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NATIONAL DAM SAFETY PROGRAM. KEARNEY LAKE DAM (MO 11099), UPPER--ETC(U)
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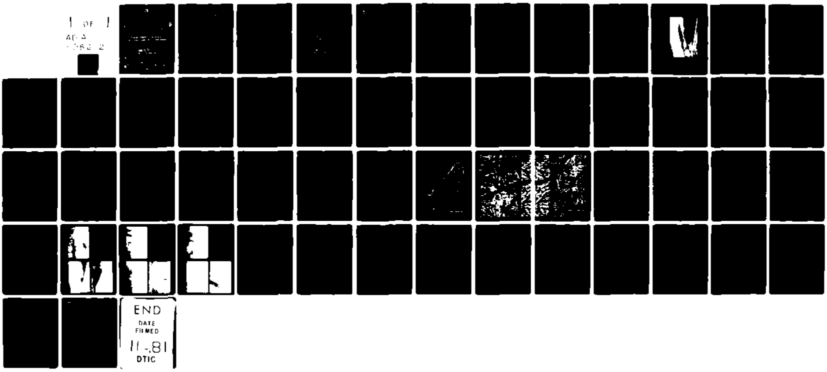

LEVEL II

AD A106212

UPPER MISSISSIPPI - KASKASKIA - ST. LOUIS BASIN

KEARNEY LAKE DAM

JEFFERSON COUNTY, MISSOURI

MO 11099

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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

St. Louis District

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

FOR: STATE OF MISSOURI

NOVEMBER 1980

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO. AD-A106

3. RECIPIENT'S CATALOG NUMBER 212

4. TITLE (and Subtitle)
Phase I Dam Inspection Report
National Dam Safety Program
Lake Kearney Dam (MO 11099)
Jefferson County, Missouri

5. TYPE OF REPORT & PERIOD COVERED
(9) Final Report

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
Horner & Shifrin, Inc.

8. CONTRACT OR GRANT NUMBER(s)
(15) DACW43-80-C-0063

9. PERFORMING ORGANIZATION NAME AND ADDRESS
U.S. Army Engineer District, St. Louis
Dam Inventory and Inspection Section, LMSED-PD
210 Tucker Blvd., North, St. Louis, Mo. 63101

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
U.S. Army Engineer District, St. Louis
Dam Inventory and Inspection Section, LMSED-PD
210 Tucker Blvd., North, St. Louis, Mo. 63101

12. REPORT DATE
(11) November 1980

13. NUMBER OF PAGES
Approximately 40 (12) 53

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)
(10) Harold B. /Lockett
Albert B. /Becker, Jr

15. SECURITY CLASS. (of this report)
UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for release; distribution unlimited.

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

(6) National Dam Safety Program. Kearney Lake Dam (MO 11099), Upper Mississippi - Kaskaskia - St. Louis Basin, Jefferson County, Missouri. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

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

Dam Safety, Lake, Dam Inspection, Private Dams

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

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

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411 553

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

UPPER MISSISSIPPI - KASKASKIA - ST. LOUIS BASIN

KEARNEY LAKE DAM

JEFFERSON COUNTY, MISSOURI

MO 11099

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
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St. Louis District

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

FOR: STATE OF MISSOURI

NOVEMBER 1980

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

REPLY TO
ATTENTION OF

LMSED-P

SUBJECT: Kearney Lake Dam, MO 11099, Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Kearney Lake Dam (MO 11099):

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 without overtopping the dam.

2) *Overtopping of the dam could result in failure of the dam.*

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

SUBMITTED BY: SIGNED — Chief, Engineering Division — 18 DEC 1980 Date

APPROVED BY: SIGNED — Colonel, CE, District Engineer — 22 DEC 1980 Date

KEARNEY LAKE DAM

MISSOURI INVENTORY NO. 11099

JEFFERSON COUNTY, MISSOURI

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

HORNER & SHIFRIN, INC.
5200 OAKLAND AVENUE
ST. LOUIS, MISSOURI 63110

FOR:

U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS

NOVEMBER 1980

HS-8011

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Kearney Lake Dam
State Located:	Missouri
County Located:	Jefferson
Stream:	Tributary of Sugar Creek
Date of Inspection:	22 September 1980

The Kearney Lake Dam was visually inspected by engineering personnel of Horner & Shifrin, Inc., Consulting Engineers, St. Louis, Missouri. The purpose of this inspection was to assess the general condition of the dam with respect to safety and, based upon this inspection and available data, determine if the dam poses a hazard to human life or property.

The following summarizes the findings of the visual inspection and the results of certain hydrologic/hydraulic investigations performed under the direction of the inspection team. Based on the visual inspection and the results of the hydrologic/hydraulic investigations, the present general condition of the dam is considered to be somewhat less than satisfactory. The following deficiencies were noticed during the inspection and are considered to have an adverse effect on the overall safety and future operation of the dam:

1. Holes believed to be remnants of old animal burrows were present along the upstream face of the dam. A stand of 2-to-3 inch diameter pine trees exists on the downstream face near the toe of the dam. Animal burrows and tree roots can provide passageways for lake seepage which could lead to a piping condition (progressive internal erosion) that can result in failure of the dam.

2. Erosion, presumably by spillway flows, has created several gulleys up to about 2.5 feet in depth within the spillway outlet channel near the downstream end of the crest section. Unchecked erosion of the

spillway channel could, in time, allow spillway releases to impinge upon the dam which could result in failure by erosion of the structure. Continued erosion in the direction of the lake could lower the spillway crest which would adversely affect the normal level of the reservoir.

3. The upstream face of the dam has only a grass cover to prevent erosion of the embankment by wave action or by fluctuations of the lake level. A grass covered slope is not considered adequate protection to prevent erosion of the embankment by wave action or fluctuations of the lake level. Loss of material by erosion can be detrimental to the stability of the dam.

4. At the time of the inspection, the grass on the downstream face of the dam was about 2-to-3 feet high. Grass should not be allowed to reach a height that provides cover for burrowing animals or hinders inspection of the dam.

According to the criteria set forth in the recommended guidelines, the magnitude of the spillway design flood for the Kearney Lake Dam, which is classified as small in size and of high hazard potential, is specified to be a minimum of one-half the Probable Maximum Flood (PMF). Considering the fact that a relatively small volume of water is impounded by the dam, that the downstream flood plain is fairly broad, and that there are but two dwellings within the potential flood damage zone, it is recommended that the spillway for this dam be designed for one-half the PMF. The Probable Maximum Flood (PMF) is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

Results of a hydrologic/hydraulic analysis indicated that the spillway is inadequate to pass lake outflow resulting from a storm of one-half PMF magnitude without overtopping the dam. The spillway is capable of passing lake outflow corresponding to about 23 percent of the PMF lake inflow and the lake outflow resulting from the 1 percent chance (100-year frequency) flood.

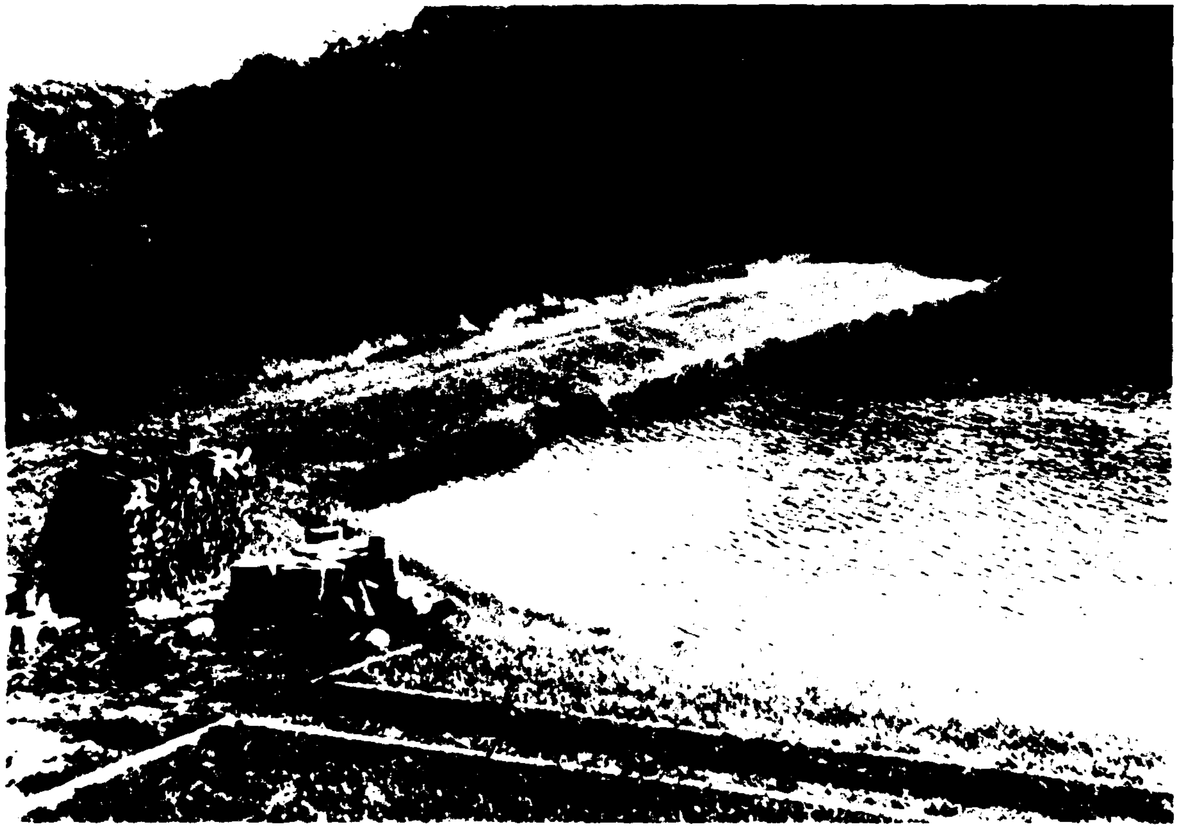
According to the St. Louis District, Corps of Engineers, the length of the downstream damage zone, should failure of the dam occur, is estimated to be two miles. Within the possible damage zone are two dwellings, a warehouse, and several other types of buildings.

A review of available data did not disclose that seepage or stability analyses of the dam were performed. This is considered a deficiency and should be rectified.

It is recommended that the Owner take the necessary action within the near future to correct or control the deficiencies and safety defects reported herein. Provision of additional spillway capacity should be assigned a high priority.

Harold B. Lockett
P. E. Missouri E-4189

Albert B. Becker, Jr.
P. E. Missouri E-9168



OVERVIEW KEARNEY LAKE DAM

PHASE 1 INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

KEARNEY LAKE DAM - MO 11099

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PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

KEARNEY LAKE DAM - MO 11099

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, dated 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, directed that a safety inspection of the Kearney Lake Dam be made.

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

c. Evaluation Criteria. This evaluation was performed in accordance with the "Phase I" investigation procedures as prescribed in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report to the Chief of Engineers on the National Program of Inspection of Non-Federal Dams", dated May 1975.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances. The Kearney Lake Dam is an earthfill type embankment rising approximately 25 feet above the natural streambed at the downstream toe of the barrier. The embankment has an upstream slope (above the waterline) of approximately 1v on 3.3h, a crest width of about 10 feet, and a downstream slope on the order to 1v on 2.0h, although the slope becomes less steep, 1v on 3.8h, at a point about 15 feet below the top of the dam. The length of the dam is approximately 261 feet. A plan and profile of the dam is shown on Plate 3 and a cross-section of the dam, at about the location of the original stream on which the dam was constructed, is shown on Plate 4. At normal pool elevation, the reservoir impounded by the dam occupies approximately 3 acres. There is no lake drawdown facility to unwater the lake. An overview photo of the Kearney Lake Dam is shown following the preface at the beginning of the report.

The spillway, an excavated earth trapezoidal section, is located at the right, or east, abutment. An earthen bank, or berm, on the left side of the spillway serves to confine flow to the channel and to protect the dam. The berm extends approximately 45 feet from the center of the dam, or to about the downstream end of the crest section. Through the exit section and the valley floor, the spillway outlet channel is not well defined; however, it appears to join the original stream channel at a point about 80 feet beyond the downstream toe of the dam. A profile of the spillway crest and a cross-section of the channel at the crest location are also shown on Plate 4.

