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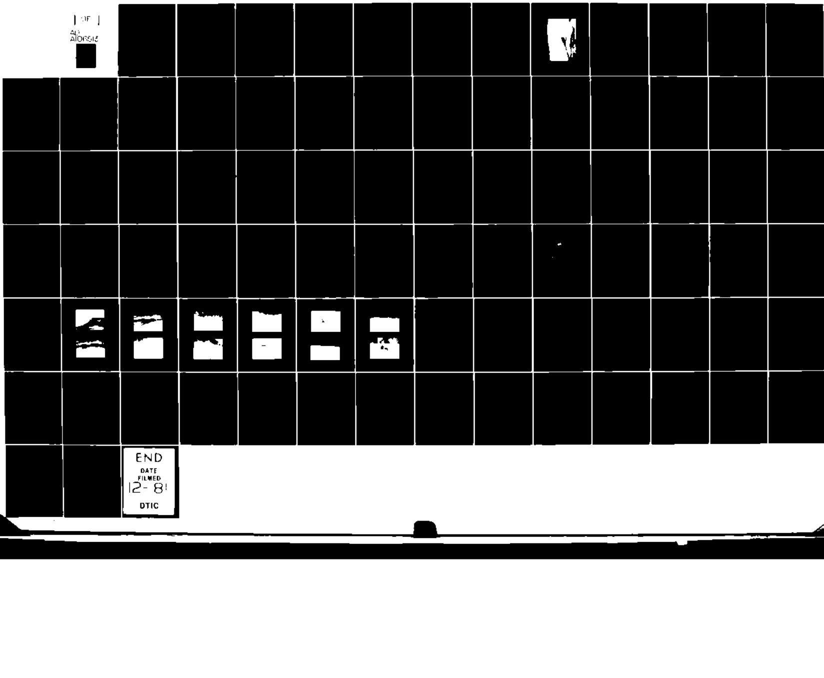

LEVEL

MISSOURI - KANSAS CITY RIVER BASIN

AD A106513

LITTLE LAKE IN THE WOODS DAM
ST. CHARLES COUNTY, MISSOURI
MO. 31366

PHASE I 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 1981

UNCLASSIFIED

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

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

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

REPLY TO
ATTENTION OF

SUBJECT: Little Lake in the Woods Dam (Mo. 31366) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Little Lake in the Woods Dam (Mo. 31366).

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. The combined capacity of the spillways 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 16 JUL 1981
Chief, Engineering Division — Date

APPROVED BY: SIGNED 16 JUL 1981
Colonel, CE, Commanding — Date

LITTLE LAKE IN THE WOODS DAM

ST. CHARLES COUNTY, MISSOURI

MISSOURI INVENTORY NO. 31366

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY

PRC CONSOER TOWNSEND, INC.

ST. LOUIS, MISSOURI

AND

PRC ENGINEERING CONSULTANTS, INC.

ENGLEWOOD, COLORADO

A JOINT VENTURE

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

JULY 1981

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Little Lake in the Woods Dam, Missouri Inv. No. 31366
State Located:	Missouri
County Located:	St. Charles
Stream:	Unnamed tributary of Schluersburg Creek
Date of Inspection:	March 2, 1981

Assessment of General Condition

Little Lake in the Woods Dam was inspected by the engineering firms of PRC Consoer Townsend, Inc., of St. Louis, Missouri, and PRC Engineering Consultants, Inc., of Englewood, Colorado, (A Joint Venture) in accordance with the U. S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District of the Corps of Engineers. Based upon the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. Located within the estimated damage zone of four miles downstream of the dam are at least three dwellings and three buildings which may be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Little Lake in the Woods Dam is in the small size classification since it is more than 25 feet but less than 40 feet in height and impounds more than 50 acre-feet but less than 1,000 acre-feet of water.

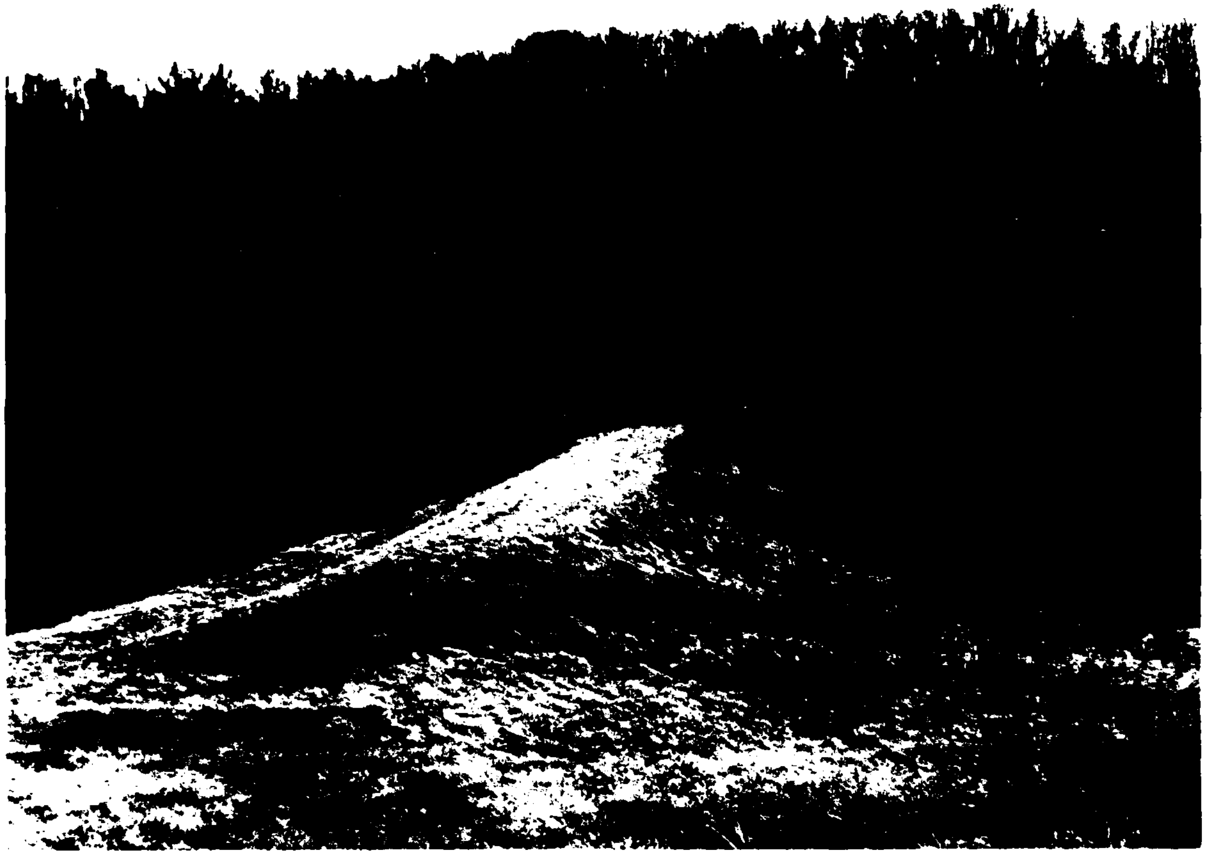
The inspection and evaluation indicates that the spillway system of Little Lake in the Woods Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Little Lake in the Woods Dam being a small size dam with a high hazard potential is required by the guidelines to pass from one-half of the Probable Maximum Flood (PMF) to the Probable Maximum Flood before overtopping of the dam occurs. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region. Considering the number of inhabited dwellings located in the downstream hazard zone, the PMF is considered the appropriate spillway design flood for Little Lake in the Woods Dam. It was determined that the reservoir/spillway system can accommodate approximately 11 percent of the Probable Maximum Flood without overtopping the dam. The evaluation also indicates that the reservoir/spillway system can accommodate the ten-percent chance flood (10-year flood) without overtopping the dam, but can not accommodate the one-percent chance flood (100-year flood) without overtopping the dam.

The overall condition of the dam and the spillways appears to be good; however, a few deficiencies were noted by the inspection team. The deficiencies included: an area of boggy ground observed at the downstream toe of the dam indicating possible seepage through the embankment or foundation; the erosion gullies observed in the emergency spillwav channel and along the downstream, embankment/left abutment contact; the configuration of the area around the control section of the emergency spillway; the vegetation growing around the inlet and outlet areas of the principal spillway; a need for periodical maintenance of the grass cover and vegetation on the embankment and in the emergency spillway channel and a lack of a maintenance schedule; and there also exists a need for periodic inspection by a qualified engineer. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above.

Walter G. Shifrin, P.E.

STATE OF MISSOURI
WALTER
G. SHIFRIN
NUMBER
E-8834
REGISTERED PROFESSIONAL ENGINEER



Overview of Little Lake in the Woods Dam

NATIONAL DAM SAFETY PROGRAM

LITTLE LAKE IN THE WOODS DAM, I.D. No. 31366

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

LITTLE LAKE IN THE WOODS DAM, Missouri Inv. No. 31366

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Little Lake in the Woods Dam was carried out under Contract DACW 43-81-C-0063 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of PRC Consoer Townsend, Inc., of St. Louis, Missouri, and PRC Engineering Consultants, Inc., of Englewood, Colorado (A Joint Venture).

b. Purpose of Inspection

The visual inspection of Little Lake in the Woods Dam was made on March 2, 1981. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project, presents a summary of visual observations made during the field inspection, presents an assessment of hydrologic and hydraulic conditions at the site and of the structural adequacy of the various project features, and assesses the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing, and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted that in this report reference to left or right abutments is viewed as looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the southwest abutment or side, and right to the northeast abutment or side.

d. Evaluation Criteria

The inspection and evaluation of the dam is performed in accordance with the U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District office of the Corps of Engineers for Phase I Dam Inspection.

1.2 Description of the Project

a. Description of Dam and Appurtenances

The following description is based upon observations and measurements made during the visual inspection and conversations with Mr. Les Volmert, the design engineer for the dam. No design or "as-built" drawings were available for this dam.

The dam is a homogeneous, rolled, earthfill structure with a core trench excavated into the foundation soils, according to Mr. Volmert. The axis of the dam is slightly curved in the downstream direction. A plan and elevation of the dam are shown on Plate 3 and Photos 1 through 3 show views of the dam. The top of dam was measured to be 400 feet long between the left abutment and the emergency spillway and has a top width of 14 feet. The top of dam was surveyed to be level from the left abutment contact to a point 100 feet to the right of the left abutment. From this point, the top of dam slopes upward with a rise in elevation of 1.8 feet to a point 100 feet to the left of the emergency spillway. The remaining 100 feet of the embankment was measured to be level. The minimum elevation of the top of dam was assumed to be 660 feet above mean sea level (M.S.L.) at the left abutment. The embankment has a maximum structural height of 34.6 feet with a downstream slope of 1 vertical to 2 horizontal (1V to 2H). An eight-feet wide berm was constructed on the upstream slope at an elevation of 655.7 feet above M.S.L. The upstream slope above and below the berm and above the water surface was measured to be 1V to 3H. The embankment was placed between earth abutments.

There are two spillways at this damsite that are referred to in this report as the principal and emergency spillways. The principal spillway is a drop inlet spillway consisting of a vertical riser inlet connected to an outlet pipe. The riser is a 2.5-feet tall, 26-inch diameter, 1/4-inch thick, welded steel pipe (see Photo 5). The riser is situated in the upstream berm of the embankment 150 feet from the left abutment. The crest elevation of the riser is 657.3 feet above M.S.L. The riser is topped with a 1/16-inch thick steel, anti-vortex device. The anti-vortex device is connected to the riser with the welding of six, 1/2-inch diameter, reinforcing bars and two steel angle irons. The reinforcing bars also function as a trashrack. The outlet pipe is a 12-inch diameter, 1/4-inch thick, 110 feet long welded steel pipe, (see Photo 6). The alignment pipe of the outlet is approximately perpendicular to the axis of the dam and is inclined at 15 degrees from horizontal through the embankment. The outlet pipe discharges into an earth-lined stilling basin two feet deep and four feet in diameter at the downstream toe of the dam. An earth-lined channel from the stilling basin leads directly to the downstream channel.

The emergency spillway is a grass-lined channel excavated into the right abutment (see Photo 7). The channel cross-section at the control section of the spillway is roughly trapezoidal in shape with a top width of 67 feet, a bottom width of 24 feet and side slopes of 1V to 7.6H on the left and 1V to 8.3H on the right. At the control section, the spillway channel was measured to be 1.2 feet lower on the left side than on the right side (see Plate 3). The minimum crest elevation of the control section is 658.5 feet above M.S.L. The emergency spillway channel drops 0.9 feet in the first 30 feet just downstream of the control section and then steepens to a slope of 12 percent. The alignment of the channel runs perpendicular to the axis of the dam to a point 30 feet downstream of the control section, where the channel begins to curve towards the embankment until it parallels the axis of the dam. Flows through the emergency spillway channel intersect the downstream channel slightly downstream of the principal spillway stilling basin.

