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NATIONAL DAM SAFETY PROGRAM. KERNODLE LAKE DAM NUMBER 2, (MO 20--ETC(U)
SEP 79 P R ZAMAN, E R BURTON, H L CALLAHAN DACW43-79-C-0040

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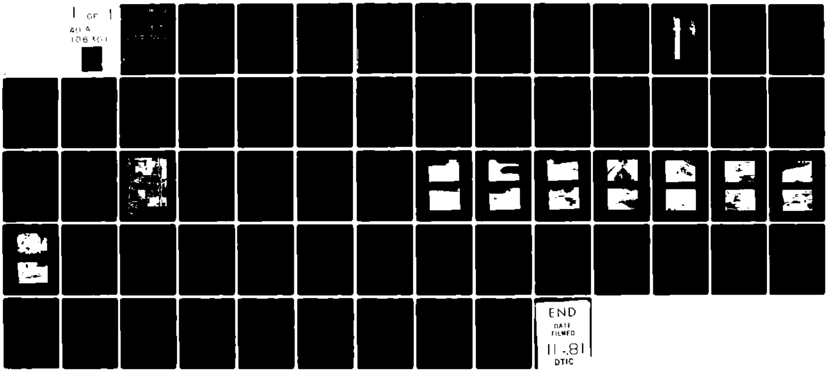

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MISSOURI-KANSAS CITY BASIN

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KERNODLE LAKE DAM NO. 2

JACKSON COUNTY, MISSOURI

MO 20374

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

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

SEPTEMBER 1979

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REPORT DOCUMENTATION PAGE

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Phase I Dam Inspection Report
National Dam Safety Program
Kernodle Lake Dam #2 (MO 20374)
Jackson County, Missouri

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National Dam Safety Program. Kernodle Lake Dam Number 2,(MO 20374), Missouri - Kansas City Basin, Jackson 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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MISSOURI-KANSAS CITY BASIN

KERNODLE LAKE DAM NO. 2

JACKSON COUNTY, MISSOURI

MO 20374

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

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

SEPTEMBER 1979

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

REPLY TO
ATTENTION OF

SUBJECT: Kernodle Lake Dam No. 2 Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Kernodle Lake Dam No. 2 (MO 20374).

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

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

1) Spillway will not pass a 10-year frequency flood without overtopping of the dam. The spillway is, therefore, considered to be unusually small and seriously inadequate.

2) Overtopping could result in dam failure.

3) Dam failure significantly increases the hazard to life and property downstream.

Submitted By:	SIGNED Chief, Engineering Division	28 FEB 1980 Date
Approved By:	SIGNED Colonel, CE, District Engineer	28 FEB 1980 Date

KERNODLE LAKE DAM NO. 2

JACKSON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 20374

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

SEPTEMBER 1979

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Kernodle Lake Dam No. 2
State Located	Missouri
County Located	Jackson County
Stream	Tributary to the Blue River
Date of Inspection	6 September 1979

Kernodle Lake Dam No. 2 was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and developed with the help of several Federal and state agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers, failure would threaten the life and property of approximately nine families downstream of the dam and would potentially cause damage to two buildings, two improved roads, two lakes and a park area within the estimated damage zone, which extends approximately three miles downstream of the dam.

Our inspection and evaluation indicates the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will not pass the 10-year flood but will pass 5 percent of the probable maximum flood without overtopping the dam. Considering the small volume of water impounded, the characteristics of upstream reservoirs, and the downstream hazard zone, 50 percent of the probable maximum flood is the appropriate spillway design flood. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

Deficiencies visually observed by the inspection team were an area of possible seepage at the right abutment, brush and small trees growing on both the upstream and downstream embankments, erosion on the upstream slope, and mole paths on the crest and downstream slopes. Seepage and stability analyses required by the guidelines were not available.

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

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Black & Veatch

OVERVIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
KERNODLE LAKE DAM NO. 2

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APPENDIX

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Kernodle Lake Dam No. 2 be made.

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

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

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The Kernodle Lake Dam No. 2, hereafter referred to in this report as Dam No. 2, is an earthen structure located in southwestern Jackson County, Missouri on a tributary to the Blue River. The principal purpose for this dam is recreation. Dam No. 2 is located on property owned by Mr. John Kernodle of Kansas City, Missouri. The dam is 24 feet wide at the crest, 765 feet long, and 29 feet high. The dam has a spillway located at the left abutment. The embankment has riprap protection on the upstream slope and adequate grass cover on the crest and downstream slope. The clubhouse is located on the right abutment. The foundation of the clubhouse, as observed by the inspection team, is a concrete wall which extends one story below the crest. A swimming area is formed in the northwest corner of the lake in front of the clubhouse by a concrete wall extending below the water surface.

(2) A concrete spillway is located at the left abutment. It consists of a narrow crest and a discharge chute. The channel has a rectangular section with a heavy growth of brush and trees on each side. Several rocks and concrete blocks lie at the upstream side of the crest.

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

b. Location. The dam is located in southwestern Jackson County, Missouri, as indicated on Plate 1. The lake formed by the dam is shown on the United States Geological Survey 7.5 minute series quadrangle map for Grandview, Missouri in Section 10 of T47N, R33W.

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

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Kernodle Lake Dam No. 2 has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, agricultural, industrial, and commercial facilities, and to important public utilities, main highways, or railroads. For Dam No. 2, the estimated flood damage zone extends downstream for approximately three miles. Within the damage zone are nine homes, two buildings, two lakes, a park, and two improved roads.

e. Ownership. The dam is owned by Mr. John Kernodle, 4100 E. 119th St., Kansas City, Missouri 64137, Telephone (816)763-7000.

f. Purpose of Dam. The dam forms a 19-acre recreational lake.

g. Design and Construction History. According to the owner the dam was constructed in 1954 by James Gould Construction Company. Data relating to the design and construction were not available.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, and evaporation, in addition to the operation of the 8-inch siphon and the discharge through the uncontrolled spillway, all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 784 acres (includes 660 acres of area above several upstream impoundments).

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through an uncontrolled principal spillway.

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

(3) Estimated ungated spillway capacity at maximum pool elevation - 600 cfs (Probable Maximum Flood Pool El.911.0).

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

(1) Top of dam - 906.8 (see Plate 3)

(2) Spillway crest - 904.6

(3) Streambed at toe of dam - 878.0

(4) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 1,400 feet ±

(2) Length of normal pool - 1,300 feet ±

e. Storage (Acre-feet).

(1) Top of dam - 209

(2) Spillway crest - 167

f. Reservoir Surface (Acres).

(1) Top of dam - 20 ±

(2) Spillway crest - 19 ±

g. Dam.

(1) Type - Earth embankment

(2) Length - 765 feet

(3) Height - 29 feet ±

(4) Top width - 24 feet

(5) Side slopes - upstream face 1.0 V on 2.2 H, downstream face between 1.0 V on 2.3 H and 1.0 V on 5.9 H.

(6) Zoning - Unknown.

(7) Impervious core - Unknown.

(8) