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MISSOURI · KANSAS CITY RIVER BASIN

GUTHRIE LAKE DAM
CALLAWAY COUNTY, MISSOURI
MO. 10990

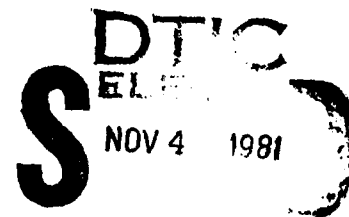# PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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

FOR: STATE OF MISSOURI

SEPTEMBER, 1980

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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 POULEVARD, NORTH
ST. LOUIS, MISSOURI 6310;

REPLY TO
ATTENTION OF

Con'td

SUBJECT: Guthrie Lake Dam (Mo. 10990) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Guthrie Lake Dam (Mo. 10990).

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

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

1) Spillway will not pass 50 percent of the Probable Maximum Flood;
2) Overtopping could result in dam failure; and
3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: _____SIGNED_____   0 3 OCT 1980
              Chief, Engineering Division   Date

APPROVED BY: _____SIGNED_____   0 7 Oct 1980
             Colonel, CE, District Engineer   Date

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GUTHRIE LAKE DAM

CALLAWAY COUNTY, MISSOURI

MISSOURI INVENTORY NO. 10990

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY

CONSOER, TOWNSEND AND ASSOCIATES, LTD.

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

SEPTEMBER 1980

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam: Guthrie Lake Dam, Missouri Inv. No. 10990

State Located: Missouri

County Located: Callaway

Stream: McKinney Creek

Date of Inspection: June 4, 1980

Assessment of General Condition

Guthrie Lake Dam was inspected by the engineering firms of Consoer, Townsend and Associates, Ltd. and PRC Engineering Consultants, Inc. (A Joint Venture) of St. Louis, Missouri according to the U. S. Army Corps of Engineers "Engineer Regulation No. 1110-2-106" 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. Within the estimated damage zone of three miles downstream of the dam are twelve dwellings, a commercial building, a bank, a Post Office, a U.S. Highway (U.S. 54), and an Interstate Highway (I-70), all of which may be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Guthrie Lake Dam is in the small size classification since it is less than 40 feet in height and impounds less than 1000 acre-feet of water.

Our inspection and evaluation indicates that the reservoir/spillway system of Guthrie Lake Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Guthrie Lake Dam being a small size dam with a high hazard potential is required by the guidelines to be able to pass from one-half of the Probable Maximum Flood to the Probable Maximum Flood (PMF) without overtopping of the dam. Considering, however, the number of inhabited dwellings, commercial buildings, and highway crossings located downstream of the dam, the PMF is considered the appropriate spillway design flood for Guthrie Lake Dam. It was determined that the reservoir/spillway system can accommodate approximately 30 percent of the Probable Maximum Flood before overtopping of the dam occurs. Our evaluation also indicates that the reservoir/spillway system will accommodate the one-percent chance flood (100-year 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 meteorological and hydrologic conditions that are reasonably possible in the region.

Guthrie Lake Dam and its appurtenant structures are in fair condition. Some deficiencies were noted by the inspection team, which could affect the safety of the dam and its appurtenant structures. These items are as follows: considerable damage to the downstream slope due to inadequate protection of the slope, cracks on the embankment, inadequate protection of the upstream slope both above and below the normal water surface, one small tree on the downstream slope, unmaintained vegetative cover on most of the embankment, the missing metal hood for the inlet of the principal spillway, the object lodged in the principal spillway pipe, the surface rusting of the principal spillway pipe, the tall grass and erosion in the emergency spillway channel and discharge channel, a need for periodic inspection by a qualified engineer and a lack of a maintenance schedule. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.

The owner of the dam, Mr. Guthrie, voiced a concern about some
of the deficiencies and stated that remedial measures have been taken to
control the problems.   Nevertheless, it is recommended that action be
taken to correct or control the other deficiencies described above.

Walter G. Shifrin, P.E.

Overview of Guthrie Lake Dam

NATIONAL DAM SAFETY PROGRAM

GUTHRIE LAKE DAM, I.D. No. 10990

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

GUTHRIE LAKE DAM, Missouri Inv. No. 10990

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 inspec-
         tions.   Inspection for Guthrie Lake Dam was carried out under
         Contract DACW 43-80-C-0094 between the Department of the Army,
         St. Louis District, Corps of Engineers, and the engineering firms of
         Consoer, Townsend & Associates, Ltd., and PRC Engineering Consul-
         tants, Inc. (A Joint Venture), of St. Louis, Missouri.

         b.   Purpose of Inspection

               The visual inspection of Guthrie Lake Dam was made on
         June 4, 1980.   The purpose of the inspection was to make a general
         assessment regarding 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, provides a summary of visual observations made during the field inspection, gives an assessment of hydrologic and hydraulic conditions at the site, presents an evaluation of the structural adequacy of the various project features and appraises 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 in this report that reference to the left or right abutments is viewed looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the east abutment or side, and right abutment or right side to the north 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 "Engineer Regulation No. 1110-2-106" and additional guidelines furnished by the St. Louis District office of the Corps of Engineers for Phase 1 Dam Inspections.

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. Robert Guthrie, the owner, and Mr. Nelson Wilson, the contractor, who constructed the dam. No design drawings were available for the preparation of this report.

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The dam is a homogeneous, rolled, earthfill structure between earth abutments, consisting of two straight portions of embankment angled at approximately 70 degrees to each other. A plan and elevation of the dam is shown on Plate 2 and Photos 1 through 3 show views of the dam. The major portion of the embankment has a bearing of approximately N 70° W and a length of 570 feet between the emergency spillway and the point of intersection of the two axes. The other portion of the dam runs in the North-South direction and has a length of 200 feet between the point of intersection of the two axes and the right abutment. The top of dam has a total length of 770 feet between the emergency spillway and the right abutment, and a top thickness which varies from 12 to 16 feet. The top of dam was measured to be level with an assumed elevation of 865 feet above mean sea level (M.S.L.). The maximum structural height of the dam was measured as 26 feet. The upstream slope was measured to be 1 vertical to 4 horizontal (1V to 4H), above the water surface. The downstream slope varies between 1V to 2H and 1V to 1.75H. According to Mr. Guthrie and Mr. Wilson, a 6-foot wide by 6-foot deep core trench was constructed paralle' to the dam axis but not into bedrock.

The dam was constructed with a double spillway scheme; the first is considered the principal spillway and operates as a closed conduit when full, and the second is considered the emergency spillway and operates as an open channel.

The principal spillway was constructed from welded steel pipe with a 3/16-inch wall thickness and a 10.5-inch inside diameter (see Photo 5). It was laid through the embankment 370 feet to the right of the emergency spillway on a grade of approximately 21 percent. The inlet end of the conduit is a direct entrance type of inlet and is cut at approximately 35 degrees with the top of the pipe protruding out over the bottom (see Photo 5). There is supposed to be a circular steel hood attached to the inlet end of the pipe as an anti-vortex device that also acts as sort of a trash rack; however, it has been broken off and now lies on the ground

nearby. The spillway crest elevation is at 860 feet above M.S.L. When the reservoir is high enough, water flows through the pipe to the outlet and directly into a discharge pool, falling vertically approximately a foot before entering the downstream channel (see Photo 6). According to Mr. Guthrie, there were two metal seepage collars installed on the pipe during construction.

The emergency spillway was constructed at the left abutment of the dam with a discharge channel that follows along the toe of the dam until it intersects with the downstream channel (see Photo 8). The spillway operates as a trapezoidal open channel with a top width of approximately 84 feet, a bottom width of 25 feet, and side slopes varying from about 1V in 10H to about 1V in 20H. The slope of the approach to the emergency spillway crest is about 8 percent, the crest itself is level for a distance of 25 feet and the slope of the discharge channel is about 4 percent. The elevation of the crest is about 862.8 feet above M.S.L.; this makes it about 2.8 feet above the principal spillway crest and about 2.2 feet below the top of dam.

No low-level outlets or outlet works were provided for this dam; however, a portable, diesel powered, centrifugal pump is used at the damsite (see Photo 11). The pump is used to pump water from the reservoir to a central pivot irrigation sprinkler system on the reservoir rim. According to Mr. Guthrie, the pump has a capacity of 1,100 gallons per minute (gpm). The pump was last used during the summer of 1979.

b. Location

Guthrie Lake Dam is located in Callaway County of the State of Missouri on McKinney Creek. The dam is located approximately 1.5 miles northwest of Kingdom City in the southwest corner of Section 5 of Range 9 West, Township 48 North as shown on the Kingdom City, Missouri Quadrangle (7.5 minute series) sheet.

c.   Size Classification

Guthrie Lake Dam impounds less than 1,000 acre-feet but more than 50 acre-feet, which classifies it as a "small" size dam. However, the maximum structural height is less than 40 feet and greater than 25 feet and this also classifies it as a "small" size dam. The size classification is determined by either the storage or the height, whichever gives the larger size category. Therefore, the size classification is determined to fall within the "small" category, according to the "Engineer Regulation No. 1110-2-106, Appendix D" 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. There are twelve dwellings, a commercial building, a bank, a Post Office, a U.S. highway (U.S. 54), and an Interstate highway (I-70) crossing within the estimated damage zone, which extends approximately three miles downstream of the dam (see Photos 13 and 14).

e.   Ownership

Guthrie Lake Dam is owned privately by Mr. and Mrs. Robert B. Guthrie. The mailing address is as follows: Mr. and Mrs. Robert B. Guthrie, R.R. 1, Kingdom City, Missouri, 65262.

f. Purpose of Dam

    The main purpose of the dam is to impound water to be
used for irrigation.

g. Design and Construction History

    Guthrie Lake Dam was designed by the Department of
Agriculture, Soil Conservation Service, in the Fulton, Missouri,
office in June of 1976. Mr. Leland Tippet was the soil conserva-
tionist for the project. The dam was built in 1976 by Mr. Nelson
Wilson, a local contractor from Mexico, Missouri.

h. Normal Operational Procedures

    The normal procedure is to pump water from the reservoir
during the summer months and to allow the reservoir to refill from
runoff during the remaining months of the year. The water level in
the reservoir is controlled by rainfall, runoff, evaporation, the
elevation of the principal spillway crest, and the operation of the
pump. The reservoir is allowed to remain as full as possible when
the irrigation pump is not in operation.

    According to Mr. Guthrie, every year since the construc-
tion of the dam, the reservoir has been drawn down during the summer
months and is completely full by the spring of the following year.
However, in the summer of 1979, the reservoir was drawn down but the
reservoir did not completely recharge from runoff. The water
surface elevation on the day of the inspection was measured to be
7.5 feet below the principal spillway crest.

1.3   Pertinent Data

a. Drainage Area (square miles):. 0.48

b. Discharge at Damsite

Estimated experienced maximum flood (cfs): 2

Estimated ungated spillway capacity with
reservoir at top of dam elevation (cfs): 411

c. Elevation (Feet above M.S.L.)

Top of dam:. . . . . 865.0 (Assumed)

Spillway crest:

        Principal Spillway 860.0

        Emergency Spillway 862.8

Normal Pool: 860.0

Maximum Experienced Pool:. . . . . 861.0 (Approximately)

Observed Pool: 852.5

d. Reservoir

Length of pool with water surface
at top of dam elevation (feet):. 2400

e. Storage (Acre-Feet)

Top of dam:. 436

Spillway crest:

        Principal Spillway 236

        Emergency Spillway 336

Normal Pool: 236

Maximum Experienced Pool:. 268

Observed Pool: 90.5

f. Reservoir Surfaces (Acres)

Top of dam:. 50

Spillway crest:

        Principal Spillway 30

Emergency Spillway 41.5

Normal Pool: 30

Maximum Experienced Pool:.   34

Observed Pool: 15.5

                    g. Dam

Type:. . . . .   Rolled, Earthfill

Length:. . . . .   770 feet

Structural Height: . . . .   26 feet

Hydraulic Height:. . . . .   26 feet

Top width: . . . .   Varies from 12 to 16 feet

Side slopes:

        Downstream . . . .   Varies, 1V to 2H to 1V to 1.75H

        Upstream . . . .   1V to 4H

Zoning:. . . . .   Homogeneous

Impervious core: . . . .   NA

Cutoff:. . . . .   A core trench 6 feet wide and
                                         6 feet deep (According to Mr.
                                         Guthrie)

Grout curtain: . . . .   None

Freeboard above normal
reservoir level: . . . .   5 feet

Volume:. . . . .   24,960 cu.yds. (SCS estimate)

        h. Diversion and Regulating Tunnel. . . . . .None

        i. Spillway

Type:

    Principal Spillway . . . . Pipe, uncontrolled

    Emergency Spillway . . . . Earthcut channel, uncontrolled

Length of crest:

    Principal Spillway . . . . NA, 10.5-inch inside diameter pipe

    Emergency Spillway . . . . 25 feet

Crest Elevation (feet above MSL):

    Principal Spillway 860.0

    Emergency Spillway 862.8

j.   Regulating Outlets. . . None; however a pump is used at
                             the dam site to supply water
                             from the reservoir to a sprinkler
                             system on the reservoir rim.

Type: . . . . Diesel powered, centrifugal
                             pump (portable)

Location: . . . . On the left side of the
                             reservoir. (on the day of the
                             inspection)

Closure:. . . . . None

Maximum Capacity: . . . . 1,100 gpm. (According to Mr.
                             Guthrie)

SECTION 2: ENGINEERING DATA

2.1   Design

Guthrie Lake Dam was designed by the Soil Conservation Service
of Callaway County, Missouri.   The only design information obtained from
the Soil Conservation Service consists of a copy of the original sur-
veying notes of the damsite and hydraulic calculations.   The hydraulic
calculations are presented in this report (see Plate 4) and are dated
January 26, 1976.

2.2   Construction

The construction data obtained for this dam consisted mostly
of surveying notes and cut-fill quantities. Other information on the
construction of the dam was obtained during a telephone conversation with
Mr. Nelson Wilson, the contractor for the project, and confirmed by Mr.
Guthrie on the day of the inspection. Mr. Wilson stated that a core
trench was excavated into solid clay parallel to the axis of the dam.
The fill was placed according to Soil Conservation Service standards and
specifications.   The Soil Conservation Service periodically inspected the
construction of the dam; however, no compaction tests were made on the
fill while it was being placed.   One self-propelled scraper and one pull
scraper were used to construct and compact the dam embankment.   The soil
for the embankment is primarily clay which was taken from the reservoir
area and higher areas above the lake.   Silty material was used in some
areas to cover the clay for seeding the slopes of the embankment.

2.3 Operation

No operation records are available for Guthrie Lake Dam. The only information on the operation of the dam and appurtenant structures was obtained from Mr. Guthrie and is described in Section 1.2h.

2.4 Evaluation

a. Availability

The availability of engineering data is somewhat lacking and consists only of surveying notes, hydraulic calculations, 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 documented information was available on the construction or operation of the dam.

b. Adequacy

The available 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 visual inspection, past performance, 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

        The only valid engineering data are the surveying notes
and hydraulic calculations obtained from the Soil Conservation
Service. The hydraulic calculations show that the dam and spillways
were designed to pass at least the 50-year flood. From our calcula-
tions (see Section 5.1d), it was determined that the dam and spill-
way are capable of passing the one-percent chance flood (100-year
flood) without overtopping the dam.

SECTION 3: VISUAL INSPECTION

3.1   Findings

a.   General

A visual inspection of the Guthrie Lake Dam was made on June 4, 1980. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Mark Haynes, P.E.	PRC Engineering Consultants, Inc.	Project Engineer, Soils and Mechanical
Jerry Kenny	PRC Engineering Consultants, Inc.	Hydraulics and Hydrology
Robert McLaughlin, P.E.	PRC Engineering Consultants, Inc.	Civil
Razi Ouraishi, R.P.G.	PRC Engineering Consultants, Inc.	Geology
John Lauth, P.E.	Consoer, Townsend & Assoc., Ltd.	Civil and Structural
Robert Guthrie	Owner	

Specific observations are discussed below.

b.   Dam

The overall condition of the dam appears to be fair. Some items of concern were observed and are described below.

The top of dam appears to be adequately protected against surface erosion by a tall, unmaintained grass cover (see Photo 2). The grass, according to Mr. Guthrie, is being allowed to go to seed so that it will spread into unprotected areas on the slopes. The top of dam is occasionally used as a farm access road and, consequently, tire tracks due to vehicular traffic were observed. No tire ruts or depressions, which are sometimes associated with vehicular traffic across earthen structures, were seen. Noncontinuous longitudinal and transverse cracks were seen on the main section of the embankment. The cracks measured up to 6 inches deep, 1/4 of a inch wide and several feet long. No depressions indicating a settlement of the embankment were observed. No significant deviation in the vertical or horizontal alignment was apparent. According to Mr. Guthrie, the dam has never been overtopped and no evidence indicating the contrary was observed.

