam in the upper reaches of the watershed. The lake water was noted to be clean (visible to a depth of approximately 2 feet) with minor siltation.

f. Downstream Channel. The emergency spillway discharges into a natural channel to the original streambed at the outlet end of the principal spillway.

3.2 EVALUATION

The various deficiencies observed at the time of the inspection are not believed to represent an immediate safety hazard. They do, however, warrant monitoring and control. The sinkholes on the crest should be repaired or they will continue to erode due to surface runoff. The potential for sloughing and sliding of slope segments will increase as additional water enters the holes. The steep upstream slope should be protected. Surveys made during the inspection reveal several descrepancies between elevations and measurements shown on the design plans. The inspection surveys were made using the principal spillway crest as a bench mark. Some of the elevation differencies could be the results of settlement, however, the as-built conditions may not have conformed to the design drawings.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, transpiration, and overflow through the uncontrolled outlet pipes.

4.2 MAINTENANCE OF DAM

The upstream face of the dam had recently been redressed and the crest had been graded and mowed. This was probably done when the water-line was installed across the dam.

4.3 MAINTENANCE OF OPERATING FACILITIES

There is no known maintenance of the valved, 6-inch plastic low level outlet pipe.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no existing warning system or preplanned scheme for alerting downstream residents for this dam.

4.5 EVALUATION

A maintenance program should be initiated which would include mowing the grass cover on the embankment in order to discourage animal burrowing.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No design data pertaining to hydrology and hydraulics were available.

b. Experience Data. The drainage area and lake surface area are developed from USGS Osage City and Meta (15') Quadrangle Maps. The dam layout is from a survey made during the inspection.

c. Visual Observations.

(1) The principal and emergency spillways appear to be in good condition. The lake level at the time of the inspection (El.720.2) was below the inlet levels and there was no flow through the pipes. Only the inlet and outlet ends of each pipe were observable. The spillway pipes discharge with a free outfall into a natural channel. A cattle barn and several cattle feeders are located near the downstream channel.

(2) Spillway discharges do not endanger the integrity of the dam.

d. Overtopping Potential. The spillways will not pass the probable maximum flood without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The spillways will pass 15 percent of the probable maximum flood without overtopping the dam. The spillways will pass the one percent chance flood estimated to have a peak outflow of 25 cfs developed by a 24-hour, one percent chance rainfall. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of small size should pass 50 to 100 percent of the probable maximum flood. Considering the volume of water impounded by the dam and the downstream hazard, the appropriate spillway design flood should be 50 percent of the probable maximum flood. The portion of the estimated peak discharge of 50 percent of the probable maximum flood overtopping the dam would be 1,630 cfs of the total discharge from the reservoir of 1,670 cfs. The estimated duration of overtopping is 9.9 hours with a maximum height of 1.9 feet. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 3,530 cfs of the total discharge from the reservoir of 3,580 cfs. The estimated duration of overtopping is 11.8 hours with a maximum height of 2.4 feet. The embankment could be jeopardized should overtopping occur for these periods of time.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately four miles downstream of the dam. Three dwellings and three highway bridges could be severely damaged and lives could be lost should failure of the dam occur. Contents of the estimated downstream hazard zone were verified by the inspection team. Cole County, Missouri uses Flood Insurance Rate maps as a guide for subdevelopments in the county. However, the flood insurance program which restricts development in certain areas has not been adopted.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which affect the structural stability of this dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design data relating to the structural stability of the dam were found. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. No operational records exist.

d. Postconstruction Changes. The original emergency spillway channel as shown on the design drawings has been filled in and replaced with the present pipe. It appears that material has been excavated to form a berm on the upstream face of the embankment. A 2-inch plastic waterline has been installed across the length of the dam at a depth of approximately 30-inches. This line supplies water to the residence located approximately 200 feet south of the dam on the west side of the lake. It is unknown when the above postconstruction changes were made.

e. Seismic Stability. The dam is located in Seismic Zone 1 which is a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservatism should pose no serious stability problems during earthquakes in this zone. The seismic stability of an earth dam is dependent upon a number of factors: embankment and foundation material classifications and shear strengths; abutment materials, conditions, and strengths; embankment zoning; and embankment geometry. Adequate descriptions of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the stability analysis required by the guidelines.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several conditions observed during the visual inspection by the inspection team should be monitored and/or controlled. These are the absence of adequate slope protection on the very steep upstream slope, several sinkholes on the crest, animal burrows on the downstream slope, and erosion at the embankment-abutment interfaces. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

b. Adequacy of Information. Due to the inadequacy of engineering design data, the conclusions in this report were based only on performance history and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. A program should be developed as soon as possible to monitor at regular intervals the deficiencies described in this report. The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam nor does it identify any serious dangers which would require a Phase II investigation. However, the additional analyses noted in paragraph 2.5b are necessary for compliance with the guidelines.

e. Seismic Stability. This dam is located in Seismic Zone 1. Adequate description of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the recommended stability analysis.

7.2 REMEDIAL MEASURES

a. Alternatives. The original emergency spillway channel should be reopened and/or the height of the dam would need to be increased or the lake level would need to be lowered to increase available flood storage in order to pass the spillway design flood. The emergency spillway should be protected to prevent erosion.

b. <u>Operation and Maintenance Procedures</u>. The following operation and maintenance procedures should be carried out under the direction of a professional engineer experienced in the design, construction, and maintenance of earth dams.

(1) Riprap should be placed on the upstream face of the dam at the normal lake level to prevent erosion of the embankment material. The very steep upstream slope should be flattened using riprap bedding material prior to placing riprap.

(2) The sinkholes on the crest should be repaired by backfilling with suitable compacted material.

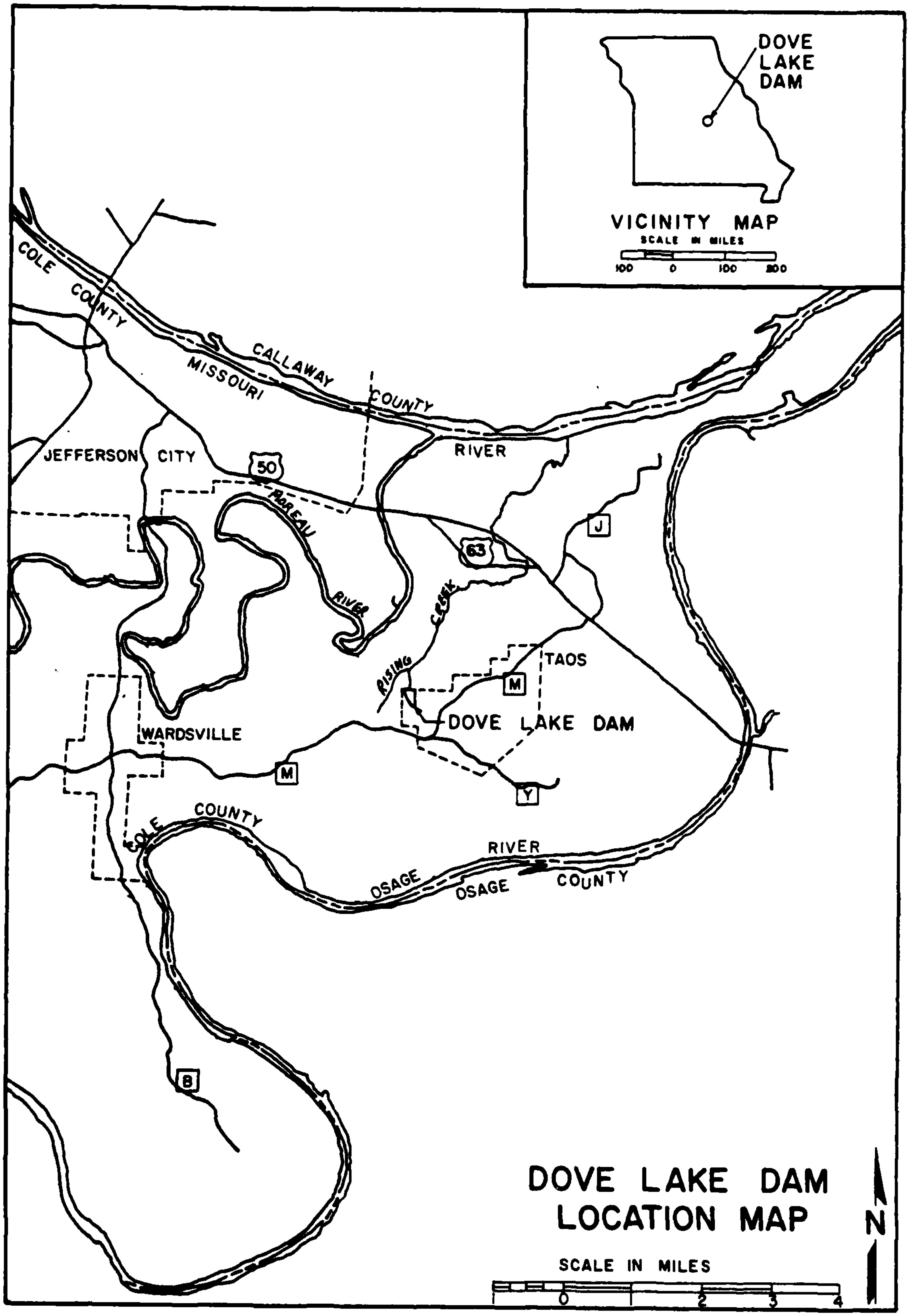
(3) An improved maintenance program should be developed. Grass cover on the embankments should be cut periodically.

(4) The erosion gulleys at the left and right abutment-downstream slope interfaces should be repaired and slope protection established to control erosion.

(5) The animal burrows on the downstream slope of the embankment should be repaired and control measures should be implemented to discourage increased animal activity in the area.

(6) Seepage and stability analysis should be performed.

(7) A detailed inspection of the dam should be made periodically. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increase.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CALLAWAY COUNTY
MISSOURI RIVER
JEFFERSON CITY
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MOREAU RIVER
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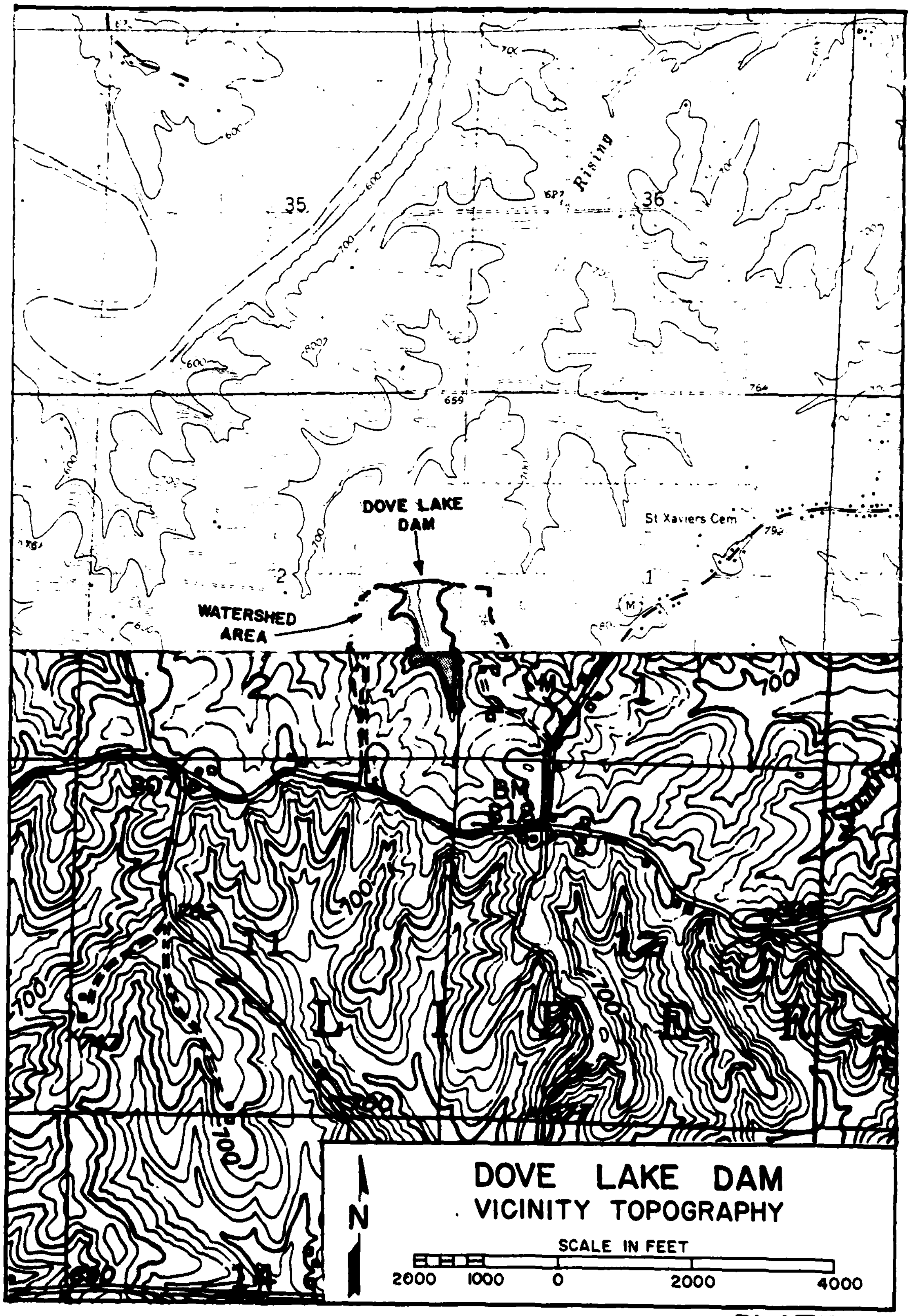
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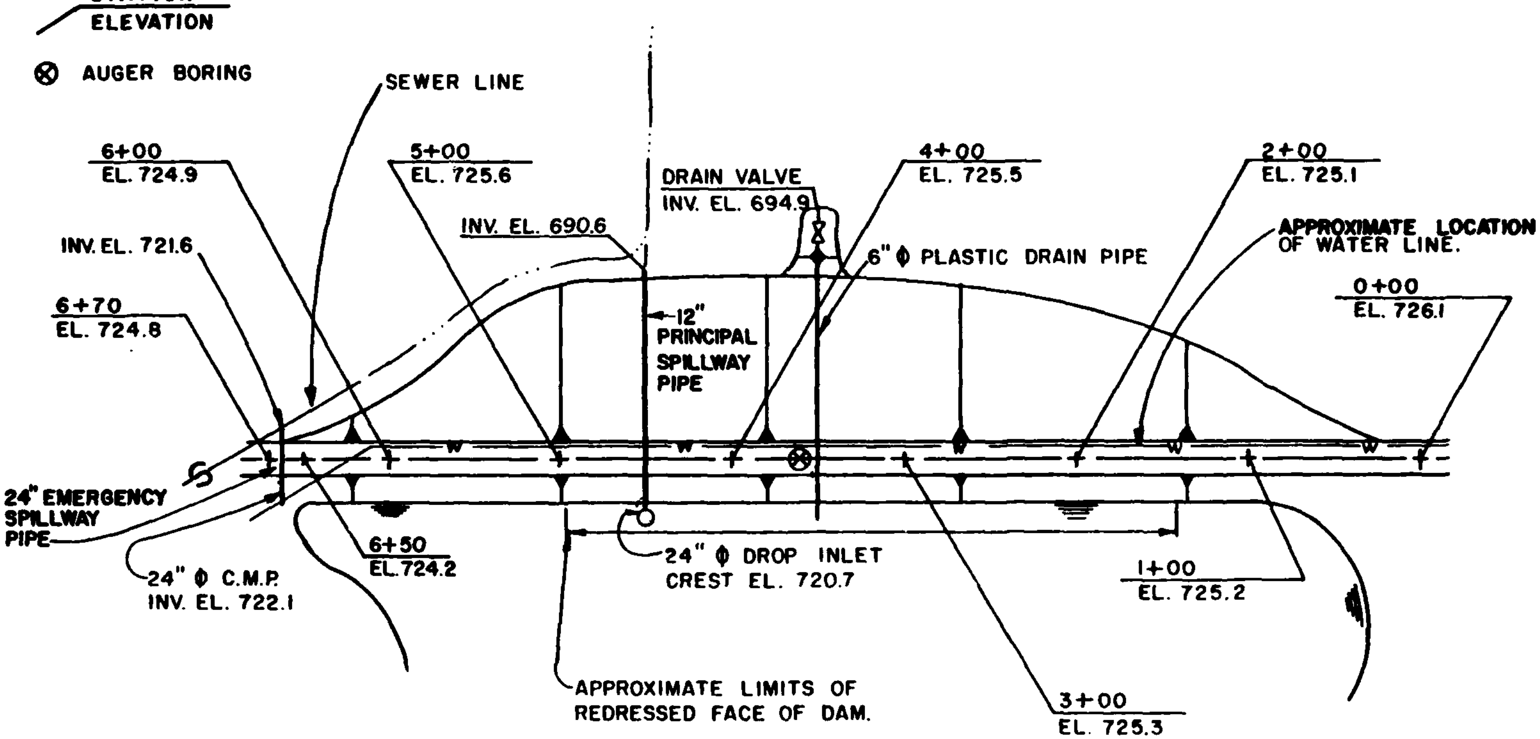
VICINITY TOPOGRAPHY
SCALE IN FEET
2000 1000 0 2000 4000
N
St Xaviers Cem
Rising
35
36
2
1
659
764
BM
700
600

PLATE 2

LEGEND

STATION / ELEVATION

⊗ AUGER BORING



NOTE:
DAM PLAN BASED ON FIELD SURVEY.

SCALE IN FEET

100 0 100 200

N

DOVE LAKE DAM
DAM PLAN

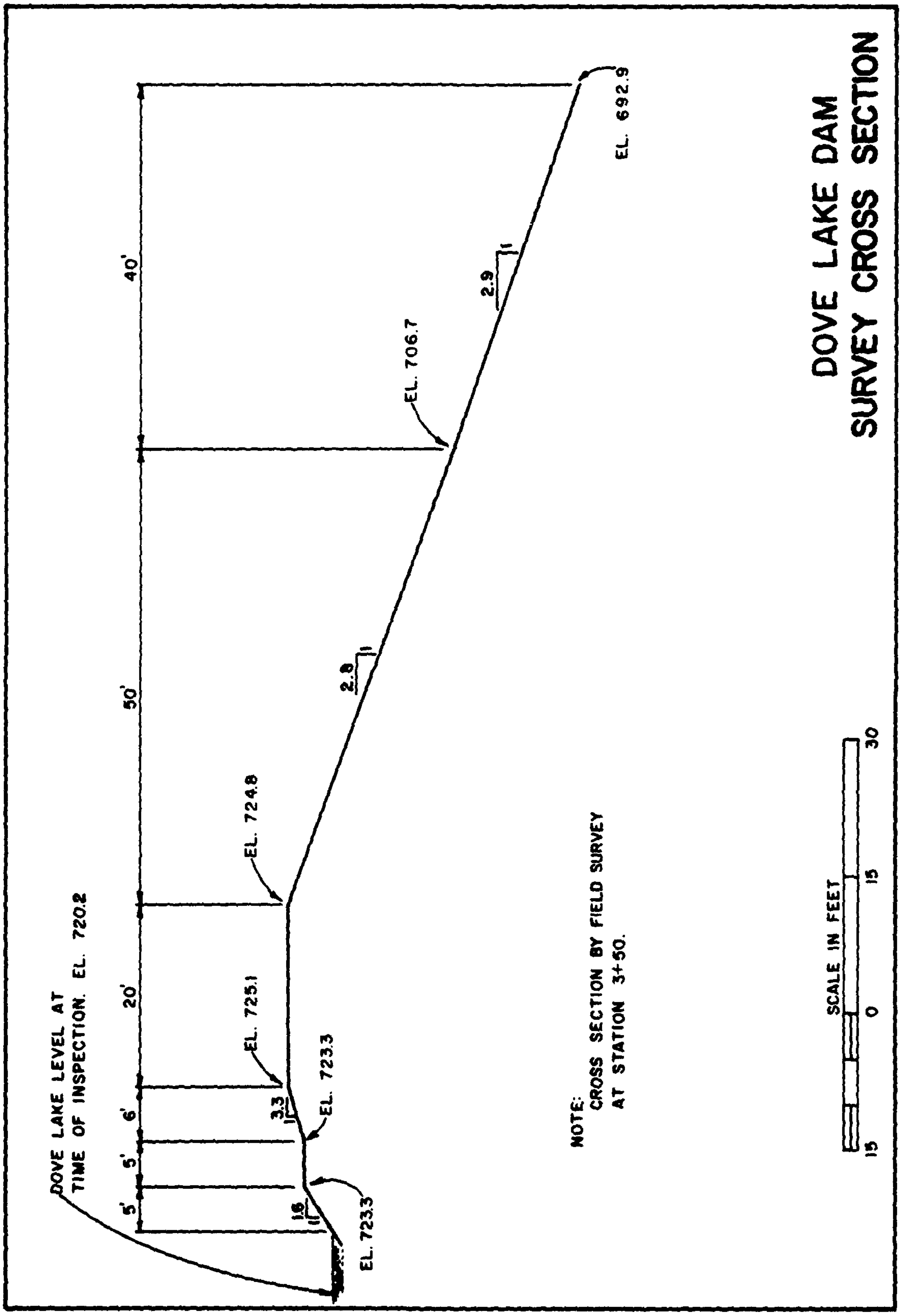
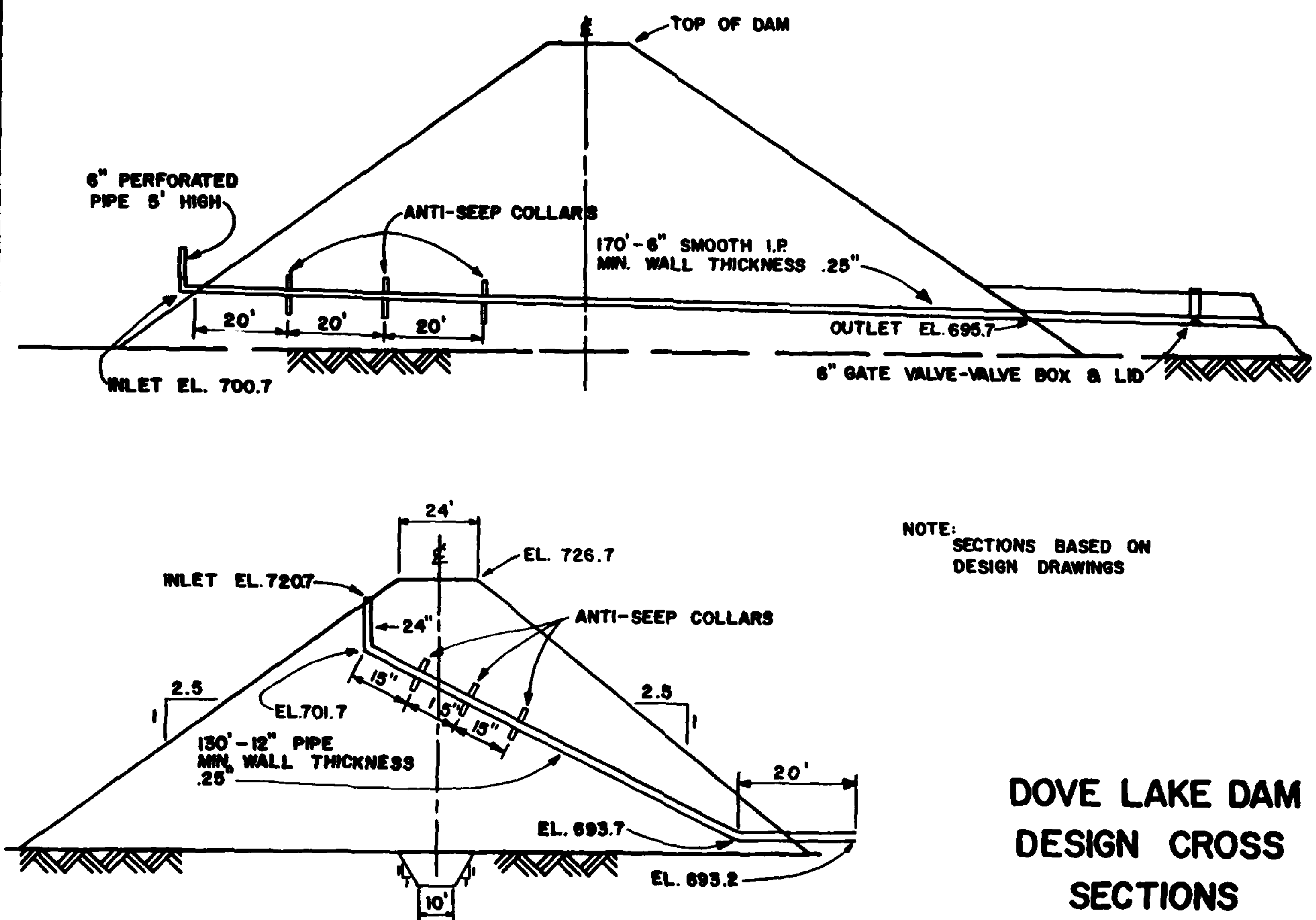

DOVE LAKE DAM
SURVEY CROSS SECTION
DOVE LAKE LEVEL AT TIME OF INSPECTION. EL. 720.2
5'
5'
6'
20'
50'
40'
EL. 725.1
EL. 723.3
EL. 723.3
EL. 724.8
EL. 706.7
EL. 692.9
1.6
1
3.3
1
2.8
1
2.9
1
NOTE:
CROSS SECTION BY FIELD SURVEY
AT STATION 3+50.
SCALE IN FEET
15
0
15
30