Location. The dam is located on an unnamed tributary of Sugar Creek, about 1.2 miles southeast of the intersection of Highway PP and Highway 30 and approximately 1.5 miles southeast of the Town of High Ridge, Missouri, as shown on the Regional Vicinity Map, Plate 1. The dam is located in the southeast one-quarter of Section 24, Township 43 North, Range 4 East, within Jefferson County.

c. Size Classification. The size classification based on the height of the dam and storage capacity, is categorized as small (per Table 1, Recommended Guidelines for Safety Inspection of Dams).

d. Hazard Classification. The Kearney Lake Dam, according to the St. Louis District, Corps of Engineers, has a high hazard potential, meaning that if the dam should fail, there may be loss of life, serious damage to homes, or extensive damage to agricultural, industrial and commercial facilities, important public utilities, main highways, or railroads. The estimated flood damage zone, should failure of the dam occur, as determined by the St. Louis District, extends two miles downstream of the dam. Within the possible damage zone are two dwellings, a warehouse, and several other types of buildings. Those features lying within the downstream damage zone reported by the Corps of Engineers, St. Louis District, were verified by the inspection team.

e. Ownership. The lake and dam are owned by David C. Kearney. Mr. Kearney's address is Box 539, Route 3, High Ridge, Missouri 63049.

f. Purpose of Dam. The dam impounds water for recreational use.

g. Design and Construction History. According to Mr. Kearney, at the time the dam was constructed, the property was owned by Arnold Greer. Mr. Kearney stated that he purchased the property from Mr. Greer in September of 1979. Mr. Greer was contacted and reported that the dam was constructed in 1971 by the Martin Excavating Company of St. Louis, Missouri. Mr. Greer stated that the dam was constructed without the benefit of professional assistance and that he and Jim Martin of the Martin Excavating Company co-designed the structure.

h. Normal Operational Procedure. The lake level is unregulated. Lake outflow is governed by the capacity of an excavated earth type spillway.

1.3 PERTINENT DATA

a. Drainage Area. The area tributary to the lake is for the most part in a native state covered with trees. A small spring located in the bluff on the west side of the lake just south of the Owner's home, flows year around. The watershed above the dam amounts to approximately 61 acres. The watershed area is outlined on Plate 2.

b. Discharge at Damsite.

(1) Estimated known maximum flood at damsite ... 70 cfs* (W.S. Elev. 716.5)
(2) Spillway capacity ... 201 cfs (W.S. Elev. 717.5)

c. Elevation (Ft. above MSL). Unless otherwise indicated, the following elevations were determined by survey and are based on topographic data shown on the 1954 House Springs, Missouri, Quadrangle Map, 7.5 Minute Series, (photo revised 1968 and 1974).

*Based on an estimate of maximum depth of flow at spillway as reported by Owner.

(1) Observed pool ... 714.8

(2) Normal pool ... 715.0

(3) Spillway crest ... 715.0

(4) Maximum experienced pool ... 716.5 (per Owner)

(5) Top of dam ... 717.5 (min.)

(6) Streambed at centerline of dam ... 695± (Est.)

(7) Maximum tailwater ... Unknown

(8) Observed tailwater ... None

d. Reservoir.

(1) Length at normal pool (Elev. 715.0) ... 600 ft.

(2) Length at maximum pool (Elev. 717.5) ... 660 ft.

e. Storage.

(1) Normal pool ... 16 ac. ft.

(2) Top of dam (incremental) ... 8 ac. ft.

f. Reservoir Surface.

(1) Normal pool ... 2.7 acres

(2) Top of dam (incremental) ... 0.5 acre

g. Dam. The height of the dam is defined to be the overall vertical distance from the lowest point of foundation surface at the downstream toe of the barrier to the top of the dam.

(1) Type ... Earthfill

(2) Length ... 261 ft.

(3) Height ... 25 ft.

(4) Top width ... 10 ft.

(5) Side slopes

a. Upstream ... 1v on 3.3h (above waterline)

b. Downstream ... 1v on 2.0h (max.)

(6) Cutoff ... Core trenches(two)*

(7) Slope protection

a. Upstream ... Grass

b. Downstream ... Grass

h. <u>Principal Spillway</u>.

(1) Type ... Uncontrolled, excavated earth, trapezoidal section

(2) Location ... Right abutment

(3) Crest elvation ... 715.0

(4) Approach channel ... Lake

(5) Outlet channel ... Excavated earth, irregular section

i. <u>Emergency Spillway</u>. ... None

j. <u>Lake Drawdown Facility</u>. ... None

*Per Arnold Greer, original owner.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No data relating to the design of the dam are known to exist.

2.2 CONSTRUCTION

As previously stated, the dam was constructed in 1971 by the Martin Excavating Company of St. Louis, Missouri. No records of the construction activities are known to exist, and efforts to contact the Martin Company were unsuccessful. According to Arnold Greer, the owner of the property at the time the dam was constructed, a seepage cutoff core trench approximately 10 feet wide at the bottom and 8-to-10 feet in depth, was excavated to rock along the centerline of the dam. Mr. Greer reported that no gravel was encountered during construction of the core; however, a pocket of gravel was found within the reservoir bottom near the original stream just upstream of the toe of the dam. Mr. Greer indicated that about 3 feet of material within an area approximately 30 feet in diameter was removed at the gravel pocket location, and the entire area was backfilled with compacted clay. Mr. Greer also stated that, because of the uncertainty of the extent of the gravel underlying the basin and dam, a second core trench of similar proportions as the first core, was constructed beneath the upstream side of the embankment along a line about midway between the gravel pocket and the center of the structure, or approximately 50-to-60 feet upstream of the original core. Mr. Greer indicated that material used to backfill the core trenches and to build the dam was clay which was obtained from the area to be occupied by the lake.

2.3 OPERATION

The lake level is uncontrolled and governed by the elevation of the crest of the excavated earth spillway. There is no lake drawdown facility. No indication was found that the dam has been overtopped. Both Mr. Kearney and Mr. Greer, the original owner, reported that the dam has never been overtopped. The highest lake level observed, according to Mr. Kearney, occurred during July of 1980 when a storm produced a depth of flow at the spillway estimated to be on the order of 18 inches.

2.4 EVALUATION

a. Availability. Engineering data for assessing the design of the dam and spillway were unavailable.

b. Adequacy. No data available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidlines 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.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Kearney Lake Dam was made by Horner & Shifrin engineering personnel, R. E. Sauthoff, Civil Engineer, H. B. Lockett, Hydrologist, and A. B. Becker, Jr., Civil and Soils Engineer, on 22 September 1980. An examination of the dam site was also made by an engineering geologist, Jerry D. Higgins, Ph.D., a consultant retained by Horner & Shifrin for the purpose of assessing the area geology. Also examined at the time of the inspection were the areas and features below the dam within the potential flood damage zone. Photographs of the dam taken at the time of the inspection are included on pages A-1 through A-3 of Appendix A. The locations of the photographs taken during the inspection are indicated on Plate 3.

b. Site Geology. The topography of the Kearney Lake drainage basin is moderately rugged, and there is about 200 feet of relief between Sugar Creek Valley and the adjacent uplands. The area is included within the northeastern part of the Ozark Plateaus Physiographic Province, and the regional dip of the bedrock is northeastward toward the Illinois Basin.

The site is located near the axis of the House Springs Anticline. Although the structure affects the dip of the strata in this area, the bedrock formations at the dam site still dip to the northeast. Several faults are associated with the anticlinal structure, although no faulting was observed at the site. The bedrock formations consist of Ordovician- and Mississippian-age limestones, sandstones, and shales. Although no bedrock outcrops were observed at stream level, the underlying bedrock is most probably the Maquoketa shale. This is overlain by the Bushberg sandstone and younger carbonates, principally the Fern Glen and Burlington formations, which make up the bedrock of the valley walls and uplands.

The Maquoketa is a thin-bedded, silty, calcareous shale. It is very susceptible to weathering and disintegrates rapidly upon exposure to the elements. The shale weathers to a black, plastic clay (CH, according to the

Unified Soil Classification System) which is very impermeable and unstable on steep slopes. Because of its impermeable characteristics, seeps and springs are uniquely characteristic along the contact of the Maquoketa and the overlying Bushberg sandstone.

The Bushberg is a massive, cross-bedded, brown, fine- to coarse-grained, porous sandstone that transmits water readily. Soils derived from the Bushberg are sandy, but usually include components from the weathered residuum of overlying formations. This apparently is the situation at the Kearney Lake site. The soils around the shoreline area are sandy and silty clays (ML-CL).

Overlying the Bushberg are the undifferentiated Fern Glen and Burlington formations which comprise most of the valley walls and uplands. The bedrock consists principally of a light grey, massively- to medium-bedded limestone with considerable amounts of nodular and bedded chert. The residual soils are light red to reddish-brown clays mixed with chert fragments (stony CH). In general, the clay and chert residuum from the Burlington is a major component of the soils comprising the upland areas around the reservoir.

No adverse geologic conditions were observed that would be considered conducive to severe reservoir leakage or embankment stability.

c. Dam. The visible portions of the upstream and downstream faces of the dam, as well as the dam crest (see Photos 1, 2 and 3) were examined and, except for the remnants of several animal burrows (see Photo 7) along the left side of the upstream slope, found to be in sound condition. No seepage or significant erosion of the embankment at the normal waterline or at the abutments was observed. No cracking of the surface, sloughing of the embankment slopes, or undue settlement of the dam was noted. At the time of the inspection, the grass, a fescue, on the upstream face and crest of the dam was about 3 inches high, whereas on the downstream face, the grass, a mixture of sericea lespedeza and fescue, was 2-to-3 feet high. A stand of pine trees, on the order of 2-to-3 inches in diameter and about 8 feet tall (see Photo 8), was present across the middle one-half of the embankment near the downstream toe of the dam. Examination of a soil sample obtained from the downstream face of the embankment near the center of the dam indicated the surficial material to be a yellow-brown, silty lean clay (CL) of low-to-medium plasticity.

The grass-lined spillway outlet (see Photo 4) was also examined and was found to be in less than satisfactory condition. Erosion, apparently by spillway flows, had created several gulleys up to 24 inches in width and 30 inches in depth within the spillway channel (see Photo 9) beginning at a point about 40 feet downstream of the crest. These erosion gulleys extended to a point approximately 80 feet downstream of the crest. Through the exit section of the spillway (see Photo 5) the channel was not well defined, but appeared to spread out over a fairly broad area, which was grown over with small trees and a moderate amount of brush. Downstream of the exit section, the channel was indistinguishable (see Photo 6); however, the area was well protected with grass and no significant erosion was observed.

d. Appurtenant Structures. No appurtenant structures were observed at this dam site.

e. Downstream Channel. Except at roadway crossings, the channel downstream of the dam within the potential flood damage zone is unimproved. The channel section is irregular and for the most part, lined with trees. The tributary stream joins Sugar Creek at a point about 500 feet downstream of the dam.

f. Reservoir. Except for the area in the immediate vicinity of the Owner's residence, the area surrounding the lake is covered with trees. A small spring that emerges from the hillside bluff just south of the Owner's home flows year around. No significant erosion of the lake banks was noted. At the time of the inspection, the lake water was slightly cloudy and about 0.2 foot below normal pool level. The amount of sediment within the lake could not be determined during the inspection; however, due to the fact that the drainage area is well covered with vegetation, it is not expected to be significant.

3.2 EVALUATION

The deficiencies observed during this inspection and noted herein are not considered of significant importance to warrant immediate remedial action.