No low-level outlet or outlet works were provided for this dam.

b. Location

Little Lake in the Woods Dam is located in St. Charles County in the State of Missouri on an unnamed tributary of Schluersburg Creek. The dam is located approximately 5.5 miles north of Labadie and four miles west of Matson in the southwest quadrant of Section 36 of Range 1 East, Township 45 North, as shown on the Labadie, Missouri Quadrangle (7.5 minute series) sheet (see Plate 2).

c. Size Classification

The reservoir impoundment of Little Lake in the Woods Dam is less than 1,000 acre-feet but more than 50 acre-feet, which would classify it as a "small" size dam. The maximum structural height of the dam is less than 40 feet and greater than 25 feet, which also classifies it as a "small" size dam. The size classification is determined by either the storage or height, whichever gives the larger size category. Therefore, the size classification is determined to fall within the "small" category, according to the "Recommended Guidelines for Safety Inspection of Dams" by the U.S. Department of the Army, Office of the Chief Engineer.

d. Hazard Classification

The dam has been classified as having a "high" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. From a visual inspection of the downstream area, our findings concur with this classification. Located within the estimated damage zone, which extends less than four miles downstream of the dam, are at least three dwellings and three buildings (see Photos 11 and 12).

e. Ownership

Little Lake in the Woods Dam is privately owned by Mrs. Jean Coggeshall. The mailing address is Mrs. Jean Coggeshall, 721 Cranbrook Drive, St. Louis, Missouri, 63122.

f. Purpose of Dam

The purpose of the dam is to impound water for recreational use as a private lake.

g. Design and Construction History

The dam was designed and inspected during the construction by the Department of Agriculture, Soil Conservation Service (SCS), St. Charles, Missouri office. Mr. Les Volmert was involved in the design of the dam and also conducted periodic inspections during the construction of the dam.

According to Mr. Volmert, the dam was built by Mr. Lee Moorman, of Warrenton, Missouri in 1965. Mr. Moorman used rubber tired scrapers to place and compact the materials used for the dam. A seven-feet deep, ten-feet wide core trench with side slopes of 1V to 1H was excavated along the axis of the dam. The trench was excavated into the foundation soils and not to sound bedrock. Mr. Volmert also states that the files and design information for the dam have been destroyed.

The construction inspection tasks performed by Mr. Volmert included the inspection of the core trench, principal spillway pipe installation, slope stakes and the excavation of the emergency spillway.

h. Normal Operational Procedures

Normal operational procedure is to allow the reservoir to remain as full as possible while the water level below the crest elevation of the principal spillway is controlled by rainfall, runoff, and evaporation.

1.3 Pertinent Data

a. Drainage Area (square miles): . . . 0.21

b. Discharge at Damsite

Estimated experienced maximum flood (cfs): . . . . Unknown

Estimated ungated spillway capacity with reservoir at top of dam elevation (cfs): 102

c. Elevation (Feet above MSL)

Top of dam (minimum): . . . . 660.0 (assumed)*

Spillway crest:

Principal Spillway 657.3

Emergency Spillway 658.5

Normal Pool: 657.3

Maximum Experienced Pool: . . . . Unknown

Observed Pool: 652.3

d. Reservoir

Length of pool with water surface at top of dam elevation (feet): 1000

e. Storage (Acre-Feet)

Top of dam (minimum): 98

Spillway crest:

Principal Spillway 78

Emergency Spillway 86

Normal Pool: 78

Maximum Experienced Pool: . . . . Unknown

Observed Pool: 51

f. Reservoir Surfaces (Acres)

Top of dam (minimum): 8.0

Spillway crest:

Principal Spillway 6.5

Emergency Spillway 7.0

Normal Pool: 6.5

Maximum Experienced Pool:. . . . . Unknown

Observed Pool: 5.0

g. Dam

Type:. . . . . Rolled, Earthfill

Length:. . . . . 400 feet

Structural Height: . . . . 34.6 feet

Hydraulic Height**: . . . . 34.6 feet

Top width: . . . . 14 feet

Side slopes:

Downstream . . . . 1V to 2H

Upstream. . . . . 1V to 3H (Above and below the berm and above the water surface)

Zoning:. . . . . Homogeneous

Impervious core: . . . . N.A.

Cutoff:. . . . . A core trench 7 feet deep, 10 feet wide with 1V to 1H side slopes was excavated into the foundation soils, according to Mr. Volmert.

Grout curtain: . . . . None

Volume:. . . . . 28,200 cu.yds. (Estimated)

h. Diversion and Regulating Tunnel . . . . None

i. Spillways

Type:

Principal Spillway . . . . Drop inlet with a 26 inch diameter riser pipe and a 12 inch diameter outlet pipe, uncontrolled.

Emergency Spillway	. . . .	Roughly trapezoidal shaped, earthcut channel, uncontrolled.

Length of crest:

Principal Spillway	. . . .	6.8 feet, (26-inch diameter riser)
Emergency Spillway	. . . .	24.0 feet (Bottom width) 67.0 feet (Top width)

Crest Elevation (Feet above MSL):

Principal Spillway	. . . .	657.3
Emergency Spillway	. . . .	658.5

j. Regulating Outlets . . . None

* No exact elevation is known for the top of dam, therefore, an elevation was estimated from the Labadie, Missouri, U.S.G.S. Quadrangle sheet. This estimated elevation is referred to as assumed elevation. All other elevations were determined from the assumed top of dam elevation and field measurements.

** The hydraulic height of the dam is the vertical distance from the lowest point on the downstream toe to the top of dam or the maximum water surface, if below the top of dam.

SECTION 2: ENGINEERING DATA

2.1 Design

The dam was designed by the Department of Agriculture, Soil Conservation Service, St. Charles, Missouri office. According to Mr. Volmert, the original files and design data for the dam have been destroyed. No other drawings or data are available for the dam.

2.2 Construction

The dam was built by Mr. Lee Moorman, of Warrenton, Missouri in 1965. No documented data are available concerning the construction of the dam and appurtenant structures, other than the construction history given in Section 1.2g.

2.3 Operation

No operational records are available for Little Lake in the Woods Dam.

2.4 Evaluation

a. Availability

The availability of engineering data is poor and consists only of a general soils map of the State of Missouri published by the Soil Conservation Service, State Geological Maps and U.S.G.S. quadrangle sheets. No design drawings, design computations, construction data, or operation data are available.

b. Adequacy

The lack of engineering data did not allow for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluating design, operation, and construction data, but is based primarily on the visual inspection, past performance history, and present condition of the dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

No valid engineering data pertaining to the design or construction of the dam and the spillways were available.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of the Little Lake in the Woods Dam was made on March 2, 1981. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Mark Haynes, P.E.	PRC Engineering Consultants, Inc.	Soils
Jerry Kenny	PRC Engineering Consultants, Inc.	Hydraulics and Hydrology
James Nettum, P.E.	PRC Engineering Consultants, Inc.	Civil-Structural and Mechanical
Razi Quraishi, R.P.G.	PRC Engineering Consultants, Inc.	Geology
John Lauth, P.E.	PRC Consoer Townsend, Inc.	Civil and Structural

Specific observations are discussed below.

b. Dam

The overall condition of the dam appears to be good; however, some items of concern were observed and are described below.

The top of dam appears to be adequately protected against surface erosion by a dense grass cover (see Photo 2). Evidence of occasional vehicular traffic across the dam was seen; however, no damage to the dam due to the traffic was apparent. No depressions or cracks indicating a settlement of the embankment were apparent on the top of dam. No significant deviation in the horizontal or vertical alignment was apparent except for the curvature in the dam axis and the variation in elevation across the dam. Neither of these deviations appeared to be due to an instability of the embankment. No signs were observed that would indicate that the dam has ever been overtopped.

The upstream slope and berm, for the most part, were covered with a dense grass cover and a dense growth of cattails at the normal water surface level (see Photo 1). The grass cover on the slope appeared to be adequate protection against surface erosion. No riprap was provided on the upstream slope; however, very little, if any, wave erosion was observed. The cattails on the slope appeared to be providing the necessary wave action protection for the slope. Nevertheless, the dense growth of vegetation on the slope hampered a comprehensive inspection of the slope. No bulges, depressions or cracks indicating an instability of the embankment or foundation were apparent.

The downstream slope was covered by a tall, unmaintained, dense grass covering, which appeared to be providing adequate protection against surface erosion (see Photo 3). No erosion was observed on the slope; however, along the embankment/left abutment contact, a one-foot deep and five-feet wide erosion gully was observed (see Photo 4). Some saplings and small cedar trees were observed on the slope. No bulges, depressions or cracks indicative of a slope movement were observed on the slope.

An area of moist, boggy ground and cattails was observed at the downstream toe of the dam and to the left of the outlet of the principal spillway. The area was about 20 feet long and 10 feet wide. No measurable flow of water was apparent; however, the cattails observed in the area would indicate that moisture is generally present in the area. The source of the moisture was apparently due to seepage through the embankment or foundation. No other areas of possible seepage were apparent on the slope or downstream of the dam.

Both abutments slope moderately upward from the dam. No instabilities or seepage were observed on either abutment. One erosion gully was observed on the left abutment, which was an extension of the erosion gully along the embankment/abutment contact mentioned above.

No evidence of burrowing animals was apparent on either the embankment or the abutments.

c. Project Geology and Soils

(1) Project Geology

The damsite is located on an unnamed tributary of the Schluersburg Creek in the Springfield Plateau section of the Ozark Plateaus Physiographic Province. The Springfield Plateau includes that part of the Ozarks which is underlain mainly by rocks of the Mississippian age. Most of the Springfield Plateau are prairies, which are separated by valleys cut 200 to 300 feet below the upland surface. Most of the area of the Springfield Plateau is overlain by a mantle of chert derived by weathering of the Mississippian Limestone. Widespread distribution of dolomites and limestone bedrock with deep dissection is responsible for the development of many springs in the regional area of the damsite. A major component of the surface discharge of water to the regional drainage is contributed by these springs.

The topography in the vicinity of the damsite is rolling to hilly with V-shaped valleys. Elevations of the ground surface range from 865 feet above M.S.L. approximately 1.4 miles southeast of the damsite to 660 feet above M.S.L. at the damsite. The reservoir slopes are generally from eight to ten degrees from horizontal. The reservoir slopes are stable and the reservoir appears to be watertight. The area near the damsite is covered with glacial-fluvial deposits and residual soils consisting of yellowish-brown, moderately plastic, silty clay with a trace of fine to coarse sand.

The regional bedrock geology beneath the glacial-fluvial deposits and the residual soils in the damsite area as shown on the Geologic Map of Missouri (1979) (see Plate 5), consist of Pennsylvanian age rocks of the Cherokee Group; Mississippian age rocks of the Keokuk-Burlington Formation, Undifferentiated Chouteau Group and Hannibal Formation; and Ordovician age rocks consisting of Noix Limestone, Kimmswick Limestone, and St. Peter Sandstone. The predominent bedrock underlying the glacial-fluvial deposits and the residual soils in the vicinity of the damsite are of the Ordovician age rocks.

Outcroppings of Ordovician Noix-Kimmswick Limestone (brownish-gray, fine to medium grained, hard, unweathered, horizontally bedded, limestone) is exposed on the right abutment just downstream of the control section of the emergency spillway (see Photo 9).

No faults have been identified in the vicinity of the damsite. The closest trace of a fault to the damsite is the Moselle fault nearly 11 miles southwest of the damsite. The Moselle fault had its last movement in post-Early Ordovician time. Thus, the fault has no effect on the damsite.

No boring logs or construction reports were available that would indicate foundation conditions encountered during construction. Based upon the visual inspection and conversations with Mr. Volmert, the embankment probably rests on the glacial-fluvial deposits with the core trench probably excavated into the deposits. The riser and outlet pipe of the principal spillway rests on the compacted embankment fill and the emergency spillway channel was cut into the residual soils on the right abutment.

(2) Project Soils

According to the "Missouri General Soil Map and Soil Association Descriptions" published by the Soil Conservation Service, the materials in the general area of the dam belong to the soil series of Hatton-Keswick-Goss-Gasconade in the Central Mississippi Valley Wooded Slopes association. The soils were basically formed from loess deposits, glacial till and weathered limestone. These soils vary from a slowly to moderately permeable silty clay loam to a slowly permeable clay loam.