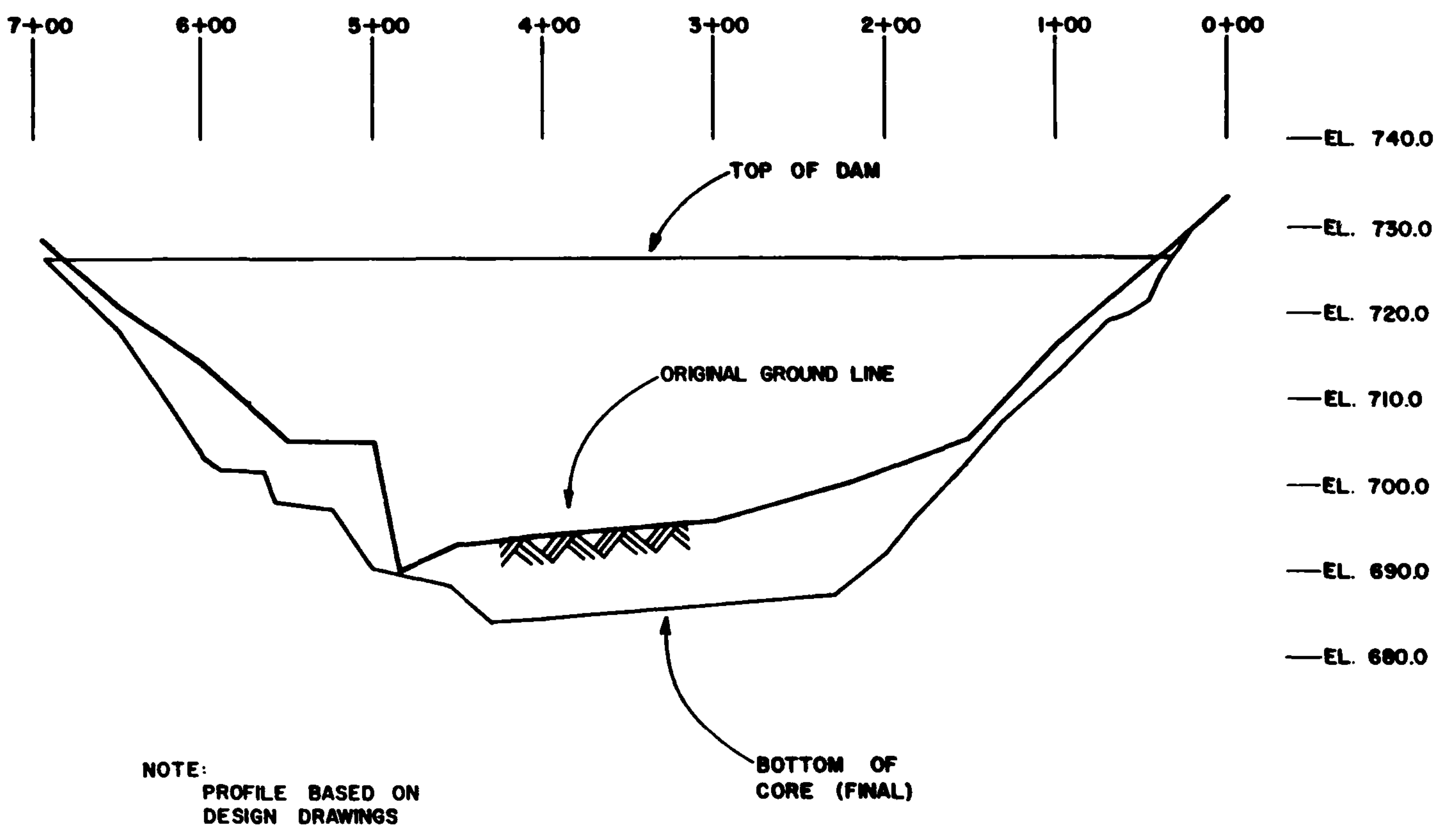
PLATE 4



NOTE:
SECTIONS BASED ON DESIGN DRAWINGS

DOVE LAKE DAM DESIGN CROSS SECTIONS

PLATE 5



DOVE LAKE DAM
DAM PROFILE

PLATE 6

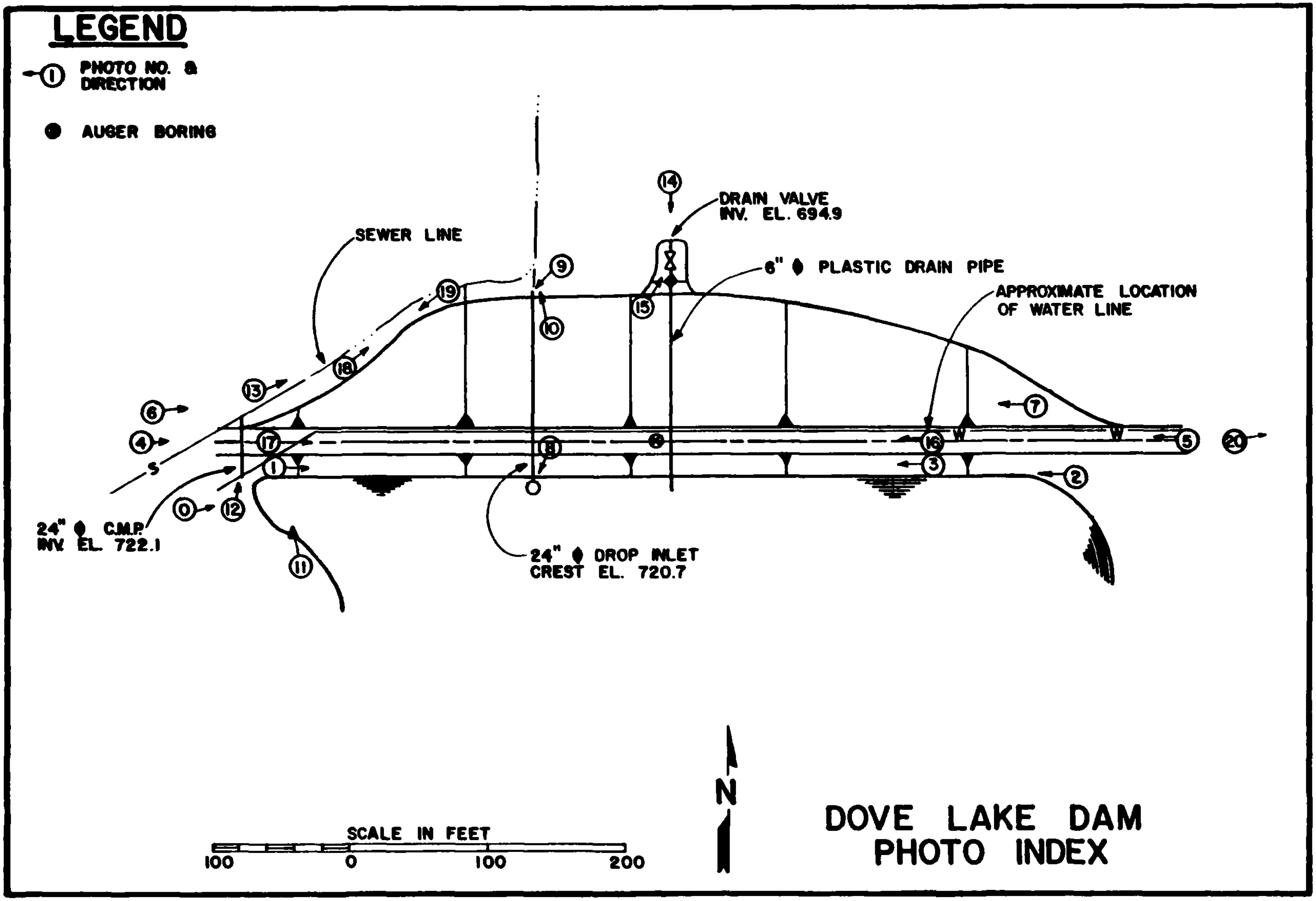

LEGEND
PHOTO NO. & DIRECTION
AUGER BORING
SEWER LINE
DRAIN VALVE
INV. EL. 694.9
6" ⌀ PLASTIC DRAIN PIPE
APPROXIMATE LOCATION
OF WATER LINE
24" ⌀ C.M.P.
INV. EL. 722.1
24" ⌀ DROP INLET
CREST EL. 720.7
SCALE IN FEET
100
0
100
200
N
DOVE LAKE DAM
PHOTO INDEX