SECTION 4 - OPERATION PROCEDURES

4.1 PROCEDURES

The spillway is uncontrolled. The lake surface level is governed by precipitation runoff, evaporation, seepage, and the capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM

According to the Owner, the dam receives periodic routine maintenance such as mowing of the grass on the dam crest and upstream face of the dam. The Owner also reported that during the last winter, muskrats were removed from the dam area by trapping. Arnold Greer, the former owner, reported that muskrat burrows and excessive vegetation on the dam were items causing maintenance difficulties during his period of ownership. Mr. Greer also indicated that some erosion of the spillway channel occurred in 1972 shortly after the reservoir had filled to the level of the spillway crest. However, the Owner reported that a good deal of the channel erosion occurred in July of 1980 when a major storm occurred in the area and large spillway flow resulted.

4.3 MAINTENANCE OF OUTLET OPERATING FACILITIES

No outlet facilities requiring operation exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEMS IN EFFECT

The Owner reported that telephone numbers of the local police and fire departments were readily available in the case of an emergency, such as the iminent failure of the dam. The inspection did not reveal the existence of any other type of dam failure warning system.

4.5 EVALUATION

It is recommended that maintenance of the dam also include periodic cutting of grass on the downstream face of the dam, restoration of the dam at the old animal burrows along the upstream face, and provision of a suitable form of protection (not grass) along the upstream face of the dam in order to prevent erosion by wave action or by fluctuations of the lake level. Measures should also be taken to restore the eroded areas of the spillway channel and to provide some form of protection to prevent future erosion of the channel by spillway flows. Although the pine trees on the downstream face of the dam are of ornamental value, they should be removed since tree roots can provide passageways for lake seepage that can lead to a piping condition and failure of the dam. It is also recommended that a detailed inspection of the dam be instituted on a regular basis by an engineer experienced in the design and construction of dams and that records be kept of all inspections made and remedial measures taken.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data were not available.

b. Experience Data. The drainage area and lake surface area were determined from the 1954 USGS House Springs, Missouri, Quadrangle Map (photorevised 1968 and 1974). The proportions and dimensions of the spillway and dam were developed from surveys made during the inspection. Records of rainfall, streamflow, or flood data for the watershed were not available.

Due to the fact that the watershed for this reservoir is small and since there is no history of excessive reservoir leakage that would adversely affect the normal operational level of the lake, the lake level was assumed to be at normal pool as a result of antecedent storms prior to occurrence of the PMF and the probabilistic storm.

According to the St. Louis District, Corps of Engineers, the estimated flood damage zone, should failure of the dam occur, extends two miles downstream of the dam.

c. Visual Observations.

(1) The spillway, an excavated earth trapezoidal section, is located at the right, or east, abutment.

(2) The spillway outlet channel joins the original stream channel at a point approximately 150 feet downstream of the center of the dam.

(3) There is no lake drawdown facility.

d. Overtopping Potential. The spillway is inadequate to pass the probable maximum flood, or 1/2 the probable maximum flood, without overtopping the dam. The spillway is adequate, however, to pass the 1 percent chance (100-year frequency) flood without overtopping the dam. The results of the dam overtopping analyses are as follows:

(Note: The data appearing in the following table were extracted from the computer output data appearing in Appendix B. Decimal values have been rounded to the nearest one-tenth in order to prevent assumption of unwarranted accuracy.)

Ratio of PMF	Q-Peak Outflow (cfs)	Max. Lake W.S. Elev.	Max. Depth (Ft.) of Flow over Dam (Elev. 717.5)	Duration of Overtopping of Dam (Hours)
0.50	665	718.4	0.9	0.6
1.00	1,419	719.0	1.5	3.1
1% Chance Flood	190	717.4	0.0	0.0

Elevation 717.5 was found to be the lowest point in the dam crest. The flow safely passing the spillway just prior to dam overtopping was determined to be approximately 201 cfs, which is the routed outflow corresponding to about 23 percent of the probable maximum flood inflow. This flow is greater than the outflow from the 1 percent chance (100-year frequency) flood. During peak flow of the probable maximum flood, the greatest depth of flow over the dam is projected to be 1.5 feet and overtopping will extend across almost the entire length of the dam.

e. Evaluation. Experience with embankments constructed of similar material (a silty lean clay of low-to-medium plasticity) to that used to construct this dam has shown evidence that under certain conditions, such as high velocity flow, the material can be very erodible. An example of such erosion is evident at the spillway outlet channel. Such a condition exists during the PMF when large lake outflow, accompanied by high flow velocities, occurs. For the PMF condition where the depth of the flow over the dam crest, a maximum of 1.5 feet, and the duration of flow over the dam, 3.1 hours, are considerable, damage by erosion to the crest and downstream face of the dam is expected. The extent of these damages is not predictable within the scope of this investigation; however, there is a possibility that they could result in failure by erosion of the dam. A similar condition, but not as severe, also exists during occurrence of one-half the PMF.

f. References. Procedures and data for determining the probable maximum flood, the 100-year flood, and the discharge rating curve for flow passing the spillways and dam crest are presented on pages B-1 and B-2 of the Appendix. Listings of the HEC-1 (Dam Safety Version) input data for both the probable maximum flood, and the probabilistic flood, are shown on pages B-3 through B-5. Computer output data, including unit hydrograph ordinates, tabulation of PMF rainfall, loss and inflow data are shown on pages B-6 through B-9; tabulation of lake surface area, elevation and storage volume is shown on page B-10; tabulations titled "Summary of Dam Safety Analysis" for the PMF and the 1 percent chance (100-year frequency) flood are also shown on page B-10 of Appendix B. Calculations for determining the capacity of the spillway are presented on page B-11.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

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

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam are known to exist. 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. Operating Records. No appurtenant structures or facilities requiring operation exist at this dam. According to both the former and present Owners, no records of the lake level, spillway discharge, dam settlement, or lake seepage have been kept.

d. Post Construction Changes. According to both the former and present Owner, no post construction changes have been made or have occurred which would affect the structural stability of the dam.

e. Seismic Stability. The dam is located within a Zone II seismic probability area. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed earthen dam of this size provided that static stability conditions are satisfactory and conventional safety margins exist. However it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. A hydraulic analysis indicated that the spillway is capable of passing lake outflow of about 201 cfs without the level of the lake exceeding the low point in the top of the dam. A hydrologic analysis of the lake watershed area, as discussed in Section 5, paragraph 5.1d, indicates that for storm runoff of one-half probable maximum flood magnitude, the recommended spillway design flood, the lake outflow would be about 665 cfs, and that for the 1 percent chance (100-year frequency) flood, the lake outflow would be about 190 cfs.

Seepage and stability analyses of the dam were not available for review, and therefore, no judgment could be made with respect to the structural stability of the dam.

Several items were noticed during the inspection that could adversely affect the safety of the dam. These items include trees and high grass on the downstream slope of the embankment, the remnants of animal burrows on the upstream face of the dam, erosion of the spillway channel, and the lack of adequate slope protection to prevent erosion of the upstream face of the dam.

b. Adequancy of Information. Due to lack of design and construction data, the assessments reported herein were based on external conditions as determined during the visual inspection. The assessments of the hydrology of the watershed and capacity of the spillway were based on a hydrologic/hydraulic study as indicated in Section 5. Seepage and stability analyses comparable to the requirements of "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 for the items concerning the safety of the dam noted in paragraph 7.1a should be accomplished within the near future. The item concerning increasing spillway capacity should be pursued on a high priority basis.

d. Necessity for Phase II. Based on the results of the Phase I inspection, a Phase II investigation is not recommended.

e. Seismic Stability. The dam is located within a Zone II seismic probability area. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed earthen dam of this size provided that static stability conditions are satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES

a. Recommendations. The following actions are recommended.

(1) Based upon criteria set forth in the recommended guidelines, spillway size and/or height of dam should be increased in order to pass lake outflow resulting from a storm of one-half probable maximum flood magnitude, the recommended spillway design flood for this dam.

(2) Obtain the necessary soil data and perform dam seepage and stability analyses in order to determine the structural stability of the dam for all operational conditions. Seepage and stability analyses should be performed by a qualified professional engineer experienced in the design and construction of earthen dams.

b. Operations and Maintenance (O & M) Procedures. The following O & M Procedures are recommended:

(1) Restore the upstream face of the dam at the holes believed to be remnants of old animal burrows, and remove the trees in the downstream face of the dam. The removal of trees should be performed under the direction and guidance of an engineer experienced in the design and construction of earthen dams, since indiscriminate clearing can jeopardize the safety of the dam. The existing turf cover should be restored if destroyed or missing. Animal burrows and tree roots can provide passageways for lake seepage that can

develop into a piping condition (progressive internal erosion) which can lead to failure of the dam.

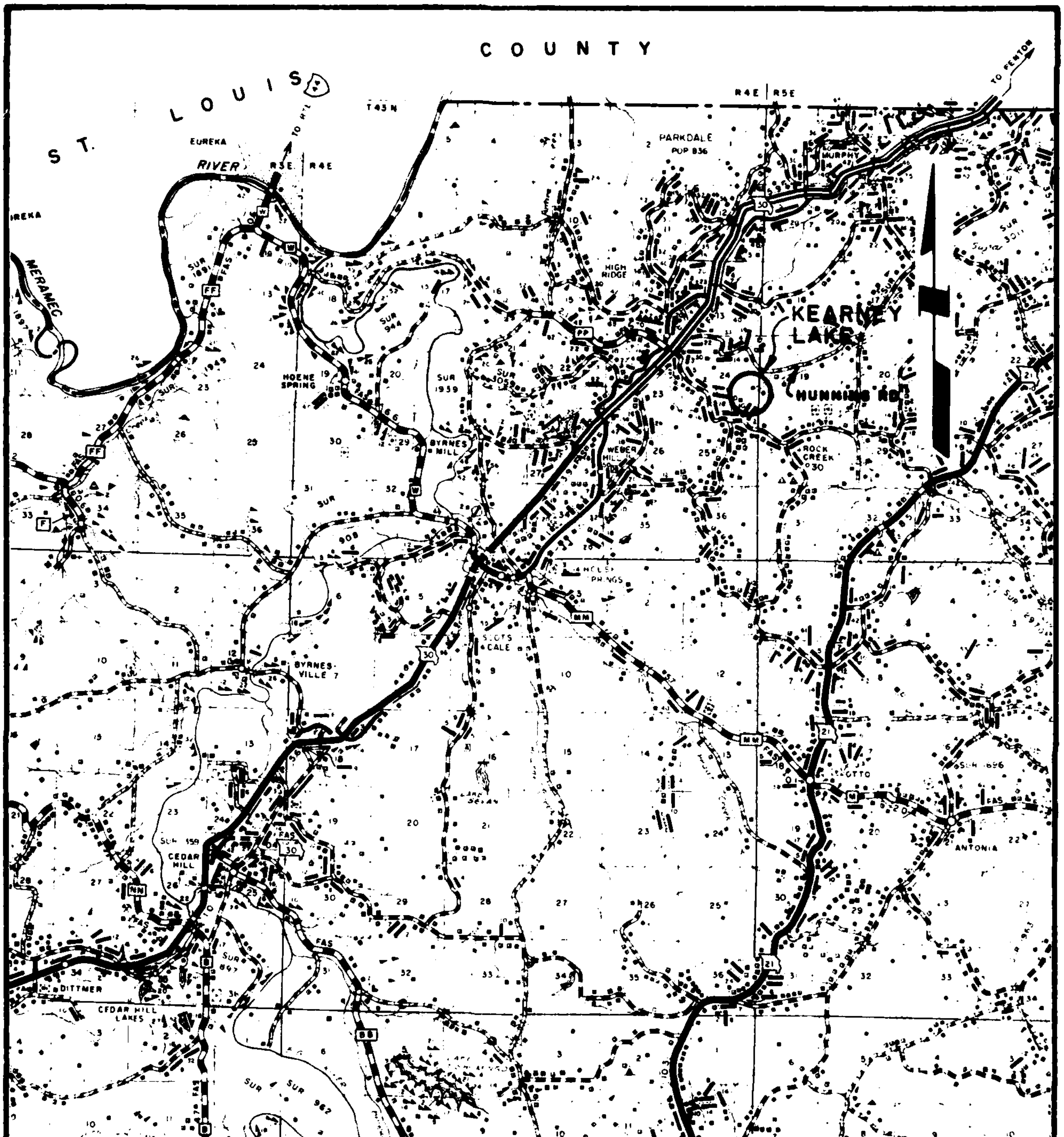
(2) Restore the eroded areas of the spillway outlet channel and provide some form of protection to prevent future erosion by spillway flows. Loss of material due to erosion may result in spillway releases impinging upon the dam which could impair the structural stability of the embankment. Continued erosion in the direction of the lake could lower the spillway crest which would adversely affect the normal level of the reservoir.