Materials removed from the embankment on the upstream and downstream slopes below the vegetative cover was a brown and dark gray mottled, slightly to moderately plastic, silty clay with a trace of fine sand. Based upon the Unified Soil Classification System, the soil would probably be classified as a CL. This is an impervious soil type, which generally has the following characteristics: a coefficient of permeability less than one foot per year, medium shear strength, and a high resistance to piping. This soil type also has a high resistance to erosion under low velocity flow; however, excessive erosion can occur during the high velocity flows that can be expected when the dam is overtopped.

d. Appurtenant Structures

(1) Principal Spillway

The metal components of the principal spillway are uniformly coated with rust but appeared to be in sound condition (see Photos 5 and 6). There was no evidence of erosion or piping around the inlet of the riser or the outlet of the discharge pipe. The riser and discharge pipe were unobstructed at the present time and should function as originally intended; however, in the area around the inlet to the riser and in the stilling basin of the spilway, cattails and brush were observed. The anti-vortex device was securely attached to the top of the riser. The stilling basin and outlet appeared stable with no sign of erosion, which would affect the stability of the spillway or embankment.

(2) Emergency Spillway

The spillway channel is covered by a well maintained grass cover in the vicinity of the embankment; however, an erosion gully has developed in the lower reach of the channel (see Photo 8). The erosion presently poses no threat to the embankment or spillway. If allowed to continue, the gully will progress up the spillway channel toward the control section where it could become a hazard to the safe operation of the spillway. Discharges through the spillway do not appear to be properly directed away from the embankment; however, no evidence of damage due to releases through the spillway were seen on the embankment. The side slopes of the spillway appeared to be stable.

The present shape of the spillway channel at the control section area is most likely different from the way it was originally designed by the SCS. The bottom of the control section and the channel invert just downstream of the control section are not level. The current design standard of an earth-lined spillway as used by the SCS is a trapezoidal shaped channel with a level bottom at the control section. The channel is also designed to be level for a specified distance downstream of the control section. The above mentioned measures help assure the stability of the spillway channel in the area of the dam embankment. The present deviations from this concept at this dam have caused no discernible damage at the present time, although the spillway probably does not function as intended by the SCS.

(3) Outlet Works

No low-level outlet or outlet works were provided for this dam.

e. Reservoir Area

The reservoir water surface elevation at the time of the inspection was 652.3 feet above M.S.L. The reservoir has a normal water surface elevation of 657.3 feet above M.S.L. and a surface area of 6.5 acres at the normal water surface level.

The rim appeared to be stable with no erosional or stability problems observed (see Photo 10). The land around the reservoir slopes gently to moderately upward from the reservoir rim and is mostly wooded. No houses are built near the reservoir shoreline. No evidence of excessive siltation was observed in the reservoir on the day of the inspection.

f. Downstream Channel

The downstream channel near the dam is the original, natural streambed, which is undefined and obstructed with trees and brush. Outside of the streambed, the downstream channel widens into a narrow flood plain. Further downstream of the dam, the downstream channel becomes a 5-feet deep and 10-feet wide channel with a wide flood plain outside of the channel.

3.2 Evaluation

The visual inspection uncovered nothing of a consequential nature which would require immediate remedial action. However, the following conditions were observed which could adversely affect the dam in the future.

1. The area of moist boggy ground observed at the downstream toe of the dam could affect the structural stability of the dam; however, it does not constitute an unsafe condition at the present time. If the moisture in this area is indeed due to seepage through the embankment or foundation, with time, it is possible the rate of seepage could increase and transport soil particles. This could cause piping of embankment material which could lead to the eventual failure of the embankment.

2. The erosion in the lower reach of the emergency spillway will worsen with future flows through the spillway. Presently this condition does not jeopardize the safety of the dam or spillway but increased aggravation of the erosion could become a hazard.

3. The present shape of the emergency spillway control section is not the most stable configuration for an earth-lined spillway as intended by the SCS.

4. The erosion along the embankment/left abutment contact does not jeopardize the stability of the dam in its present condition; however, continual erosion in this area can only be detrimental to the stability of the dam.

5. The tall, dense, unmaintained grass cover and the cattails on the embankment do not endanger the safety of the dam. Nevertheless, a tall vegetative growth on the embankment prevents a comprehensive inspection of the embankment and potential problems could go undetected. The saplings and small cedar trees could also jeopardize the safety of the dam in the future if allowed to grow.

5. The cattails and brush in the inlet and outlet areas of the principal spillway do not obstruct the safe operation of the spillway at this time. Nevertheless, with time, they could overgrow the areas and prevent the spillway from functioning properly.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Little Lake in the Woods Dam is used to impound water for recreation. There are no specific procedures which are followed for the operation of the dam. The water level below the principal spillway crest is allowed to remain as high as possible. The water level is controlled by rainfall, runoff, evaporation, and the elevation of the principal spillway crest.

4.2 Maintenance of Dam

The dam is maintained by Mr. Vernon Ditch, a caretaker of the dam property for Mrs. Coggeshall. The dam does not appear to be neglected. The inlet and trashrack of the principal spillway were unobstructed at the time of the inspection. According to Mr. Ditch, the dam was graded and reseeded three times before an adequate stand of grass grew on the dam slopes. The embankment is presently covered with a dense grass cover, which is providing adequate protection against surface erosion. The grass cover on the top of dam and the upstream slope and in the emergency spillway channel at the control section appears to be periodically maintained. Cattails are growing at the normal water surface level on the upstream slope.

4.3 Maintenance of Operating Facilities

There are no operating facilities associated with this dam.

4.4 Description of Any Warning System in Effect

The inspection team is not aware of any existing warning system for this dam, such as an electrical warning system or a manual notification plan.

4.5 Evaluation

The maintenance at Little Lake in the Woods Dam appears to be fair; however, the remedial measures described in Section 7 should be undertaken to improve the condition of the dam.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

No hydrologic and hydraulic design data are available for Little Lake in the Woods Dam. The sizes of physical features utilized to develop the stage-outflow relation for the spillways and overtopping of the dam were prepared from field notes and sketches prepared during the field inspection. The reservoir elevation-area data were based on the U.S.G.S. Labadie, Missouri Quadrangle topographic map (7.5 minute series). The spillways and overtop release rates and the reservoir elevation-area data are presented in Appendix B.

The hydrologic soil groups of the watershed was determined from information available in the U.S.D.A. Soil Conservation Service publication "Missouri General Soil Map and Soil Association Descriptions", 1979. The Probable Maximum Precipitation (PMP) used to determine the Probable Maximum Flood (PMF) was determined by using the U.S. Weather Bureau publication, "Hydrometeorological Report No. 33" (April, 1956). The 100-year and the 10-year floods were derived from the 100-year rainfall and the 10-year rainfall, respectively, of Warrenton, Missouri.

b. Experience Data

Records of reservoir stage or spillway discharges are not maintained for this site. However, there was no evidence of the dam ever having been overtopped.

c. Visual Observations

Observations made of the spillways during the visual inspection are discussed in Section 3.1d and evaluated in Section 3.2.

d. Overtopping Potential

Both the Probable Maximum Flood, and one-half of the Probable Maximum Flood when routed through the reservoir, resulted in overtopping of the dam. The peak inflows for the PMF and one-half of the PMF are 3,225 cfs and 1,613 cfs, respectively. The peak outflow discharges for the PMF and one-half of the PMF are 2,953 and 1,298 cfs, respectively. The maximum capacity of the spillway just before overtopping the dam is 102 cfs. The PMF overtopped the dam by 2.31 feet and one-half of the PMF overtopped the dam by 1.48 feet. The total duration of overflow over the dam is 8.00 hours during the occurrence of the PMF and 5.67 hours during one-half of the PMF. The spillway/reservoir system of Little Lake in the Woods Dam is capable of accommodating a flood equal to approximately 11 percent of the PMF just before overtopping the dam. Further evaluation showed that the reservoir/spillway system of Little Lake in the Woods Dam will accommodate the ten-percent chance flood (10-year flood) without overtopping the dam, but the one-percent chance flood (100-year flood) overtopped the dam by 0.21 feet with a total duration of overflow over the dam of 45 minutes.

The surface soils on the embankment and in the emergency spillway appear to be a silty clay. The emergency spillway and the dam embankment have a good cover of grass. The dam will be overtopped in excess of two feet during the occurrence of the PMF which can cause severe erosion to the embankment due to the high velocity of flow on its downstream slope and could lead to the eventual failure of the dam. The maximum velocity of flow in the emergency spillway during the PMF will be about 8.0 ft/sec, which could also cause excessive erosion in the spillway channel due to the high velocity of flow.

The failure of the dam could cause extensive damage to the property downstream of the dam and possible loss of life. The estimated damage zone extends less than four miles downstream of the dam. Located within the damage zone are at least three dwellings and three buildings.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There were no major signs of settlement or distress observed on the embankment or foundation during the visual inspection. The area of moist boggy ground, which indicates possible seepage, at the downstream toe and to the left of the principal spillway could be detrimental to the stability of the embankment, but it does not appear to constitute an unsafe condition at this time. The erosion along the embankment/left abutment contact does not appear to endanger the structural stability of the embankment in its present condition; however, continual erosion in this area could be detrimental to the embankment. In the absence of seepage and stability analyses, no quantitative evaluation of the structural stability can be made.

The structural stability of the principal spillway appeared good. The metal components were in sound condition. No erosion or piping was evident around the riser inlet or the outlet pipe. The stilling basin and outlet channel were stable. The vegetation around the inlet and outlet areas of the spillway does not jeopardize the safe operation of the spillway at this time; however if allowed to grow, the vegetation could prevent the spillway from functioning properly, which could have an adverse affect on the stability of the dam.

The emergency spillway at the right abutment appeared stable. But, this condition could be impaired by continual and progressive erosion of the lower reach of the spillway discharge channel. Also, prolonged flows through the warped control section could be detrimental to the stability of the spillway.

b. Design and Construction Data

No design computations pertaining to the embankment were uncovered during the report preparation phase. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters were available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction were available for use in a stability analysis.

c. Operating Records

No operating records are available relating to the stability of the dam or appurtenant structures. The water level on the day of the inspection was 5.0 feet below the crest of the principal spillway; however, it is believed that the reservoir remains close to full most of the time.

d. Post Construction Changes

No post construction changes to the embankment are known to exist that will affect the structural stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 2, as defined in the "Recommended Guidelines For Safety Inspection of Dams" as prepared by the Corps of Engineers (see Plate 8). Seismic Zone 2 is characterized by a moderate earthquake hazard. An earthquake of the magnitude that would be expected in Seismic Zone 2 should not cause significant distress to a well designed and constructed earth dam. Available literature indicates that no active faults exist near the vicinity of the damsite. The maximum recorded historic magnitude earthquake in the immediate vicinity of the damsite was the January 24, 1902 event of magnitude 5 located at a distance of 32 miles east of the damsite. This event cannot be correlated with known tectonic structure and is considered to probably be related to the release of accumulated residual strain along the buried pre-Quaternary fault. The attenuation of this event to the damsite would produce a peak ground acceleration of less than 0.05g which would not produce a significant seismic impact on the dam.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based upon observations of field conditions at the time of the inspection along with data available to the inspection team.

It is also important to realize that the condition of a dam depends upon numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be assurance that an unsafe condition could be detected.

a. Safety

The spillway capacity of Little Lake in the Woods Dam is found to be "Seriously Inadequate". The spillway/reservoir system will accommodate about 11 percent of the PMF without overtopping the dam. If the dam is overtopped, the safety of the embankment would be in jeopardy due to the susceptibility of the embankment materials to erosion. High velocity flow on the downstream slope of the dam could cause excessive erosion and eventually lead to a failure of the dam. The emergency spillway would also receive considerable damage during the occurrence of a PMF.

The overall condition of the dam and appurtenant structures appears to be good; however, some items of concern were noted which will require attention. A quantitative evaluation of the safety of the embankment could not be made in view of the absence of seepage and stability analyses. The present embankment and appurtenant structures, however, appear to have performed satisfactorily since their construction without failure or evidence of instability. No evidence indicating that the dam has ever been overtopped was observed. The safety of the dam can only be improved if the deficiencies described in Sections 3.2 and 6.1a are properly corrected as described in Section 7.2b.

b. Adequacy of Information

The conclusions presented in this report are based upon field measurements, past performance and present condition of the dam. Information on the design hydrology, hydraulic design, operation, and maintenance of the dam was not available. Seepage and 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

The items recommended in Paragraph 7.2a should be pursued on a high priority basis. The remedial measures recommended in Paragraph 7.2b should be accomplished within a reasonable period of time.

d. Necessity for Phase II Inspection

Based upon results of the Phase I inspection, and if the remedial measures recommended in Paragraph 7.2 are undertaken, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

There are several options that may be considered to reduce the possibility of dam failure or to diminish the harmful consequences of such a failure. Some of these options are:

1. Increase the emergency spillway capacity to pass the PMF, without overtopping the dam. The spillway should also be protected to prevent excessive erosion during the occurrence of the PMF.

2. Increase the height of the dam in order to pass the PMF without overtopping the dam; an investigation should also include studying the effects that increasing the height of the dam would have on the structural stability of the present embankment. The overtopping depth during the occurrence of the PMF, stated in Section 5.1d, is not the required or recommended increase in the height of the dam.