PLATE 7

PHOTO 1: UPSTREAM FACE OF DAM LOOKING EAST

PHOTO 2: UPSTREAM FACE OF DAM LOOKING WEST

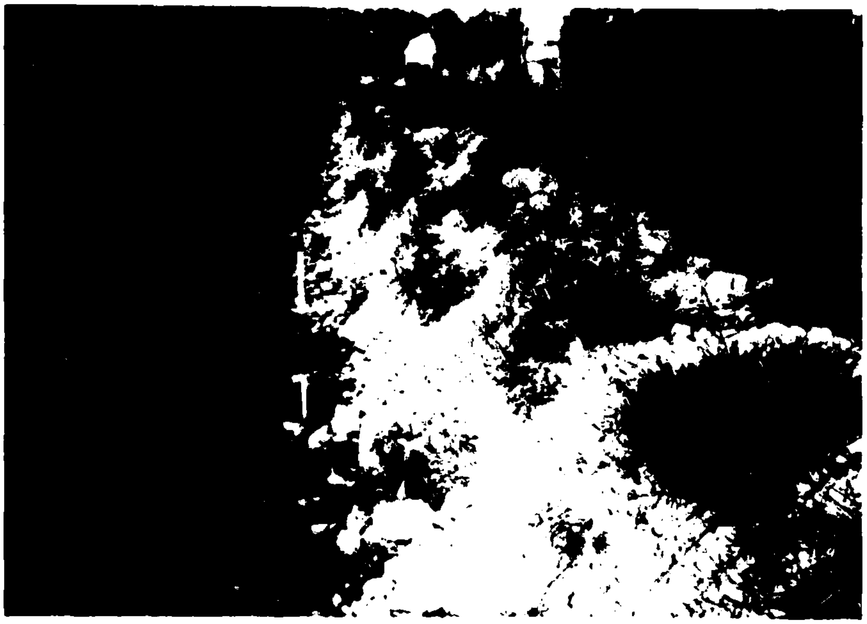


PHOTO 3: UPSTREAM FACE OF DAM NEAR CENTER

PHOTO 4: CRES1 OF DAM LOOKING EAST

PHOTO 5: CREST OF DAM LOOKING WEST

PHOTO 6: DOWNSTREAM SLOPE OF DAM LOOKING EAST

PHOTO 7: DOWNSTREAM SLOPE OF DAM LOOKING WEST

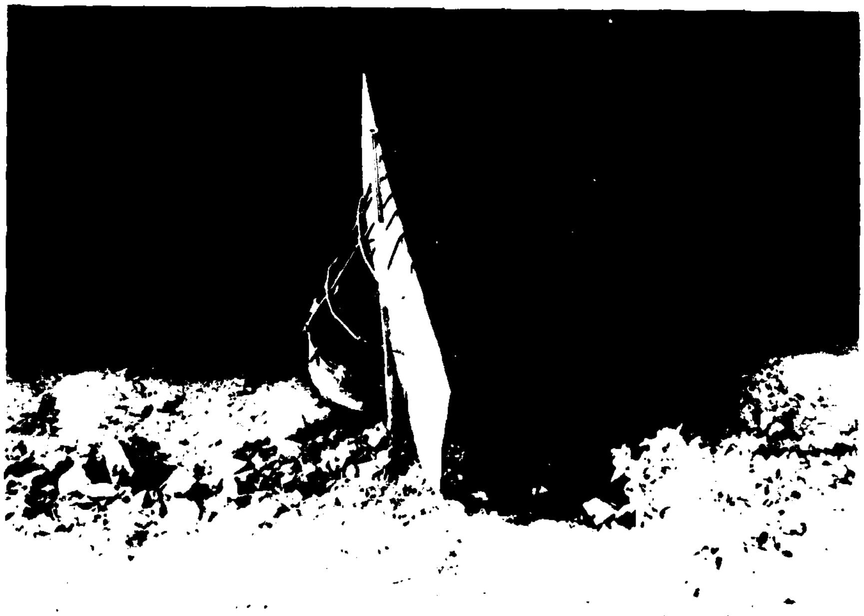


PHOTO 8: PRINCIPAL SPILLWAY DROP INLET


PHOTO 9: OUTLET END OF PRINCIPAL SPILLWAY PIPE


PHOTO 10: CHANNEL BELOW PRINCIPAL SPILLWAY OUTLET

PHOTO 11: APPROACH TO EMERGENCY SPILLWAY

PHOTO 12: UPSTREAM END OF EMERGENCY SPILLWAY PIPE

PHOTO 13: CHANNEL BELOW EMERGENCY SPILLWAY

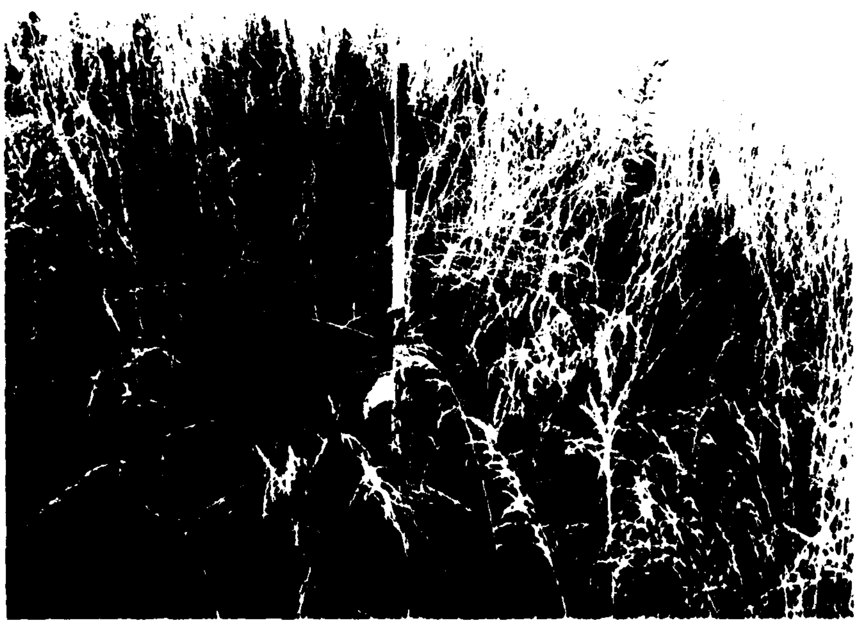


PHOTO 14: OUTLET TO DRAIN PIPE BELOW DAM

PHOTO 15: VALVE BOX TO DRAIN PIPE VALVE BELOW DAM

PHOTO 16: SINK HOLE ON CREST OF DAM

PHOTO 17: SINK HOLE ON CREST OF DAM NEAR LEFT END

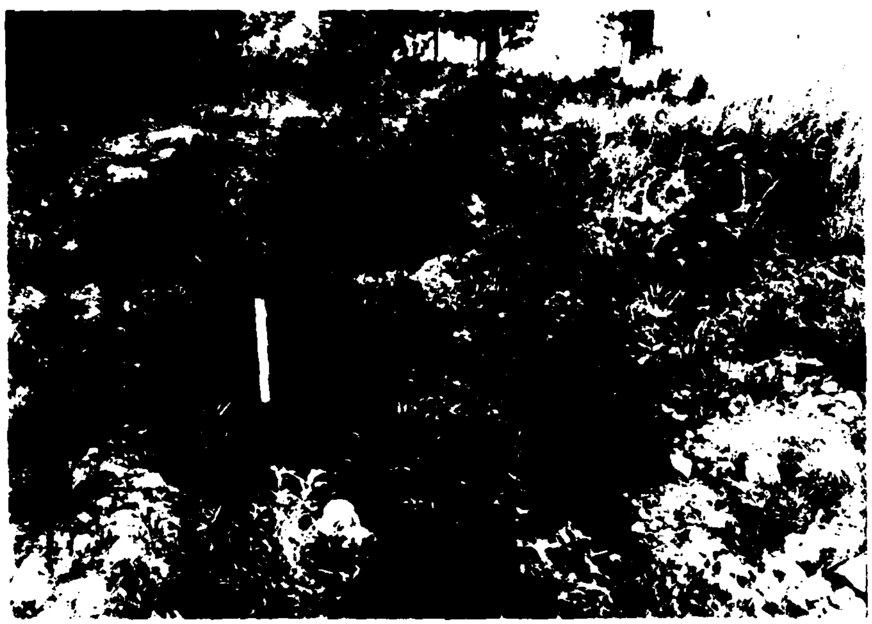


PHOTO 18: SANITARY SEWER OUTLET PIPE DOWNSTREAM OF DAM

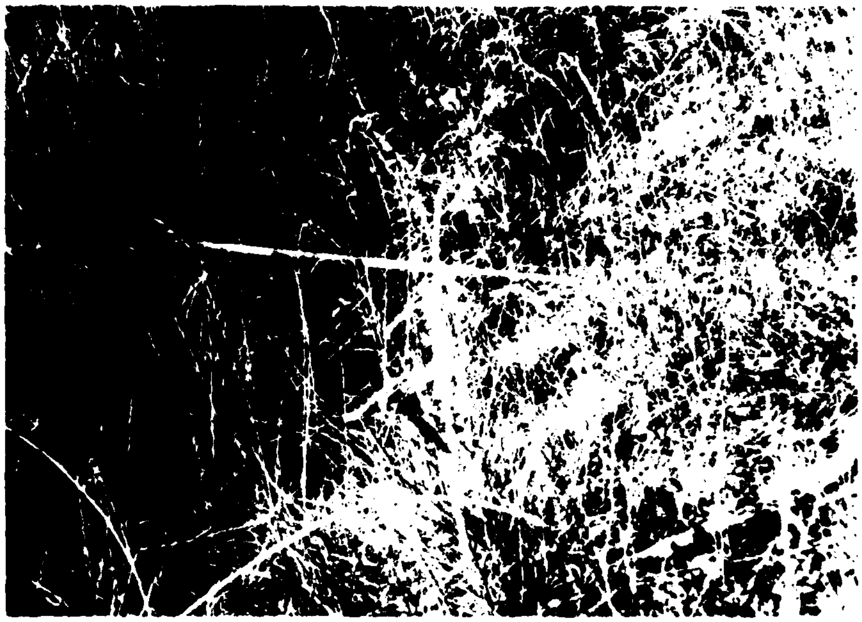


PHOTO 19: EROSION BELOW SANITARY SEWER OUTLET

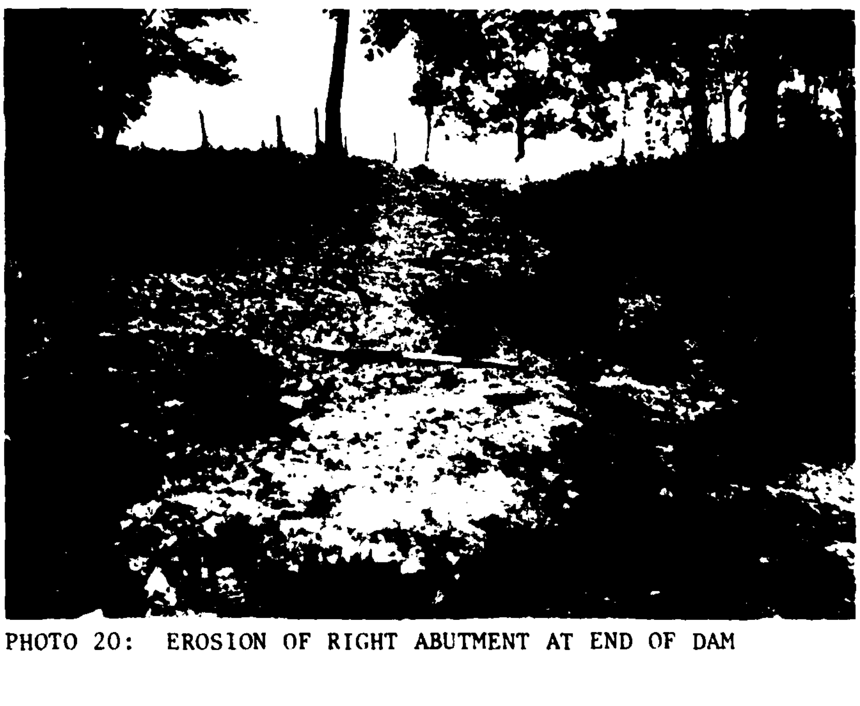


PHOTO 20: EROSION OF RIGHT ABUTMENT AT END OF DAM

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC ANALYSES

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillways. The overtopping analysis was determined using the computer program HEC-1 (Dam Safety Version) (1).

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33" (HMR-33). Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm was determined according to the procedures outlined in HMR-33 and EM 1110-2-1411. The Jefferson City, Missouri rainfall distribution (5 min. interval - 24 hours duration), as provided by the St. Louis District, Corp of Engineers, was used when the one percent chance probability flood was routed through the reservoir and spillways.

The synthetic unit hydrograph for the watershed was developed by the computer program using the Soil Conservation Service (SCS) method. The parameters for the unit hydrograph are shown in Table 1.

The SCS curve number (CN) method was used in computing the infiltration losses for the rainfall-runoff relationship. The CN values used, and the result from the computer output, are shown in Table 2.

The reservoir routing was performed using the Modified Puls Method. The initial reservoir pool elevation for the routing of each storm was determined to be equivalent to the crest elevation of the principal spillway pipe at elevation 720.7 feet m.s.l. in accordance with antecedent storm conditions preceding the one percent probability and probable maximum storms outlined by the U.S. Army Corps of Engineers, St. Louis District (2). The hydraulic capacity of the spillways and the storage capacity of the reservoir were defined by the elevation, surface area, storage, and discharge relationships shown in Table 3.

The rating curve for the spillways is shown in Table 4. The flow over the crest of the dam was determined using the non-level dam crest option ($L and $V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir. Principal spillway release rates were based on the minimum of the discharge calculated for flow into the drop inlet using the weir equation and the discharge calculated for flow through the pipe using the orifice equation. Emergency spillway release rates were based on the discharge calculated for flow through the pipe using the orifice equation. The value which controls discharge through the low-level outlet was considered to be closed for the purposes of this analysis.

The result of the routing analysis indicates that 15 percent of the PMF will not overtop the dam.

A summary of the routing analysis for different ratios of the PMF is shown in Table 5.

The computer input data and a summary of the output data are presented at the back of this appendix.

TABLE 1

SYNTHETIC UNIT HYDROGRAPH

Parameters:

Drainage Area (A)	190 acres
Length of Longest Watercourse (L)	0.40 miles
Elevation Differences in Watershed (H)	97 feet
Lag Time (L_g)	0.09 hours
Time of concentration (T_c)	0.15 hours
Duration (D)	1.2 min. (use 5 minutes)

Time (Min.) *	Discharge (cfs) *
0	0
5	784
10	972
15	364
20	133
25	47
30	17
35	6

* From HEC-1 computer output

FORMULAS USED:

$$T_c = (11.9 \times L^3/H)^{0.385} \quad (3)$$

$$L_g = 0.6\ T_c$$

$$D = 0.133\ T_c$$

TABLE 2

RAINFALL-RUNOFF VALUES

Selected Storm Event	Storm Duration (Hours)	Rainfall (Inches)	Runoff (Inches)	Loss (Inches)
PMP	24	33.02	31.86	1.16

Additional Data:

1) The soil associations in this watershed are Winfield, Macedonia, and Goss (4).
   100 percent of drainage area in hydrologic soil group C.
   10 percent of the land use was timber.
   35 percent of the land use was grassland.
   50 percent of the land use was cropland.
   5 percent of the land use was urban.
2) SCS Runoff Curve CN = 91 (AMC III) for the PMF.
3) SCS Runoff Curve CN = 79 (AMC II) for the one percent probability (5).

TABLE 3

ELEVATION, SURFACE AREA, STORAGE, AND DISCHARGE RELATIONSHIPS

Elevation (feet-MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
*720.7	19.6	210	0
**722.1	21.0	238	14
***724.2	23.2	284	29

*Principal spillway crest elevation
**Emergency spillway pipe invert elevation
***Top of dam elevation

The relationships in Table 3 were developed from the Osage City, Missouri 7.5 minute quadrangle map and the field measurements.

TABLE 4

SPILLWAY RATING CURVE

Reservoir Elevation (ft-msl)	Principal Spillway Discharge (cfs)	Emergency Spillway Discharge (cfs)	Total Spillway Discharges (cfs)
*720.7	0	0	0
**722.1	14	0	14
***724.2	17	12	29

*Principal Spillway Crest Elevation
**Emergency Spillway Pipe Invert Elevation
***Top of Dam Elevation

METHOD USED:

Principal spillway release rates were based on the minimum of the discharge calculated for flow into the drop inlet using the weir equation and the discharge calculated for flow through the pipe using the orifice equation.

Weir equation:

$$Q = C_o[2\Pi R_s] H_o^{3/2}$$

where:

C_o ranges from 1.0 to 2.0 = weir coefficient for drop-inlet spillways
R_s = 1.0 feet = radius of the drop inlet
H_o = head above the crest of the weir (6)

Orifice equation:

$$Q = Ca[2gH]^{1/2}$$

where:

C = 0.46 = coefficient of discharge
a = 0.79 sq. ft. = net area of the orifice in square feet
g = gravitational acceleration
H = difference between the energy gradient elevation upstream and the tailwater elevation downstream (6)

Emergency spillway release rates were based on the discharge calculated for flow through the pipe using the orifice equation.

Orifice equation:

$$Q = Ca[2gH]^{1/2}$$

where:

C = 0.62 = coefficient of discharge
a = 3.14 sq. ft. = net area of the orifice in square feet
g = gravitational aceleration
H = difference between the energy gradient upstream and the tailwater elevation downstream (6)

TABLE 5

RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (CFS)	Peak Lake Elevation (ft.-MSL)	Total Storage (AC.-FT.)	Peak Outflow (CFS)	Depth (ft.) Over Top of Dam
-	0	*720.7	210	0	-
0.15	632	723.7	273	26	0
0.50	2,107	726.1	328	1,670	1.9
1.00	4,214	726.6	342	3,575	2.4

* Principal spillway crest elevation

BIBLIOGRAPHY

(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Davis, California.