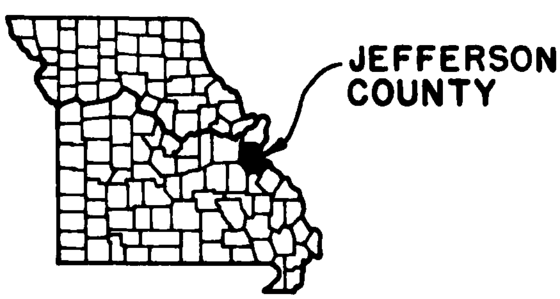
(3) Provide some form of protection other than grass for the upstream face of the dam at and above the normal waterline in order to prevent erosion by wave action or by a fluctuating lake level. A grass covered slope is not considered adequate protection to prevent erosion by wave action or by a fluctuating lake level. Erosion of the embankment can impair the structural stability of the dam.

(4) Maintain the grass cover on the dam at a height that will not provide cover for burrowing animals or hinder inspection of the dam.

(5) Provide maintenance of all areas of the dam and spillway on a regularly scheduled basis in order to insure features of being in satisfactory operational condition.

(6) A detailed inspection of the dam should be instituted on a regular basis by an engineer experienced in the design and construction of dams. It is also recommended, for future reference, that records be kept of all inspections made and remedial measures taken.





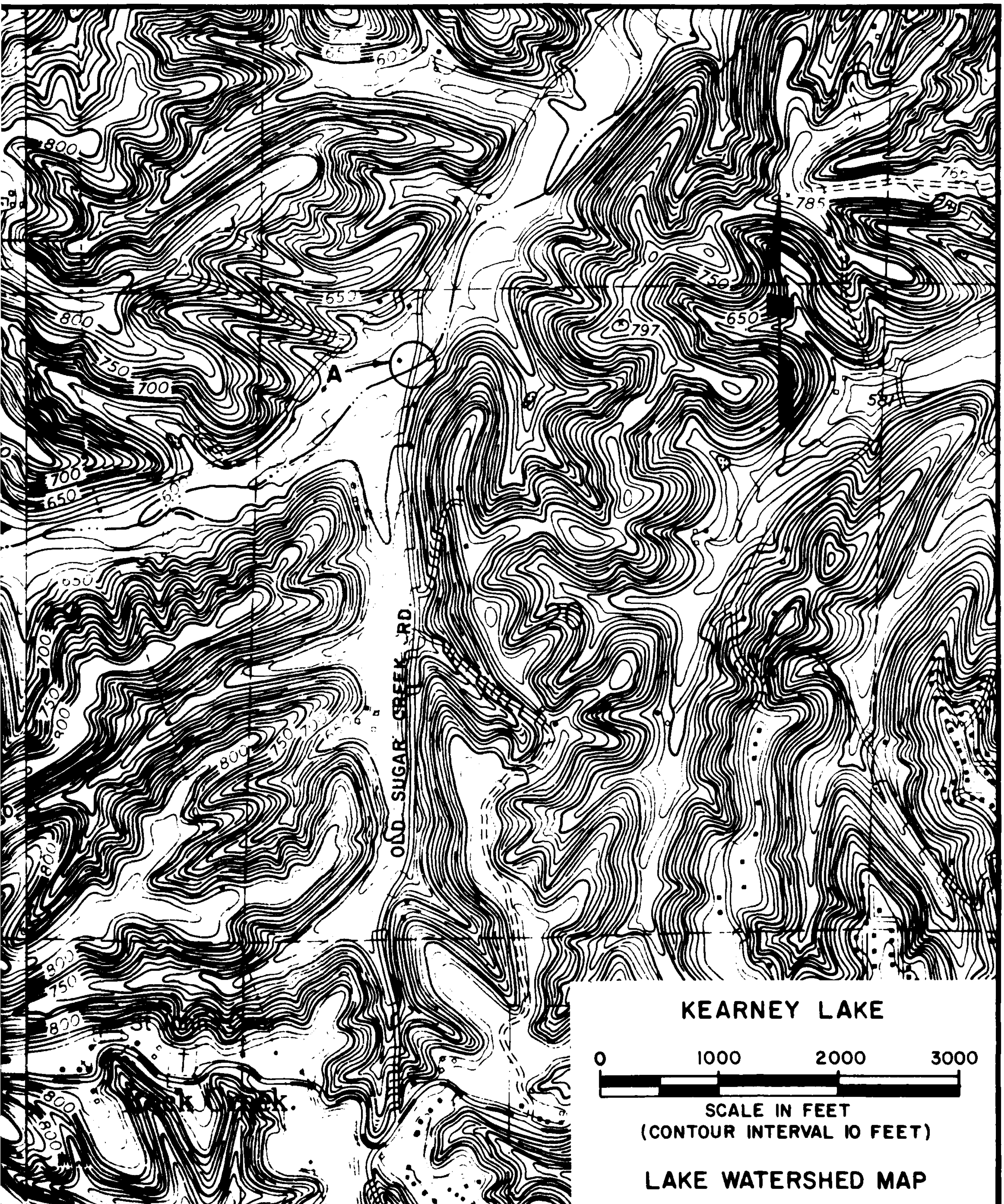
LOCATION MAP

KEARNEY LAKE

REGIONAL VICINITY MAP

PLATE I

Trailer Park
Sugar
Creek
DAM
ROCK
CREEK



KEARNEY LAKE

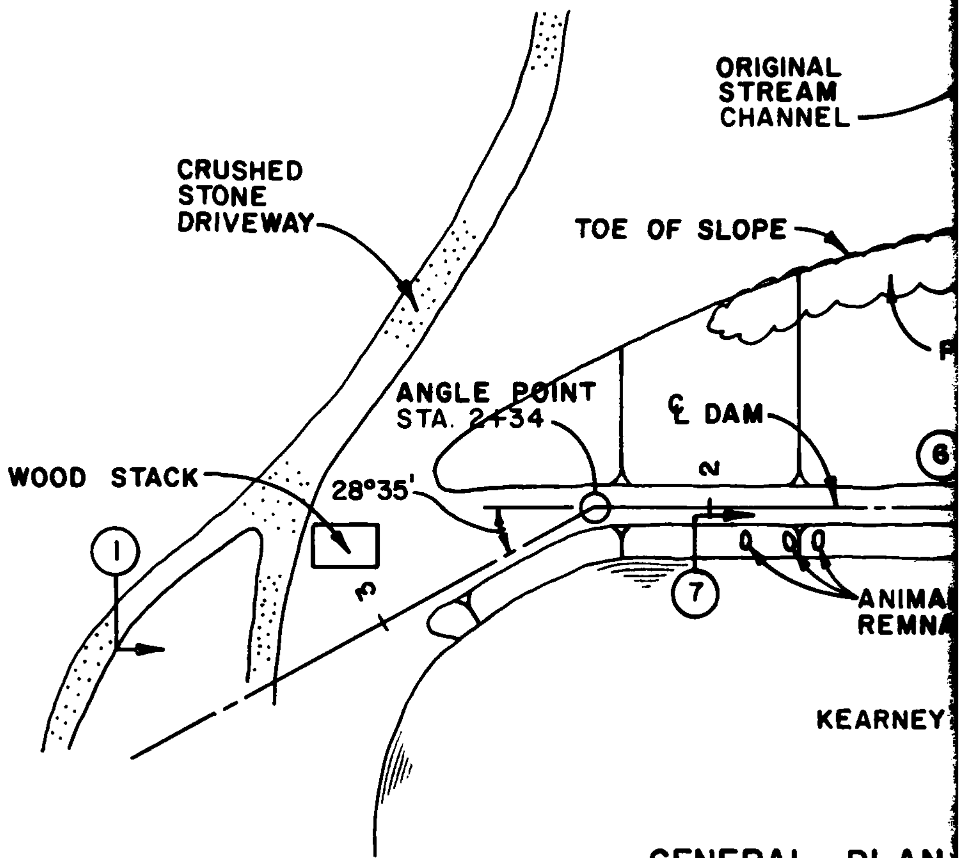
0 1000 2000 3000

SCALE IN FEET

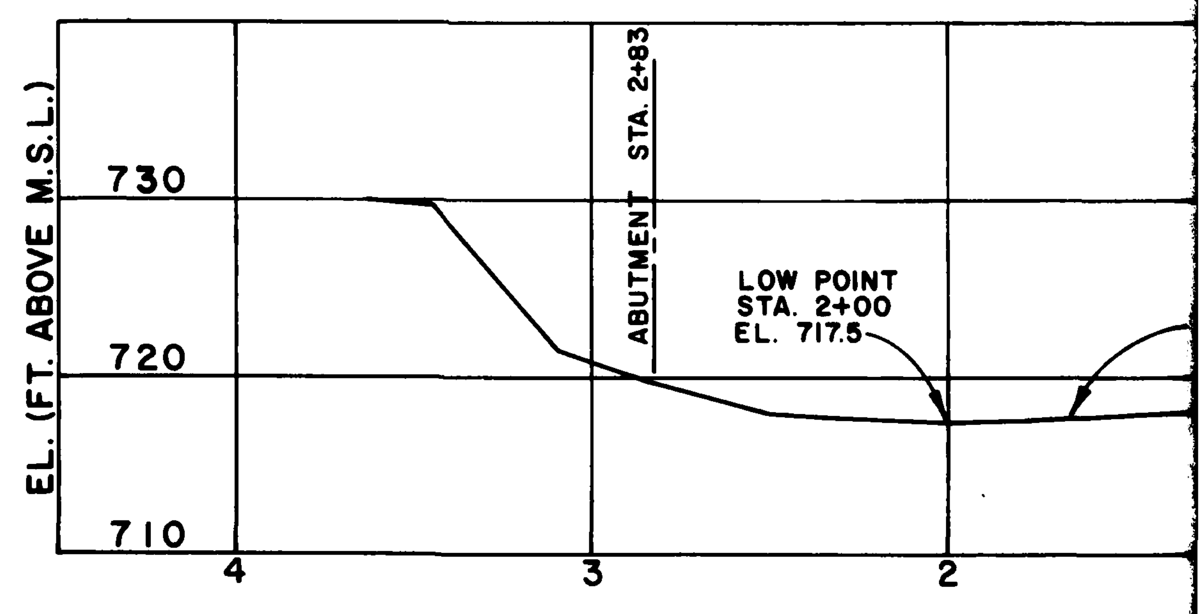
(CONTOUR INTERVAL 10 FEET)