3. A combination of 1 and 2 above.

b. O & M Procedures

1. The moist boggy area at the downstream toe of the dam should be monitored to detect any flow of water or changes in location of the area. Any changes in the condition of the area should be investigated further by a qualified professional engineer and proper repairs made as required.

2. The erosion in the lower reach of the emergency spillway outlet channel should be repaired and stabilized against further damage.

3. The shape of the emergency spillway should be modified to conform with the design standard for an earth-lined spillway as used by the SCS. The control section should have a level bottom and a level section should follow the control section.

4. The erosion gully along the downstream, embankment/left abutment contact should be backfilled and the area properly protected from further damage due to erosion.

5. A well maintained grass cover should be retained on the downstream slope and in the emergency spillway channel to protect them from erosion and to prevent excessive erosion in the event the dam is overtopped or during high flows through the spillway. The saplings and cedar trees on the downstream slope and the cattails on the upstream slope should be removed from the embankment and prevented from growing back. Large vegetation, such as bushes and trees, should also be prevented from growing on the embankment at all times.

6. The vegetation around the inlet and outlet areas of the principal spillway should be removed and regrowth prevented.

7. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.

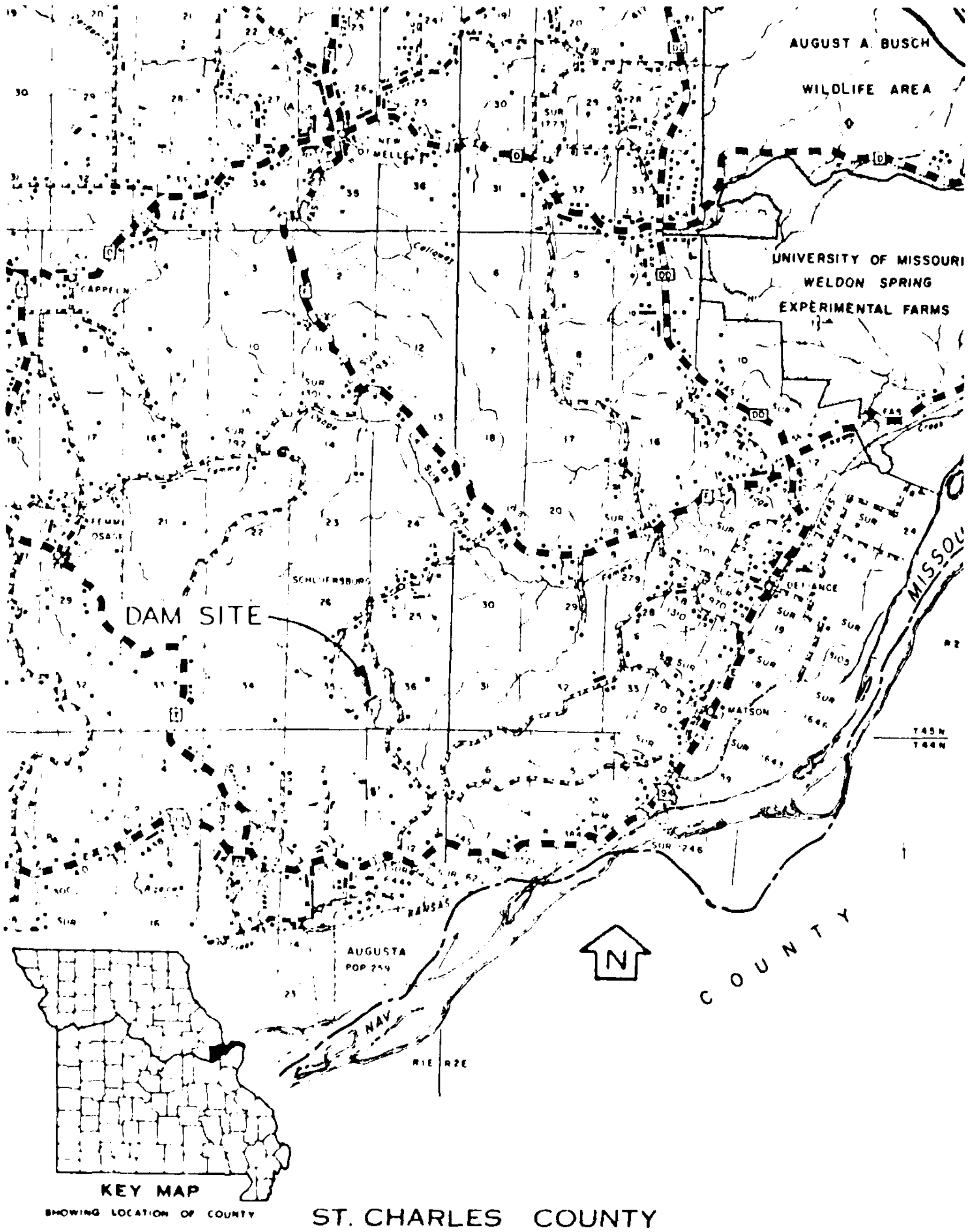
8. The owner should initiate the following programs:

   (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earthen dams.

(b) Set up a maintenance schedule and log all repairs and maintenance.

PLATES

PLATE 1



ST. CHARLES COUNTY

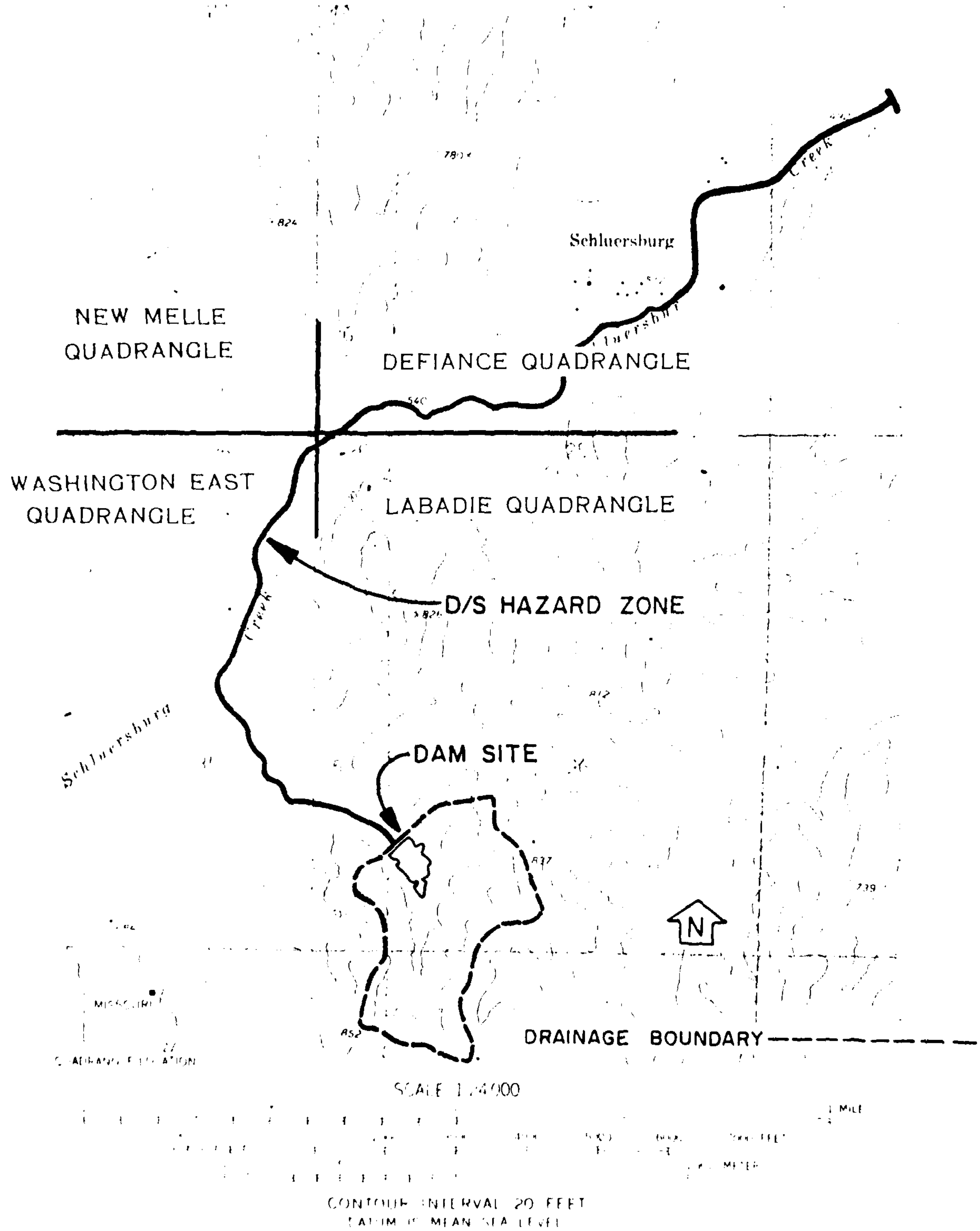
SCALE

MILES

POLYCONIC PROJECTION

LOCATION MAP-LITTLE LAKE IN THE WOODS DAM

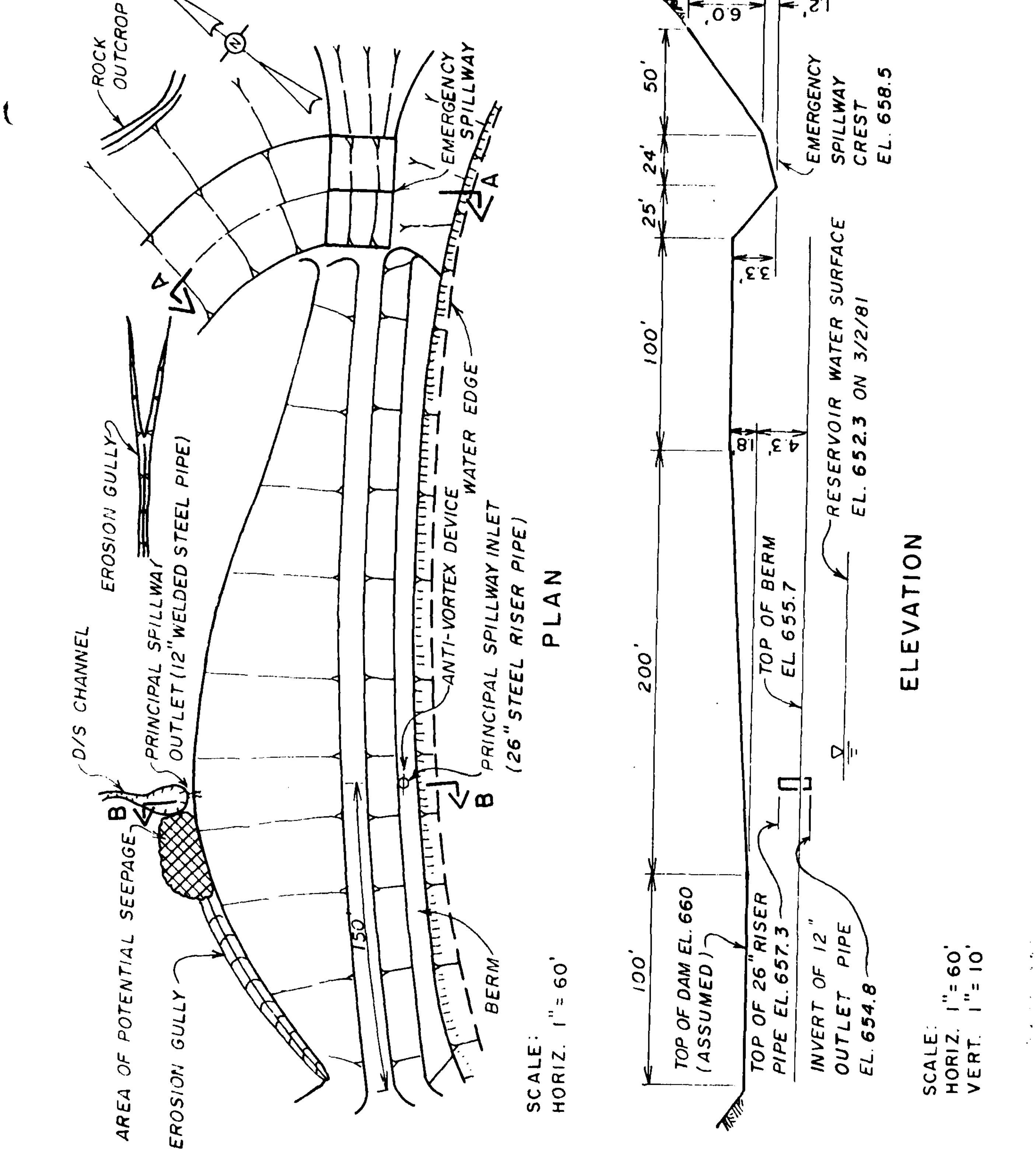
MO. 31366



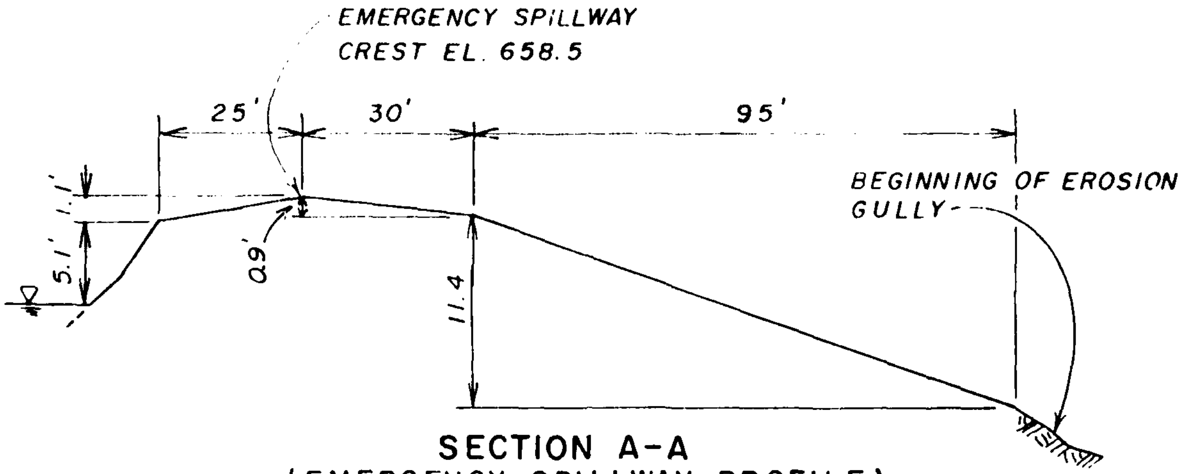
LITTLE LAKE IN THE WOODS DAM (MO.- 31366)

DRAINAGE BASIN AND
DOWNSTREAM HAZARD ZONE

PLATE 3

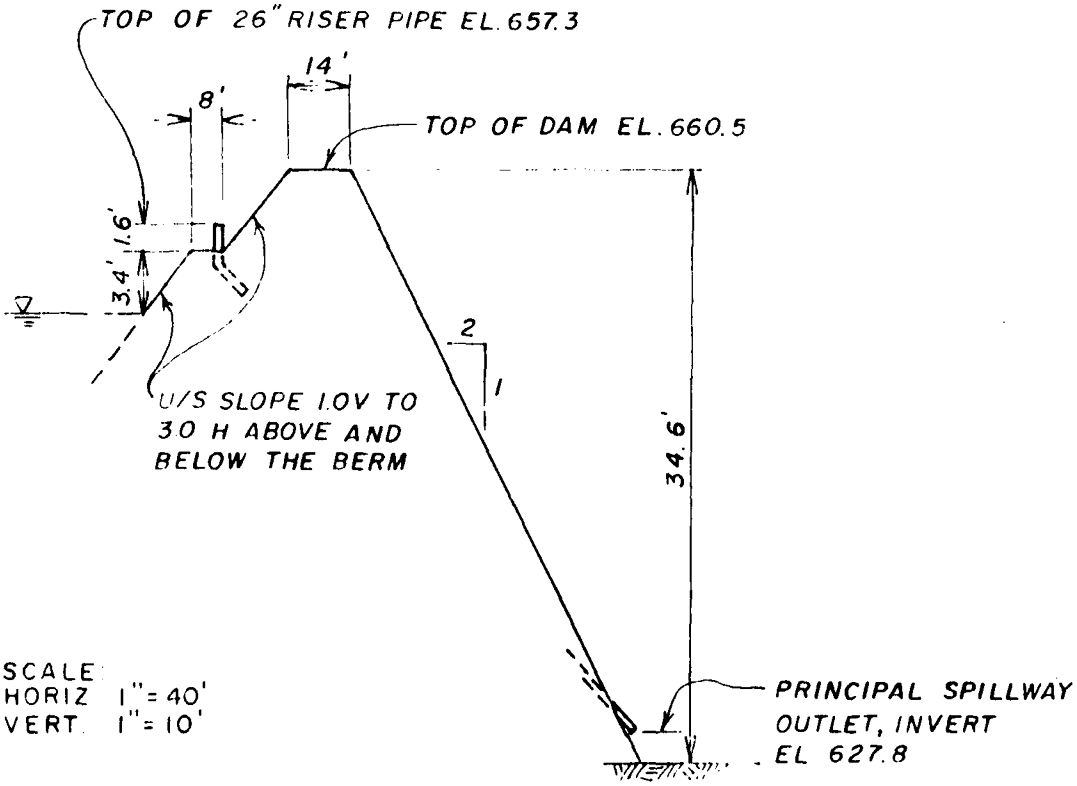


LITTLE LAKE IN THE WOODS DAM (MO. 31366)
PLAN AND ELEVATION
(SHEET 1 OF 2)



SECTION A-A
(EMERGENCY SPILLWAY PROFILE)

SCALE:
HORIZ. 1" = 30'
VERT. 1" = 10'

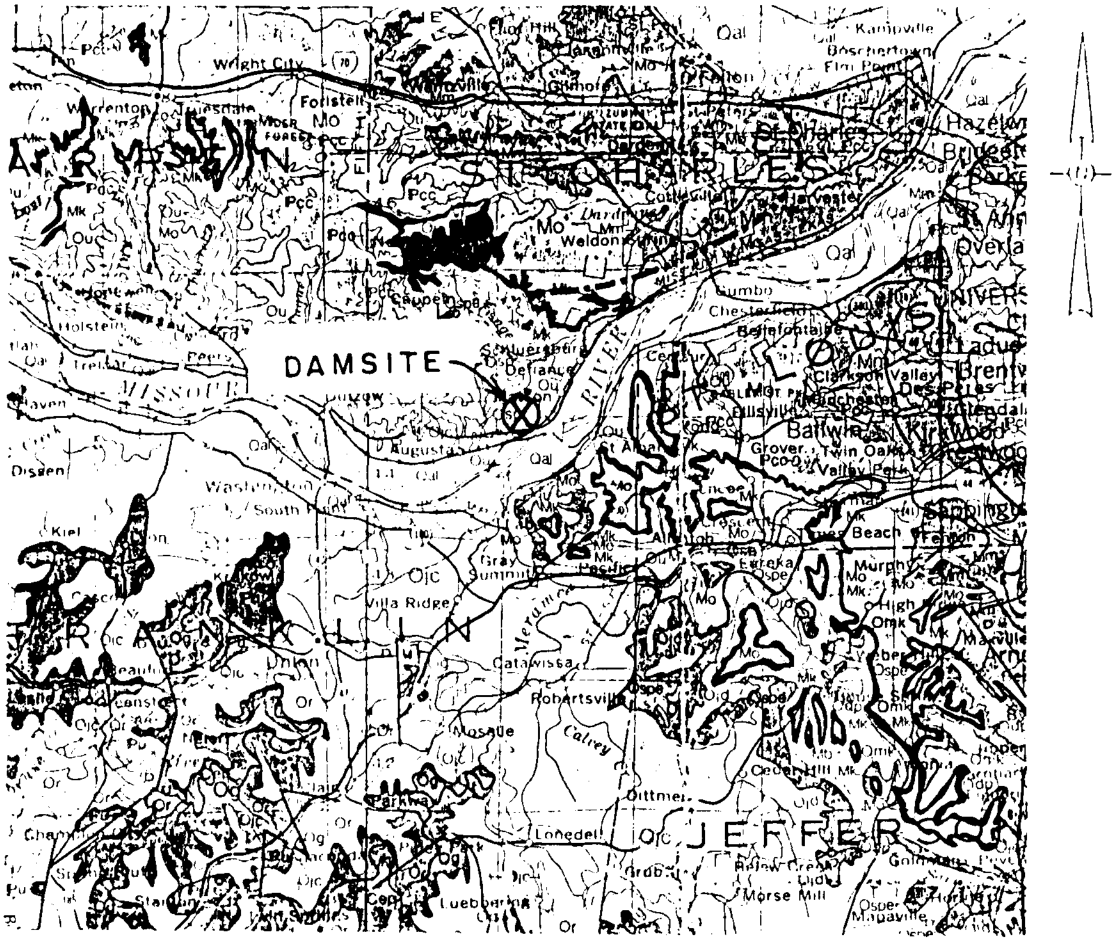


SCALE:
HORIZ 1" = 40'
VERT. 1" = 10'

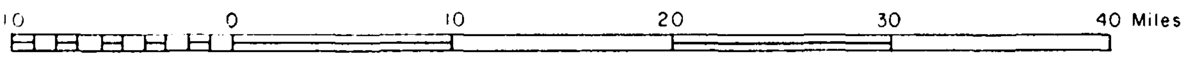
SECTION B-B
(MAXIMUM SECTION)

LITTLE LAKE IN THE WOODS DAM (MO. 31366)
EMERGENCY SPILLWAY PROFILE AND MAXIMUM SECTION
(SHEET 2 OF 2)

PLATE 5



SCALE



⊕ LOCATION OF DAM

NOTE: LEGEND FOR THIS MAP IS ON PLATES 6 AND 7

REFERENCE:

GEOLOGIC MAP OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
MISSOURI GEOLOGICAL SURVEY
KENNETH H. ANDERSON, 1979

REGIONAL GEOLOGICAL MAP
OF
LITTLE LAKE IN THE WOODS DAM

LITTLE LAKE IN THE WOODS DAM
PLATE 6

LEGEND

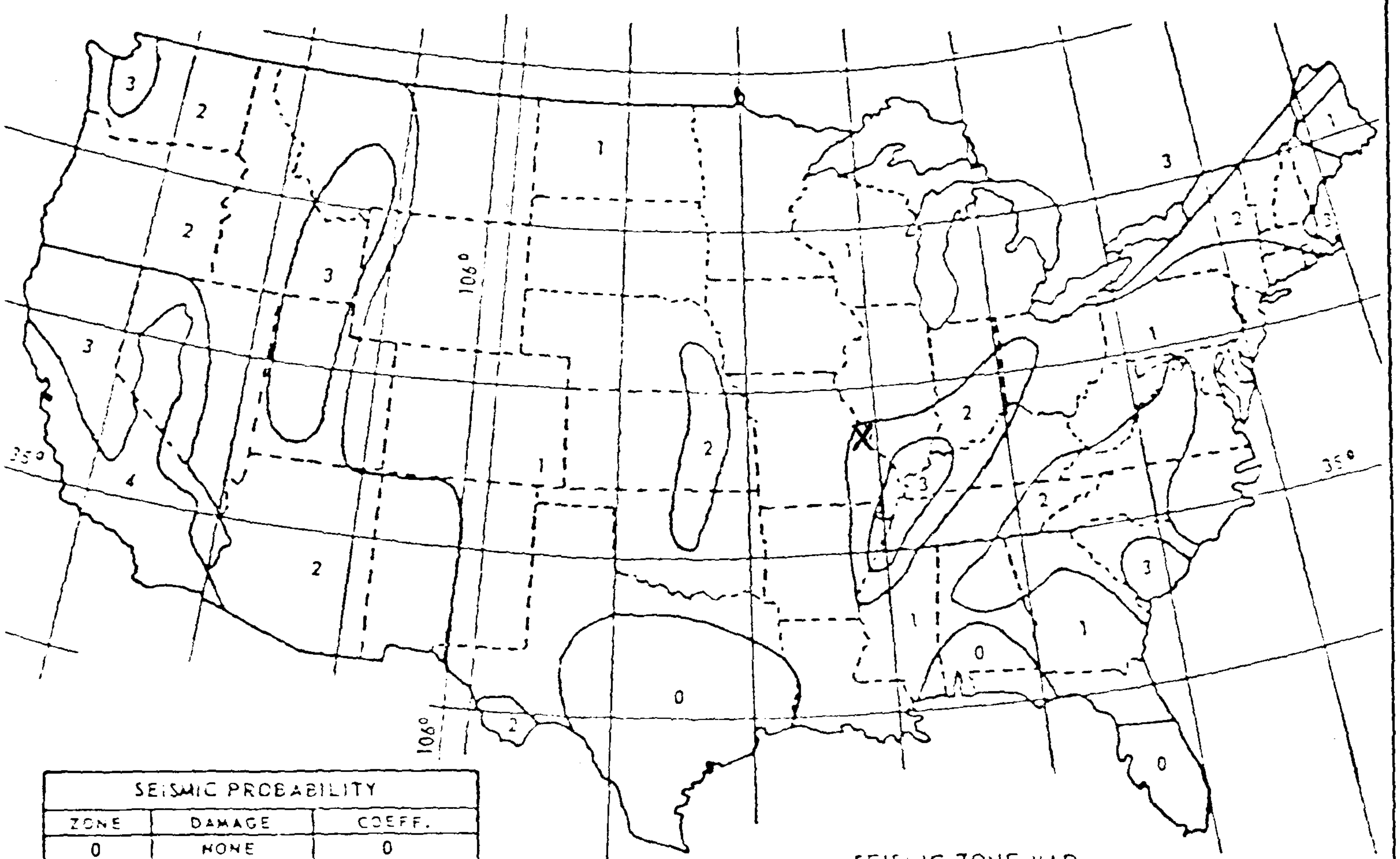
PERIOD	SYMBOL	DESCRIPTION
QUATERNARY	Qal	ALLUVIUM: SAND, SILT, GRAVEL
PENNSYLVANIAN	₱p	PLEASANTON GROUP: CYCLIC DEPOSITS OF SANDSTONE, SHALE AND LIMESTONE
	₱m	MARMATON GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
	₱cc	CHEROKEE GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
	₱u	PENNSYLVANIAN UNDIFFERENTIATED ROCKS
MISSISSIPPIAN	Mm	ST. LOUIS FORMATION: LIMESTONE INTERBEDDED WITH SHALE
	Mm	SALEM FORMATION: LIMESTONE INTERBEDDED WITH SHALE
	Mm	WARSAW FORMATION: ARGILLACEOUS LIMESTONE AND CALCAREOUS SHALE
	Mo	KEOKUK- BURLINGTON FORMATION: CHERTY GRAYISH BROWN SANDY LIMESTONE
	Mk	UNDIFFERENTIATED CHOUTEAU GROUP: LIMESTONE
	Mk	HANNIBAL FORMATION: SHALE AND SILTSTONE