(2) U.S. Army Corps of Engineers, St. Louis District, Hydrologic/ Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams, 12 December 1979.

(3) U.S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, 1974, Washington, D.C.

(4) U.S. Department of Agriculture, Soil Conservation Service, Preliminary Soil Survey of Cass County, Missouri.

(5) U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, August 1972.

(6) Horace W. King and Ernest F. Brater, Handbook of Hydraulics, Sixth Edition, McGraw Hill Book Company, 1976.

(7) U.S. Department of Agriculture, Soil Conservation Service, Soil Survey Interpretations and Field Maps, 1980.

(8) Mary H. McCracken, Missouri Division of Geological Survey, Geologic Map of Missouri, 1961.

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  06 FEB 80
******************************
A1MISSOURI DAM INSPECTION PROGRAM
A2ST. LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
A3DOVE LAKE DAM
B     288       0       5       0       0       0       0       0       0       0
B1      5
J       1       9       1
J1    .05      .1     .15      .2     .25      .3     .35      .5     1.0
K       0       1                               3       1
K1    DOVE LAKE (24 HR. PROBABLE MAXIMUM RUNOFF)
M       1       2     .30                       1
P            25.4     101     120     130
T                                                      -1     -91
W2            .09
X                       1
K       1       2                                       1
K1    ROUTE THROUGH SPILLWAY
Y                               1       1
Y1      1                                      -720.70     -1
Y4720.7 721.7   722.1   722.7   723.7   724.7   725.7   726.7   727.7   728.7
Y5O.    13.     14.     18.     26.     33.     40.     45.     50.     53.
SA0.0   2.3     18.9    39.3
SE685.0 700.0   720.0   740.0
SS720.70
SD724.2
SL0.    75.     110.    270.    355.    510.    640.    710.
SV724.2 724.9   725.1   725.2   725.3   725.5   725.6   726.1
K       99
```

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B L A C K   &   V E A T C H                                                    PROJECT 9166.      DATE  6 AUG 80   PAGE   20
*****************************************************************************************************************************
FLOOD HYDROGRAPH PACKAGE - HEC-1                                               PROGRAM H21/02-QU  TIME  17:52:31   CASE 100

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  06 FEB 83
*************************************
                          MISSOURI DAM INSPECTION PROGRAM
                          ST. LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
                          DOVE LAKE DAM

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

                                   MULTI-PLAN ANALYSES TO BE PERFORMED
                                         NPLAN= 1 NRTIO= 9 LRTIO= 1
                       RTIOS=    .05     .10     .15     .20     .25     .30     .35     .50    1.00

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

                                          SUB-AREA RUNOFF COMPUTATION

                   DOVE LAKE (24 HR. PROBABLE MAXIMUM RUNOFF)

                                 ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
                                     1        0        0        0        0        3        1        0        0

                                                 HYDROGRAPH DATA
                   IHYDG     IUHG    TAREA     SNAP    TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
                       1        2      .30      .00      .30     1.00     .000        0        0        0

                                                   PRECIP DATA
                                SPFE      PMS       R6      R12      R24      R48      R72      R96
                                 .00    25.40   101.00   120.00   130.00      .00      .00      .00

                                                    LOSS DATA
              LROPT    STRKR    DLTKR    RTIOL    ERAIN    STRKS    RTIOK    STRTL    CNSTL    ALSMX    RTIMP
                  0      .00      .00     1.00      .00      .00     1.00    -1.00   -91.00      .00      .00

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

                                              UNIT HYDROGRAPH DATA
                                           TC=    .00     LAG=    .09

                                                RECESSION DATA
                                 STRTQ=      .00    QRCSN=     .00    RTIOR= 1.00

                   TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

                  UNIT HYDROGRAPH   7 END OF PERIOD ORDINATES, TC=      .00 HOURS, LAG=    .09  VOL= 1.00
              784.      972.      364.      133.       47.       17.        6.
```

UNIT HYDROGRAPH 7 END OF PERIOD ORDINATES, TC= .00 HOURS, LAG= .09 VOL= 1.00

784.	972.	364.	133.	47.	17.	6.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP W	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	0.	1.01	12.05	145	.21	.21	.00	265.
1.01	.10	2	.01	.00	.01	0.	1.01	12.10	146	.21	.21	.00	405.
1.01	.15	3	.01	.00	.01	0.	1.01	12.15	147	.21	.21	.00	457.
1.01	.20	4	.01	.00	.01	0.	1.01	12.20	148	.21	.21	.00	477.
1.01	.25	5	.01	.00	.01	0.	1.01	12.25	149	.21	.21	.00	484.
1.01	.30	6	.01	.00	.01	0.	1.01	12.30	150	.21	.21	.00	487.
1.01	.35	7	.01	.00	.01	0.	1.01	12.35	151	.21	.21	.00	488.
1.01	.40	8	.01	.00	.01	0.	1.01	12.40	152	.21	.21	.00	489.
1.01	.45	9	.01	.00	.01	0.	1.01	12.45	153	.21	.21	.00	489.
1.01	.50	10	.01	.00	.01	0.	1.01	12.50	154	.21	.21	.00	490.
1.01	.55	11	.01	.00	.01	0.	1.01	12.55	155	.21	.21	.00	490.
1.01	1.00	12	.01	.00	.01	0.	1.01	13.00	156	.21	.21	.00	490.
1.01	1.05	13	.01	.00	.01	0.	1.01	13.05	157	.26	.25	.00	524.
1.01	1.10	14	.01	.00	.01	0.	1.01	13.10	158	.26	.25	.00	565.
1.01	1.15	15	.01	.00	.01	0.	1.01	13.15	159	.26	.25	.00	561.
1.01	1.20	16	.01	.00	.01	1.	1.01	13.20	160	.26	.25	.00	587.
1.01	1.25	17	.01	.00	.01	1.	1.01	13.25	161	.26	.25	.00	589.
1.01	1.30	18	.01	.00	.01	2.	1.01	13.30	162	.26	.25	.00	590.
1.01	1.35	19	.01	.00	.01	3.	1.01	13.35	163	.26	.25	.00	590.
1.01	1.40	20	.01	.00	.01	4.	1.01	13.40	164	.26	.25	.00	591.
1.01	1.45	21	.01	.00	.01	5.	1.01	13.45	165	.26	.25	.00	591.
1.01	1.50	22	.01	.00	.01	5.	1.01	13.50	166	.26	.25	.00	591.
1.01	1.55	23	.01	.00	.01	6.	1.01	13.55	167	.26	.25	.00	591.
1.01	2.00	24	.01	.00	.01	7.	1.01	14.00	168	.26	.25	.00	592.
1.01	2.05	25	.01	.00	.01	7.	1.01	14.05	169	.32	.32	.00	642.
1.01	2.10	26	.01	.00	.01	8.	1.01	14.10	170	.32	.32	.00	704.
1.01	2.15	27	.01	.00	.01	9.	1.01	14.15	171	.32	.32	.00	727.
1.01	2.20	28	.01	.00	.01	9.	1.01	14.20	172	.32	.32	.00	736.
1.01	2.25	29	.01	.00	.01	10.	1.01	14.25	173	.32	.32	.00	739.
1.01	2.30	30	.01	.00	.01	10.	1.01	14.30	174	.32	.32	.00	740.
1.01	2.35	31	.01	.00	.01	11.	1.01	14.35	175	.32	.32	.00	741.
1.01	2.40	32	.01	.01	.01	11.	1.01	14.40	176	.32	.32	.00	741.
1.01	2.45	33	.01	.01	.01	12.	1.01	14.45	177	.32	.32	.00	741.
1.01	2.50	34	.01	.01	.01	12.	1.01	14.50	178	.32	.32	.00	741.
1.01	2.55	35	.01	.01	.01	13.	1.01	14.55	179	.32	.32	.00	741.
1.01	3.00	36	.01	.01	.01	13.	1.01	15.00	180	.32	.32	.00	742.
1.01	3.05	37	.01	.01	.01	14.	1.01	15.05	181	.19	.19	.00	644.
1.01	3.10	38	.01	.01	.01	14.	1.01	15.10	182	.39	.39	.00	674.
1.01	3.15	39	.01	.01	.01	14.	1.01	15.15	183	.39	.39	.00	818.
1.01	3.20	40	.01	.01	.01	15.	1.01	15.20	184	.58	.58	.00	1024.
1.01	3.25	41	.01	.01	.01	15.	1.01	15.25	185	.68	.68	.00	1309.
1.01	3.30	42	.01	.01	.01	15.	1.01	15.30	186	1.66	1.65	.00	2244.
1.01	3.35	43	.01	.01	.01	16.	1.01	15.35	187	2.73	2.72	.01	4092.
1.01	3.40	44	.01	.01	.01	16.	1.01	15.40	188	1.07	1.07	.00	4214.
1.01	3.45	45	.01	.01	.01	17.	1.01	15.45	189	.68	.68	.00	2828.
1.01	3.50	46	.01	.01	.01	17.	1.01	15.50	190	.56	.56	.00	1963.
1.01	3.55	47	.01	.01	.01	17.	1.01	15.55	191	.39	.39	.00	1422.
1.01	4.00	48	.01	.01	.01	17.	1.01	16.00	192	.39	.39	.00	1092.
1.01	4.05	49	.01	.01	.01	18.	1.01	16.05	193	.30	.30	.00	899.
1.01	4.10	50	.01	.01	.01	18.	1.01	16.10	194	.30	.30	.00	764.
1.01	4.15	51	.01	.01	.01	18.	1.01	16.15	195	.30	.30	.00	717.
1.01	4.20	52	.01	.01	.01	19.	1.01	16.20	196	.30	.30	.00	702.
1.01	4.25	53	.01	.01	.01	19.	1.01	16.25	197	.30	.30	.00	696.

1.01	4.20	52	.01	.01	.01	19.	1.01	16.20	196	.30	.30	.00	702.
	4.25	53	.01	.01	.01	19.	1.01	16.25	197	.30	.30	.00	696.
1.01	4.30	54	.01	.01	.01	19.	1.01	16.30	198	.30	.30	.00	695.
1.01	4.35	55	.01	.01	.01	19.	1.01	16.35	199	.30	.30	.00	694.
1.01	4.40	56	.01	.01	.01	20.	1.01	16.40	200	.30	.30	.00	694.
1.01	4.45	57	.01	.01	.01	20.	1.01	16.45	201	.30	.30	.00	694.
1.01	4.50	58	.01	.01	.01	20.	1.01	16.50	202	.30	.30	.00	694.
1.01	4.55	59	.01	.01	.01	20.	1.01	16.55	203	.30	.30	.00	694.
1.01	5.00	60	.01	.01	.01	20.	1.01	17.00	204	.30	.30	.00	694.
1.01	5.05	61	.01	.01	.01	21.	1.01	17.05	205	.24	.23	.00	644.
1.01	5.10	62	.01	.01	.01	21.	1.01	17.10	206	.24	.23	.00	582.
1.01	5.15	63	.01	.01	.00	21.	1.01	17.15	207	.24	.23	.00	558.
1.01	5.20	64	.01	.01	.00	21.	1.01	17.20	208	.24	.23	.00	550.
1.01	5.25	65	.01	.01	.00	21.	1.01	17.25	209	.24	.23	.00	547.
1.01	5.30	66	.01	.01	.00	22.	1.01	17.30	210	.24	.23	.00	546.
1.01	5.35	67	.01	.01	.00	22.	1.01	17.35	211	.24	.23	.00	545.
1.01	5.40	68	.01	.01	.00	22.	1.01	17.40	212	.24	.23	.00	545.
1.01	5.45	69	.01	.01	.00	22.	1.01	17.45	213	.24	.23	.00	545.
1.01	5.50	70	.01	.01	.00	22.	1.01	17.50	214	.24	.23	.00	546.
1.01	5.55	71	.01	.01	.00	23.	1.01	17.55	215	.24	.23	.00	546.
1.01	6.00	72	.01	.01	.00	23.	1.01	18.00	216	.24	.23	.00	546.
1.01	6.05	73	.07	.05	.02	52.	1.01	18.05	217	.02	.02	.00	378.
1.01	6.10	74	.07	.05	.02	90.	1.01	18.10	218	.02	.02	.00	170.
1.01	6.15	75	.07	.05	.02	106.	1.01	18.15	219	.02	.02	.00	92.
1.01	6.20	76	.07	.05	.02	114.	1.01	18.20	220	.02	.02	.00	64.
1.01	6.25	77	.07	.05	.01	118.	1.01	18.25	221	.02	.02	.00	54.
1.01	6.30	78	.07	.05	.01	121.	1.01	18.30	222	.02	.02	.00	50.
1.01	6.35	79	.07	.05	.01	123.	1.01	18.35	223	.02	.02	.00	49.
1.01	6.40	80	.07	.05	.01	125.	1.01	18.40	224	.02	.02	.00	49.
1.01	6.45	81	.07	.06	.01	127.	1.01	18.45	225	.02	.02	.00	49.
1.01	6.50	82	.07	.06	.01	129.	1.01	18.50	226	.02	.02	.00	49.
1.01	6.55	83	.07	.06	.01	130.	1.01	18.55	227	.02	.02	.00	49.
1.01	7.00	84	.07	.06	.01	131.	1.01	19.00	228	.02	.02	.00	49.
1.01	7.05	85	.07	.06	.01	133.	1.01	19.05	229	.02	.02	.00	49.
1.01	7.10	86	.07	.06	.01	134.	1.01	19.10	230	.02	.02	.00	49.
1.01	7.15	87	.07	.06	.01	135.	1.01	19.15	231	.02	.02	.00	49.
1.01	7.20	88	.07	.06	.01	136.	1.01	19.20	232	.02	.02	.00	49.
1.01	7.25	89	.07	.06	.01	137.	1.01	19.25	233	.02	.02	.00	49.
1.01	7.30	90	.07	.06	.01	138.	1.01	19.30	234	.02	.02	.00	49.
1.01	7.35	91	.07	.06	.01	138.	1.01	19.35	235	.02	.02	.00	49.
1.01	7.40	92	.07	.06	.01	139.	1.01	19.40	236	.02	.02	.00	49.
1.01	7.45	93	.07	.06	.01	140.	1.01	19.45	237	.02	.02	.00	49.
1.01	7.50	94	.07	.06	.01	141.	1.01	19.50	238	.02	.02	.00	49.
1.01	7.55	95	.07	.06	.01	141.	1.01	19.55	239	.02	.02	.00	49.
1.01	8.00	96	.07	.06	.01	142.	1.01	20.00	240	.02	.02	.00	49.
1.01	8.05	97	.07	.06	.01	142.	1.01	20.05	241	.02	.02	.00	49.
1.01	8.10	98	.07	.06	.01	143.	1.01	20.10	242	.02	.02	.00	49.
1.01	8.15	99	.07	.06	.01	143.	1.01	20.15	243	.02	.02	.00	49.
1.01	8.20	100	.07	.06	.00	144.	1.01	20.20	244	.02	.02	.00	49.
1.01	8.25	101	.07	.06	.00	144.	1.01	20.25	245	.02	.02	.00	49.
1.01	8.30	102	.07	.06	.00	145.	1.01	20.30	246	.02	.02	.00	49.
1.01	8.35	103	.07	.06	.00	145.	1.01	20.35	247	.02	.02	.00	49.
1.01	8.40	104	.07	.06	.00	145.	1.01	20.40	248	.02	.02	.00	49.
1.01	8.45	105	.07	.06	.00	146.	1.01	20.45	249	.02	.02	.00	49.
1.01	8.50	106	.07	.06	.00	146.	1.01	20.50	250	.02	.02	.00	49.
1.01	8.55	107	.07	.06	.00	146.	1.01	20.55	251	.02	.02	.00	49.
1.01	9.00	108	.07	.06	.00	147.	1.01	21.00	252	.02	.02	.00	49.
1.01	9.05	109	.07	.06	.00	147.	1.01	21.05	253	.02	.02	.00	49.

1.01	8.50	106	.07	.06	.00	146.	1.01	20.50	250	.02	.02	.00	49.
1.01	8.55	107	.07	.06	.00	146.	1.01	20.55	251	.02	.02	.00	49.
1.01	9.00	108	.07	.06	.00	147.	1.01	21.00	252	.02	.02	.00	49.
1.01	9.05	109	.07	.06	.00	147.	1.01	21.05	253	.02	.02	.00	49.

1.01	9.10	110	.07	.06	.00	147.	1.01	21.10	254	.02	.02	.00	49.
1.01	9.15	111	.07	.06	.00	147.	1.01	21.15	255	.02	.02	.00	49.
1.01	9.20	112	.07	.06	.00	148.	1.01	21.20	256	.02	.02	.00	49.
1.01	9.25	113	.07	.06	.00	148.	1.01	21.25	257	.02	.02	.00	49.
1.01	9.30	114	.07	.06	.00	148.	1.01	21.30	258	.02	.02	.00	49.
1.01	9.35	115	.07	.06	.00	148.	1.01	21.35	259	.02	.02	.00	49.
1.01	9.40	116	.07	.06	.00	149.	1.01	21.40	260	.02	.02	.00	49.
1.01	9.45	117	.07	.06	.00	149.	1.01	21.45	261	.02	.02	.00	49.
1.01	9.50	118	.07	.06	.00	149.	1.01	21.50	262	.02	.02	.00	49.
1.01	9.55	119	.07	.06	.00	149.	1.01	21.55	263	.02	.02	.00	49.
1.01	10.00	120	.07	.06	.00	149.	1.01	22.00	264	.02	.02	.00	49.
1.01	10.05	121	.07	.06	.00	150.	1.01	22.05	265	.02	.02	.00	49.
1.01	10.10	122	.07	.06	.00	150.	1.01	22.10	266	.02	.02	.00	49.
1.01	10.15	123	.07	.06	.00	150.	1.01	22.15	267	.02	.02	.00	49.
1.01	10.20	124	.07	.06	.00	150.	1.01	22.20	268	.02	.02	.00	49.
1.01	10.25	125	.07	.06	.00	150.	1.01	22.25	269	.02	.02	.00	49.
1.01	10.30	126	.07	.06	.00	150.	1.01	22.30	270	.02	.02	.00	49.
1.01	10.35	127	.07	.06	.00	150.	1.01	22.35	271	.02	.02	.00	49.
1.01	10.40	128	.07	.06	.00	151.	1.01	22.40	272	.02	.02	.00	49.
1.01	10.45	129	.07	.06	.00	151.	1.01	22.45	273	.02	.02	.00	49.
1.01	10.50	130	.07	.06	.00	151.	1.01	22.50	274	.02	.02	.00	49.
1.01	10.55	131	.07	.07	.00	151.	1.01	22.55	275	.02	.02	.00	49.
1.01	11.00	132	.07	.07	.00	151.	1.01	23.00	276	.02	.02	.00	49.
1.01	11.05	133	.07	.07	.00	151.	1.01	23.05	277	.02	.02	.00	49.
1.01	11.10	134	.07	.07	.00	151.	1.01	23.10	278	.02	.02	.00	49.
1.01	11.15	135	.07	.07	.00	151.	1.01	23.15	279	.02	.02	.00	49.
1.01	11.20	136	.07	.07	.00	151.	1.01	23.20	280	.02	.02	.00	49.
1.01	11.25	137	.07	.07	.00	151.	1.01	23.25	281	.02	.02	.00	49.
1.01	11.30	138	.07	.07	.00	152.	1.01	23.30	282	.02	.02	.00	49.
1.01	11.35	139	.07	.07	.00	152.	1.01	23.35	283	.02	.02	.00	49.
1.01	11.40	140	.07	.07	.00	152.	1.01	23.40	284	.02	.02	.00	49.
1.01	11.45	141	.07	.07	.00	152.	1.01	23.45	285	.02	.02	.00	49.
1.01	11.50	142	.07	.07	.00	152.	1.01	23.50	286	.02	.02	.00	49.
1.01	11.55	143	.07	.07	.00	152.	1.01	23.55	287	.02	.02	.00	49.
1.01	12.00	144	.07	.07	.00	152.	1.02	.00	288	.02	.02	.00	49.
									SUM	33.02	31.86	1.16	73926.
										(839.)	(809.)	(29.)	(2093.35)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4214.	819.	257.	257.	73908.
CMS	119.	23.	7.	7.	2093.
INCHES		25.39	31.83	31.83	31.83
MM		644.79	808.47	808.47	808.47
AC-FT		406.	509.	509.	509.
THOUS CU M		501.	628.	628.	628.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	211.	41.	13.	13.	3695.
CMS	6.	1.	0.	0.	105.
INCHES		1.27	1.59	1.59	1.59
MM		32.24	40.42	40.42	40.42