LAKE WATERSHED MAP

PLATE 2



GENERAL PLAN
SCALE: 1"=



PROFILE DAM
SCALES: 1"=10'V.,

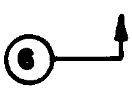
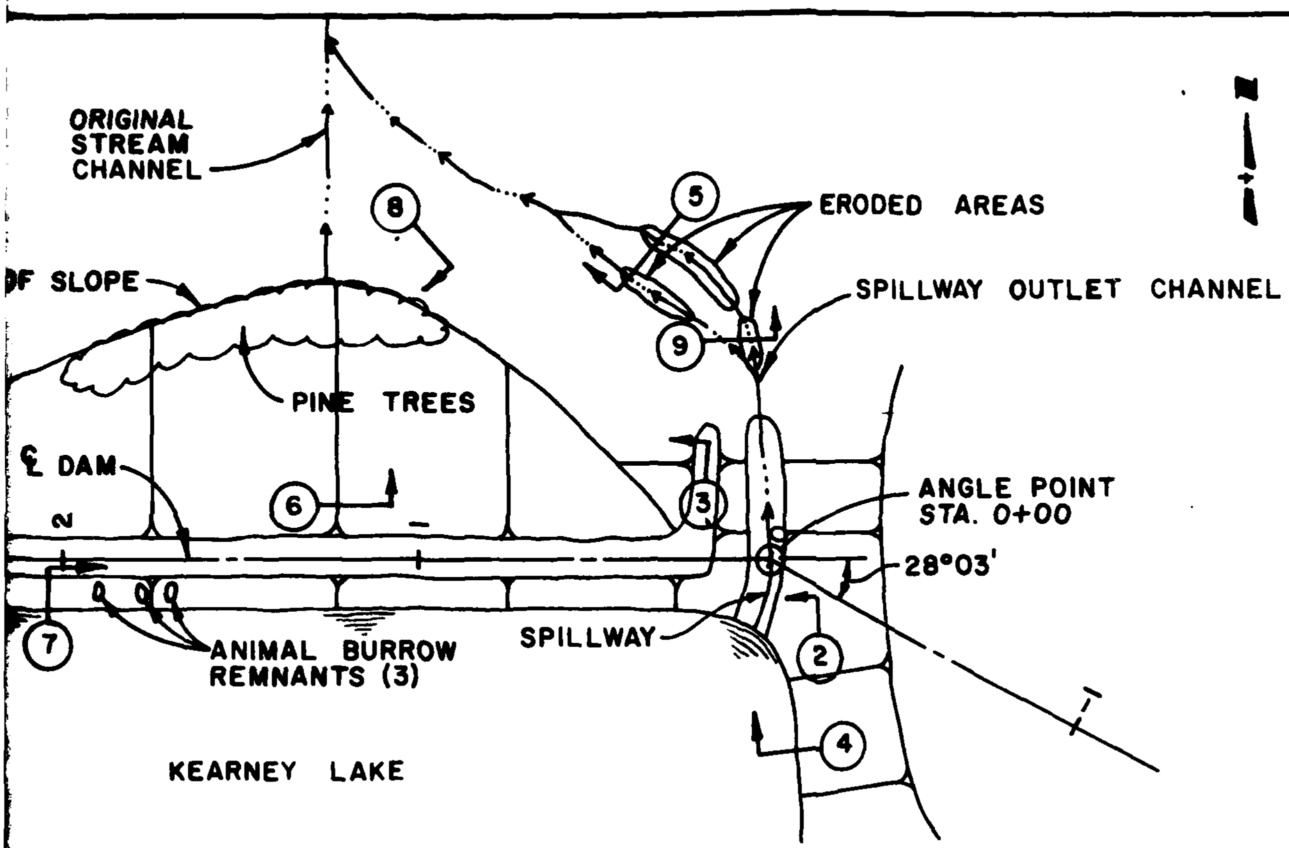
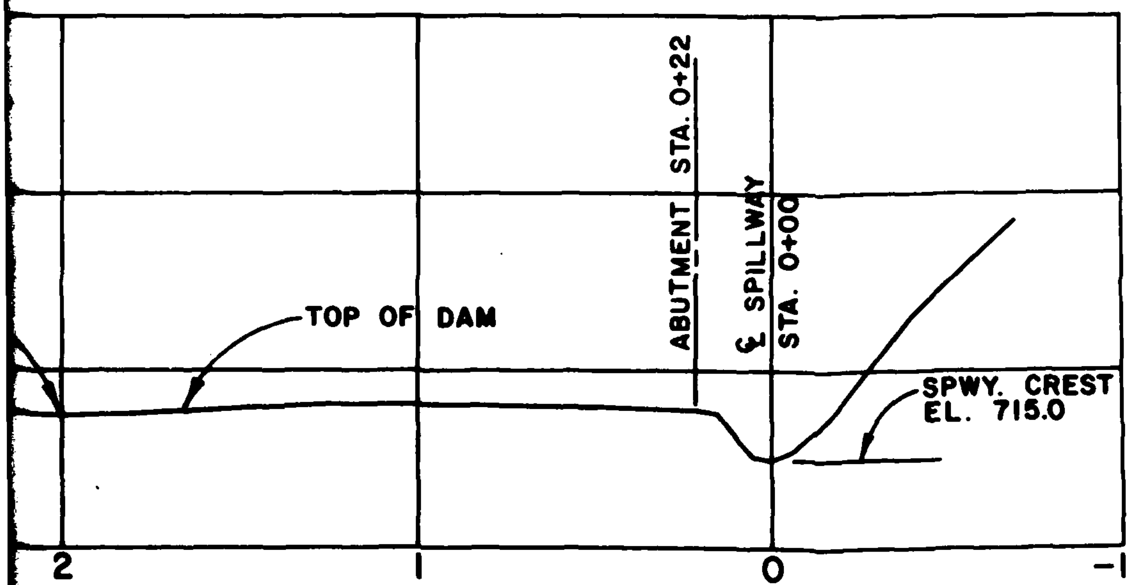


PHOTO LOCATION & KEY
(SEE APPENDIX A)



GENERAL PLAN OF DAM
SCALE: 1" = 50'

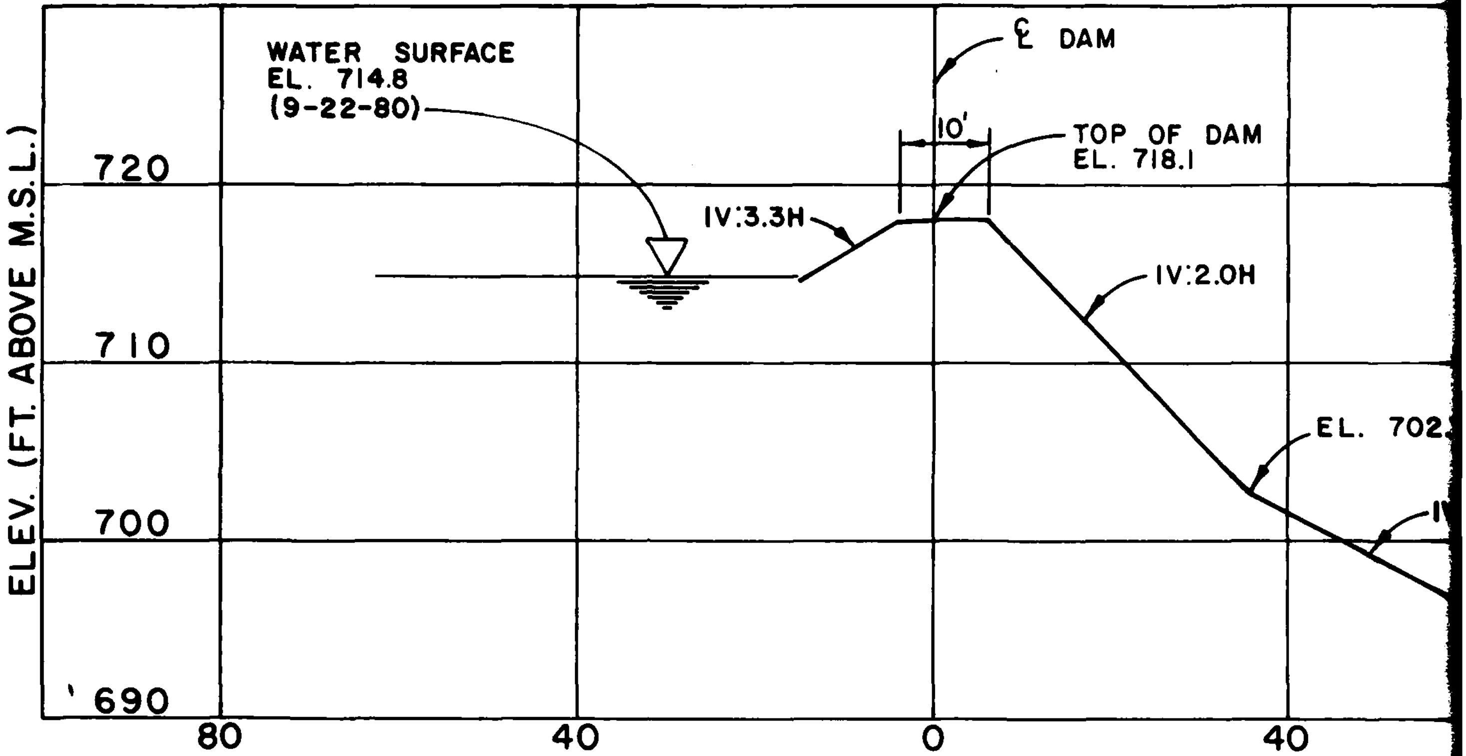


PROFILE DAM CREST
SCALES: 1"=10'V., 1"=50'H.

KEARNEY LAKE
DAM PLAN & PROFILE

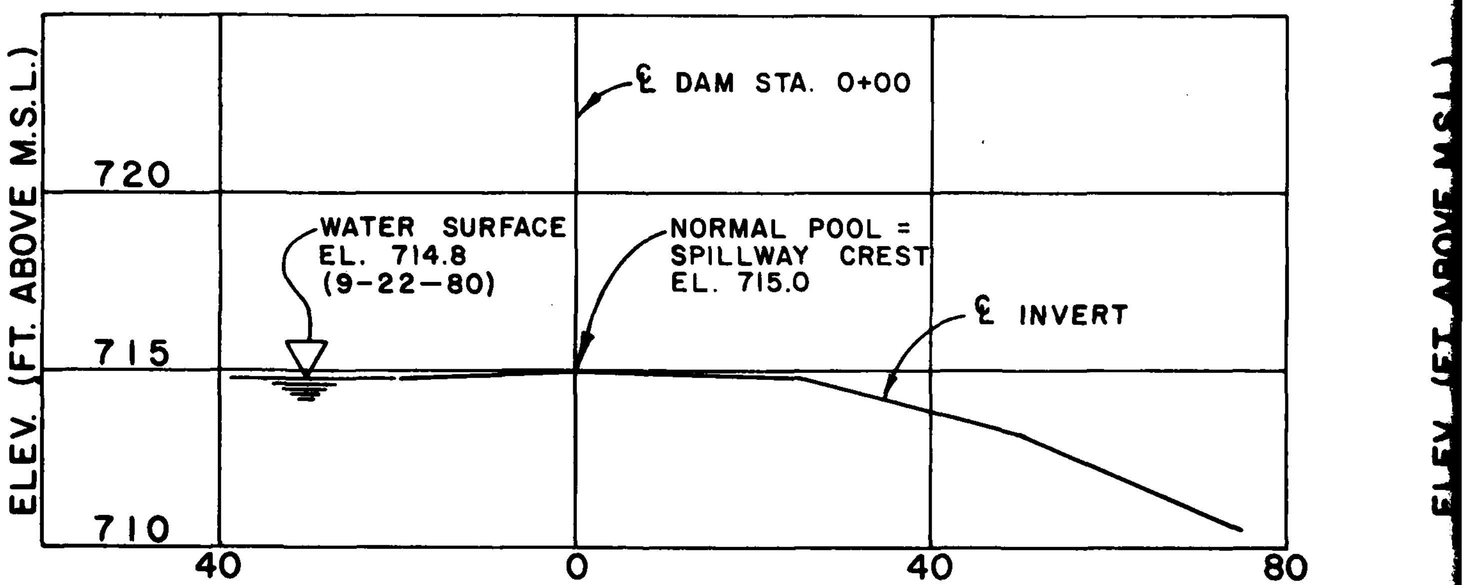
Horner & Shifrin, Inc. Oct. 1980

1 2



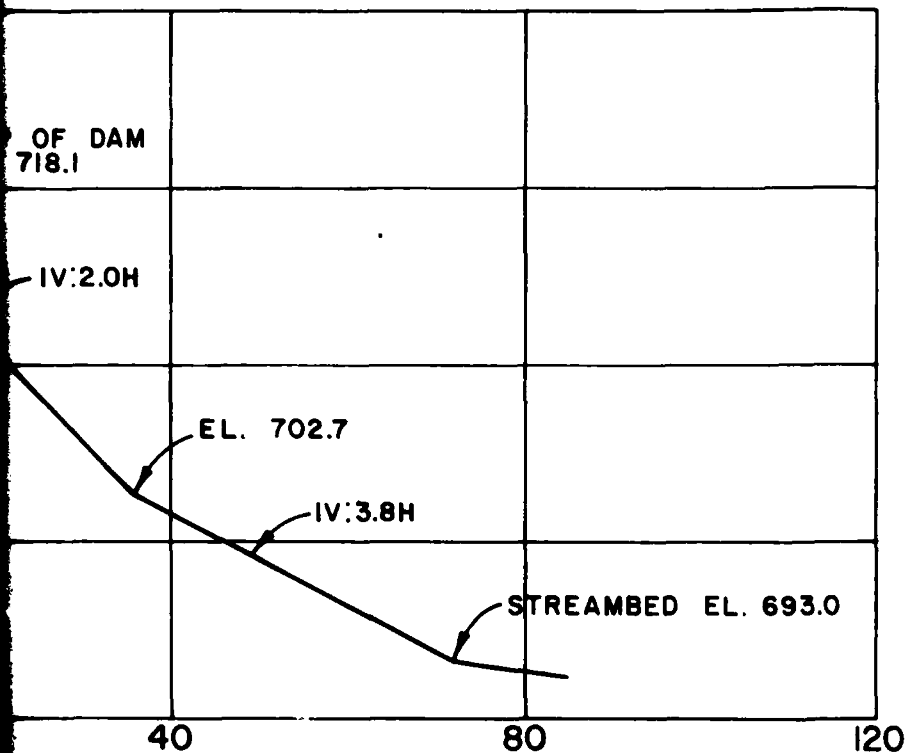
DAM CROSS-SECTION STA. 1+25

SCALE: 1"=10'V., 1"=20'H.