LITTLE LAKE IN THE WOODS DAM
PLATE 7
SHEET 2 OF 2

LEGEND

PERIOD	SYMBOL	DESCRIPTION
ORDOVICIAN	Ou	NOIX LIMESTONE
	Omk	MAQUOKETA SHALE, KIMMSWICK LIMESTONE
	Odp	DECORAH FORMATION: GREEN TO GRAY CALCAREOUS SHALE WITH THIN FOSSILIFEROUS LIMESTONE
	Osp	ST. PETER SANDSTONE
	Ospe	ST. PETER SANDSTONE, EVERTON FORMATION
	Ojd	JOACHIM DOLOMITE
	Ojc	JEFFERSON CITY DOLOMITE
	Or	ROUBIDOUX FORMATION: INTERBEDS OF CHERTY LIMESTONE AND SANDSTONE
	Og	GASCONADE DOLOMITE
	U D	NORMAL FAULT
	U D	INFERRED FAULT
	U =	UPTHROWN SIDE
	D =	DOWNTHROWN SIDE

PLATE 8



SEISMIC ZONE MAP
of
CONTIGUOUS STATES

SEISMIC PROBABILITY		
ZONE	DAMAGE	COEFF.
0	NONE	0
1	MINOR	0.025
2	MODERATE	0.05
3	MAJOR	0.10
4	GREAT	0.15

X APPROXIMATE LOCATION OF LITTLE LAKE IN THE WOODS DAM

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

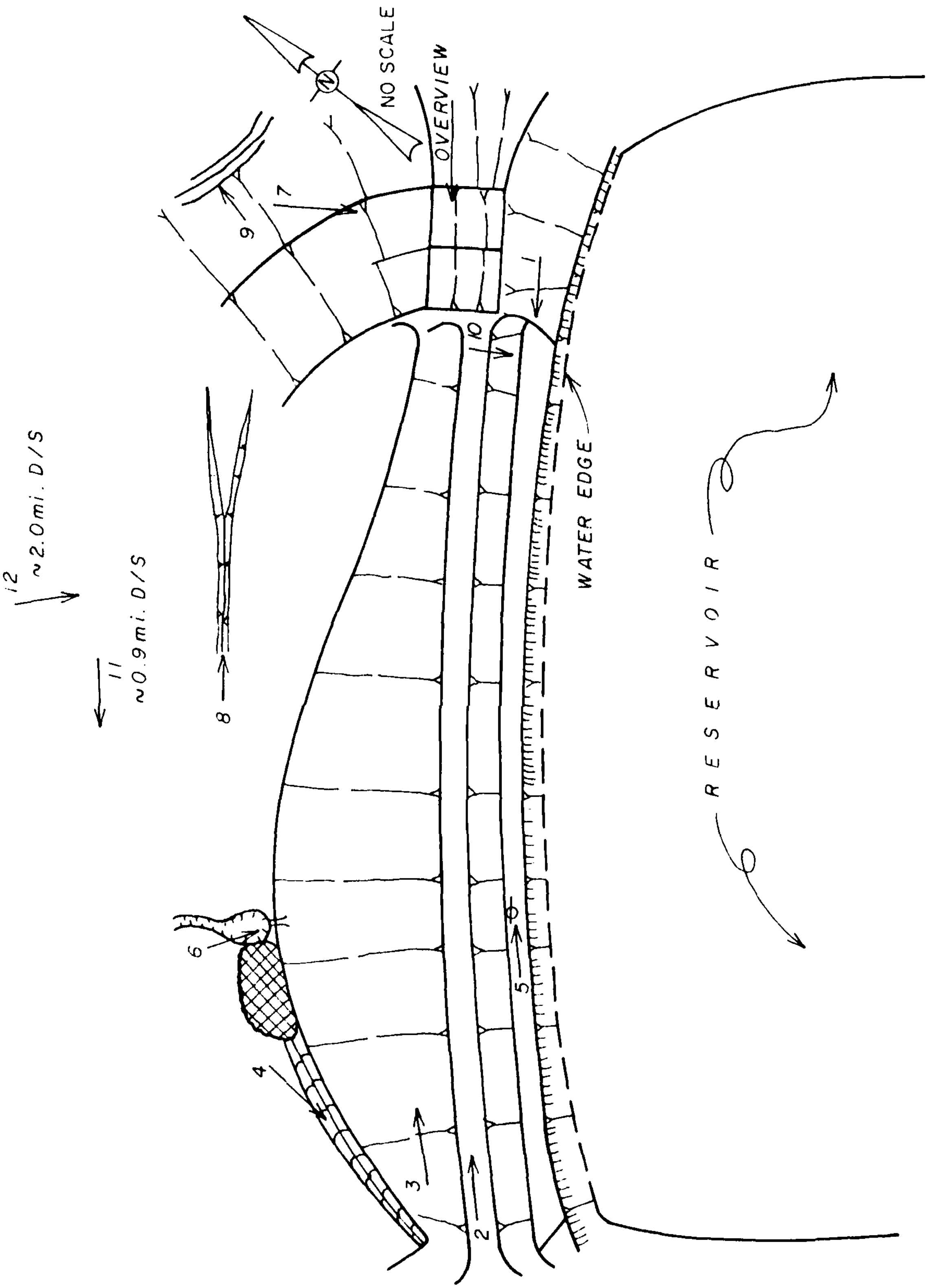


PHOTO INDEX
FOR
LITTLE LAKE IN THE WOODS DAM

Photo 1 - View of the upstream slope from the right abutment.

Photo 2 - View of the top of dam from the left abutment with the emergency spillway in the background.

Photo 3 - View of the downstream slope from the left abutment.

Photo 4 - View of the erosion gully along the downstream, embankment/left abutment contact.

Photo 5 - View of the principal spillway drop inlet riser, with anti-vortex device and trashrack.

Photo 6 - View of the principal spillway outlet pipe.

Photo 7 - View of the emergency spillway located on the right abutment.

Photo 8 - Close-up view of the erosion gully in the discharge channel of the the emergency spillway, looking upstream.

Photo 9 - View of outcropping of unweathered, horizontally bedded, limestone on the right hillside above and slightly downstream of the emergency spillway.

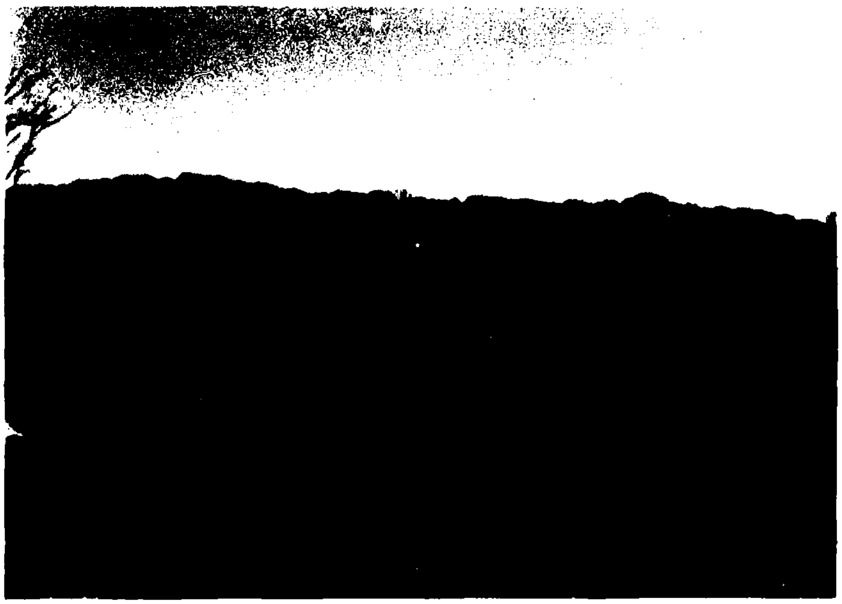


Photo 10 - View of the reservoir and rim.

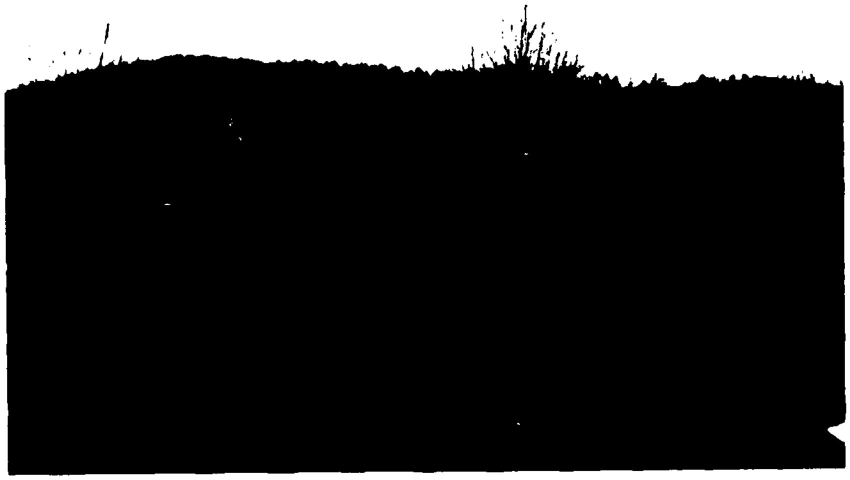


Photo 11 - View of a dwelling in the downstream hazard zone taken from the bank of Schluersburg Creek.

Photo 12 - View of a dwelling in the downstream hazard zone with Schluersburg Creek in the background.

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

LITTLE LAKE IN THE WOODS DAM

HYDROLOGIC AND HYDRAULIC DATA, ASSUMPTIONS AND METHODOLOGY

1. SCS Unit Hydrograph procedures and the HEC-1DB computer program are used to develop the inflow hydrographs. The hydrologic inputs are as follows:

   (a) 24-hour Probable Maximum Precipitation from Hydrometeorological Report No. 33, 24-hour 100-year rainfall and 24-hour 10-year rainfall of Warrenton, Missouri.

   (b) Drainage area = 0.21 square miles.

   (c) Lag time = 0.07 hours.

   (d) Hydrologic Soil Group:
   Soil Group "C".

   (e) Runoff curve number:
   CN = 73 for AMC II and CN = 87 for AMC III.

2. Flow rates through the emergency spillway are based on HEC-2 generated profiles assuming critical depth and a Manning's n = 0.030. Flow rates through the principal spillway are based on weir or orifice flow, depending upon the stage in the reservoir. Flow rates over the dam are based on the broad crested weir equation $Q = CLH^{3/2}$ and critical depth assumption, in accordance with the procedures used in the HEC-1 computer program.

3. The principal and emergency spillways and the dam overtop rating curves are hand calculated and combined as shown on pages B-4 through B-16. This combined rating curve is input into HEC-1DB on the Y4 and Y5 cards. The $L and $V cards are, therefore, not used.

4. Floods are routed through the reservoir of Little Lake in the Woods Dam to determine the capability of the spillways.

PRC. E[illegible] [illegible]TS, INC.