CMS	6.	1.	0.	0.	105.
INCHES		1.27	1.59	1.59	1.59
MM		32.24	40.42	40.42	40.42

AC-FT		20.	25.	25.	25.
THOUS CU M		25.	31.	31.	31.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	421.	82.	26.	26.	7391.
CMS	12.	2.	1.	1.	209.
INCHES		2.54	3.18	3.18	3.18
MM		64.48	80.85	80.85	80.85
AC-FT		41.	51.	51.	51.
THOUS CU M		50.	63.	63.	63.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	632.	123.	38.	38.	11086.
CMS	18.	3.	1.	1.	314.
INCHES		3.81	4.77	4.77	4.77
MM		96.72	121.27	121.27	121.27
AC-FT		61.	76.	76.	76.
THOUS CU M		75.	94.	94.	94.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	843.	164.	51.	51.	14782.
CMS	24.	5.	1.	1.	419.
INCHES		5.08	6.37	6.37	6.37
MM		128.96	161.69	161.69	161.69
AC-FT		81.	102.	102.	102.
THOUS CU M		100.	126.	126.	126.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1054.	205.	64.	64.	18477.
CMS	30.	6.	2.	2.	523.
INCHES		6.35	7.96	7.96	7.96
MM		161.20	202.12	202.12	202.12
AC-FT		101.	127.	127.	127.
THOUS CU M		125.	157.	157.	157.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 6

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 6

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1264.	246.	77.	77.	22172.
CMS	36.	7.	2.	2.	628.
INCHES		7.62	9.55	9.55	9.55
MM		193.44	242.54	242.54	242.54
AC-FT		122.	153.	153.	153.
THOUS CU M		150.	188.	188.	188.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 7

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1475.	287.	90.	90.	25868.
CMS	42.	8.	3.	3.	732.
INCHES		8.86	11.14	11.14	11.14
MM		225.68	282.96	282.96	282.96
AC-FT		142.	178.	178.	178.
THOUS CU M		175.	220.	220.	220.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 8

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2107.	409.	128.	128.	36954.
CMS	60.	12.	4.	4.	1046.
INCHES		12.69	15.91	15.91	15.91
MM		322.40	404.24	404.24	404.24
AC-FT		203.	255.	255.	255.
THOUS CU M		250.	314.	314.	314.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 9

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4214.	819.	257.	257.	73908.
CMS	119.	23.	7.	7.	2093.
INCHES		25.39	31.83	31.83	31.83
MM		644.79	808.47	808.47	808.47
AC-FT		406.	509.	509.	509.
THOUS CU M		501.	628.	628.	628.

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

HYDROGRAPH ROUTING

ROUTE THROUGH SPILLWAY

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

ROUTING DATA

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

ROUTING DATA

B L A C K & V E A T C H PROJECT 9166. DATE 6 AUG 80 PAGE 26

FLOOD HYDROGRAPH PACKAGE - HEC-1 PROGRAM H21/02-OU TIME 17:52:31 CASE 100

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
.0	.000	.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	.069	.000	.000	-721.	-1

STAGE	720.70	721.70	722.10	722.70	723.70	724.70	725.70	726.70	727.70	728.70
FLOW	.00	13.00	14.30	18.00	26.00	33.00	40.00	45.00	50.00	53.00

SURFACE AREA=	0.	2.	19.	39.
CAPACITY=	0.	11.	197.	766.
ELEVATION=	685.	706.	720.	740.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
720.7	.0	.0	.0	.0	.0	.0	.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
724.2	.0	.0	0.

CREST LENGTH	0.	75.	110.	270.	355.	510.	640.	710.
AT OR BELOW ELEVATION	724.2	724.9	725.1	725.2	725.3	725.5	725.6	726.1

STATION 2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	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.	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.	2.	2.	2.	2.	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.	5.	5.
5.	5.	5.	5.	5.	6.	6.	6.	6.	6.
6.	6.	7.	7.	7.	7.	8.	9.	10.	10.
12.	11.	11.	11.	11.	11.	11.	11.	11.	12.
12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
13.	13.	13.	13.	13.	13.	13.	13.	13.	13.
13.	13.	13.	13.	13.	13.	13.	12.	12.	12.
12.	12.	12.	12.	12.	12.	12.	12.	12.	12.

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 .25	RATIO 6 .30	RATIO 7 .35	RATIO 8 .50	RATIO 9 1.00
HYDROGRAPH AT	1	.30	1	211.	421.	632.	843.	1054.	1264.	1475.	2107.	4214.
	(	.78)	(	5.97)(	11.93)(	17.90)(	23.87)(	29.83)(	35.80)(	41.77)(	59.66)(	119.33)
ROUTED TO	2	.30	1	13.	18.	26.	47.	129.	237.	584.	1670.	3575.
	(	.78)	(	.36)(	.51)(	.74)(	1.34)(	3.65)(	6.71)(	16.54)(	47.28)(	101.24)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	720.70	720.70	724.20
STORAGE	210.	210.	264.
OUTFLOW	0.	0.	29.

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	721.69	.00	230.	13.	.00	18.17	.00
.10	722.72	.00	251.	18.	.00	18.17	.00
.15	723.70	.00	273.	26.	.00	18.17	.00
.20	724.63	.43	294.	47.	6.50	18.17	.00
.25	725.06	.86	304.	129.	8.33	18.00	.00
.30	725.30	1.10	309.	237.	6.50	16.17	.00
.35	725.60	1.40	316.	584.	8.75	15.92	.00
.50	726.07	1.87	328.	1670.	9.92	15.75	.00
1.00	726.64	2.44	342.	3575.	11.75	15.67	.00

APPENDIX B

GEOLOGY REPORT

ENGINEERING GEOLOGY OF THE GRONER & PICKER LAKE SITE, COLE COUNTY

From a surficial investigation, the lake site located in the NE1/4 SE1/4 sec. 2, T.43 N., R. 11W. (Jefferson City 15' Quad.) appears worthy of future consideration and investigation from a geologic viewpoint.

The lake area is underlain by the Jefferson City Formation. The dolomite and sandstone is jointed and eroded bedding planes are in evidence. No water loss was observed through rock fractures during this investigation. Bedrock can be observed in the present stream bed although alluvial material several feet or more in depth covers the major portions of the valley floor.

Approximately 200 acres of open land drains in to this valley and should provide sufficient water for a stable water level in a lake of 15-20 acres.

Adequate amounts of silty clay (CL) material were located in the stream valley floor on the valley slopes and on the ridge tops.

Further investigations will have to be made with a backhoe or other equipment to determine the depth and condition of the bedrock in the valley bottom and slopes in the abutment areas.

If conditions warrant further investigation of this lake site, it is recommended that:

1. The size of the lake be limited to a drainage to lake ratio of 10 or 12:1 to provide a relatively stable water level.

2. A backhoe capable of digging depths of 7-10 feet be employed to excavate test pits in the dam area to determine the depth and condition of bedrock.

3. No borrow material should be removed from below the proposed water line within 150-200 feet of the dam. This natural sealant material prevents rapid downward percolation of water to the jointed bedrock below.

4. Traffic during construction should be selectively routed along the valley bottom to provide maximum compaction.

5. The bedrock in the present stream channel should be covered with several feet of borrow material to prevent downward percolation and lateral movement of water under the core of the dam.

6. The core trench should be excavated into fresh unbroken rock to intercept lateral water movement. In the event no rock is encountered, the core trench should cut into a clay material that is relatively impervious. The material on either side of the abutments should not be removed or disturbed except for compaction.

Thomas J. Dean
Engineering Geologist
Missouri Geological Survey
June 5, 1968

ADDENDUM TO THE ENGINEERING GEOLOGY OF THE GRONER & PICKER LAKE SITE, COLE COUNTY

LOCATION: NE1/4 SE1/4 sec. 2, T. 43 N., R. 11 W. (Jefferson City Quadrangle)

Excavation of a core trench at this location revealed an excess of 10 feet of clay and silty clay material overlying the bedrock in the east half of the valley bottom and four to five feet of clay and silty clay material overlying the bedrock on the west portion of the valley bottom with bedrock appearing near the surface on both abutment areas. The bedrock underlying the deep colluvial and alluvial material on the right abutment area on the valley bottom appears to be in a relatively unweathered condition and should present no problems with laterally moving water beneath the core trench. The bedrock within 50 feet of the present streambed near the left abutment in the valley bottom is weathered to a depth of three or four feet with large joints that are generally clay filled in evidence. The removal of this jointed weathered bedrock down to solid, unjointed bedrock should be sufficient to cut off laterally moving waters in this area. The removal of the gravels and loose flaggy dolomite on the left abutment to relatively solid bedrock should be sufficient to cut off water in the left abutment provided ample material is used to pad the exposed bedrock in the streambed immediately upstream of the left abutment. Two to three feet of good quality borrow material should be used to pad the streambed and the rock bluff that can be seen immediately upstream of the left abutment. Any broken, loose rubble material should be removed from the right abutment until relatively fresh bedrock is encountered. The bedrock in the right abutment probably cannot be excavated very deep without blasting due to the hardness of the rock. It is not thought that it is necessary to excavate the right abutment into the rock except for removal of the loose material. The core trench in the right abutment should be widened considerably and all loose soil and broken material should be removed from both sides of the existing core trench and clay material packed on firm, fresh bedrock. No borrow material should be removed from the upstream or downstream abutment area within several hundred feet. This material will help prevent lateral seepage of water through the dolomite that would normally go around the right abutment through the bedding planes which cannot be intercepted due to the hardness of the rock. It is important that no material be removed from the right abutment area upstream or downstream of the core.

Due to the thickness of colluvial and alluvial silt and clays in the valley bottom on the east side of the valley upstream of the dam, it is thought that the removal of four or five feet of this material to be incorporated into the dam would not harm the water holding potential of the valley bottom in this area. If gravel lenses are intercepted during this borrow removal, the gravel should be removed down to relatively water tight clay. These gravel lenses, if left exposed in the bottom upstream of the dam, could transmit water into the core area of the dam.

Generally this site has potential for a very successful water retention structure. The entire valley bottom, with the exception of the present streambed, is well covered with a relatively impermeable soil material which should prevent rapid downward percolation of water into the bedrock. Colluvial material in the valley walls is generally thick enough to help prevent lateral movement of water into the bedrock.

If any unusual geologic conditions are encountered during further construction, don't hesitate to call on our office.

Thomas J. Dean
Engineering Geologist
Missouri Geological Survey
August 11, 1969