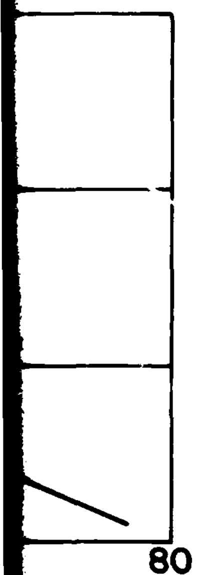
PROFILE SPILLWAY CHANNEL

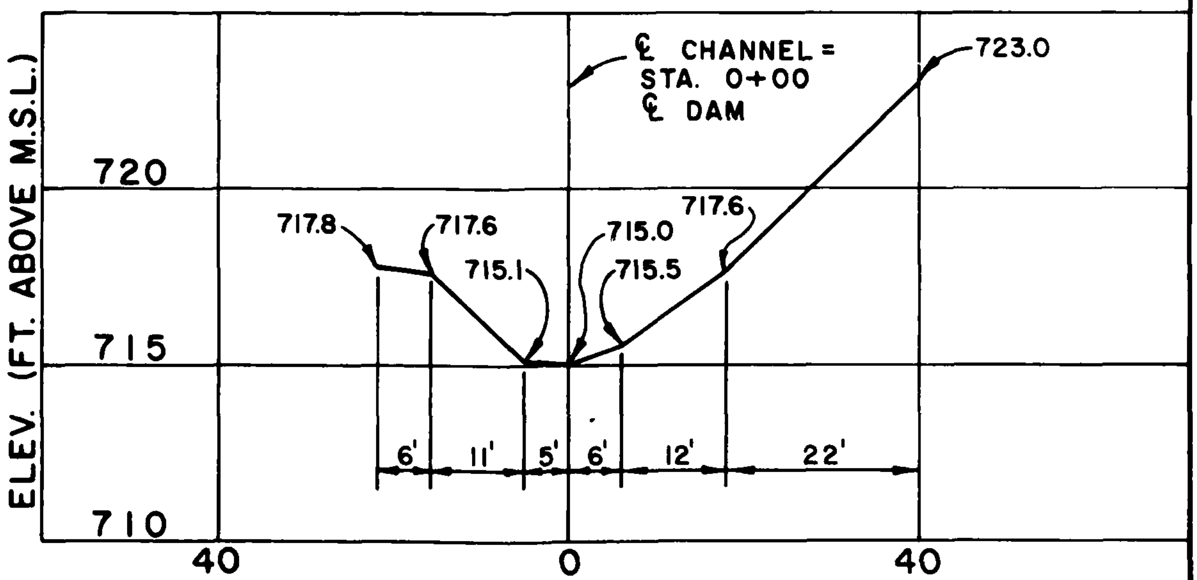
SCALE: 1"=5'V., 1"=20'H.



TION STA. 1+25

,1"=20'H.





CROSS-SECTION SPILLWAY CHANNEL

SCALE: 1"=5'V., 1"=20'H.

KEARNEY LAKE
DAM CROSS-SECTION &
SPILLWAY DETAILS

Horner & Shifrin, Inc. Oct. 1980

PLATE 4

, 2

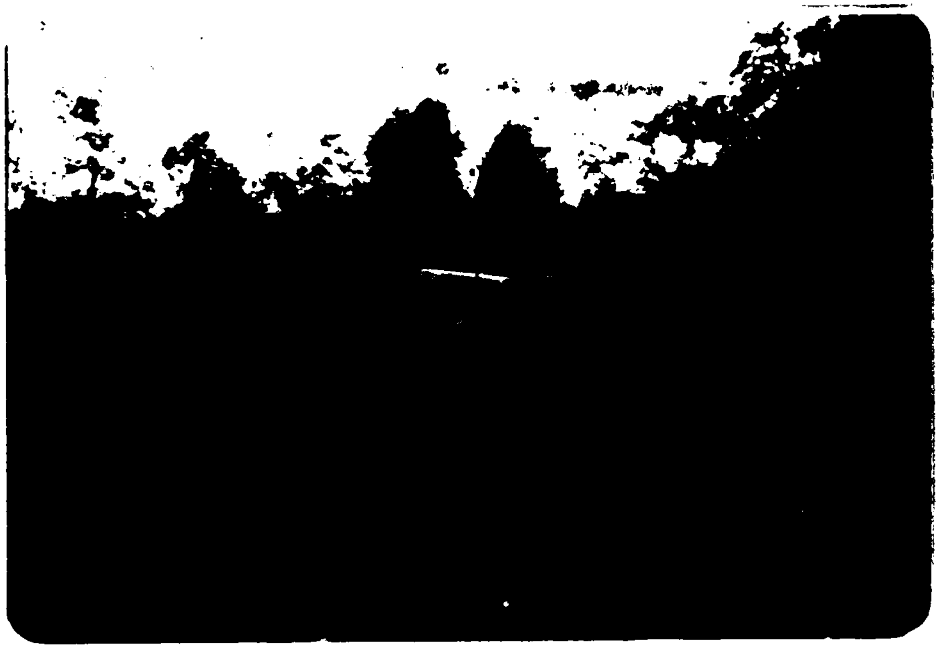
APPENDIX A

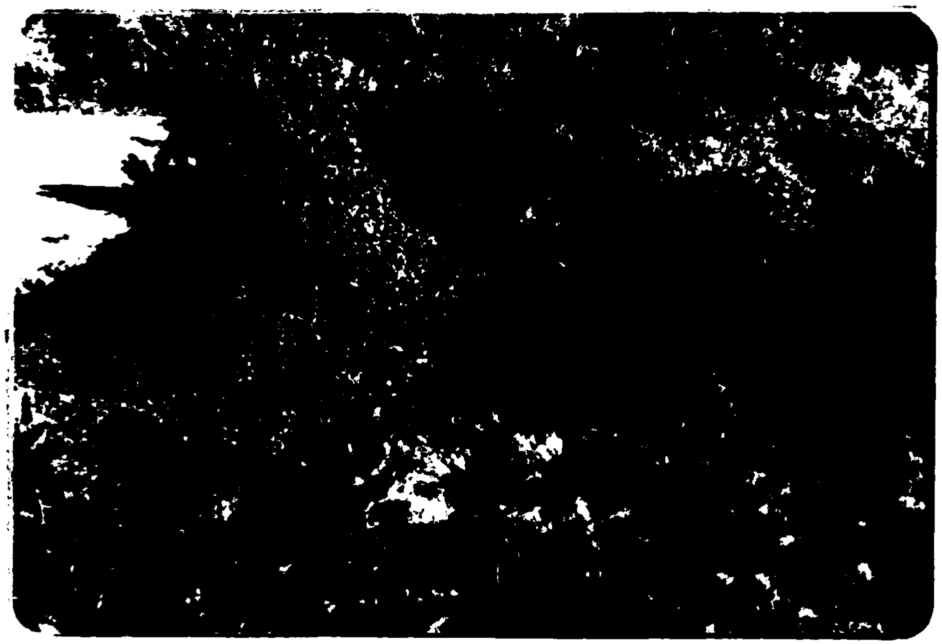
INSPECTION PHOTOGRAPHS

1	2
3	X

PHOTO KEY

NO.	DESCRIPTION
1	DAM OVERVIEW
2	UPSTREAM FACE OF DAM
3	DOWNSTREAM FACE OF DAM





4	5
6	☒

PHOTO KEY

NO.	DESCRIPTION
4	SPILLWAY CREST
5	EXIT SECTION OF SPILLWAY CHANNEL
6	DOWNSTREAM AREA ADJACENT TO DAM

7	8
9	⊠

PHOTO KEY

NO.	DESCRIPTION
7	REMNANT OF ANIMAL BURROW
8	TREES IN DOWNSTREAM FACE OF DAM
9	EROSION GULLEY IN SPILLWAY CHANNEL

APPENDIX B

HYDROLOGIC AND HYDRAULIC ANALYSFS

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

1. The HEC-1 Dam Safety Version (July 1978, Modified 26 February 1979) program was used to develop inflow and outflow hydrographs and dam overtopping analyses, with hydrologic inputs as follows:

a. Probable maximum precipitation (200 sq. miles, 24-hour value equals 25.5 inces) from Hydrometerological Report No. 33. The precipitation data used in the analysis of the 1 percent chance (100-year frequency) and the 10 percent chance (10-year frequency) floods were provided by the St. Louis District, Corps of Engineers.

b. Drainage area = 0.095 square miles = 61 acres.

c. SCS parameters:

Time of Concentration (Tc) = $\left(\frac{11.9L^3}{H}\right)^{0.385}$ = 0.124 hours

Where: T_c = Travel time of water from hydraulically most distant point to point of interest, hours.
L = Length of longest watercourse = 0.407 miles.
H = Elevation difference = 180 feet.

The time of concentration (Tc) was obtained using method C as described in Fig. 30, "Design of Samll Dams", by the United States Department of the Interior, Bureau of Reclamation, and was verified using average channel velocity estimates and watercourse lengths.

Lag time = 0.075 hours (0.60 Tc)

Hydrologic Soil Group = 100% D (Gasconade Series with wooded hillsides per SCS Missouri General Soil Map and field inspection)

Soil type CN = 79 (AMC II, 100-yr flood)
= 91 (AMC III, PMF condition)

2. The spillway consists of a broad-crested trapezoidal section, for which conventional weir formulas do not apply.

Spillway release rates were determined as follows:

a. Spillway crest section properties (areas, "a", and top width, "t") were computed for various depths, "d".

b. It was assumed that flow over the spillway crest would occur at critical depth. Flow at critical depth Q_c was computed as $Q_c = \left(\frac{a^3 g}{t}\right)^{0.5}$ for the various depths, "d". Corresponding velocities (v_c) and velocity heads (H_{vc}) were determined using conventional formulas.* Reference "Handbook of Hydraulics", Fifth Edition, by King & Brater, page 8-7.

c. Static lake levels corresponding to the various flow values passing the spillway were computed as critical depths plus critical velocity heads ($d_c + H_{vc}$), and the relationship between lake level and spillway discharge was thus obtained. The procedure neglects the minor insignificant friction losses across the length of the spillway.

d. The spillway discharges for corresponding elevations were entered on the Y4 and Y5 cards. Calculations for determining the capacity of the spillway are presented on page B-11.

3. The profile of the dam crest is irregular and flow over the dam cannot be determined by application of conventional weir formulas. Crest length and elevation data for the dam crest proper were entered into the HEC-1 Program on the $L and $V cards. The program assumes that flow over the dam crest occurs at critical depth and computes internally the flow passing the dam crest and adds this flow to the flow passing the spillways as entered on the Y4 and Y5 cards.