DAM SAFETY INSPECTION / MISSOURI
DAM NAME: LITTLE LAKE IN THE WOODS — 1283
UNIT HYDROGRAPH PARAMETERS — TP 3/23/81

1) DRAINAGE AREA, A = 0.21 sq. mi. = (133.0 acres)

2) LENGTH OF STREAM, L = (1.1" × 2000'/1" = 2200') = 0.42 mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

H_1 = 865

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST, H_2 = 657.3

5) ELEVATION OF CHANNEL BED AT 0.85L, E_{85} = 790

6) ELEVATION OF CHANNEL BED AT 0.10L, E_{10} = 670

7) AVERAGE SLOPE OF THE CHANNEL, $S_{AVG} = (E_{85} - E_{10}) / 0.75L = 0.073$

8) TIME OF CONCENTRATION:

A) BY KIRPICH'S EQUATION,

$t_c = [(11.9 \times L^3)/(H_1 - H_2)]^{0.385} = [(11.9 \times (0.42)^3)/(865 - 657.3)]^{0.385} = 0.12$ hr.

B) BY VELOCITY ESTIMATE,

SLOPE = 7.3% ⇒ AVG. VELOCITY = 5 ft/sec.

$t_c = L/V = [2200' / 5'/\text{sec} \div 3600 \text{ sec/hr}] = 0.12$ hr.

USE t_c = 0.12 hr.

9) LAG TIME, $t_\ell = 0.6\, t_c = 0.07$

10) UNIT DURATION, $D \le t_\ell / 3 = 0.024$ hours < 0.083 hr.

USE D = 0.083

11) TIME TO PEAK, $T_p = D/2 + t_\ell = 0.112$ hours

12) PEAK DISCHARGE,

$q_p = (484 \times A) / T_p = (484 \times 0.21 \text{ mi}^2) / 0.112 = 908$ cfs

PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection

Little Lake in The Woods Dam 1283

Reservoir Elevation, Surface Area data TP 3/25/78

Reservoir Elevation (NGVD)	Surface Area (acres)
630.	0. (Estimated Streambed u/s of dam)
640	2.0 Interpolated
650.	4.5 Interpolated
657.3	6.5 Principal Spillway crest
658.5	7.0 Emergency Spillway crest
660.	8.0 Minimum Top of dam (Assumed)
670.	11.5 Interpolated
680.	16.5 (from Labadie, Mo. 7.5' Quad)
690	22.5 Interpolated
700.	29.0 (from Labadie, MO, 7.5' Quad)

PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection

Little lake in the woods (Mo. 31366) TP 283 3/19/81

Principal Spillway Rating Curve

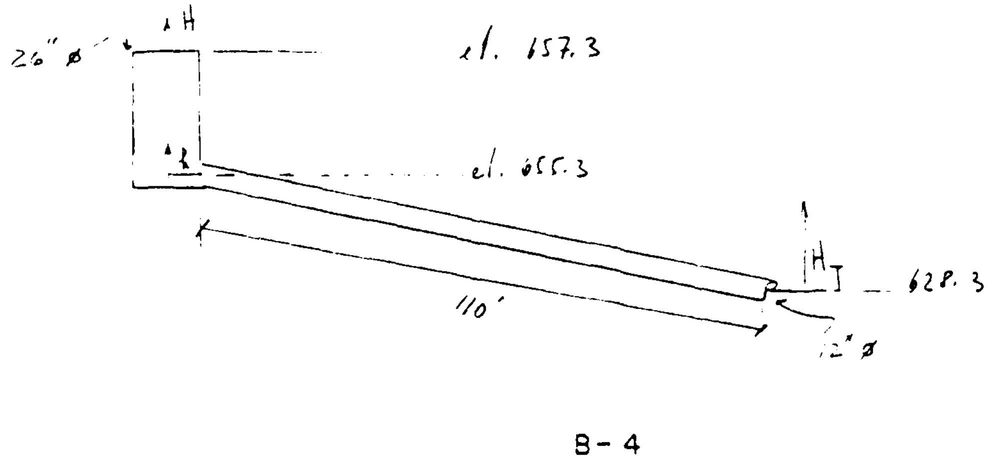
Flow Regime = Weir Flow

Governing Equation $Q = C L H^{3/2}$, $C = 3.1$, $L = \pi d$

$\therefore Q = (3.1)(\pi)(\frac{26''}{12}) H^{3/2} = 21.10 H^{3/2}$, $H = WSE - 657.3$

Crest elevation of outlet works (Top of riser) = 657.3

WSEL (NGVD)	Discharge (Q_w) (cfs)
657.3	0
657.6	3.47
657.9	9.81
658.0	12.36
658.3	21.10
658.6	31.28
659.0	46.77
659.3	59.68
659.6	73.60
660.0	93.61
660.5	120.78
661.0	150.17
662.0	215.00
663.0	287.14
664.0	365.93



PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection
Little Lake in the Woods 1283
Principal Spillway Rating Curve 3/19/81

<u>Flow Regime</u> = Orifice Flow [Riser]

Governing Equation $Q = CA\sqrt{2gH}$

$C = 0.6$

$A = \frac{\pi}{4}(26/12)^2 = 3.69 \text{ ft}^2$

$\sqrt{2g} = 8.02$

$Q = (0.6)(3.69)(8.02)H^{1/2} = 17.76\sqrt{H}$, $H = WSEL - 657.3$

<u>Crest elevation of outlet works</u> : 657.3

WSEL (NGVD)	Discharge (Q_{OR}) (cfs)
657.3	0.0
657.6	9.73
657.9	13.76
658.0	14.86
658.3	[illegible].76
658.6	20.25
659.0	23.16
659.3	25.12
659.6	26.93
660.0	29.19
660.5	[illegible]
661.0	[illegible]4.16
662.0	38.50
663.0	42.40
664.0	45.97

PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection

Little Lake in the Woods

Principal Spillway Rating Curve

1283 3/19/8

Flow Regime = Orifice flow

Governing Equation $Q = CA\sqrt{2gh}$

$C = 0.6$

$A = \frac{\pi}{4}\left(\frac{12}{12}\right)^2 = \pi/4 = 0.79 \text{ ft}^2$

$\sqrt{2g} = 8.02$

$Q = (0.6)(0.79)(8.02)\sqrt{h} = 3.80\sqrt{h}$, $h = WSEL - 655.3$

INVET ℄ of 12" pipe $= 654.3 + \frac{1}{2}\left(\frac{12}{12}\right) = 655.3$

WSEL (NGVD)	DISCHARGE (Q_{op})
657.3	0.0
657.6	5.76
657.9	6.13
658.0	6.24
658.3	6.58
658.6	6.90
659.0	7.31
659.3	7.60
659.6	7.88
660.0	8.24
660.5	9.67
661.0	9.07
662.0	9.84
663.0	10.54
664.0	11.21
664.4	[illegible]

PRO ENGINEERING

Dam Safety Inspection

Little Lake in the Woods 1283 3/20/81

Principal Spillway Rating Curve

Flow Regime = Full pipe (Pressure) flow

Governing Equation:

$$Q = A\sqrt{\frac{2gH_T}{\Sigma K}} \qquad V = \sqrt{\frac{2gH_T}{\Sigma K}}$$

$$\Sigma K = K_{ent.} + K_{exit} + K_{friction}$$

$K_{ent} = 0.6$

$K_{exit} = 1.0$

$$K_f = \frac{29.16\, n^2 \ell}{R^{4/3}} \qquad n = 0.012, \quad \ell = 110.0$$

$$R = \frac{A}{P} = \frac{D}{4} = \left(\frac{12}{12}\right)\frac{1}{4} = 0.25$$

$$K_f = \frac{29.16(0.012)^2(110)}{(0.25)^{1.33}} = 2.90$$

$$\Sigma K = 0.6 + 1.0 + 2.90 = 4.5$$

$$A = (12/12)^2 \pi/4 = \pi/4 = 0.79\ ft^2$$

$$Q = (0.79)\sqrt{\frac{2g}{4.45}}\sqrt{H_T} = 3.0\sqrt{H_T}, \quad H_T = W.S.E. - 628.3$$

Crest elevation of outlet works = 657.3 ⟶

Outlet) ℄ of 12" pipe = 628.3

PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Design
Little Lake in the Woods
Principal Spillway Rating Curve

1283 3/20/5

FULL PIPE FLOW

WSEL (NGVD)	DISCHARGE (Q_{sp}) (cfs)
657.3	0.
657.6	16.29
657.9	16.38
658.0	16.40
658.3	16.49
658.6	16.57
659.0	16.68
659.3	16.76
659.6	16.84
660.0	16.95
660.5	17.08
661.0	17.21
662.0	17.47
663.0	17.73
664.0	17.98

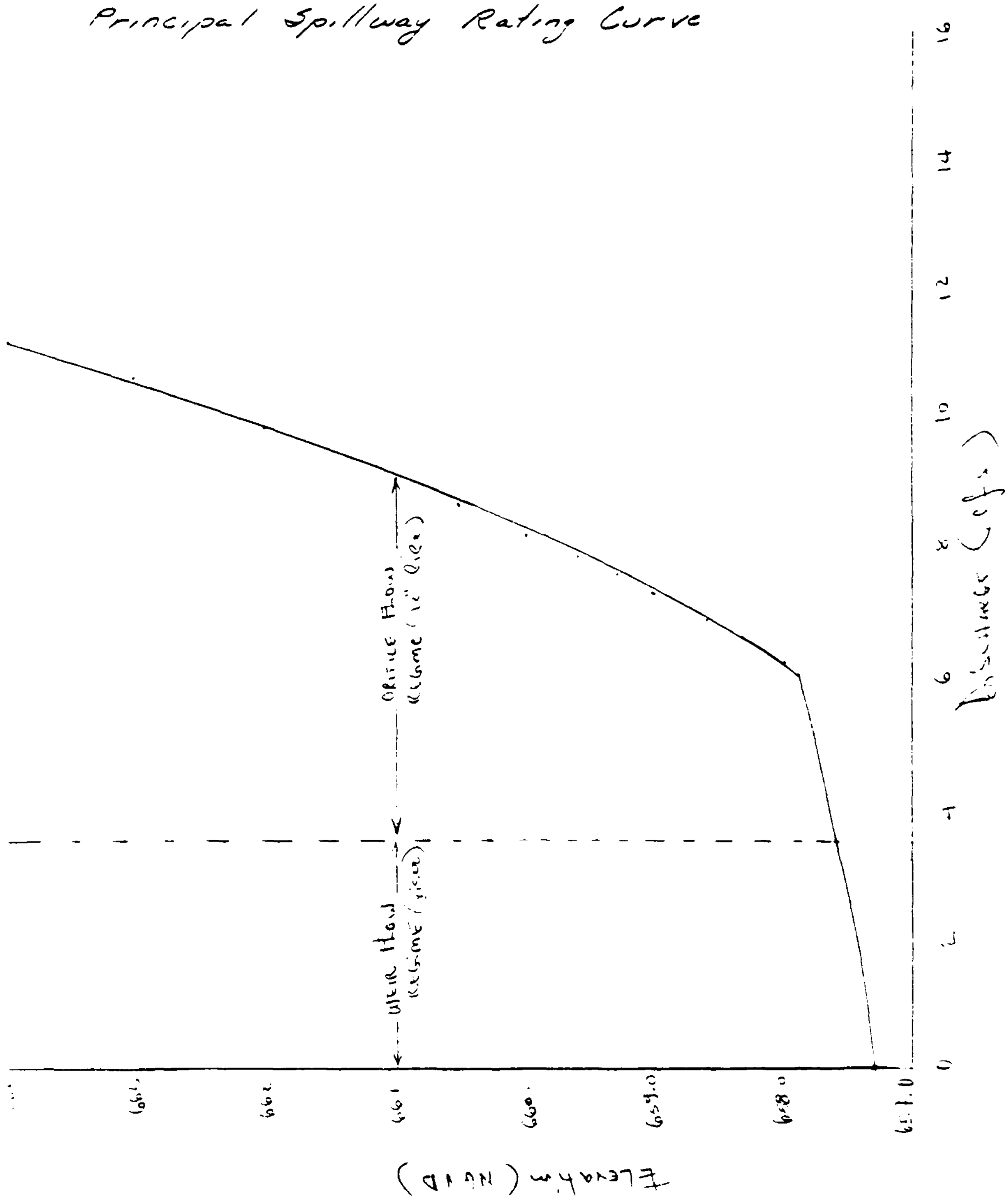
ARC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection
Little Lake in the Woods

283

3/20/81

Principal Spillway Rating Curve

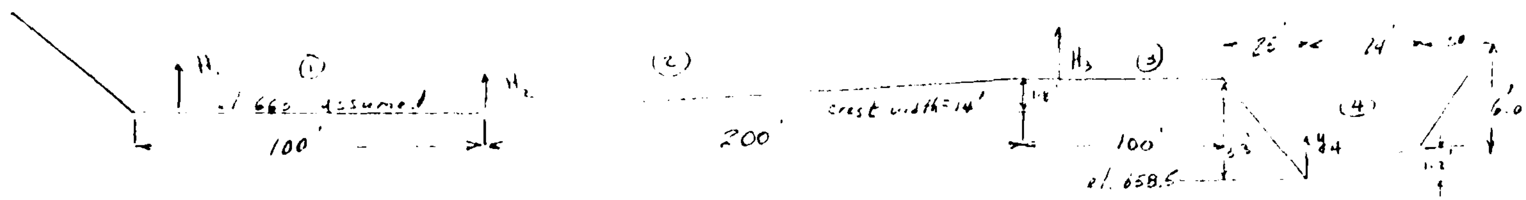


PRO ENGINEERING CONSULTANTS, INC.