The upstream slope has no riprap protection; however, only minor wave erosion to the slope at the normal water surface level was found (see Photo 1). The water surface on the day of the inspection was measured to be about 7.5 feet below the normal water surface level, which facilitated a comprehensive inspection of the entire slope. The slope above the normal water surface level was supporting a sparse cover of grass. The grass cover did not appear to be adequate protection against surface erosion and some minor surface erosion was observed. On the slope below the normal water surface level, a considerable amount of small erosion gullies were observed and the slope has no erosion protection. Noncontinuous longitudinal and transverse cracks were observed on the upper portion of the slope. The cracks measured up to 12 inches deep, 1/4 of an inch wide and a few feet long. No bulges or depressions indicative of an instability of the slope were observed. The effect

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of drawing down the reservoir has had no apparent adverse effect on the stability of the embankment.

For the most part, the downstream slope supports an unmaintained grass cover. The slope, however, is not adequately protected against surface erosion. In one area, approximately 150-feet long, above the principal spillway outlet, the slope has very little grass cover (see Photo 4) and, consequently, considerable damage to the slope due to surface erosion has occurred in this area. Attempts are being made to correct the problems as described above. Erosion gullies were observed over most of the slope. The gullies were measured up to 2 to 2.5 feet wide and 12 to 15 inches deep. Some shallow surface scarps due to sloughing were observed. Noncontinuous longitudinal cracks measuring up to 12 inches deep and 1/2 of an inch wide were observed at the top of some of the scarps, which is indicative of potential sloughing in the future. Noncontinuous longitudinal and transverse cracks were also observed over most of the slope. These cracks were also measured up to 12 inches deep and 1/2 of an inch wide. One small tree was observed growing on the slope. Several large trees were observed near the toe. No bulges or depressions indicative of an instability of the slope were observed. No seepage was observed on the embankment or downstream of the toe. However, standing water was observed in the discharge pool at the outlet end of the principal spillway (see Photo 6). Due to the fact that the reservoir water surface was fairly low on the day of inspection and has been there for some time and that no flowing water was observed downstream of the pool, it is believed that the water in the discharge pool is not due to seepage but is attributed to recent rainstorms in the area.

Both abutments slope gently upward from the top of dam. No instabilities, seepage or erosion were observed on either abutment.

No evidence of burrowing animals was observed on either of the abutments or the embankment. Muskrats, according to Mr. Guthrie, have been a problem in the reservoir in the past. The muskrats are generally trapped when present.

c. Project Geology and Soils

(1) Project Geology

The damsite is located on McKinney Creek in the Dissected Till Plains Section of the central Lowland Physiographic Province. Loess-mantled Kansas drift covers the surface of most of the Dissected Till Plains Section. This section is distinguished from the Young Drift Section to the north and from the Till Plains on the east by the stage it has reached in the post-glacial erosion cycle. Broadly generalized, this section is a nearly flat till plain submature to mature in its erosion cycle.

The topography at the damsite is flat to rolling with V- to U-shaped valleys. Elevation of the ground surface ranges from 865 feet above M.S.L. at the damsite to 900 feet above M.S.L. nearly 1 mile northeast of the damsite. The reservoir slopes are in the range of 4° to 10° from the horizontal. The area near the damsite is covered with slope wash deposits of glacial-fluvial and loess origins consisting of mottled yellowish brown to gray, silty clay.

The regional bedrock geology beneath the glacial outwash deposits within the damsite area, as shown on the Geological Map of Missouri (1979) (see Plate 5), consists of Pennsylvanian undifferentiated rocks, Pennsylvanian Marmaton-Cherokee Group rocks (cyclic deposits of shale, limestone and sandstone), Mississippian Burlington Limestone (cherty, grayish brown, sandy limestone), the Mississippian Chouteau Group, the Devonian Sulphur Springs Group (Bushberg Sandstone, Glen Park Limestone and Grassy Creek Shale), and Ordovician rocks consisting of Maquoketa Shale, Kimmswick Limestone, St. Peter Sandstone, Powell Dolomite, and Roubidoux Formation. The

predominant bedrock underlying the glacial-fluvial deposits at the damsite are the Pennsylvanian cyclic deposits of shale, limestone and sandstone of the Marmaton-Cherokee Group. No outcropping of bedrock was seen at the damsite. Inlet and outlet areas of McKinney Creek exhibit Quaternary alluvium.

No faults have been identified at the damsite. The closest trace of a fault in the vicinity of the damsite is the Kingdom City Fault nearly 12 miles south of the damsite. The Kingdom City Fault had its last movement in post-Ordovician time. Thus, the fault has no effect on the damsite.

Guthrie Lake Dam consists of a homogeneous earthfill embankment, a principal spillway pipe located near the maximum section of the embankment, and an emergency spillway located at the left abutment end of the embankment.

No boring logs or construction reports were available which would indicate foundation conditions encountered during the construction. Based on the visual inspection and conversations with the owner, Mr. Guthrie, the embankment probably rests on glacial-fluvial deposits (yellowish brown, silty clay) with a core trench excavated into the glacial-fluvial deposits. The foundation material underneath the principal spillway pipe consists of compacted embankment fill (mottled yellowish brown to gray, silty clay). The emergency spillway was cut into the compacted embankment fill.

(2) Project Soils

According to the "Missouri General Soil Map and Soil Association Description" published by the Soil Conservation Service, the materials in the general area of the dam belong to the soil series of Putnam-Mexico in the Central Claypan Area forest. The soils are basically formed from loess. These soils are mostly a very slowly permeable silty clay.

Materials removed from the upstream and downstream slopes of the embankment appeared to be a mottled yellowish brown to gray, silty clay with traces of fine to coarse sand. Based upon the Unified Soil Classification System, the soil would probably be classified as a CL. This is an impervious soil type that generally has the following characteristics: a coefficient of permeability less than 1.0 foot per year, medium shear strength, and a high resistance to piping.

d.   Appurtenant Structures

(1) Principal Spillway

The principal spillway was provided with a metal hood bolted to the top of the pipe at the inlet. This has apparently come loose recently and fallen to the ground. There seems to be no protective coating on the welded steel pipe and the resultant rust appears to be pitting the surface of the pipe (see Photo 5). Also, an object of some kind is lodged about midway inside the pipe.

(2) Emergency Spillway

The emergency spillway has grass and weeds growing within the channel that provide good ground cover; this ground cover, however, is 2 to 3 feet high (see Photos 3, 7, and 8). There is also a relatively small area in the downstream channel where the grass cover is rather sparse and erosion has taken place (see Photo 9). Since the reservoir level is so low, a portion of the reservoir bottom is exposed in front of the spillway inlet area and is being eroded due to surface runoff (see Photo 12).

(3) Outlet Works

There are no low-level outlets or outlet works provided
for this dam. However, a portable, diesel-powered centrifugal pump,
which cannot be considered an appurtenant structure, is used at the
damsite.   The pump is operable and is capable of draining the
reservoir, according to Mr. Guthrie. The pump was last used during
the summer months of 1979.

e. Reservoir Area

The reservoir water surface elevation at the time of the
inspection was 852.5 feet above M.S.L.

The surface area of the reservoir at normal water level
is about 30 acres. The rim appeared to be stable with no major
erosional problems observed. The land around the reservoir slopes
gently upward from the rim and is primarily used for agricultural
purposes. No houses are built near the reservoir.

f. Downstream Channel

The downstream channel is narrow and well defined, but
is obstructed with trees and large vegetation. The floodplain
outside of the channel is fairly wide and cleared for agricultural
use near the damsite.

3.2   Evaluation

The visual inspection did not reveal any conditions which were
felt to pose an immediate threat to the safety of the structure; however,
the following conditions do exist that could affect the overall integrity
of the dam.

1. The damage to the downstream slope caused by surface runoff, due primarily to the lack of adequate protection on the slope, has the potential to negatively affect the stability of the embankment. Corrective measures have been employed by Mr. Guthrie to control the problem.

2. It is unknown whether the cracks observed on the embankment are indicative of shrinkage, slope movement or foundation settlement. The longitudinal cracks observed at the top of some of the scarps on the downstream slope indicate that future sloughing of the slope is possible. Most of the cracks on the embankment, however, appear to be due to shrinkage judging from the extent and location of them.

3. The erosional problem on the upstream slope due to the lack of adequate slope protection does not appear to be detrimental to the stability of the embankment in its present condition. Because the slope is fairly flat, the surface erosion problem has been lessened to some degree. The reservoir is used to store water for irrigation and since it is anticipated that the water surface shall be drawn down periodically, the slope below the normal water level should also be adequately protected.

4. The small tree observed on the downstream slope does not pose a danger to the safety of the dam at this time. Depending upon the extent of the root system, the roots of large trees present possible paths for piping through the embankment. The root systems can also do damage to the embankment from being uprooted by a storm.

5. Although an adequate vegetative cover is recommended to be retained on the embankment, a tall growth of vegetation on the embankment hinders a comprehensive inspection of the dam and potential problems could go undetected.

6. The object lodged within the central portion of the principal spillway could cause further blockage of the opening, thereby causing reduced capacity of the principal spillway.

7. When the reservoir level reaches an elevation above the top of the principal spillway, the lack of the metal hood could result in a debris-clogged pipe.

8. Although the rust condition of the principal spillway does not seem to pose any severe problems at this time, it will probably get worse, as the dam is only 4 years old.

9. The erosive areas of the downstream portion of the emergency discharge channel would probably not sustain the flows of large excess rainfall and reservoir flows. Due to the location of the erosion, it is possible that further erosion could encroach upon the toe of the dam and endanger the safety of the dam. The tall grass within the emergency spillway channel would contribute to reduced outflow in the event of a large amount of excess overflow.

SECTION 4: OPERATIONAL PROCEDURES

4.1   Procedures

Guthrie Lake Dam was constructed to impound water for irrigation. There are no set operational procedures other than the procedures described in Section 1.2h, which are implemented only when water for irrigation is required.

4.2   Maintenance of Dam

The dam and appurtenant structures are maintained by the owner, Mr. Robert B. Guthrie. Maintenance is performed as it is required and, according to Mr. Guthrie, the grass cover is being allowed to go to seed so that it can spread into bare areas on the embankment. Several areas of erosion were present on the downstream slope about which Mr. Guthrie expressed some concern. Mr. Guthrie has taken some measures to correct this problem as described above. There is one small tree growing on the downstream slope. A circular steel plate, used as an anti-vortex device at one time was bolted to the top of the principal spillway pipe. The plate has since fallen off of the pipe and, on the day of the inspection, was observed laying on the ground beneath the pipe.

4.3   Maintenance of Operating Facilities

The only operable facility at the damsite is the diesel powered irrigation pump. The pump is portable and is located on the left side of the reservoir. According to Mr. Guthrie, the pump is in good condition and operable.

4.4   Description of Any Warning System in Effect

The inspection team is not aware of any existing warning
system consisting of any electrical warning systems or manual warning
notification plans in effect for this dam.

4.5   Evaluation

The maintenance at Guthrie Lake Dam seems to be adequate and
the dam does not appear to be neglected. Nevertheless, 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

The watershed area of the Guthrie Lake Dam upstream from
the dam axis consists of approximately 305 acres.   The watershed
area is mostly row crops or pasture and range land with some wooded
areas.   Land gradients in the watershed average roughly 1 percent.
The Guthrie Lake Dam Reservoir is located on McKinney Creek.   The
reservoir is about 1-1/2 miles upstream from the U.S. Highway 54
crossing of McKinney Creek.   The watershed at its longest arm is
approximately 1 mile long.   A drainage map showing the watershed and
the downstream hazard zone is presented as Plate 1 in Appendix B.

Evaluation of the hydraulic and hydrologic features of
Guthrie Lake Dam was based upon criteria set forth in the Corps of
Engineers' "Engineer Regulation No. 1110-2-106" and additional
guidance provided by the St. Louis District of the Corps of Engi-
neers.   The Probable Maximum Flood (PMF) was calculated from the
Probable Maximum Precipitation (PMP) using the methods outlined in
the U.S. Weather Bureau Publication, Hydrometerological Report No.
33.   The probable maximum storm duration was set at 24 hours, and
storm rainfall distribution was based upon criteria given in the
Corps of Engineers' EM 1110-2-1411 (Standard Project Storm).   The
Soil Conservation Service (SCS) method was used for deriving the
unit hydrograph, utilizing the Corps of Engineers' computer program
HEC-1 (Dam Safety Version).   The unit hydrograph parameters are
presented in Appendix B.   The SCS method also was used for deter-
mining the loss rate.   The hydrologic soil group of the watershed
was determined by use of published soil maps.   The hydrologic soil
group of the watershed and the SCS curve number are presented in

Appendix B. The curve number, unit hydrograph parameters, the PMP index rainfall and the percentages for various durations were direct input to the HEC-1 (Dam Safety Version) computer program to obtain the PMF hydrograph. The computed peak inflows of the PMF and the one-half PMF are 4,844 cfs and 2,422 cfs, respectively.

Both the PMF and the one-half PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method, also utilizing the HEC-1 (Dam Safety Version) computer program. An antecedent storm of 50 percent of the PMF preceded the PMF and an antecedent storm of 25 percent of the PMF, preceded the one-half PMF, each by four days. The reservoir was assumed at the mean annual high water level at the beginning of the antecedent storm. The mean annual high water level for Guthrie Lake was estimated to be at the crest of the principal spillway. The antecedent storms of 50 percent of the PMF and 25 percent of the PMF, when routed through the reservoir, will both leave the reservoir at approximately an elevation of 861.6 feet above M.S.L. at the end of the four-day period. Thus, the reservoir was assumed at an elevation of 861.6 feet above M.S.L. at the start of the routing computation for the PMF, the one-half PMF, and other PMF ratio floods. The peak outflow discharges for the PMF and the one-half PMF are 4,034 and 1,691 cfs, respectively. Both the PMF and the one-half PMF when routed through the reservoir resulted in overtopping of the dam.

The sizes of physical features utilized to develop the stage-outflow relation for the spillway and overtopping of the dam were taken from field notes and sketches prepared during the field inspection. The reservoir elevation-area data were obtained from the U.S.G.S. Kingdom City, Missouri Quadrangle topographic map (7.5 minute series). The reservoir elevation-area curve and the spillway and overtop rating curve are presented as Plates 2 and 3, respectively, in Appendix B.

From the standpoint of dam safety, the hydrologic design
of a dam must aim at avoiding overtopping the dam. Overtopping is
especially dangerous for an earth dam because of its erodable
characteristics. The safe hydrologic design of an embankment dam
requires a spillway discharge capability combined with an embankment
crest height that can handle a very large and exceedingly rare flood
without overtopping.

The Corps of Engineers designs dams to safely pass the
Probable Maximum Flood that could be generated from the dam's
watershed. This is the generally accepted criterion for major dams
throughout the world and is the standard for dam safety where
overtopping would pose any threat to human life. Accordingly, the
hydrologic requirement for safety for this dam is the capability to
pass the Probable Maximum Flood without overtopping.

b. Experience Data

It is believed that records of reservoir stage or spill-
way discharge are not maintained for this site. However, according
to Mr. Guthrie, the maximum reservoir level is approximately two
feet below the crest of the emergency spillway.

c. Visual Observations

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

d. Overtopping Potential

As indicated in Section 5.1a, both the Probable Maximum
Flood and the one-half Probable Maximum Flood, when routed through
the reservoir, resulted in overtopping of the dam. The peak outflow
discharges for the PMF and the one-half PMF are 4,034 and 1,691 cfs,
respectively. The maximum capacity of the spillway just before

overtopping the dam is 411 cfs. The PMF overtopped the dam by 1.19 feet and the one-half PMF overtopped the dam by 0.6 feet. The total duration of flow over the top of dam is 5.25 hours during the PMF and 2.58 hours during the occurrence of the one-half PMF. The spillway/reservoir system of Guthrie Lake Dam is capable of accommodating a flood equal to approximately 30 percent of the PMF just before overtopping the dam. The reservoir/spillway system of Guthrie Lake Dam will accommodate the one-percent chance flood (100-year flood) without overtopping.

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 approximately three miles downstream of the dam. There are twelve dwellings, a commercial building, a bank, a Post Office, a U.S. highway crossing (U.S. 54), and an Interstate highway crossing (I-70) within the damage zone.

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.   Nevertheless, the erosion on the downstream slope, the observed scarps and the longitudinal cracks above the scarps (these are indicative of the possibility of future sloughing) could be detrimental to the stability of the structure. The downstream slope should be properly repaired and the slope properly protected.   The minor erosional problem on the upstream slope does not appear to be detrimental to the stability of the dam in its present condition. Nevertheless, continued erosion of the slope can only jeopardize the embankment.   The upstream slope should be adequately protected both above and below the normal water surface level. The upstream slope below the normal water surface level requires some sort of protection due to the fact that the water surface is drawn down annually. No adverse effect to the stability of the embankment due to the drawing down of the reservoir was apparent.   It was not apparent whether the majority of the cracks on the embankment were due to shrinkage, slope movement or foundation settlement.   Therefore, monitoring of the cracks is warranted.   In the absence of seepage and stability analyses, no quantitative evaluation of the structural stability can be made.

       The spillway system appeared to be structurally stable on the day of the inspection.

b.   Design and Construction Data

The hydraulic computations given to the inspection team had a limited use in the assessment of the structural stability of the dam and appurtenant structures. 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 the embankment compaction were available for use in a stability analysis.

c.   Operating Records

No operating records are available relating to the dam or appurtenant structures. The only operable facility at the damsite is the diesel powered pump used to supply water to the irrigation system. According to Mr. Guthrie, the reservoir level is drawn down annually during the summer months and fills back up during the remaining months of the year except for the year of 1979 as stated previously. The drawing down of the reservoir does not appear to have affected the stability of the dam. The water level on the day of the visual inspection was 7.5 feet below the principal spillway crest. The reservoir level, reportedly, remains full most of the time except for when water is being pumped from the reservoir for irrigation.

d.   Post Construction Changes

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

e.   Seismic Stability

The dam is located in Seismic Zone 1 (see Plate 7), as defined in "Recommended Guidelines for Safety Inspection of Dams" prepared by the Corps of Engineers, and will not require a seismic stability analysis. An earthquake of the magnitude which would be expected in Seismic Zone 1 will 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.

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 inspections. 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 inspec-
tion 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 an assurance that an unsafe
condition would be detected.

a.   Safety

The spillway capacity of Guthrie Lake Dam is found to be
"Seriously Inadequate". The spillway/reservoir system will accommo-
date about 30 percent of the PMF without overtopping the dam. The
safety of the embankment will be in jeopardy if the dam is over-
topped. The embankment itself would be susceptible to erosion due
to the high velocity of flow on its downstream slope, which could
lead to an eventual failure of the dam.

The dam and appurtenant structures appeared to be in fair condition. However, 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, reportedly have performed satisfactorily since their construction without failure or evidence of instability. The dam, reportedly, has never been overtopped and no evidence indicating the contrary was observed. The safety of the dam can be improved if the deficiencies described in Sections 3.2 and 6.1a are properly corrected as described in Section 7.2.

b.   Adequacy of Information

The hydraulic computations were of limited use to the overall assessment of the dam and appurtenant structures. The conclusions presented in this report are primarily based upon field measurements and present condition of the dam. Information on the operation and maintenance of the dam was not available except for the information received from Mr. Guthrie. 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

The remedial measures recommended in Paragraph 7.2 should be accomplished in the near future. The items recommended in paragraph 7.2a should be pursued on a high priority basis.

d.   Necessity for Phase II Inspection

Based upon results of the Phase I inspection, and assuming that 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 general options that may be considered to reduce the possibility of dam failure or to diminish the harmful aspects of such a failure. Some of these options are:

1.   Increase the spillway capacity to pass the PMF without overtopping.

2.   Increase the height of the dam enough to pass the PMF without overtopping the dam; an investigation should be done that also includes studying the effects on the structural stability of the existing 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 damage to the downstream slope (surface erosion, scarps and cracks) should be properly repaired and the slope adequately protected. (Measures to correct this condition are being implemented at this time by Mr. Guthrie.)

2.   The observed cracking on the embankment should be monitored to ensure that it is not symptomatic of distress in the slopes or foundation. Large cracks should be properly repaired.

3.   The upstream slope above the normal water surface level should be adequately protected against surface runoff. (Measures to correct this condition are being implemented at this time by Mr. Guthrie.)

4. The upstream slope below the normal water surface level
    should also be protected against surface erosion.

5. The small tree on the downstream slope should be removed
    from the slope and regrowth prevented.

6. The vegetative growth on the embankment should be properly
    maintained and an adequate vegetative cover retained on
    the embankment to protect it from surface erosion.

7. The metal hood should be permanently and properly reat-
    tached to the inlet end of the principal spillway.

8. The rusting of the principal spillway pipe should be
    monitored and repairs made when deemed necessary.

9. The object lodged in the central part of the principal
    spillway pipe should be removed.

10. The tall grass within the emergency spillway discharge
    channel should be maintained at a lower height, e.g. a 1-
    foot maximum. The erosion near the end of the discharge
    channel should be repaired to the extent that it would not
    further erode in the event of a large flow in the channel
    and the entire spillway channel adequately protected to
    avoid excessive erosion during flows through the spillway.

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

12. 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 visits to the dam for operation, repairs and maintenance.

PLATES

PLATE 1

KEY MAP
SHOWING LOCATION OF COUNTY

CALLAWAY COUNTY

SCALE

1   0   1   2   3   4 MILES
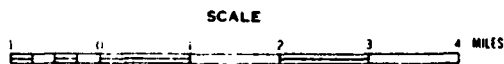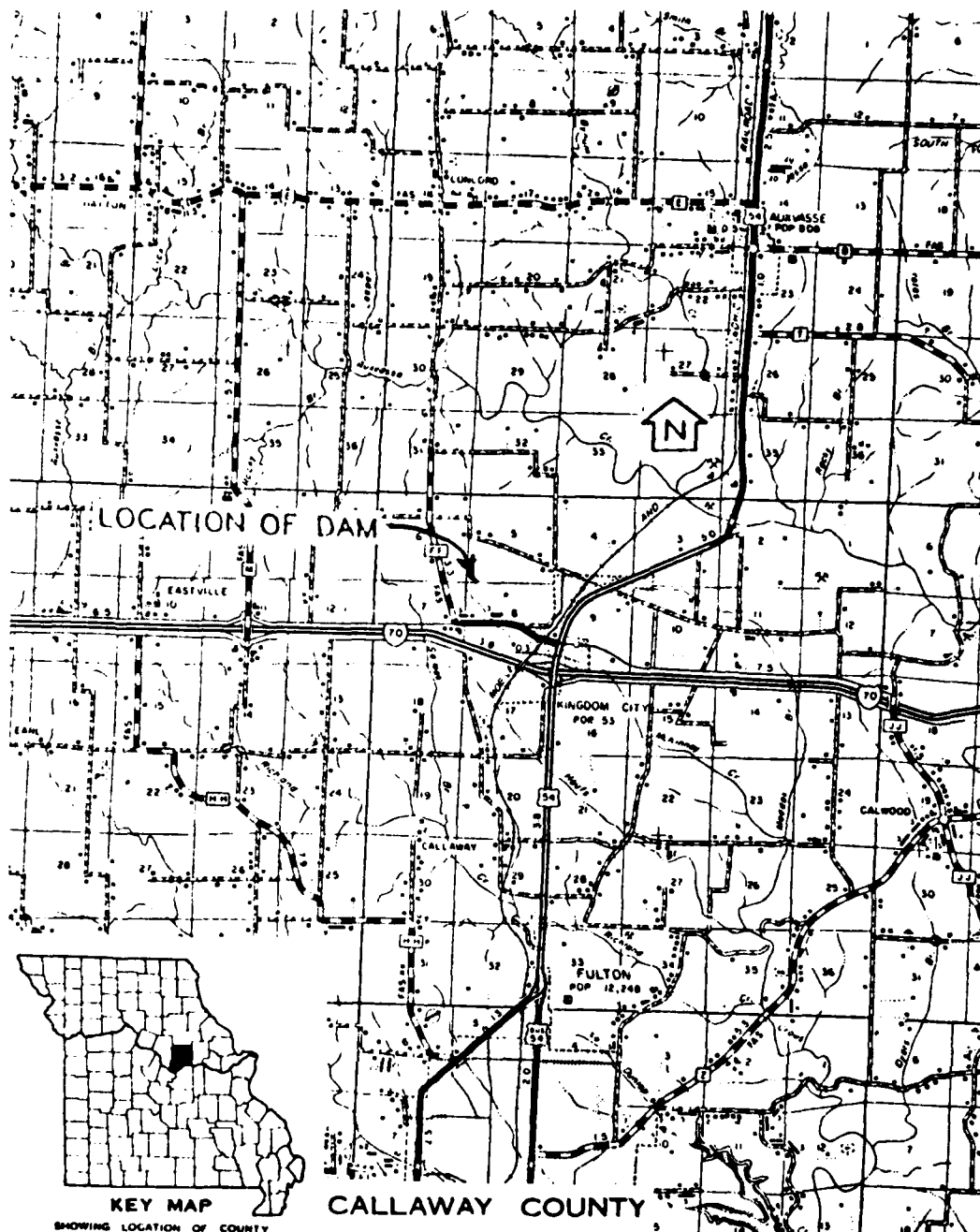
POLYCONIC PROJECTION

LOCATION MAP — GUTHRIE LAKE DAM

MO 10990

PLATE 2

EROSION GULLY

PRINCIPAL SPILLWAY DISCHARGE POOL

10.5" WELDED STEEL PIPE

200'

200'

PRINCIPAL SPILLWAY
(HOOD MISSING FROM
HOODED INLET)

N

PLAN

EMERGENCY
SPILLWAY

WATER EDGE

A

A

SCALE:
HORIZ. 1" = 100'

400'

370'

TOP OF DAM, EL. 865 (ASSUMED)

PRINCIPAL SPILLWAY,
CREST EL. 860

EMERGENCY SPILLWAY,
CREST EL. 862.8

RESERVOIR WATER SURFACE
EL. 852.5 ON JUNE 4, 1980

38.5' 25'20'

2:1
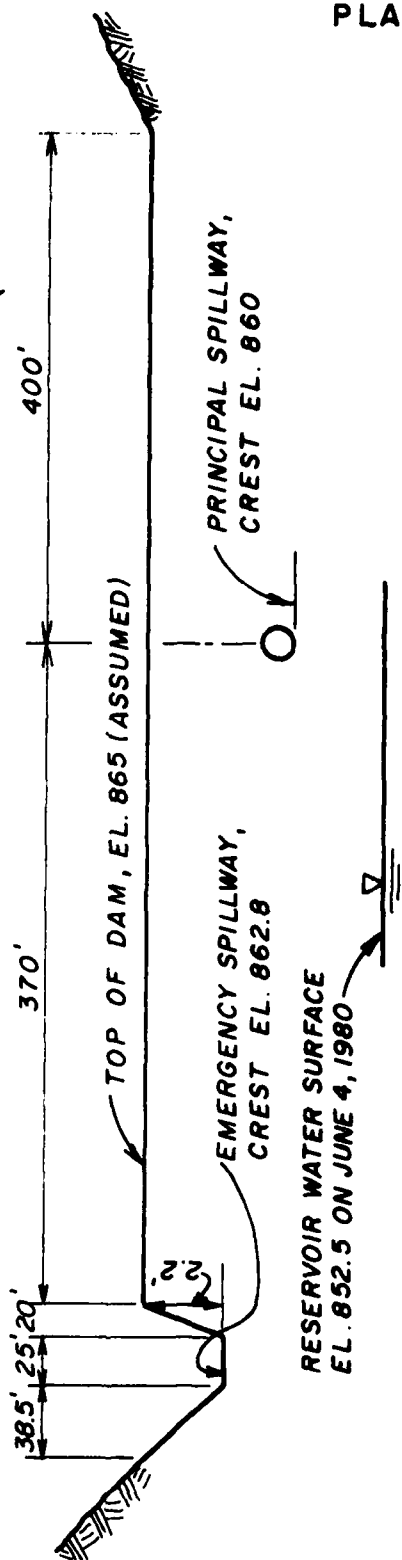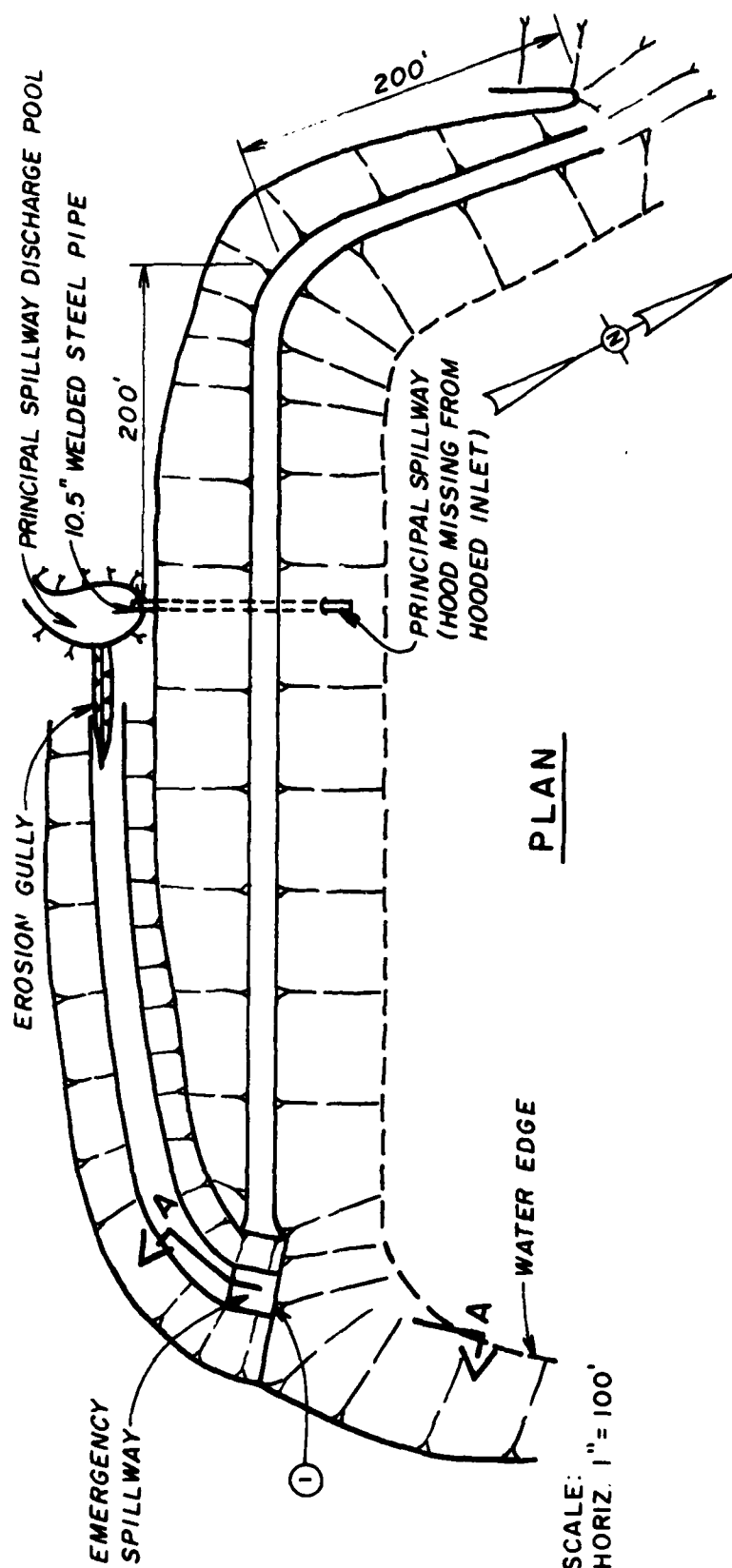
ELEVATION

NO SCALE HORIZ. OR VERT.

GUTHRIE LAKE DAM (MO. 10990)
PLAN AND ELEVATION
(SHEET 1 OF 2)

PLATE 3

TOP THICKNESS VARIES FROM 12' TO 16'

TOP OF DAM, EL. 865 (ASSUMED)

D/S SLOPE VARIES FROM I V: 1.75 H TO I V: 2 H

RESERVOIR WATER SURFACE EL. 852.5 ON JUNE 4, 1980

12.5'

23'

4 / 1

1

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

10.5" WELDED STEEL PIPE

3'

MAXIMUM SECTION

100'   25'   25'   50'

①

1.9'

1.9'

8.4'

SCALE:
HORIZ. 1" = 40'
VERT. 1" = 5'

SECTION A-A
EMERGENCY SPILLWAY PROFILE
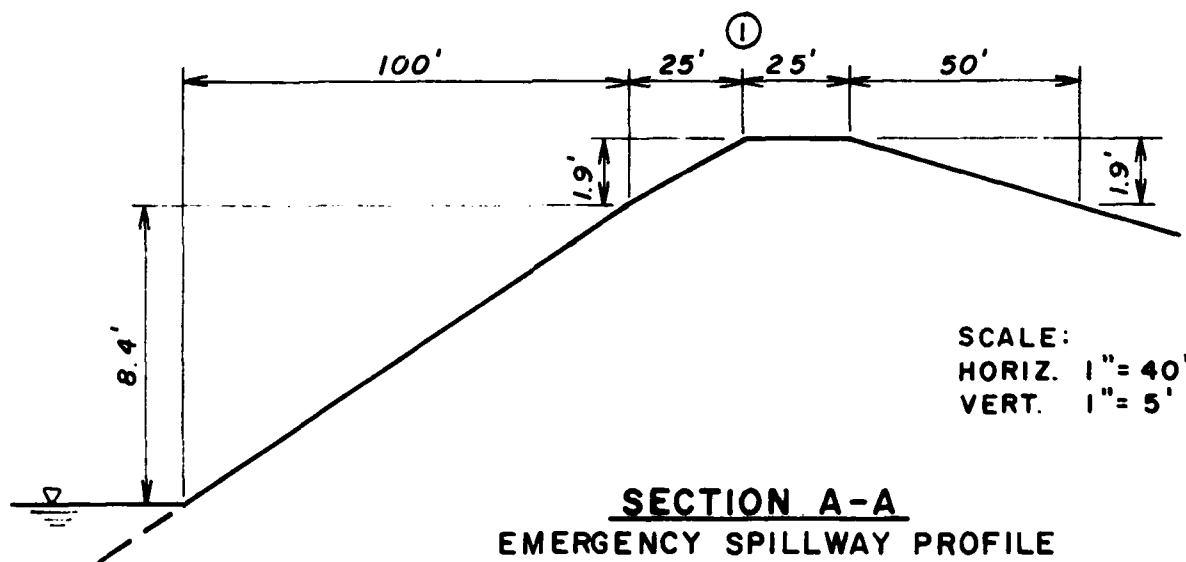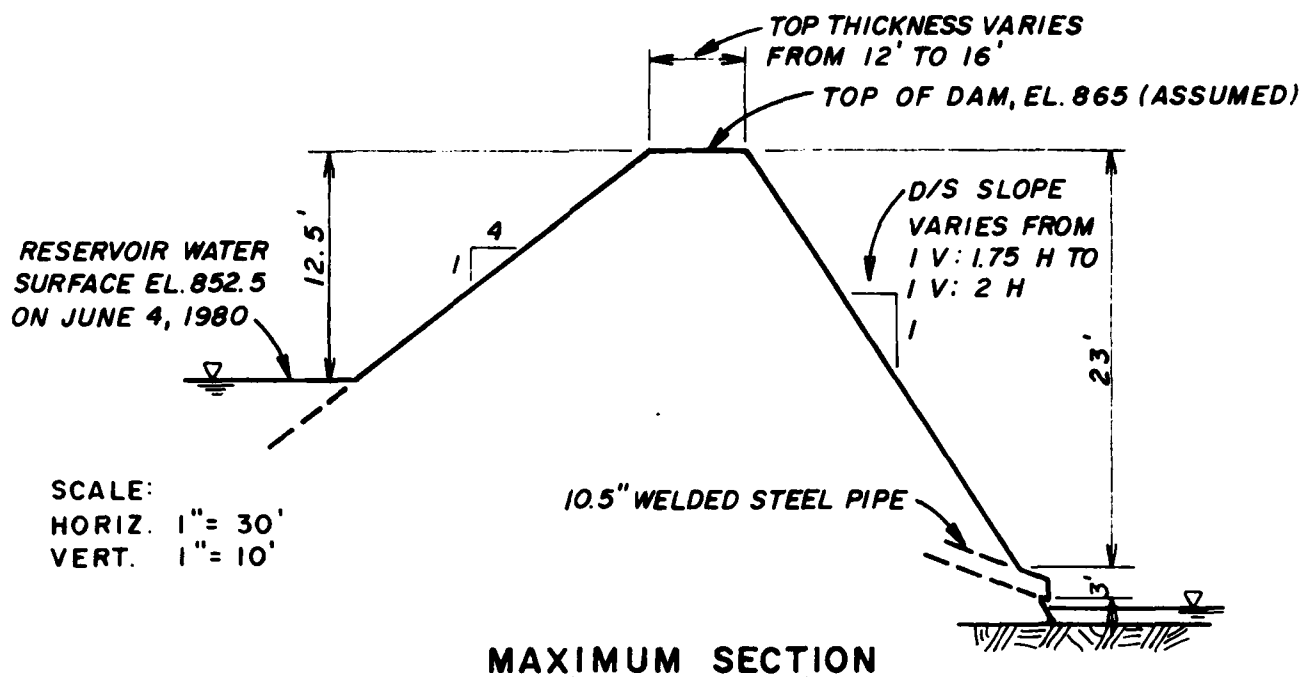
① REFERENCE POINT, SEE SHEET 1 OF 2

GUTHRIE LAKE DAM (MO. 10990)
MAXIMUM SECTION OF EMBANKMENT AND
EMERGENCY SPILLWAY PROFILE
(SHEET 2 OF 2)

PLATE 4

RESERVOIR DESIGN

LANDOWNER _Hinson & Guither_   LOCATION _Galloway_

DESIGN BY _DS 1-26-76_   CHECKED BY _____ DATE _____

DRAINAGE AREA _325_ ACRES   ENGINEERING REQUEST NO._____

PRODUCT OF FACTORS = $\underset{L}{\_\_}$ X $\underset{I}{1.1}$ X $\underset{T}{.83}$ X $\underset{V}{1.0}$ X $\underset{S}{\_\_}$ X $\underset{C}{\_\_}$ X $\underset{P}{\_\_}$ = .91

Q_{10} = _555_ cfs.   Vxl = _1.1_   HEIGHT X STORAGE = _6167_

PRINCIPAL SPILLWAY DESIGN	EMERGENCY SPILLWAY DESIGN
Principal Elev.= _260_	Emergency Elev.= _____
_10_ Year Frequency	_50_ Year Frequency
Q_{ip}= ___ x ___ cfs.= _555_ cfs.	Q_i= _1.5_ x _555_ cfs.= _832_ cfs.
V_{rp}= _.175_ x _325_ ac.= _56.9_ ac.ft.	V_r= _.26_ x _325_ ac.= _84.5_ ac. ft.

Design - Storage

V_{sp}= _591_ ac.ft. $\dfrac{V_{sp}}{V_{rp}}$ = _____

Q_{op}= ___ x ___ cfs.= ___ cfs.

Conduit Dia.=_____ Length=___

Head=___ ft.   Min.Head=_____ ft.

Capacity=_____ cfs.   Stage=_____

Design - Pipe

$\dfrac{Q_{op}}{Q_{ip}}$ = _____

V_s= ___ x ___ ac.ft.= ___ ac.ft.

Anti-Seep Collars

Length=(_____ -20) $\dfrac{(.10)}{(.15)}$ = _____

1

USE 2 _____ x _____ collars

3

Control Section

Depth of flow= _1.0_ ft. V_s= _247_ ac.ft.

$\dfrac{V_s}{V_r}$ = _____ $\dfrac{Q_{op}}{Q_i}$ = _____ %

Q_{oe}= _____ cfs. x _____ = _____ cfs.

Bottom Width=_____ ft.

Outlet Section

S=_____ %   Veg.= fair,good,excellent

(Less) (More) erosive soils   Depth=___ ft.

Perm. Vel.=_____ fps.   Design Vel.___ fps.

Width_____ ft.

Total Depth of Spillway=_____ ft.

Top of Dam Elev.=_____

PLATE 5

SCALE

10   0   10   20   30   40 Miles
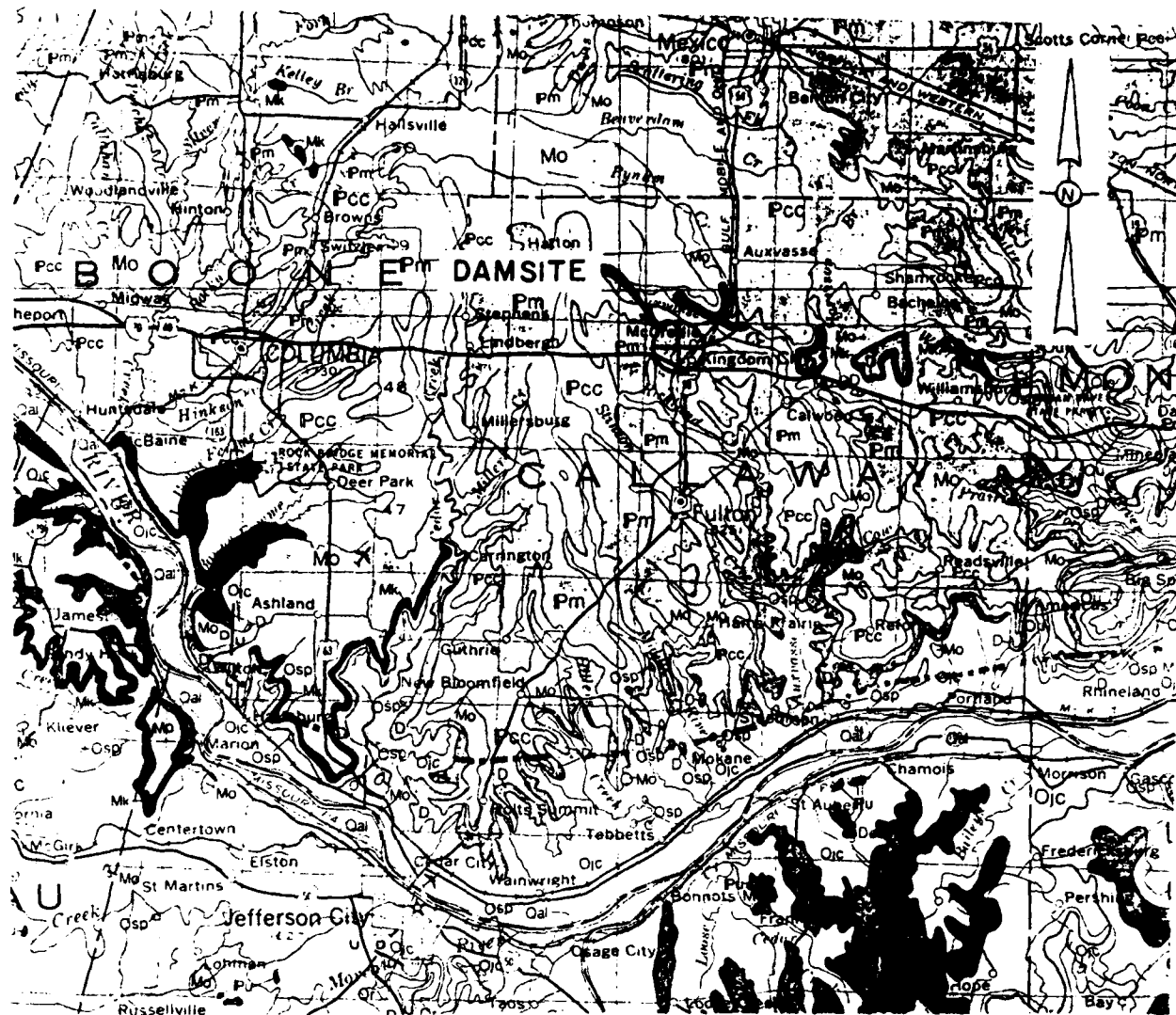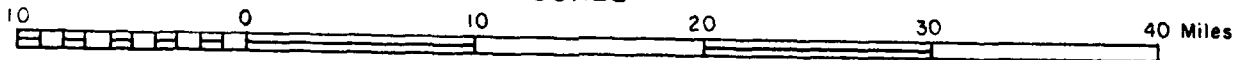
⊕ LOCATION OF DAM

NOTE: LEGEND OF THIS DAM IS ON PLATE 6

REFERENCE:

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

REGIONAL GEOLOGICAL MAP
OF
GUTHRIE LAKE DAM

LEGEND

PERIOD	SYMBOL	DESCRIPTION
QUATERNARY	Qal	ALLUVIUM: SAND, SILT, GRAVEL
PENNSYLVANIAN	Pu	PENNSYLVANIAN UNDIFFERENTIATED
	Pm	MARMATON GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
	Pcc	CHEROKEE GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
MISSISSIPPIAN	Mo	KEOKUK- BURLINGTON FORMATION: CHERTY GRAYISH BROWN SANDY LIMESTONE
	Mk	CHOUTEAU GROUP: BACHELOR, AND HANNIBAL FORMATION (LIMESTONE AND SHALE)
DEVONIAN	D	SULPHUR SPRING GROUP: BUSHBERG SANDSTONE, GLEN PARK LIMESTONE, GRASSY CREEK SHALE
ORDOVICIAN	Ou	MAQUOKETA SHALE, KIMMSWICK LIMESTONE
	Osp	ST PETER SANDSTONE
	Ojc	SMITHVILLE FORMATION, POWELL DOLOMITE
	Or	ROUBIDOUX FORMATION: LIMESTONE AND SANDSTONE

PLATE 7

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 GUTHRIE LAKE DAM
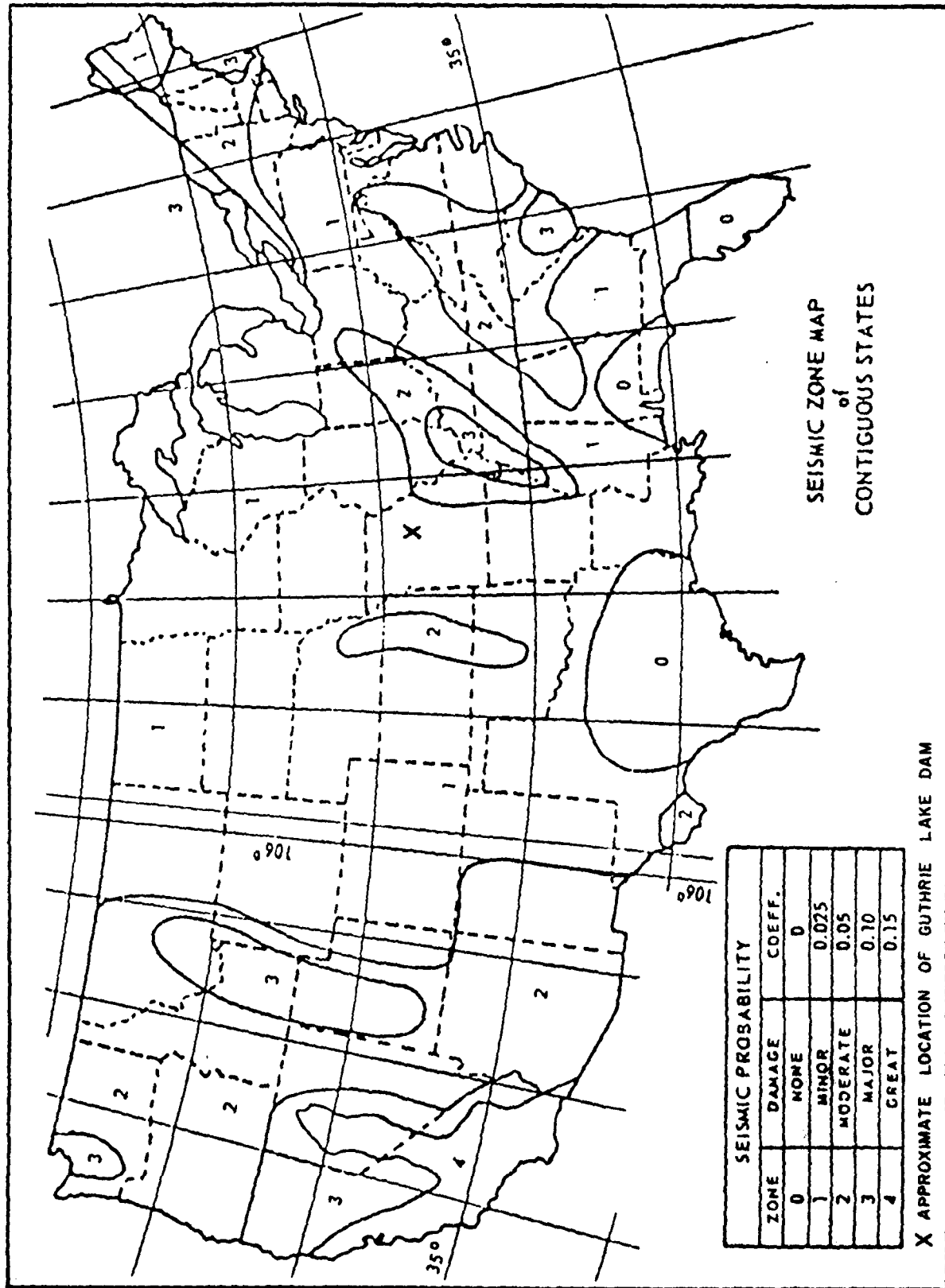
APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

OVERVIEW

13, ~ 1.2 mi. d/s

14, ~ 1.2 mi. d/s

10

6

9

8

3

12

2

7

5

1

N

NO SCALE

11

PHOTO INDEX
FOR
GUTHRIE LAKE DAM
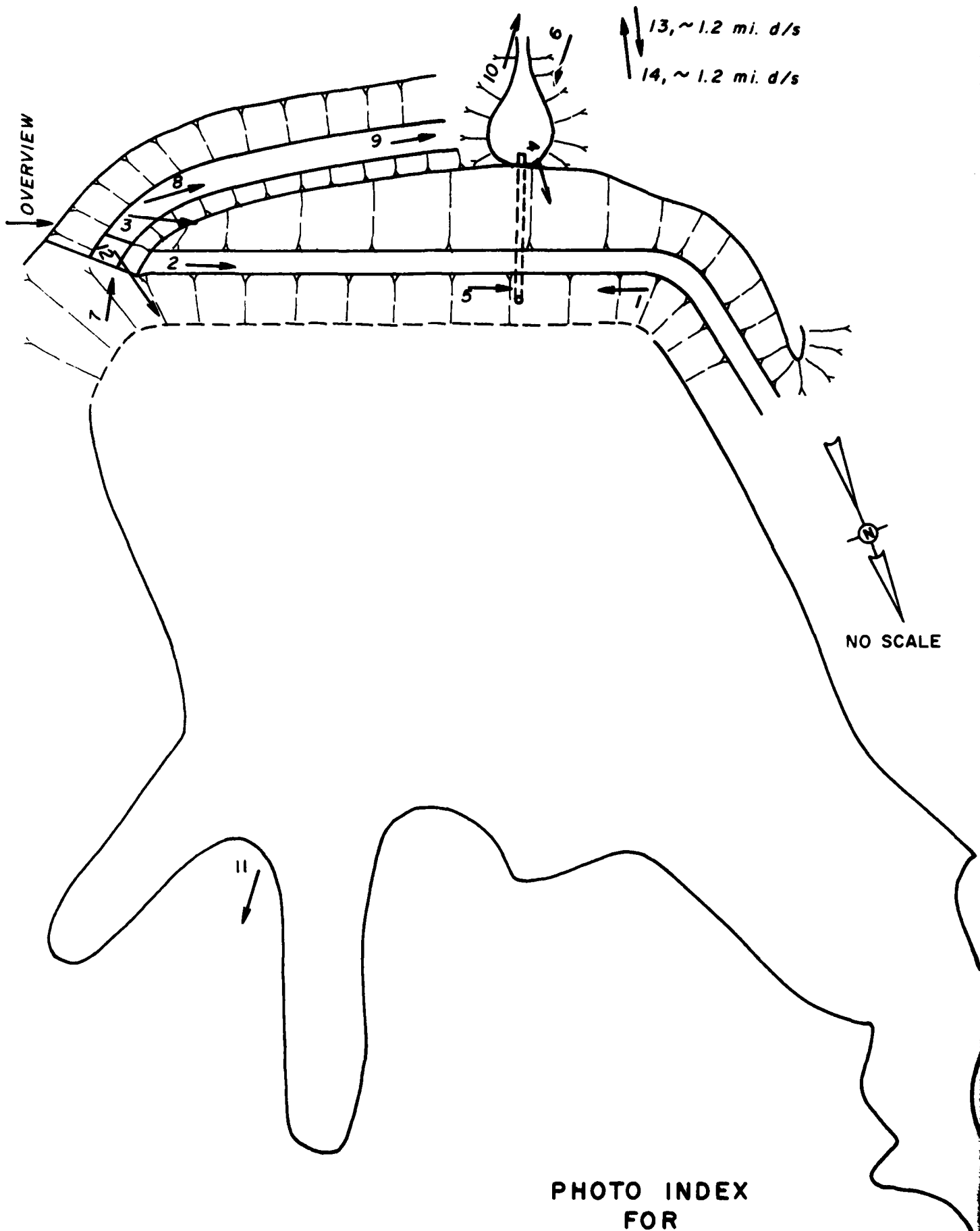
Guthrie Lake Dam
Photographs

Photo 1   –   View of the upstream slope looking toward the left abutment showing the sparse vegetation and the inlet to the principal spillway.

Photo 2   –   View of the top of dam showing the tall grass cover.

Photo 3   –   View of the downstream slope which also shows the curvature of the embankment in the background.

Photo 4   –   View of erosional gullies and the sparse vegetation cover on the downstream slope in the area near the principal spillway.

Photo 5   –   View of the principal spillway inlet showing the rusting of the pipe. Note, circular steel plate used as an anti-vortex device is shown in the lower right hand corner of Photo.

Photo 6   –   View of the principal spillway outlet showing the discharge pool.

Photo 7   –   View of the control section of the emergency spillway looking downstream.

Photo 8   –   View of the discharge channel for the emergency spillway.

Photo 9   –   View of the erosion gully at the confluence of the emergency spillway discharge channel and the principal spillway discharge pool. Note, the person in the Photo is at the principal spillway pipe.

Photo 10   -   View of the downstream channel showing the obstruction of trees and brush.

Photo 11   -   View of the diesel powered, centrifugal pump.

Photo 12   -   View of the reservoir and rim.

Photo 13   -   View of a Post Office located approximately 1.2 miles downstream of the dam. The downstream channel (McKinney Creek) is in the background.

Photo 14   -   View of a commercial bank located approximately 1.2 miles downstream of the dam. The downstream channel (McKinney Creek) is shown on the right hand side of the Photo.
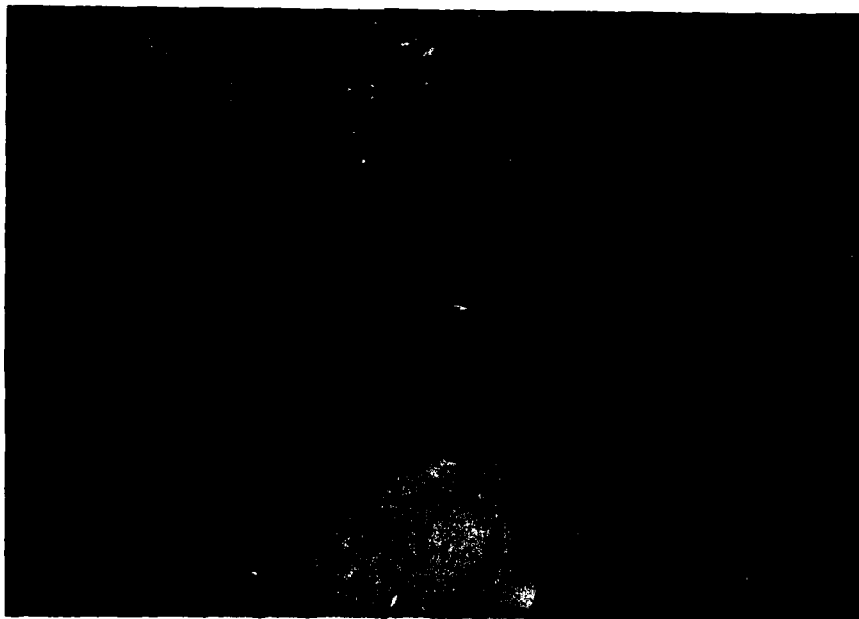
Photo 1
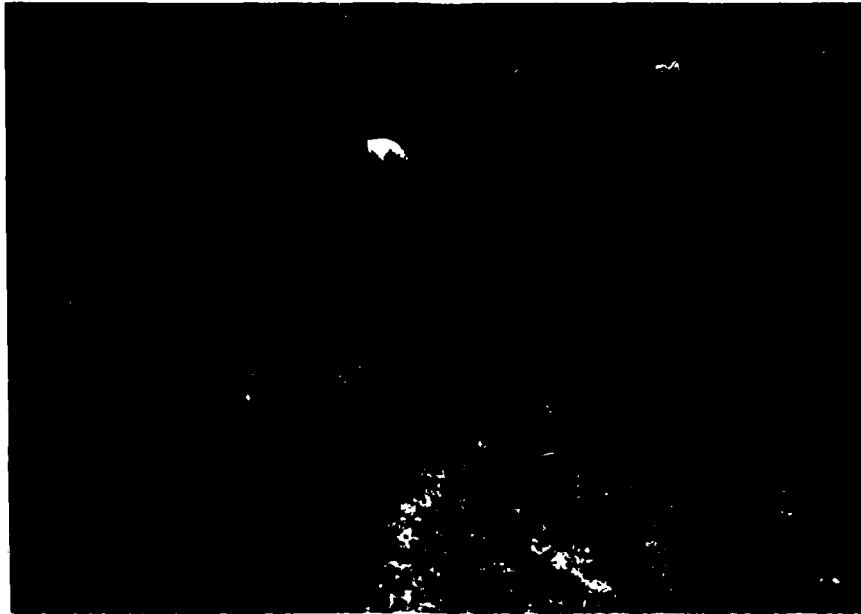
Photo 2

Photo 3

Photo 4

Photo 5

Photo 6
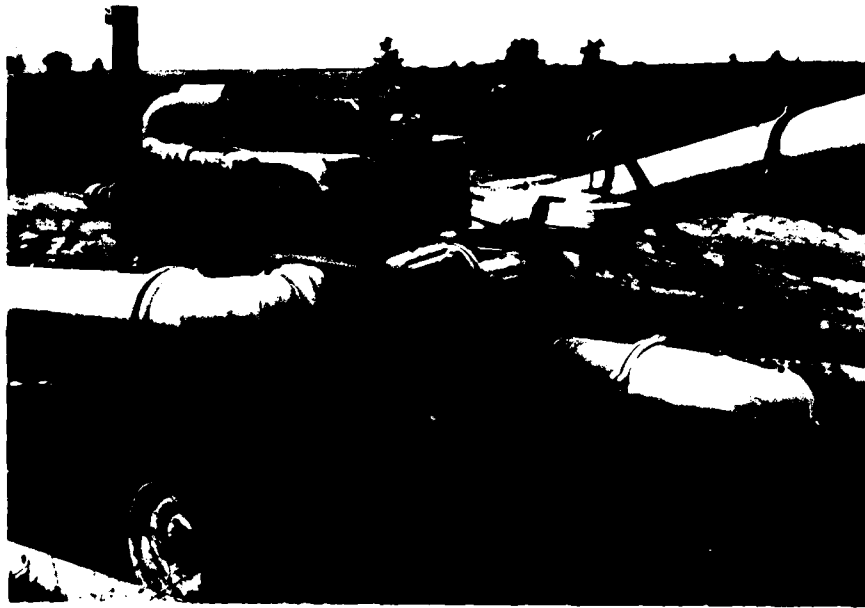
Photo 7

Photo 8

Photo 9

Photo 10

Photo 11

Photo 12

Photo 13

Photo 14

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

DAM SITE

D/S HAZARD ZONE

MISSOURI

QUADRANGLE LOCATION

KINGDOM CITY QUADRANGLE

DRAINAGE BOUNDARY ———————

SCALE 1 24000

1 MILE

1000   0   1000   2000   3000   4000   5000   6000   7000 FEET

1   5   0   1 KILOMETER

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL
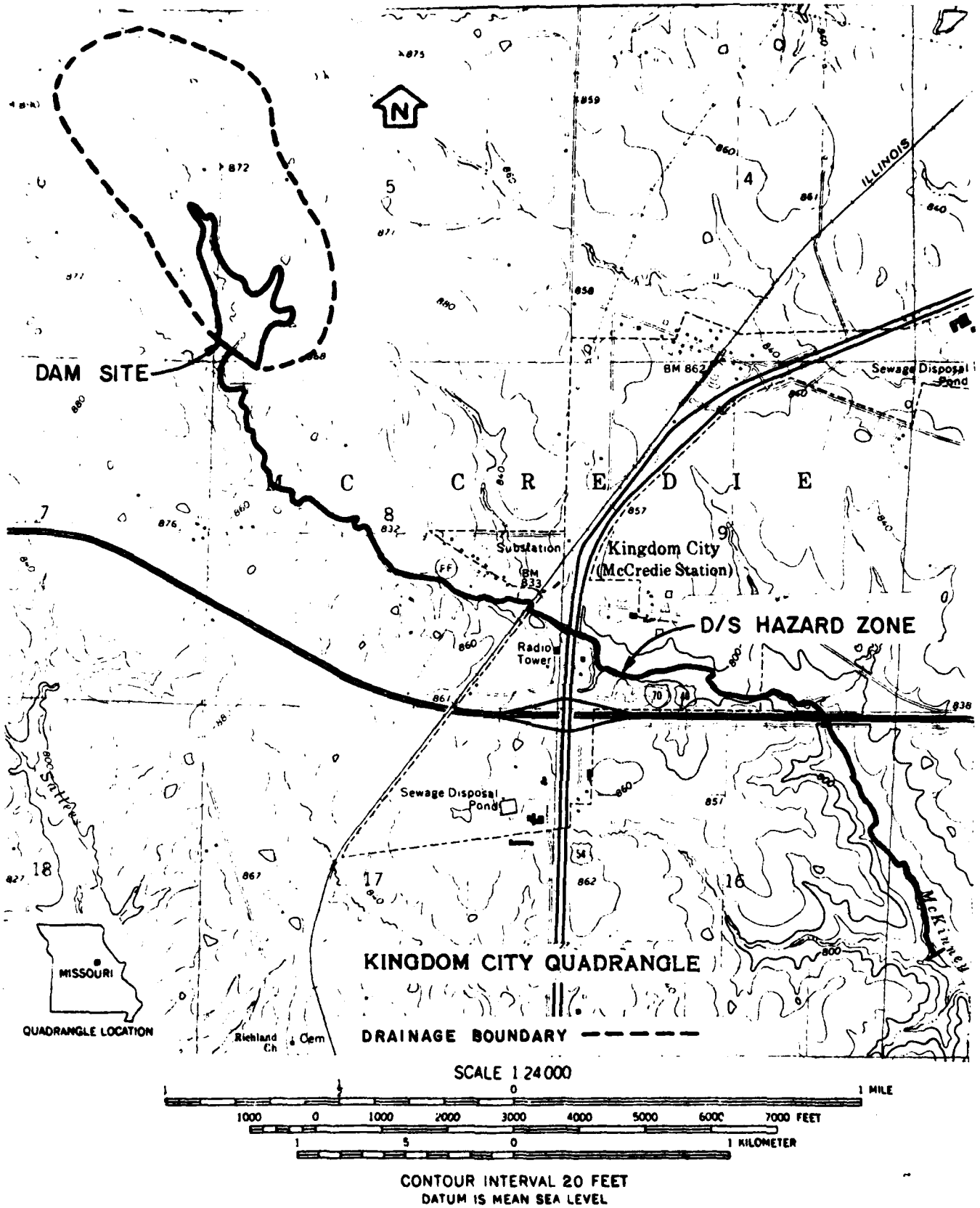
GUTHRIE LAKE DAM (MO. 10990)
DRAINAGE BASIN AND
DOWNSTREAM HAZARD ZONE

PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection - Missouri — SHEET NO. 1 OF 1

Dam Name: Guthrie Lake Dam / ID NO.: 10990 JOB NO. 1263

Reservoir Elevation-Area Data — BY [signature] DATE 6/30

ELEV. (M.S.L.) (Ft.)	RESERVOIR SURFACE AREA (Acres)	REMARKS
920	0	Estimated stream bed at dam
950	10.5	Interpolated
960	30.0	Principal Spillway
962.5	41.5	Emergency Spillway
965	50.0	Top of Dam (Assumed)
970	114.0	Interpolated
980	141.0	Measured from USGS Map
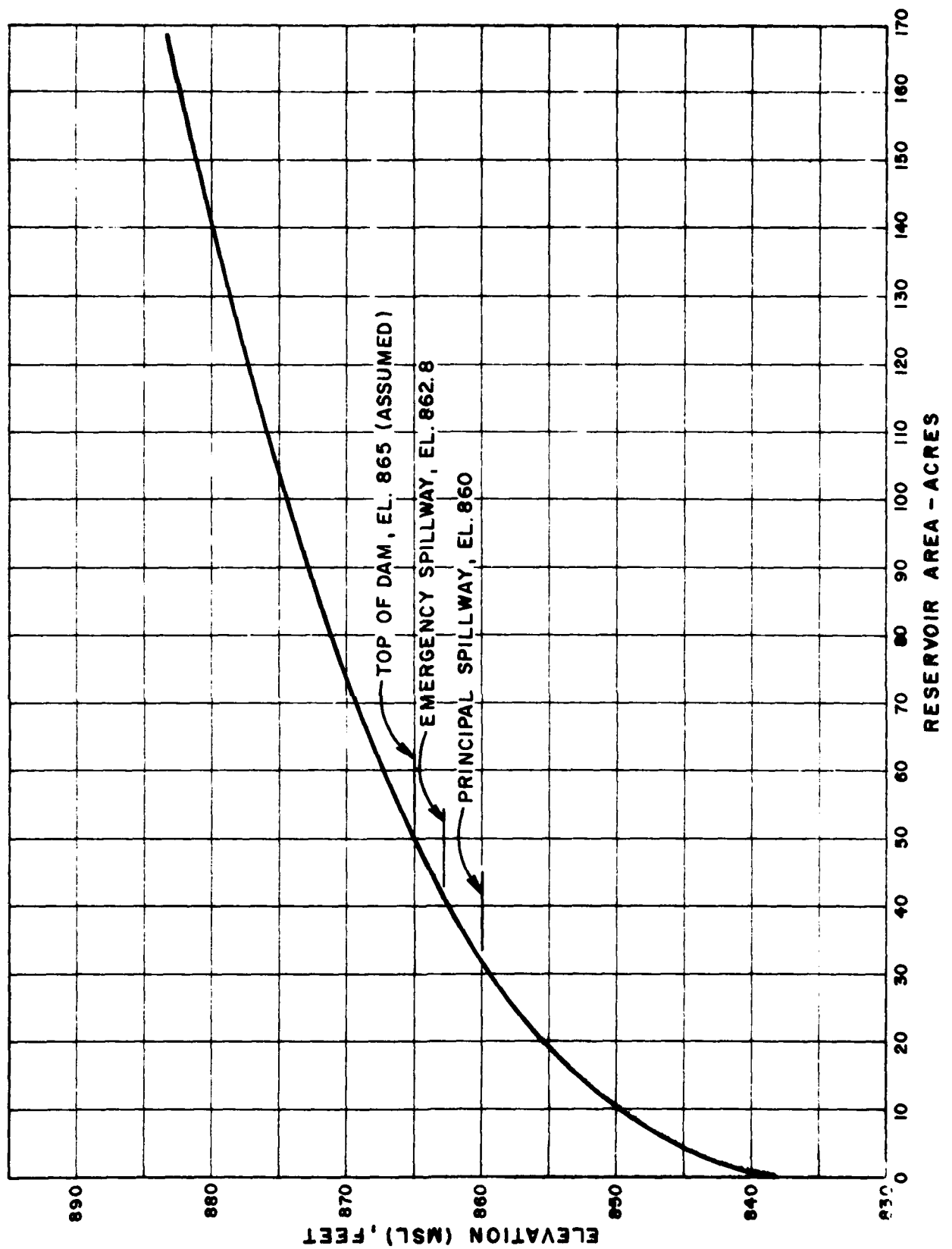
GUTHRIE LAKE DAM (MO.10990)
RESERVOIR ELEV.- AREA CURVE

PRC ENGINEERING CONSULTANTS, INC.