* $v_c = \frac{Qc}{a}$; $Hvc = \frac{v_c^2}{2g}$

```
A1         ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2         HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF KEARNEY LAKE DAM
A3         RATIOS OF PMF ROUTED THROUGH RESERVOIR
B      288       0       5       0       0       0       0       0       0       0
B1       5
J        1       4       1
J1    0.23    0.24    0.50    1.00
K        0  INFLOW                                       1
K1         INFLOW HYDROGRAPH
M        1       2   0.095                     1.0                       1
P        0    25.5     102     120     130
T                                                       -1     -91
W2           0.075
X     -1.0    -.10     2.0
K        1     DAM                                       1
K1         RESERVOIR ROUTING BY MODIFIED PULS
Y                                1       1
Y1       1                                           16.20      -1
Y4 715.0    715.12  715.66  716.33  716.65  717.36  717.87  718.38  718.54  719.25
Y4719.95    720.65  721.34  722.02  722.70  723.37  724.05  724.72
Y5       0     0.4    13.2    54.2     106   176.5     266     378     420     640
Y5     892    1179    1496    1847    2272    2640    3084    3562
$A       0     2.7     3.7     6.0     8.0
$E     697     715     720     730     740
$$ 715.0
$D 717.5
$L       0      65      79     140     230     261     288     323
$V 717.5     717.7   717.8   718.0   718.1   719.7   721.6   729.7
K       99
```

```
1A1       ANALYSIS OF DAM OVERTOPPING USING 100 YR FLOOD
A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF KEARNEY LAKE DAM
A3       100-YR FLOOD ROUTED THROUGH RESERVOIR
B     288       0       5                                             4
B1      5
J       1       1       1
J1   1.00
K       0  INFLOW                                       1
K1        INFLOW HYDROGRAPH
M       0       2   0.095                   1.0                       1
O     288   6.974
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
01   .007    .007    .012    .012    .012    .012    .012    .012    .012    .012
01   .012    .012    .012    .012    .012    .012    .012    .012    .012    .012
01   .012    .012    .012    .012    .012    .012    .012    .012    .012    .012
01   .012    .012    .012    .012    .012    .012    .012    .012    .023    .023
01   .023    .023    .023    .023    .023    .023    .023    .023    .023    .023
01   .023    .023    .023    .023    .023    .023    .030    .030    .030    .030
01   .030    .030    .048    .048    .048    .049    .049    .049    .134    .134
01   .134    .255    .255    .540    .817    .300    .255    .134    .134    .134
01   .049    .049    .049    .048    .048    .048    .030    .030    .030    .030
01   .030    .030    .023    .023    .023    .023    .023    .023    .023    .023
01   .023    .023    .023    .023    .023    .023    .023    .023    .023    .023
```

100-YR. FLOOD (Cont'd)

```
O1  .012    .012    .012    .012    .012    .012    .012    .012    .012    .012
O1  .012    .012    .012    .012    .012    .012    .012    .012    .012    .012
O1  .012    .012    .012    .012    .012    .012    .012    .012    .012    .012
O1  .012    .012    .012    .012    .012    .012    .007    .007    .007    .007
O1  .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1  .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1  .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1  .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1  .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1  .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1  .007    .007    .007    .007    .007    .007    .007    .007
T                                                     -1     -79
W2          0.075
X   -1.0    -.10     2.0
K      1     DAM                                       1
K1     RESERVOIR ROUTING BY MODIFIED PULS
Y                                1       1
Y1     1                                          16.20      -1
Y4 715.0  715.12  715.66  716.33  716.85  717.36  717.87  718.38  718.54  719.25
Y4719.95  720.65  721.34  722.02  722.70  723.37  724.05  724.72
Y5     0     0.4    13.2    54.2     106   176.5     266     378     420     640
Y5   892    1179    1496    1847    2229    2640    3086    3562
$A     0     2.7     3.7     6.0     8.0
$E   697     715     720     730     740
$$ 715.0
$D 717.5
$L     0      65      79     140     230     261     288     323
$V 717.5   717.7   717.8   718.0   718.1   719.7   721.6   729.7
K     99
```

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF KEARNEY LAKE DAM
RATIOS OF PMF ROUTED THROUGH RESERVOIR

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1
RTIOS= .23 .24 .50 1.00

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

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

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

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.10	0.00	.10	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.50	102.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

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

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

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .08

RECESSION DATA
STRTQ= -1.00 QRCSN= -.10 RTIOR= 2.00

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

UNIT HYDROGRAPH 6 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .08 VOL= 1.00
321. 288. 87. 27. 9. 3.

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.05	145	.22	.21	.01	94.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.10	146	.22	.21	.00	137.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.15	147	.22	.21	.00	150.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.20	148	.22	.21	.00	154.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.25	149	.22	.21	.00	156.
1.01	.30	6	.01	0.00	.01	0.	1.01	12.30	150	.22	.21	.00	157.
1.01	.35	7	.01	0.00	.01	0.	1.01	12.35	151	.22	.21	.00	157.
1.01	.40	8	.01	0.00	.01	0.	1.01	12.40	152	.22	.21	.00	157.
1.01	.45	9	.01	0.00	.01	0.	1.01	12.45	153	.22	.21	.00	157.
1.01	.50	10	.01	0.00	.01	0.	1.01	12.50	154	.22	.21	.00	157.
1.01	.55	11	.01	0.00	.01	0.	1.01	12.55	155	.22	.21	.00	157.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.00	156	.22	.21	.00	157.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.05	157	.26	.26	.00	171.
1.01	1.10	14	.01	.00	.01	0.	1.01	13.10	158	.26	.26	.00	184.
1.01	1.15	15	.01	.00	.01	0.	1.01	13.15	159	.26	.26	.00	187.
1.01	1.20	16	.01	.00	.01	0.	1.01	13.20	160	.26	.26	.00	189.
1.01	1.25	17	.01	.00	.01	1.	1.01	13.25	161	.26	.26	.00	189.
1.01	1.30	18	.01	.00	.01	1.	1.01	13.30	162	.26	.26	.00	189.
1.01	1.35	19	.01	.00	.01	1.	1.01	13.35	163	.26	.26	.00	190.
1.01	1.40	20	.01	.00	.01	1.	1.01	13.40	164	.26	.26	.00	190.
1.01	1.45	21	.01	.00	.01	2.	1.01	13.45	165	.26	.26	.00	190.
1.01	1.50	22	.01	.00	.01	2.	1.01	13.50	166	.26	.26	.00	190.
1.01	1.55	23	.01	.00	.01	2.	1.01	13.55	167	.26	.26	.00	190.
1.01	2.00	24	.01	.00	.01	2.	1.01	14.00	168	.26	.26	.00	190.
1.01	2.05	25	.01	.00	.01	2.	1.01	14.05	169	.33	.32	.00	211.
1.01	2.10	26	.01	.00	.01	3.	1.01	14.10	170	.33	.32	.00	229.
1.01	2.15	27	.01	.00	.01	3.	1.01	14.15	171	.33	.32	.00	235.
1.01	2.20	28	.01	.00	.01	3.	1.01	14.20	172	.33	.32	.00	237.
1.01	2.25	29	.01	.00	.01	3.	1.01	14.25	173	.33	.32	.00	238.
1.01	2.30	30	.01	.00	.01	3.	1.01	14.30	174	.33	.32	.00	238.
1.01	2.35	31	.01	.00	.01	3.	1.01	14.35	175	.33	.32	.00	238.
1.01	2.40	32	.01	.01	.01	4.	1.01	14.40	176	.33	.32	.00	238.
1.01	2.45	33	.01	.01	.01	4.	1.01	14.45	177	.33	.32	.00	238.
1.01	2.50	34	.01	.01	.01	4.	1.01	14.50	178	.33	.32	.00	238.
1.01	2.55	35	.01	.01	.01	4.	1.01	14.55	179	.33	.32	.00	238.
1.01	3.00	36	.01	.01	.01	4.	1.01	15.00	180	.33	.32	.00	233.
1.01	3.05	37	.01	.01	.01	4.	1.01	15.05	181	.20	.20	.00	197.
1.01	3.10	38	.01	.01	.01	4.	1.01	15.10	182	.40	.39	.00	224.
1.01	3.15	39	.01	.01	.01	5.	1.01	15.15	183	.40	.39	.00	270.
1.01	3.20	40	.01	.01	.01	5.	1.01	15.20	184	.59	.59	.00	347.
1.01	3.25	41	.01	.01	.01	5.	1.01	15.25	185	.69	.69	.00	440.
1.01	3.30	42	.01	.01	.01	5.	1.01	15.30	186	1.68	1.68	.00	803.
1.01	3.35	43	.01	.01	.01	5.	1.01	15.35	187	2.77	2.76	.01	1450.
1.01	3.40	44	.01	.01	.01	5.	1.01	15.40	188	1.09	1.09	.00	1316.
1.01	3.45	45	.01	.01	.01	5.	1.01	15.45	189	.69	.69	.00	829.
1.01	3.50	46	.01	.01	.01	5.	1.01	15.50	190	.59	.59	.00	575.
1.01	3.55	47	.01	.01	.01	5.	1.01	15.55	191	.40	.39	.00	416.
1.01	4.00	48	.01	.01	.01	6.	1.01	16.00	192	.40	.39	.00	328.
1.01	4.05	49	.01	.01	.01	6.	1.01	16.05	193	.30	.30	.00	271.

END-OF-PERIOD FLOW (Cont'd)