Missouri Dam Safety Inspection

[illegible] Lake [illegible] Tools — 1283

Emergency Spillway and [illegible] Rating



Section (1) for all depths H_1, $Q_1 = CLH_1^{3/2}$, H_1 = WSEL − 660

Section (2) for $0 \le y_{c2} \le 1.2$: $y_{c2} = 2/3\, H_2$, $T = \left(\frac{200}{1.2}\right) y_{c2}$, $A = \frac{T y_{c2}}{2} = \left(\frac{200}{1.2}\right)\frac{y_{c2}^2}{2}$, H_2 = WSEL − 660

$y_2 > 1.2$: $y_2 = 2/3\left(H_2 + \frac{1.2}{4}\right)$, $A = 200\left(y_2 - \frac{1.2}{2}\right)$, $T = 200$

Section (3) for all depths H_3, $Q_3 = CLH_3^{3/2}$, H_3 = WSEL − 661.8

Section (4) refer to HEC-2 runs, WSEL = 658.5 + y_4 + $V_4^2/2g$

Refer to HEC-2 printout SECNO 2 (columns y_4 through Q_4)

Elevation	H_1	C_1	Q_1	y_2	A_2	T_2	V_2	Q_2	H_3	C_3	Q_3	y_4	A_4	T_4	V_4	$V_4^2/2g$	Q_4	Q_{T}
[illegible]												0	0	0	0	0	0	0
659.6												0.88	10.56	24.14	3.79	0.22	40	40
659.7												0.96	12.63	26.39	3.96	0.24	50	50
660.08	0.08	2.90	7.0	0.06	0.23	7.11	1.02	0.23				1.26	21.80	34.02	4.59	0.33	100.	107.2
660.62	0.62	3.03	148.	0.50	15.67	55.1	2.83	39				1.66	36.68	40.39	5.45	0.46	200.	387
661.03	1.03	3.034	317.	0.82	37.72	41.6	3.64	137				1.96	49.79	45.25	6.02	0.56	300.	754
661.37	1.37	3.039	487	1.10	66.73	121.8	4.2	280				2.25	62.29	49.45	6.42	0.64	400.	1167
661.67	1.67	3.041	656.	1.34	99.16	148.4	4.64	460				2.45	73.84	53.04	6.77	0.71	500	1616
662.29	2.29	3.045	1055.	1.83	183.3	200.	5.46	1012	.49	3.025	.04	2.94	101.59	60.74	7.40	0.85	750	2921
662.80	2.80	3.05	1429.	2.17	253.3	200.	6.39	1618	1.00	3.027	203	3.34	126.83	66.8	7.88	0.97	1000.	4350
663.67	3.61	3.05	2144.	2.75	369.2	200.	7.71	2848	1.87	3.042	778	3.96	170.05	71.99	8.82	1.21	1500	7270
664.41	4.41	3.05	2825.	3.24	468.	200.	8.68	4062	2.61	3.072	1295	4.51	210.82	76.56	9.49	1.40	2000	10182
665.06	5.06	3.061	3484.	3.67	554.7	200.	9.45	5242	3.26	3.082	1874	4.99	248.44	80.56	10.06	1.57	2500	13040
665.66	5.66	3.011	4129.	4.07	663.3	200.	10.10	6395	3.85	3.09	2534	5.45	285.38	84.29	10.51	1.72	3000	15853
666.70	6.70	3.08	5341.	4.77	773.3	200.	11.16	8629	4.90	3.09	3352	6.22	354.07	90.83	11.20	1.98	4000	21322

HEC-2 INPUT AND SUMMARY TABLE

****
[illegible] UPDATED [illegible] 1980
ERROR CORR - [illegible]
[illegible]
****

T1 MISSOURI DAM SAFETY
T2 EMERGENCY SPILLWAY RATING
T3 LITTLE [illegible]

J1 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	METRIC	HVINS	[illegible]	WSEL	FQ
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.00	[illegible]	0.	659.000	0.000
J2 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	FN	ALLDC	[illegible]	CHNIM	ITRACE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.000	0.000	0.000	0.000	0.000

J3 [illegible] EXTRACT

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10.000	45.000	5.000	5.000	17.000

J4 [illegible] ******** REQUESTED SECTION NUMBERS********

	[illegible]	[illegible]	[illegible]	[illegible]	0.000	0.000	0.000	0.000	5.000	0.000
NC	[illegible]	[illegible]	[illegible]	[illegible]	0.000	0.000	0.000	0.000	0.000	0.000
X1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	403.000	[illegible]	750.000	1105.000
X1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.000	0.000	0.000	1.000	1.000
X1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.000	0.000	-.500	0.000
X2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	650.700	49.000	665.700	95.000
X3	[illegible]	[illegible]	[illegible]	[illegible]	0.000	0.000	2.000	0.000	0.000	[illegible]
X1	[illegible]	[illegible]	[illegible]	0.000	50.000	50.000	50.000	0.000	.000	0.000
EJ	[illegible]	[illegible]	[illegible]	0.000	0.000	0.000	0.000	0.000	0.000	0.000

****

[illegible] APRIL 196[illegible]

[illegible]

[illegible]

****

[illegible] AT LEFT OF [illegible] SELECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

[illegible]

[illegible]

	[illegible]	[illegible]	[illegible]	TOTAL?	[illegible]	*V	G	FG	10**5	K*XNCH
.	[illegible]	[illegible]	[illegible]	[illegible]	3.00?	.22	40.00	650.78?	176.74	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.25	50.00	[illegible]	173.73	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100.00	[illegible]	159.45?	50.00
.	[illegible]	[illegible]	[illegible]	[illegible].31	[illegible]	.47	200.00	659.72	140.27	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	300.00	[illegible]	127.27	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.66	400.00	[illegible].47	124.80?	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.70	500.00	666.77?	117.90	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	7.57?	[illegible]	750.00	661.59?	112.70	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	7.42?	.97	1000.00	[illegible]	110.12	50.00
.	[illegible]	[illegible]	[illegible].47	[illegible]	[illegible]	1.1?	1500.00	[illegible].77	100.24?	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].47	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	97.55?	50.00
.	[illegible]	[illegible]	[illegible].43?	[illegible]	[illegible]	1.75	3000.00	[illegible]	[illegible].18	50.00
.	[illegible]	[illegible]	[illegible].11	[illegible]	[illegible]	1.37?	4000.00	[illegible]	85.38?	50.00
.	[illegible]	[illegible]	[illegible]	[illegible].19?	[illegible]	.22	40.00	655.60?	170.65?	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50.00	[illegible]	171.43?	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100.00	[illegible]	[illegible]	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].45	.46	200.00	660.62	138.49	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	300.00	[illegible]	131.11	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.64	400.00	[illegible]	[illegible].53	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.73	500.00	[illegible]	121.01	50.00
.	[illegible]	[illegible]	[illegible]	.74	7.40?	[illegible]	750.00	[illegible]	[illegible].44	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	7.88?	.97	1000.00	[illegible]	[illegible]	50.00
.	[illegible]	[illegible]	17.[illegible]	[illegible]	[illegible]	1.21	1500.00	[illegible]	[illegible].81	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].47?	1.46	2000.00	[illegible].41	97.79	50.00
.	[illegible]	[illegible]	[illegible].44	[illegible]	[illegible]	1.?7	2500.00	[illegible]	[illegible].23	50.00
.	[illegible]	[illegible]	[illegible]	[illegible]	10.[illegible]	1.72	3000.00	665.65	[illegible]	50.00
.	[illegible]	[illegible]	[illegible]7	[illegible]	11.[illegible]	1.96	4000.00	[illegible]	[illegible]	50.00

[illegible]

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PRC ENGINEERING CONSULTANTS, INC.

Missouri Dam Safety Inspection
Lake in the Woods Dam
combined rating curves

1283

TP 3/24/81

COMBINED RATING CURVE

RESERVOIR ELEV. (NGVD)	Principal SPILLWAY DISCHARGE * (cfs)	EMERGENCY SPILLWAY AND OVERTOP (Q_{T1}) (cfs)	TOTAL DISCHARGE (cfs)
657.3	0	0	0
657.6	3.5	0	3.5
657.9	6.1	0	6.1
658.0	6.2	0	6.2
658.3	6.6	0	6.6
659.6	7.9	40	47.9
660.1	8.3	107.2	115.5
660.6	8.8	387	395.8
661.0	9.1	754	763.0
661.4	9.4	1167	1176.0
661.7	9.6	1616	1626.0
662.3	10.0	2921	2931.0
662.8	10.4	4350	4360.0
663.7	11.0	7270	728. 0
664.4	11.5	10182	10194.0

* NOTE: ALL DISCHARGE VALUES COMPUTED BY USING LINEAR INTERPOLATION OF VALUES PREVIOUSLY COMPUTED FOR ORIFICE FLOW (PIPE SPILLWAY) CONTROL, EXCEPT @ ELEVATION 657.6 (WEIR FLOW CONTROL).

SUMMARY OF PMF AND ONE-HALF PMF ROUTING

```
*************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION        JULY 1978
 LAST MODIFICATION    [illegible]
*************************************
A1                      MISSOURI DAM SAFETY
A2                  LITTLE LAKE IN THE WOODS
A3                       PMF AND 50 PERCENT PMF
B     300      0      5      0      0      0      0      0      0      0
B1      5
J       1      2      1
J1      1    0.5
K          07 LITTLE
K1         RUNOFF CALCULATION FOR LITTLE LAKE DRAINAGE AREA
M       1      2    .21           .21      1      0      0      1
P           25.4    100    120    130
T
W2           .07                                 -1    -87
X                     1
K          1LITTLE DM
K1         ROUT HYDROGRAPH THROUGH LITTLE LAKE DAM             1
Y                            1      1
Y1      1                                     -657.3     -1
Y4  657.3  657.6  657.9    658  658.3  659.6  660.1  660.6    661  661.4
Y4  661.7  662.3  662.8  663.7  664.4
Y5      0   3.47    6.1    5.2    6.6   47.9  115.5  395.8    763   1176
Y5   1626   2931   4360   7281  10194
$A      0      2    4.5    6.5      7      8   11.5   16.5   22.5     29
$E    630    640    650  657.3  658.5    660    670    680    690    700
$$  657.3
$D    660
K      99
```

B-18

SUMMARY OF DAM SAFETY ANALYSIS

1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	657.30	657.30	660.00
STORAGE	78.	78.	98.
OUTFLOW	0.	0.	102.

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
1.00	662.31	2.31	117.	2953.	8.00	15.67	0.00
.50	661.48	1.48	110.	1298.	5.67	15.67	0.00

PERCENT OF PMF ROUTING
EQUAL TO SPILLWAY CAPACITY

```
                 MISSOURI DAM SAFETY
              LITTLE LAKE IN THE WOODS
         11,12,13,14,15 PERC PMF
     0      0      5      0      0      0      0      0      0      0
 1   5
     1             1
J1  .11    .12    .13    .14    .15
K     IN LITTLE
K1    RUNOFF CALCULATION FOR LITTLE LAKE DRAINAGE AREA
M    1            .21           .21      1      0      0      1
P                 110    120    130
T                                               -1    -87
W
X                  1
K      1 LITTLE                                  1
K1    ROUTE HYDROGRAPH THROUGH LITTLE LAKE DAM
Y                                1      1
Y1   1                                        -657.3   -1
Y4 657.5  657.6  657.9   658   658.3   659.6   660.1   660.6   661   661.4
Y4 661.7  662.5  662.8  663.7  664.4
Y5   0    3.47    6.1    6.2    6.6    47.9   115.5   395.8   763   1176
Y5 1626   2931   4360   7281   10194
$A   0     2     4.5    6.5     7       8     11.5    16.5    22.5    29
$E  633   640    650   657.3  658.5    660     670     680     690    700
$$ 657.3
$D 660
K    99
```

SUMMARY OF DAM SAFETY ANALYSIS

1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	657.30	657.30	660.00
STORAGE	73.	73.	98.
OUTFLOW	0.	0.	102.

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
.11	[illegible]	0.00	97.	95.	0.00	15.92	0.00
.12	[illegible]	[illegible]	98.	114.	.50	15.92	0.00
.13	660.19	.1[illegible]	99.	165.	.67	15.83	0.00
.14	660.27	.27	100.	209.	.75	15.75	0.00
.15	660.3[illegible]	.35	100.	256.	.92	15.75	0.00

END

DATE
FILMED
12-81

DTIC