1) DRAINAGE AREA, $A = .476$ sq. mi = (305 acres)

2) LENGTH OF STREAM, $L = (1.4" \times 2000' = 2800') = .53$ mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

$$H_1 = 895$$

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST, $H_2 = 840$

5) ELEVATION OF CHANNEL BED AT $0.85L$, $E_{85} = 890$

6) ELEVATION OF CHANNEL BED AT $0.10L$, $E_{10} = 845$

7) AVERAGE SLOPE OF THE CHANNEL, $S_{AVG} = (E_{85} - E_{10})/0.75L = 0.012$

8) TIME OF CONCENTRATION:

    A) BY KIRPICH'S EQUATION,

$$t_c = [(11.9 \times L^3)/(H_1 - H_2)]^{0.385} = [11.9 \times (0.53)^3/(895-840)]^{0.385} = 0.32 \text{ hrs}$$

    B) BY VELOCITY ESTIMATE,

       SLOPE $= 1.2\% \Rightarrow$ AVG. VELOCITY $= 2$ fps.

$$t_c = L/V = 2800'/(2 \times 3600) = 0.39 \text{ hrs}$$

    USE $t_c = 0.32$ hrs.

9) LAG TIME, $t_\ell = 0.6\, t_c = 0.19$ hrs

10) UNIT DURATION, $D \leq t_\ell /3 = .06$ hrs < 0.083 hrs

    USE $D = .083$ hr.

11) TIME TO PEAK, $T_p = D/2 + t_\ell = 0.23$ hrs

12) PEAK DISCHARGE,

$$q_p = (484 \times A)/T_p = 484 \times 0.476/0.23 = 1000 \text{ cfs}$$

DAM SAFETY INSPECTION / MISSOURI - 1980 SHEET NO. ___ OF ___

DAM NAME: GUTHRIE LAKE DAM (10990)   JOB NO. 1263

CURVE NUMBER DETERMINATION   BY ___ DATE 6/30

I) SOIL GROUP

WATERSHED SOILS IN THE BASIN CONSIST OF:

PUTNAM , MEXICO
(GR D)   (GR D)

GROUP D SOILS SEEM TO PREDOMINATE THE BASIN. THEREFORE,

ASSUME GROUP D SOILS FOR THE ENTIRE WATERSHED

FOR HYDROLOGIC PURPOSES.

II) COVER COMPLEX

ASSUMED LAND USE	ASSUMED HYDROLOGIC CONDITION	PER CENT AREA	CN (AMC II)
WOODS	FAIR	5	79
PASTURE	FAIR	35	84
ROW CROPS (CONTOURED)	GOOD	60	86

III) CURVE NUMBER

WEIGHTED AVERAGE CN = 85 FOR AMC II

CURVE NUMBER = 94 FOR AMC III

DETERMINATION OF PMP

1) Determine drainage area of the basin

$$D.A. = .476 \text{ sq mi} (304.5 \text{ acres})$$

2) Determine PMP Index Rainfall (for D.A. = 200 sq. mi. & 24 hr. duration)

Location of centroid of basin,

Long. = 91° 57' 36"   Lat. = 38° 57' 59"

PMP = 24.8' (from Fig. 1, HMR 33)

Zone = 7

3) Determine basin rainfall in terms of percentage of PMP Index Rainfall for various durations.
(from Fig. 2, HMR 33)

Duration (Hrs.)	Percent of Index Rainfall (%)	Total Rainfall (Inches)	Rainfall Increments (Inches)	Duration of Increment (Hrs.)
6	100	24.8'	24.8	6
12	120	29.8	5.0	6
24	130	32.2	2.4	12

GUTHLIE LAKE DAM (10990)

Figure 1
PROBABLE MAXIMUM PRECIPITATION
For 200 Square Miles—24 Hours (in inches)
THE ALL SEASON ENVELOPE

⊕ Location of Bas...

20
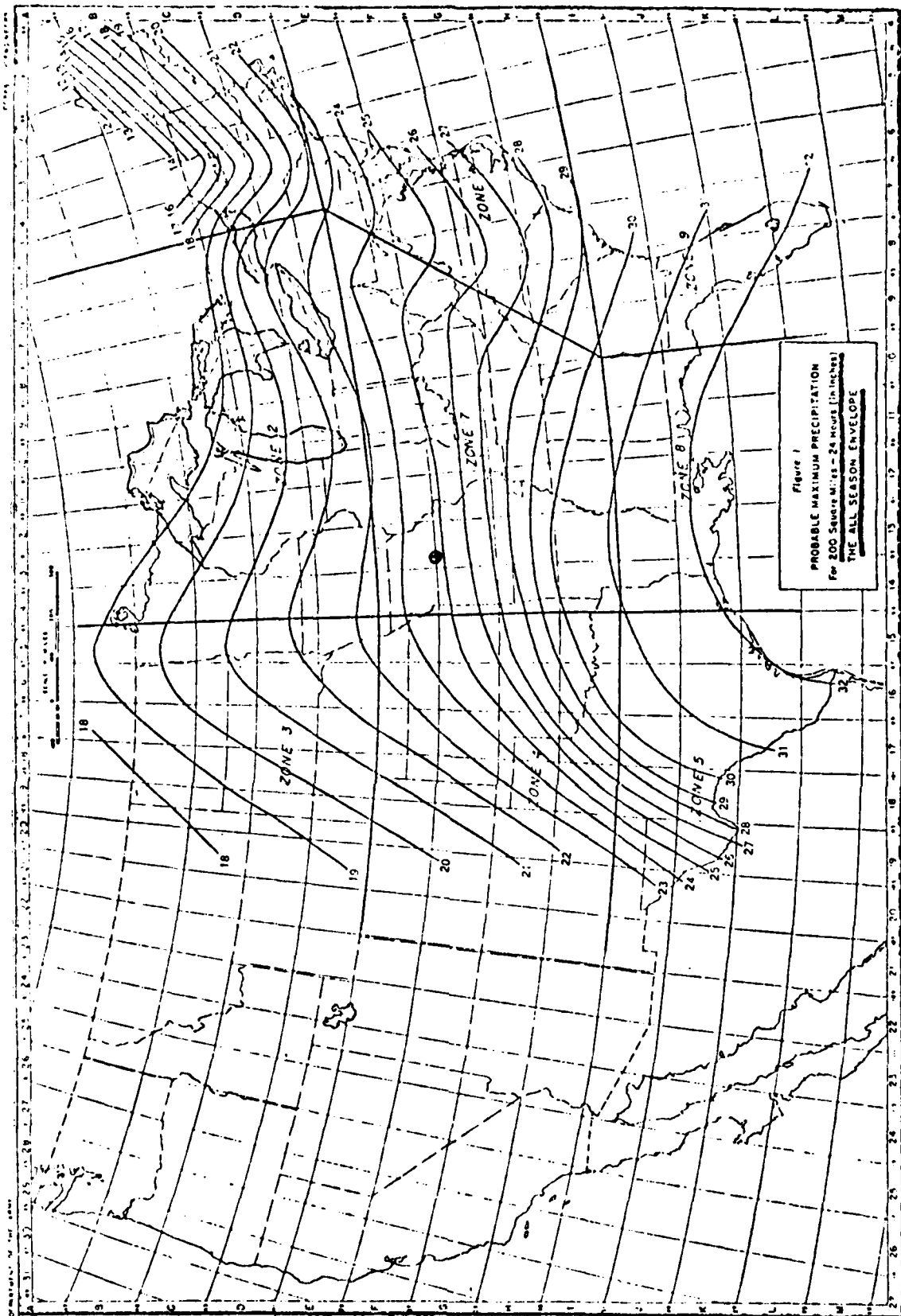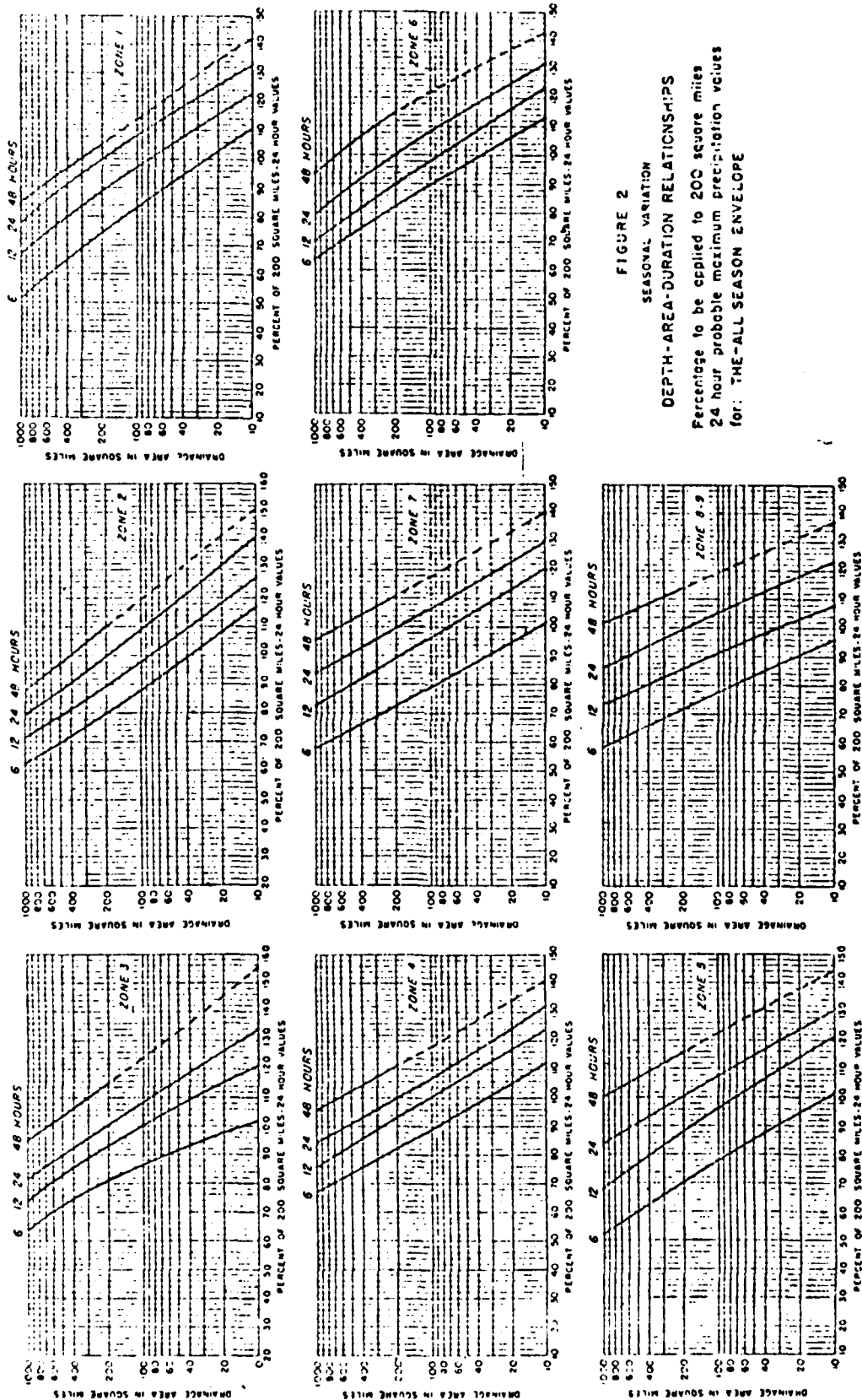
FIGURE 2

SEASONAL VARIATION

DEPTH-AREA-DURATION RELATIONSHIPS

Percentage to be applied to 200 square miles
24 hour probable maximum precipitation values
for: THE-ALL SEASON ENVELOPE

21

WEIR FLOW:

h/D	$Q/D^{5/2}$	Q	h	W.S. ELEV
0	0	0	0	860
0.2	0.16	0.12	0.18	860.18
0.4	0.46	0.33	0.35	860.35
0.6	0.88	0.63	0.53	860.53
0.8	1.56	1.12	0.70	860.70
1.0	2.20	1.58	0.88	860.88
1.1	2.50	1.79	0.96	860.96
1.2	2.80	2.00	1.05	861.05

BETWEEN WEIR FLOW AND PRESSURE FLOW:

$$\frac{h}{D} = 1.1 + 0.025 \left(Q/D^{5/2} - 2.5 \right) \quad , \text{ for } D = 0.875$$

$$Q = (h - 0.9078)\, 32.74 \checkmark$$

W.S. ELEV	h	Q
861.1	1.1	6.29
861.2	1.2	9.57
861.4	1.4	16.11
861.6	1.6	22.66
861.8	1.8	29.21
862.0	2.0	35.75
862.2	2.2	42.31

PRESSURE FLOW: Follows SCS TECHNICAL RELEASE No. 3
                           FOR HOODED INLETS

$$Q = A \sqrt{\frac{2gH}{\Sigma K}} \quad , \text{ where}$$

$K_{entrance} = 1.0$

$K_{exit} = 1.0$

$K_{friction} = 29.1 \dfrac{n^2 L}{R^{4/3}} = 29.1\,(0.012)^2\ 92\ /\ (0.875/4)^{4/3} = 2.78$

$$Q = 0.6 \sqrt{\frac{2gH}{4.78}} = 2.21 \sqrt{H}$$

PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI - 1980

GUTHRIE LAKE DAM (MO 10990)

PRINCIPAL SPILLWAY RATING CURVE DEVELOPMENT BY JFF DATE 7/3/80

$H = W.S. EL. - 839.44$

W.S. ELEV	H	Q
861.0	21.56	10.28
861.2	21.76	10.30
861.4	21.96	10.36
862.8	23.36	10.68
863.0	23.56	10.73
865.0	25.56	11.17
867.0	27.56	11.60

GUTHRIE LAKE DAM
PRINCIPAL SPILLWAY

GUTHRIE LAKE DAM (MO 10990)
PRINCIPAL SPILLWAY RATING CURVE

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI - 1980   SHEET NO. 1 OF 2
GUTHRIE LAKE DAM   (MO. 10990)   JOB NO. 1263
EMERGENCY SPILLWAY AND OVERTOP RATING CURVE   BY JFK / HLBL   DATE 1/7/80

HAND CALCULATIONS TO VERIFY HEC-2 CALCULATIONS

Diagram: cross-section with dimensions 38.5', 25', 20', EL = 862.8, 2.2', H₁, 70', CREST WIDTH VARIES FROM 12' TO 16', ①, ②

y	#	A	V = Q/A	Q = VA	#	Aᵢ	Pᵢ	$\frac{V^2}{2g}$	WS EL. $y + \frac{V^2}{2g}$	H_a	C₁	L	$Q = C_1 L H^{1.5}$		L	$Q = C_1 L H_1^{1.5}$
0	0	0	0	0	0	0	0	0	862.8				0		0	
0.16	2.58	4.48	2.23	10	17.27	9.93	1.01	0.02	863.2		2.99	770	378.3		10	
0.46	7.13	14.17	3.53	50	26.73	25.30	1.96	0.06	863.6		3.02	770	822.2		50	1322.2
0.70	11.48	23.80	4.10	100	31.02	39.32	2.54	0.10	863.9	0.3	3.03	770	1992.0		100	2792
1.04	17.56	39.46	4.98	200	34.53	62.98	3.18	0.16	864.4	0.5	3.04	770	3077.1			4077.1
1.30	23.46	54.73	5.48	300	36.78	83.50	3.59	0.20	864.7	0.9	3.04	770	4300.3			5500.3
1.51	28.26	68.33	5.85	400	118.52	101.41	3.94	0.24	865.0	1.2	3.04	770	5652.9			7052.9
1.71	32.35	81.31	6.15	500	118.52	89.24	4.22	0.28	865.3		3.05	770				8746.9
1.88	36.03	94.10	6.38	600	133.47	83.48	4.50	0.31	865.5	2.99	770					10560.5
2.17	42.78	117.11	6.83	800	159.03	83.48	5.03	0.39	865.9	3.03	770					
2.40	53.50	136.27	7.34	1000	180.73	83.48	5.53	0.48	866.2	3.04	770					
2.61	53.50	153.94	7.80	1200	200.70	83.48	5.98	0.56	866.5	3.04	770					
2.82	63.50	170.71	8.20	1400	220.72	83.48	6.34	0.62	866.8	3.04	770					
3.01	83.50	186.48	8.57	1600	238.27	83.48	6.70	0.70	867.1	3.05	770					
3.19	83.50	202.23	8.90	1800	258.03	83.48	7.03	0.77	867.4	3.06	770					

CREST WIDTH VARIES FROM 12' TO 16'

EMERGENCY SPILLWAY

SECTION 1:
at the critical depth section;

$0 < y < 2.2$, $T = 26.59y + 25$
$A = y(T - 13.3y)$

$2.2 \leq y$, $T = 83.5$
$A = 83.5y - 64.35$

SECTION 2:
at the upstream section, at the dam,
y, was determined from a backwater
analysis using HEC-2

$H_1 = W.S. EL. - 685$
$Q = C_1 L H_1^{1.5}$

CHECK EMERGENCY SPILLWAY SLOPE FOR CRITICAL DEPTH,

$$S_b = 1.9' / 50' = 0.038$$

for $y = 0.46'$,

$A = 14.17 \ ft^2$

$P = 37.13$

$n = 0.027$

$Q = 50$

$$S_c = \left[\frac{nQ}{1.49} \ \frac{1}{R^{2/3}} \ \frac{1}{A} \right]^2$$

$$S_c = \left[\frac{0.027 \ (50)}{1.49} \ \frac{1}{(0.382)^{2/3}} \ \frac{1}{14.17} \right]^2 = 0.0148 < S_b \quad O.K.$$

for $y = 3.01'$,

$A = 186.87 \ ft^2$

$P = 83.68 \ ft$

$n = 0.027$

$Q = 1600$

$$S_c = \left[\frac{nQ}{1.49} \ \frac{1}{R^{2/3}} \ \frac{1}{A} \right]^2$$

$$S_c = \left[\frac{0.027 \ (1600)}{1.49} \ \frac{1}{(2.233)^{2/3}} \ \frac{1}{186.87} \right]^2 = 0.008 < S_b \quad O.K.$$

∴ the assumption of critical depth at the emergency spillway is valid.

PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI - 1980   SHEET NO. __1__ OF __1__

GUTHRIE LAKE DAM (MO. 10990)   JOB NO. 1263

COMBINED RATING CURVE   BY JFK   DATE 7/9/80

W.S. ELEV.	Q PRINCIPAL SPILLWAY	Q EMRGNCY SPLWY AND OVERTOP	Q TOTAL
860	0		0
860.5	0.6*		0.6
861	2.0*		2.0
861.5	10.4		10.4
862	10.5		10.5
862.8	10.7	0	10.7
863.2	10.8	10	20.8
863.6	10.9	50	61
863.9	10.9	100	111
864.4	11.0	200	211
864.7	11.1	300	311
865	11.2	400	411
865.3	11.2	878.3	890
865.5	11.3	1322.2	1334
865.9	11.4	2792	2803
866.2	11.4	4077.1	4089
866.5	11.5	5500.3	5512
866.8	11.6	7052.9	7065
867.1	11.6	8746.9	8759
867.4	11.7	10560.5	10572

NOTE:
* weir flow; for elevation = 861.5 and above, pressure flow controls, where $H = W.S. ELEV - 839.44$
$$Q = 2.21 \sqrt{H}$$
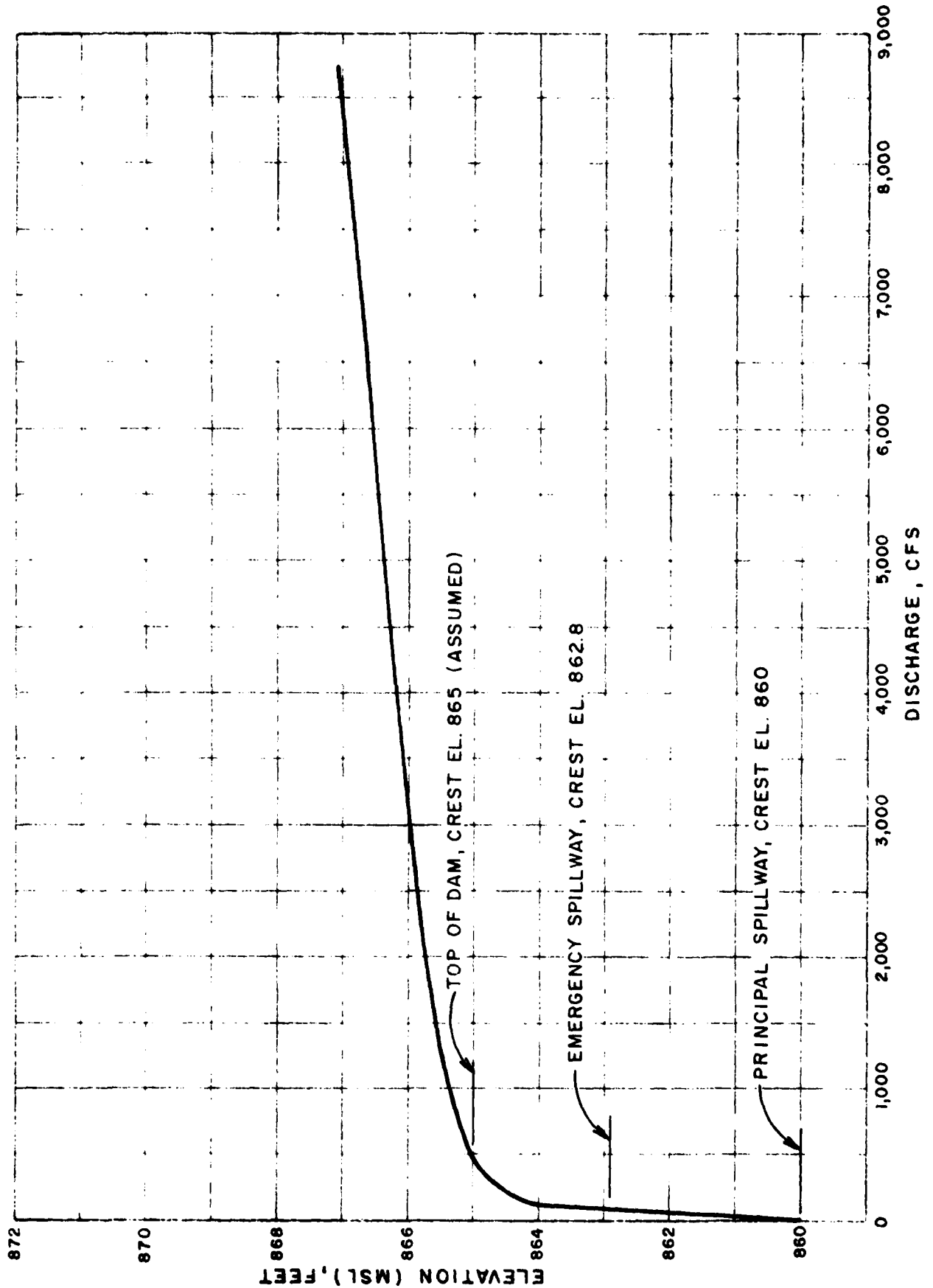
GUTHRIE LAKE DAM (MO. 10990)
SPILLWAY AND OVERTOP RATING CURVE

DAM SAFETY INSPECTION / MISSOURI - 1980   SHEET NO. _1_ OF _2_

GUTHRIE LAKE DAM (MO 10990)   JOB NO. 1263

STARTING ELEVATION FOR PMF ROUTING   BY JBK   DATE 7/16/80
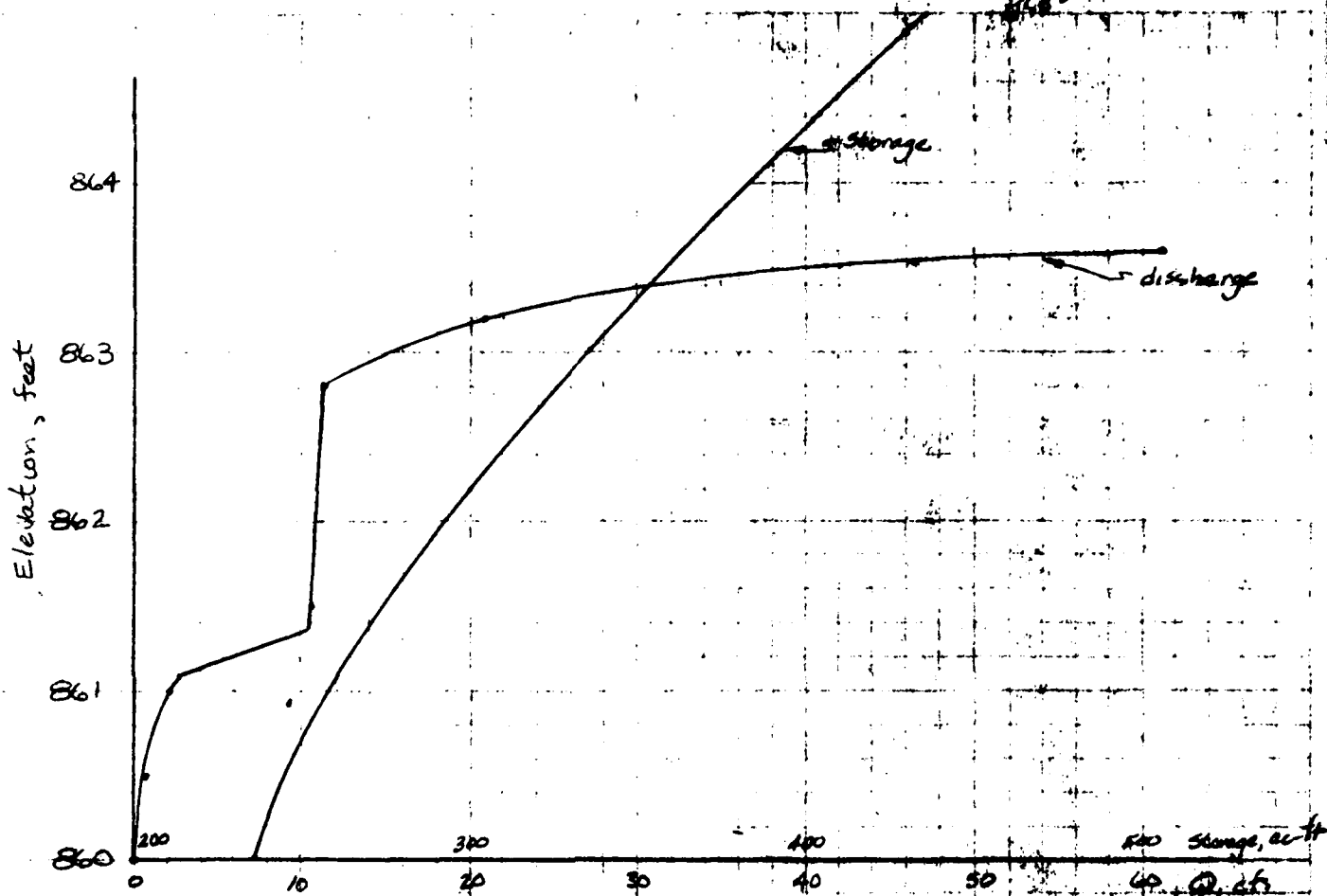
W.S. ELEV$_c$	W.S. ELEV$_f$	Δ STORAGE	Q$_{AVERAGE}$	Δ TIME (HRS)	Σ TIME
863.7*	863.2	22	50	5.33	6.33
863.2	862.8	19	20	11.50	16.83
862.8	861.6	48	10.5	55.31	72.14

* W.S. ELEV. at end of 24 hrs after the ½ PMF storm began

∴ at the end of the four day period the W.S. level is at 861.6

W.S. ELEV$_i$	W.S. ELEV$_f$	Δ STORAGE	Q AVERAGE	Δ TIME (HRS)	Σ TIME
863.5 *	863.2	12	36	4.03	4.03
863.2	862.8	19	20	11.50	15.53
862.8	861.6	49	10.5	56.47	72.0 (3 days)

* W.S. ELEV. at the end of 24 hrs. after the 1/4 PMF storm began.

∴ at the end of the four day period the W.S. level is at 861.6

HEC1DB INPUT DATA

```
 1   A1
 2   A2
 3   A3                    DAM SAFETY INSPECTION - MISSOURI
                           GUTHRIE LAKE DAM (MO.10990)
                           PMF AND 50 PERCENT PMF
 4   T      300     0      5      0      0      0      0      0      0
 5   J1      5
 6   J       1      2      1
 7   J1      1      5
 8   K       0   10990
 9   Y1   INPUT RUNOFF PARAMETERS
10   ?       1      2    .476   .476    0      1      1
11          24.8   100    120    130
12   T
13   ?2     .23
14   X
15   Y       1   10990
16   Y1   ROUTE HYDROGRAPH THROUGH GUTHRIE LAKE
17   Y       1      1      1      1
18   Y1      1          -861.6   -1          -1
19   Y4    860   860.5  861.5   862   862.8  863.2  863.6  863.9  864.4
20   Y4  864.7    865   865.3  865.9  866.2  866.5  866.8  867.1  367.4
21   Y5      0     .6      2    10.4   10.5   10.7   20.8    61    111    211
22   Y5    311    411    890   1334   2833   4089   5512   7065   8759  10572
23   ?4      0    13.5   41.5    50     74    141
24   Y5    838    850   842.8   865    870    980
25   Y8    860
26   Y0    865
27   Y      79
```

INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS

REVIEW OF SEQUENCE OF STREAM NETWORK CALCULATION.

RUNOFF HYDROGRAPH AT   16090
ROUTE HYDROGRAPH TO   16090
END OF NETWORK

DAM SAFETY INSPECTION - RESIDUAL
GUTHRIE LAKE DAM (PROJECT) 0
PMF AND 1/2 PERCENT PMF

JOB SPECIFICATION

IO	NHR	NPIN	IDAY	IHR	IMIN	MITRC	IPLT	IPNT	NSTRD
									0
		JPLT	NMT	LPRT	TAPE				
					0				

MULTI-PLAN ANALYSIS TO BE PERFORMED
NPLAN = 1 RATIO = 1 LOTIC = 1

RTIOS= 1.00   .50

SCR-295 A RUNOFF COMPUTATION

INPUT RUNOFF PARAMETERS

ISTAQ	ICOMP	ICOMP	ITAPE	JPLT	IAPVL	IST	IPRT	IAUTO
16950	0	0	0					0

HYDROGRAPH DATA

IHYDG	IUPG	TAREA	SNAP	TRSDA	TRCPL	RATIO	SNAP	ITAHR	LOCAL
1		.40	0.00	.45	1.00	0.00	1		0

PRECIP DATA

SPFE	PMC	R6	R12	R24	R72	R96
0.00	24.00	190.00	120.00	150.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	DLTKR	RTIOK
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-94.00	0.00	0.00

CURVL NO = -94.00 RETMLSS = -1.00 EFFECT CN = 94.00

UNIT HYDROGRAPH DATA

TC = 0.00   LAG = .23

RECESSION DATA

STRTQ= 0.00   QRCSN= 0.00   RTIOR= 1.00

UNIT HYDROGRAPH 16 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .23 VOL= 1.00

| 168. | 476. | 839. | 771. | 541. | 309. | 171. | 116. | 70. | 42. |
| 26. | 16. | 10. | 6. | 3. | 1. | | | | |

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.
1.01	.10	2	.01	0.00	.01	0.
1.01	.15	3	.01	0.00	.01	0.
1.01	.20	4	.01	0.00	.01	0.
1.01	.25	5	.01	0.00	.01	0.
1.01	.30	6	.01	0.00	.01	0.
1.01	.35	7	.01	0.00	.01	0.
1.01	.40	8	.01	0.00	.01	0.
1.01	.45	9	.01	0.00	.01	0.
1.01	.50	10	.01	.00	.01	0.
1.01	.55	11	.01	.00	.01	1.
1.01	1.00	12	.01	.00	.01	2.
1.01	1.05	13	.01	.00	.01	5.
1.01	1.10	14	.01	.00	.01	6.
1.01	1.15	15	.01	.00	.01	9.
1.01	1.20	16	.01	.00	.01	11.
1.01	1.25	17	.01	.00	.01	12.
1.01	1.30	18	.01	.00	.01	14.
1.01	1.35	19	.01	.00	.01	15.
1.01	1.40	20	.01	.00	.01	16.
1.01	1.45	21	.01	.00	.01	17.
1.01	1.50	22	.01	.00	.01	19.
1.01	1.55	23	.01	.01	.01	21.
1.01	2.00	24	.01	.01	.01	22.
1.01	2.05	25	.01	.01	.01	24.
1.01	2.10	26	.01	.01	.01	25.
1.01	2.15	27	.01	.01	.01	26.
1.01	2.20	28	.01	.01	.01	27.
1.01	2.25	29	.01	.01	.01	27.
1.01	2.30	30	.01	.01	.01	29.
1.01	2.35	31	.01	.01	.01	30.
1.01	2.40	32	.01	.01	.01	31.
1.01	2.45	33	.01	.01	.01	32.
1.01	2.50	34	.01	.01	.01	33.
1.01	2.55	35	.01	.01	.01	34.
1.01	3.00	36	.01	.01	.01	35.
1.01	3.05	37	.01	.01	.01	35.
1.01	3.10	38	.01	.01	.01	36.
1.01	3.15	39	.01	.01	.01	36.
1.01	3.20	40	.01	.01	.00	37.
1.01	3.25	41	.01	.01	.00	37.
1.01	3.30	42	.01	.01	.00	37.
1.01	3.35	43	.01	.01	.00	37.
1.01	3.40	44	.01	.01	.00	37.
1.01	3.45	45	.01	.01	.00	36.
1.01	3.50	46	.01	.01	.00	35.
1.01	3.55	47	.01	.01	.00	35.
1.01	4.00	48	.01	.01	.00	34.
1.01	4.05	49	.01	.01	.00	72.
1.01	4.10	50	.01	.01	.00	36.
1.01	4.15	51	.01	.01	.00	36.
1.01	4.20	52	.01	.01	.00	37.
1.01	4.25	53	.01	.01	.00	37.
1.01	4.30	54	.01	.01	.00	37.
1.01	4.35	55	.01	.01	.00	37.
1.01	4.40	56	.01	.01	.00	37.