1.01	4.10	50	.01	.01	.01	6.	1.01	16.10	194	.30	.30	.00	237.
1.01	4.15	51	.01	.01	.01	6.	1.01	16.15	195	.30	.30	.00	227.
1.01	4.20	52	.01	.01	.01	6.	1.01	16.20	196	.30	.30	.00	224.
1.01	4.25	53	.01	.01	.01	6.	1.01	16.25	197	.30	.30	.00	223.
1.01	4.30	54	.01	.01	.01	6.	1.01	16.30	198	.30	.30	.00	223.
1.01	4.35	55	.01	.01	.01	6.	1.01	16.35	199	.30	.30	.00	223.
1.01	4.40	56	.01	.01	.01	6.	1.01	16.40	200	.30	.30	.00	223.
1.01	4.45	57	.01	.01	.01	6.	1.01	16.45	201	.30	.30	.00	223.
1.01	4.50	58	.01	.01	.01	6.	1.01	16.50	202	.30	.30	.00	223.
1.01	4.55	59	.01	.01	.01	6.	1.01	16.55	203	.30	.30	.00	223.
1.01	5.00	60	.01	.01	.01	7.	1.01	17.00	204	.30	.30	.00	223.
1.01	5.05	61	.01	.01	.01	7.	1.01	17.05	205	.24	.24	.00	202.
1.01	5.10	62	.01	.01	.01	7.	1.01	17.10	206	.24	.24	.00	183.
1.01	5.15	63	.01	.01	.00	7.	1.01	17.15	207	.24	.24	.00	178.
1.01	5.20	64	.01	.01	.00	7.	1.01	17.20	208	.24	.24	.00	176.
1.01	5.25	65	.01	.01	.00	7.	1.01	17.25	209	.24	.24	.00	175.
1.01	5.30	66	.01	.01	.00	7.	1.01	17.30	210	.24	.24	.00	175.
1.01	5.35	67	.01	.01	.00	7.	1.01	17.35	211	.24	.24	.00	175.
1.01	5.40	68	.01	.01	.00	7.	1.01	17.40	212	.24	.24	.00	175.
1.01	5.45	69	.01	.01	.00	7.	1.01	17.45	213	.24	.24	.00	175.
1.01	5.50	70	.01	.01	.00	7.	1.01	17.50	214	.24	.24	.00	175.
1.01	5.55	71	.01	.01	.00	7.	1.01	17.55	215	.24	.24	.00	175.
1.01	6.00	72	.01	.01	.00	7.	1.01	18.00	216	.24	.24	.00	175.
1.01	6.05	73	.06	.05	.02	19.	1.01	18.05	217	.02	.02	.00	[illegible]
1.01	6.10	74	.06	.05	.02	29.	1.01	18.10	218	.02	.02	.00	130.
1.01	6.15	75	.06	.05	.02	33.	1.01	18.15	219	.02	.02	.00	121.
1.01	6.20	76	.06	.05	.02	35.	1.01	18.20	220	.02	.02	.00	113.
1.01	6.25	77	.06	.05	.01	36.	1.01	18.25	221	.02	.02	.00	[illegible]
1.01	6.30	78	.06	.05	.01	37.	1.01	18.30	222	.02	.02	.00	[illegible]
1.01	6.35	79	.06	.05	.01	37.	1.01	18.35	223	.02	.02	.00	[illegible]
1.01	6.40	80	.06	.05	.01	38.	1.01	18.40	224	.02	.02	.00	86.
1.01	6.45	81	.06	.05	.01	38.	1.01	18.45	225	.02	.02	.00	80.
1.01	6.50	82	.06	.05	.01	39.	1.01	18.50	226	.02	.02	.00	75.
1.01	6.55	83	.06	.05	.01	39.	1.01	18.55	227	.02	.02	.00	70.
1.01	7.00	84	.06	.05	.01	39.	1.01	19.00	228	.02	.02	.00	65.
1.01	7.05	85	.06	.05	.01	40.	1.01	19.05	229	.02	.02	.00	61.
1.01	7.10	86	.06	.06	.01	40.	1.01	19.10	230	.02	.02	.00	57.
1.01	7.15	87	.06	.06	.01	41.	1.01	19.15	231	.02	.02	.00	53.
1.01	7.20	88	.06	.06	.01	41.	1.01	19.20	232	.02	.02	.00	49.
1.01	7.25	89	.06	.06	.01	41.	1.01	19.25	233	.02	.02	.00	[illegible]
1.01	7.30	90	.06	.06	.01	41.	1.01	19.30	234	.02	.02	.00	43.
1.01	7.35	91	.06	.06	.01	42.	1.01	19.35	235	.02	.02	.00	40.
1.01	7.40	92	.06	.06	.01	42.	1.01	19.40	236	.02	.02	.00	37.
1.01	7.45	93	.06	.06	.01	42.	1.01	19.45	237	.02	.02	.00	35.
1.01	7.50	94	.06	.06	.01	42.	1.01	19.50	238	.02	.02	.00	33.
1.01	7.55	95	.06	.06	.01	42.	1.01	19.55	239	.02	.02	.00	30.
1.01	8.00	96	.06	.06	.01	43.	1.01	20.00	240	.02	.02	.00	28.
1.01	8.05	97	.06	.06	.01	43.	1.01	20.05	241	.02	.02	.00	26.
1.01	8.10	98	.06	.06	.01	43.	1.01	20.10	242	.02	.02	.00	25.
1.01	8.15	99	.06	.06	.01	43.	1.01	20.15	243	.02	.02	.00	[illegible]
1.01	8.20	100	.06	.06	.00	43.	1.01	20.20	244	.02	.02	.00	21.
1.01	8.25	101	.06	.06	.00	43.	1.01	20.25	245	.02	.02	.00	20.
1.01	8.30	102	.06	.06	.00	43.	1.01	20.30	246	.02	.02	.00	19.

END-OF-PERIOD FLOW (Cont'd)

1.01	8.35	103	.06	.06	.00	44.
1.01	8.40	104	.06	.06	.00	44.
1.01	8.45	105	.06	.06	.00	44.
1.01	8.50	106	.06	.06	.00	44.
1.01	8.55	107	.06	.06	.00	44.
1.01	9.00	108	.06	.06	.00	44.
1.01	9.05	109	.06	.06	.00	44.
1.01	9.10	110	.06	.06	.00	44.
1.01	9.15	111	.06	.06	.00	44.
1.01	9.20	112	.06	.06	.00	44.
1.01	9.25	113	.06	.06	.00	44.
1.01	9.30	114	.06	.06	.00	45.
1.01	9.35	115	.06	.06	.00	45.
1.01	9.40	116	.06	.06	.00	45.
1.01	9.45	117	.06	.06	.00	45.
1.01	9.50	118	.06	.06	.00	45.
1.01	9.55	119	.06	.06	.00	45.
1.01	10.00	120	.06	.06	.00	45.
1.01	10.05	121	.06	.06	.00	45.
1.01	10.10	122	.06	.06	.00	45.
1.01	10.15	123	.06	.06	.00	45.
1.01	10.20	124	.06	.06	.00	45.
1.01	10.25	125	.06	.06	.00	45.
1.01	10.30	126	.06	.06	.00	45.
1.01	10.35	127	.06	.06	.00	45.
1.01	10.40	128	.06	.06	.00	45.
1.01	10.45	129	.06	.06	.00	45.
1.01	10.50	130	.06	.06	.00	45.
1.01	10.55	131	.06	.06	.00	45.
1.01	11.00	132	.06	.06	.00	45.
1.01	11.05	133	.06	.06	.00	45.
1.01	11.10	134	.06	.06	.00	45.
1.01	11.15	135	.06	.06	.00	45.
1.01	11.20	136	.06	.06	.00	46.
1.01	11.25	137	.06	.06	.00	46.
1.01	11.30	138	.06	.06	.00	46.
1.01	11.35	139	.06	.06	.00	46.
1.01	11.40	140	.06	.06	.00	46.
1.01	11.45	141	.06	.06	.00	46.
1.01	11.50	142	.06	.06	.00	46.
1.01	11.55	143	.06	.06	.00	46.
1.01	12.00	144	.06	.06	.00	46.
1.01	20.35	247	.02	.02	.00	17.
1.01	20.40	248	.02	.02	.00	16.
1.01	20.45	249	.02	.02	.00	16.
1.01	20.50	250	.02	.02	.00	16.
1.01	20.55	251	.02	.02	.00	16.
1.01	21.00	252	.02	.02	.00	16.
1.01	21.05	253	.02	.02	.00	16.
1.01	21.10	254	.02	.02	.00	16.
1.01	21.15	255	.02	.02	.00	16.
1.01	21.20	256	.02	.02	.00	16.
1.01	21.25	257	.02	.02	.00	16.
1.01	21.30	258	.02	.02	.00	16.
1.01	21.35	259	.02	.02	.00	16.
1.01	21.40	260	.02	.02	.00	16.
1.01	21.45	261	.02	.02	.00	16.
1.01	21.50	262	.02	.02	.00	16.
1.01	21.55	263	.02	.02	.00	16.
1.01	22.00	264	.02	.02	.00	16.
1.01	22.05	265	.02	.02	.00	16.
1.01	22.10	266	.02	.02	.00	16.
1.01	22.15	267	.02	.02	.00	16.
1.01	22.20	268	.02	.02	.00	16.
1.01	22.25	269	.02	.02	.00	16.
1.01	22.30	270	.02	.02	.00	16.
1.01	22.35	271	.02	.02	.00	16.
1.01	22.40	272	.02	.02	.00	16.
1.01	22.45	273	.02	.02	.00	16.
1.01	22.50	274	.02	.02	.00	16.
1.01	22.55	275	.02	.02	.00	16.
1.01	23.00	276	.02	.02	.00	16.
1.01	23.05	277	.02	.02	.00	16.
1.01	23.10	278	.02	.02	.00	16.
1.01	23.15	279	.02	.02	.00	16.
1.01	23.20	280	.02	.02	.00	16.
1.01	23.25	281	.02	.02	.00	16.
1.01	23.30	282	.02	.02	.00	16.
1.01	23.35	283	.02	.02	.00	16.
1.01	23.40	284	.02	.02	.00	16.
1.01	23.45	285	.02	.02	.00	16.
1.01	23.50	286	.02	.02	.00	16.
1.01	23.55	287	.02	.02	.00	16.
1.02	0.00	288	.02	.02	.00	16.
		SUM	33.15	31.99	1.16	24750.
			(842.)	(813.)	(29.)	(701.07)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1450.	264.	36.	36.	24733.
CMS	41.	7.	1.	1.	700.
INCHES		25.80	33.64	33.64	33.64
MM		655.40	854.37	854.37	854.37
AC-FT		131.	170.	170.	170.
THOUS CU M		161.	210.	210.	210.

SURFACE AREA=	0.	3.	4.	6.	8.
CAPACITY=	0.	16.	32.	80.	150.
ELEVATION=	697.	715.	720.	730.	740.

SUMMARY OF DAM SAFETY ANALYSIS
PMF

....	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	715.00	715.00	717.50
STORAGE	16.	16.	24.
OUTFLOW	0.	0.	201.

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
.23	717.46	0.00	23.	195.	0.00	15.75	0.00
.24	717.53	.03	24.	206.	.08	15.75	0.00
.50	718.39	.89	26.	665.	.58	15.67	0.00
1.00	718.98	1.48	28.	1419.	3.08	15.67	0.00

SUMMARY OF DAM SAFETY ANALYSIS
100-YR. FLOOD

....	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	715.00	715.00	717.50
STORAGE	16.	16.	24.
OUTFLOW	0.	0.	201.

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	717.43	0.00	23.	190.	0.00	15.75	0.00

CONSULTING ENGINEERS
5200 OAKLAND AVE. ST. LOUIS, MO. 63110

SHEET NO. ____ OF ____ JOB NO. 2011

SUBJECT FILE

TITLE: Kearney Dam
Spillway Capacity #11099

BY HBL DATE 10/1/80 CHECKED ABB DATE 10/2/80

Spillway Capacity —

Elev.	d		ΔA	ΣΔA	T	A^{3}/T	Q	V	Ho	d+Ho	Elev.
715.0	0				0		0			0	715.0
715.1	0.1	$6.2(\frac{0.1}{2})$	0.31	0.31	6.2		0.4	1.27	0.02	0.12	715.12
715.5	0.5	$(6.2+12.8)\frac{0.4}{2}$	3.80	4.11	12.8		13.2	3.22	0.16	0.66	715.66
[illegible]	1.0	$(12.8+17.9)\frac{0.5}{2}$	7.65	11.76	17.9		54.2	4.61	0.33	1.33	716.33
[illegible]	1.4	$(17.9+21.9)\frac{0.4}{2}$	7.94	19.70	21.9		106.0	5.38	0.45	1.85	716.85
[illegible]	1.8	$(21.9+25.9)\frac{0.4}{2}$	9.56	29.26	25.9		176.5	6.03	0.56	2.36	717.36
[illegible]	2.2	$(25.9+30.0)\frac{0.4}{2}$	11.18	40.44	30.0		262.4	6.59	0.67	2.87	717.87
[illegible]	2.6	$(30.+34.)\frac{0.4}{2}$	12.8	53.24	34.0		372.5	7.10	0.78	3.38	718.38
[illegible]	2.8	$(34+40.8)\frac{0.2}{2}$	7.48	60.72	40.8		420.3	6.92	0.74	3.54	718.54
[illegible]	3.2	$(40.8+42.8)\frac{0.5}{2}$	20.9	81.6	42.8		539.6	7.84	0.95	4.25	719.25
[illegible]	3.8	(42.8+44.9) [illegible]	[illegible]	[illegible]	44.9		[illegible]	8.6	1.15	4.95	719.95
[illegible]	4.3	(44.9+46.9) [illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	1.35	5.65	720.65
[illegible]	4.8	(46.9+49.0) [illegible]	[illegible]	152.4	[illegible]		[illegible]	[illegible]	1.54	6.34	721.34
	5.3	(49.0+51.) [illegible]	[illegible]	175.47	[illegible]		[illegible]	10.53	1.72	7.02	722.02
[illegible]	[illegible]	(51.+53.) [illegible]	[illegible]	[illegible]	[illegible]		[illegible]	11.06	[illegible]	[illegible]	[illegible]
	[illegible]	(53.+55.) [illegible]	[illegible]	[illegible]	—		[illegible]	[illegible]	[illegible]	[illegible]	722.87
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	12.0	[illegible]	[illegible]	[illegible]
		(..+58.1) [illegible]	[illegible]	[illegible]			[illegible]	12.47	[illegible]	9.72	724.[illegible]