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	12.45	151	.21	.21	.00	716.
1.01	12.50	152	.21	.21	.00	732.
1.01	12.55	153	.21	.21	.00	742.
1.01	13.00	154	.21	.21	.00	748.
1.01	13.05	155	.21	.21	.00	752.
1.01	13.10	156	.21	.21	.00	754.
1.01	13.15	157	.25	.25	.00	762.
1.01	13.20	158	.25	.25	.00	787.
1.01	13.25	159	.25	.25	.00	822.
1.01	13.30	160	.25	.25	.00	854.
1.01	13.35	161	.25	.25	.00	877.
1.01	13.40	162	.25	.25	.00	890.
1.01	13.45	163	.25	.25	.00	898.
1.01	13.50	164	.25	.25	.00	903.
1.01	13.55	165	.25	.25	.00	906.
1.01	14.00	166	.25	.25	.00	902.
1.01	14.05	167	.25	.25	.00	909.
1.01	14.10	168	.31	.31	.00	910.
1.01	14.15	169	.31	.31	.00	921.
1.01	14.20	170	.31	.31	.00	957.
1.01	14.25	171	.31	.31	.00	1007.
1.01	14.30	172	.31	.31	.00	1047.
1.01	14.35	173	.31	.31	.00	1098.
1.01	14.40	174	.31	.31	.00	1122.
1.01	14.45	175	.31	.31	.00	1121.
1.01	14.50	176	.31	.31	.00	1125.
1.01	14.55	177	.31	.31	.00	1153.
1.01	15.00	178	.31	.31	.00	1136.
1.01	15.05	179	.31	.31	.00	1135.
1.01	15.10	180	.31	.31	.00	1139.
1.01	15.15	181	.19	.19	.00	1061.
1.01	15.20	182	.38	.38	.00	1068.
1.01	15.25	183	.38	.38	.00	1184.
1.01	15.30	184	.57	.57	.00	15FF.
1.01	15.35	185	.66	.66	.00	1422.
1.01	15.40	186	1.60	1.60	.00	2797.
1.01	15.45	187	2.64	2.64	.73	4113.
1.01	15.50	188	1.04	1.04	.00	4245.
1.01	15.55	189	.66	.66	.00	9445.
1.01	16.00	190	.57	.57	.00	3918.
1.01	16.05	191	.38	.38	.00	3094.
1.01	16.10	192	.38	.38	.00	2470.
1.01	16.15	193	.29	.29	.00	1999.
1.01	16.20	194	.29	.29	.00	1657.
1.01	16.25	195	.29	.29	.00	1430.
1.01	16.30	196	.29	.29	.00	1285.
1.01	16.35	197	.29	.29	.00	1199.
1.01	16.40	198	.29	.29	.03	1147.
1.01	16.45	199	.29	.29	.00	1115.
1.01	16.50	200	.29	.29	.00	1093.
1.01	16.55	201	.29	.29	.00	1076.
1.01	17.00	204	.23	.23	.00	1071.
1.01	17.05	205	.23	.23	.00	1068.
1.01	17.10	206	.23	.23	.00	1056.
1.01						1086.

Left table:

				idx	time	
37.	.00	.01	.01	57	4:45	1.01
38.	.00	.01	.01	58	4:50	1.01
38.	.00	.01	.01	59	4:55	1.01
38.	.00	.01	.01	60	5:00	1.01
39.	.00	.01	.01	61	5:05	1.01
39.	.00	.01	.01	62	5:10	1.01
39.	.00	.01	.01	63	5:15	1.01
	.00	.01	.01	64	5:20	1.01
39.	.00	.01	.01	65	5:25	1.01
40.	.00	.01	.01	66	5:30	1.01
40.	.00	.01	.01	67	5:35	1.01
41.	.00	.01	.01	68	5:40	1.01
41.	.00	.01	.01	70	5:45	1.01
41.	.00	.01	.01	71	5:50	1.01
49.	.00	.06	.06	72	5:55	1.01
75.	.00	.06	.06	73	6:00	1.01
151.	.00	.06	.06	74	6:05	1.01
174.	.00	.06	.06	76	6:10	1.01
	.00	.06	.06	77	6:15	1.01
214.	.01	.06	.06		6:20	1.01
210.	.01	.06	.06	80	6:25	1.01
235.	.00	.06	.06	81	6:30	1.01
224.	.00	.06	.06	82	6:35	1.01
	.00	.07	.07	83	6:40	1.01
232.	.00	.07	.07	85	6:45	1.01
234.	.00	.07	.07	86	6:50	1.01
235.	.00	.07	.07	87	6:55	1.01
236.	.00	.07	.07		7:00	1.01
237.	.00	.07	.07	89	7:05	1.01
239.	.00	.07	.07	90	7:10	1.01
239.	.00	.07	.07	91	7:15	1.01
240.	.00	.07	.07	92	7:20	1.01
240.	.00	.07	.07	93	7:25	1.01
241.	.00	.07	.07	95	7:30	1.01
242.	.00	.07	.07		7:35	1.01
243.	.00	.07	.07	98	7:40	1.01
243.	.00	.07	.07	99	7:45	1.01
244.	.00	.07	.07	100	7:50	1.01
245.	.00	.07	.07	101	7:55	1.01
245.	.00	.07	.07	102	8:00	1.01
245.	.00	.07	.07	103	8:10	1.01
246.	.00	.07	.07	104	8:15	1.01
246.	.00	.07	.07	105	8:20	1.01
247.	.00	.07	.07	106	8:25	1.01
247.	.00	.07	.07	107	8:30	1.01
247.	.00	.07	.07	108	8:40	1.01
248.	.00	.07	.07	110	8:45	1.01
248.	.00	.07	.07	111	9:00	1.01
249.	.00	.07	.07	112	9:05	1.01
249.	.00	.07	.07	113	9:15	1.01
248.	.00	.07	.07	114	9:20	1.01
248.	.00	.07	.07	115	9:30	1.01
248.	.00	.07	.07	116	9:40	1.01

Right table:

				idx	time	
957.	.00	.23	.23	207	17:15	1.01
920.	.00	.23	.23	208	17:20	1.01
886.	.00	.23	.23	209	17:25	1.01
857.	.00	.23	.23	210	17:30	1.01
845.	.00	.23	.23	211	17:35	1.01
848.	.00	.23	.23	212	17:40	1.01
844.	.00	.23	.23	213	17:45	1.01
841.	.00	.23	.23	214	17:50	1.01
839.	.00	.23	.23	215	17:55	1.02
831.	.00	.02	.02	216	18:00	1.01
703.	.00	.02	.02	217	18:05	1.01
684.	.00	.02	.02	218	18:10	1.01
710.	.00	.02	.02	219	18:15	1.01
351.	.00	.02	.02	220	18:20	1.01
233.	.00	.02	.02	221	18:25	1.01
175.	.00	.02	.02	222	18:30	1.01
136.	.00	.02	.02	223	18:35	1.01
112.	.00	.02	.02	224	18:40	1.01
99.	.00	.02	.02	225	18:45	1.01
83.	.00	.02	.02	226	18:50	1.01
80.	.00	.02	.02	227	18:55	1.01
78.	.00	.02	.02	228	19:00	1.01
77.	.00	.02	.02	229	19:05	1.01
76.	.00	.02	.02	230	19:10	1.01
76.	.00	.02	.02	231	19:15	1.01
76.	.00	.02	.02	232	19:20	1.01
76.	.00	.02	.02	233	19:25	1.01
76.	.00	.02	.02	234	19:30	1.01
76.	.00	.02	.02	235	19:35	1.01
75.	.00	.02	.02	236	19:40	1.01
75.	.00	.02	.02	237	19:45	1.01
76.	.00	.02	.02	238	19:50	1.01
76.	.00	.02	.02	239	19:55	1.01
76.	.00	.02	.02	240	20:00	1.01
76.	.00	.02	.02	241	20:05	1.01
25.	.00	.02	.02	242	20:10	1.01
74.	.00	.02	.02	243	20:15	1.01
76.	.00	.02	.02	244	20:20	1.01
76.	.00	.02	.02	245	20:25	1.01
76.	.00	.02	.02	246	20:30	1.01
76.	.00	.02	.02	247	20:35	1.01
76.	.00	.02	.02	248	20:40	1.01
76.	.00	.02	.02	249	20:45	1.01
76.	.00	.02	.02	250	20:50	1.01
76.	.00	.02	.02	251	20:55	1.01
76.	.00	.02	.02	252	21:00	1.01
74.	.00	.02	.02	253	21:05	1.01
76.	.00	.02	.02	254	21:10	1.01
76.	.00	.02	.02	255	21:15	1.01
76.	.00	.02	.02	256	21:20	1.01
76.	.00	.02	.02	257	21:25	1.01
76.	.00	.02	.02	258	21:30	1.01
76.	.00	.02	.02	259	21:35	1.01
76.	.00	.02	.02	260	21:40	1.01
76.	.00	.02	.02	261	21:45	1.01
76.	.00	.02	.02	262	21:50	1.01
76.	.00	.02	.02	263	21:55	1.01
76.	.00	.02	.02	264	22:00	1.01
76.	.00	.02	.02	265	22:06	1.01
76.	.00	.02	.02	266	22:16	1.01

PEAK ... PEAK

CFS
CMS
INCHES
AC-FT
THOUS CU M

HYDROGRAPH AT STA ..... FOR PLAN 1, ...

PMF AND ONE-HALF PMF ROUTING

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2432.	427.	201.	193.	58802.
CMS		12.	6.	5.	1642.
INCHES		1.24	15.74	15.74	15.74
HM	312.06	354.87	297.86	399.66
AC-FT	311.	399.	399.	389.
THOUS CU M	383.	493.	493.	493.

HYDROGRAPH ROUTING

OUTFLOW HYDROGRAPH THROUGH GUTERIE LAKE

	ISTAQ	ICOMP	ITAPE	ITAPE	IPLT	JPLT	INAME	ISTAQ	ISTAQ	IAUTO
	10990	1	6	1			1	1	0	0

ROUTING DATA

	GLOSS	CLOSS	AVG	TSAPE	LDFS					LST4
	0.0	0.0	0.00	1	0					

	NSTPS	NSTDL	AMSKK	X	N	CAREA	ISPRAT
	1	0	0.0	0.0	-1	0.0	-1

STAGE						CAREA	EXPL
360.00	362.00	361.00	863.00	865.00	867.00	0.0	0.0
0.73	865.00	865.30	866.00	866.50	866.50		

| FLOW | 0.0 | 2.00 | 10.50 | 10.50 | 10.70 | 20.00 | 61.00 | 211.00 |
| 411.00 | 411.00 | 900.00 | 1334.00 | 2635.00 | 4099.00 | 5512.00 | 7065.00 | 8754.00 | 10522.00 |

SURFACE AREA=	0.	0.	11.	20.	50.	74.	141.
CAPACITY=	0.	42.	234.	436.	744.	1402.
ELEVATION=	856.	856.	860.	865.	872.	875.

| | CREL | SPWID | COEH | EXPH | ELEVL | COSL | CAREA | EXPL |
| | 860.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| | TOPEL | CODO | EXPD | DAMWID |
| | 865.0 | 0.0 | 0.0 | 0. |

STATION 10990, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

END
DATE
FILMED

11–81

DTIC

PEAK FLOW IS   CFS. AT TIME   HRS.

	PEAK	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1177.	504.	504.	10314.
CMS		10.	10.	2921.
INCHES	23.01	27.97	48.09	24.00
MM	584.0	710.44	711.25	711.25
AC-FT	504.	71.	71.	711.
THOUS CU M	725.	875.	875.	876.

STATION 10500 PLAN 1 RATIO 2

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

PEAK OUTFLOW IS 1691. AT TIME 16.00 HOURS

SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING

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)

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN	RATIO 1 1.00	RATIO 2 .50
HYDROGRAPH AT	10993	.48	1	4.44	2422
	(	1.23)	(	137.17) (	68.55) (
ROUTED TO	10990	.48	1	4034	1691
	(	1.23)	(	118.24) (	47.89) (

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	ELEVATION STORAGE OUTFLOW	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
		861.60	860.80	865.00
		299.	236.	436.
		10.	84.	411.

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	866.17	1.19	499.	4034.	5.25	15.92	0.00
.50	865.60	.60	467.	1691.	2.58	16.00	0.00

PERCENT OF PMF FLOOD ROUTING
EQUAL TO SPILLWAY CAPACITY

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT   10990
ROUTE HYDROGRAPH TO   10590
END OF NETWORK

RUN DATE 20/27/18.
TIME 14.05.42.

DAM SAFETY INSPECTION - MISSOURI
GUTHRIE LAKE DAM (MO.15-003)
PERCENT PMF

JOB SPECIFICATION

NMG	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	JPRT	NSTAN
300	0	5	0	0	0	0	0	-4	0
			JOFER	JNT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 7 RTIOL= 1

PRTIOS   .30   .33   .37   .40   .7   .8   .0

SUB-AREA RUNOFF COMPUTATION

INPUT RUNOFF PARAMETERS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	IN??	ISTAGE	IAUTO
10990	0	0	0	0	0	1	1	0

HYDROGRAPH DATA

INHYCG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISAOA	ISAPE	LOCAL
1	2	.48	0.00	.48	1.00	0.000	0	0	0

PPECIP DATA

SPFE	PMS	R5	R12	R24	R4H	R72	R96
0.00	26.00	100.00	120.00	130.00	0.00	0.23	0.00

LOSS DATA

LROPT	STRKH	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	RLSKR	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-10.00	-99.00	0.00	0.00

CURVE NO = 99.00   WETNESS = -1.00   EFFECT CN = 49.00

UNIT HYDROGRAPH DATA
TC= 0.00   LAG= .23

RECESSION DATA
STRTO= 2.00   QRCSN= 0.00   RTIOR= 1.00

END-OF-PERIOD FLOW
COMP 0   MOADA HR.MN. PERIOD   RAIN   EXCS   LOSS   COMP Q

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
0		1				

****

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH GUTHRIE LAKE

SUM 32424 31649   175 119996
(319.31 800.31 19.31 3299.001)

	ISTAQ	ICOMP	IEON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	10990	1	0	0	0	0	1	0	0

	CLOSS	AVG	ROUTING DATA					LSTR
	0.000	0.00	IRES	ISAML	IOPT	IOPT	IPMP	0
			1	1	0	0	0	

	NBTPS	NSTDL	LAG	AMSKK	X	ISK	STOA	ISPKRT
	1	0	0.000	0.000	0.000	0.000	-862.	-1

STAGE
850.00   860.50   861.00   861.50   862.00   862.65   863.20   863.60   864.90
864.70   865.00   865.50   865.50   10.40   13.50   13.70   20.90   866.00   867.00

FLOW
0.00   .60   0.00   10.40   2403.00   4089.00   5512.00   51.00   211.00
311.00   411.00   990.00   1336.00   4689.00   7065.00   8759.00   10572.00

SURFACE AREA=   0.   11.   30.   92.   50.   74.   141.
CAPACITY=   0.   42.   236.   356.   936.   744.   1802.
ELEVATION=   838.   850.   860.   861.   865.   870.   880.

CREL   SPWD   COQW   EXPW   ELFVL   COQL   CAREA   EXPL
860.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0

DAM DATA
TOPEL   COQD   EXPD   DAMWID
865.0   0.0   0.0   04

PEAK OUTFLOW IS   3770. AT TIME 16.42 HOURS

PEAK OUTFLOW IS   4556. AT TIME 16.08 HOURS

PEAK OUTFLOW IS   5266. AT TIME 16.25 HOURS

PEAK OUTFLOW IS   661. AT TIME 16.17 HOURS

PEAK OUTFLOW IS   708. AT TIME 16.17 HOURS

PEAK OUTFLOW IS   808. AT TIME 16.17 HOURS

PEAK OUTFLOW IS   905. AT TIME 16.08 HOURS

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	RATIO 1 .35	RATIO 2 .32	RATIO 3 .35	RATIO 4 .12	RATIO 5 .37	RATIO 6 .38	RATIO 7 .40
HYDROGRAPH AT	1095	.64 1.23(	1	1953. 41.155(	1550. 43.903(	1579. 45.273(	1645. 46.911(	1702. 48.75?(	1841. 52.135(	1938. 54.871(
ROUTED TO	1095	.64 16.5)	1	377. 16.692(	455. 12.842(	526. 14.693(	611. 17.703(	755. 21.242(	845. 23.921(	985. 27.881(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	861.60	862.90	865.00
STORAGE	267.	236.	436.
OUTFLOW	10.	0.	11.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER 15? HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.30	864.00	0.00	431.	277.	0.00	16.42	0.00
.32	864.03	.03	438.	455.	.58	16.33	0.00
.33	864.07	.07	440.	126.	.43	16.25	0.00
.35	864.01	.16	444.	661.	1.17	16.17	0.00
.37	864.25	.25	449.	765.	1.50	16.17	0.00
.3	864.27	.27	450.	845.	1.58	16.17	0.00
.40	864.34	.34	454.	985.	1.75	16.08	0.00

HEC-2 INPUT AND SUMMARY TABLE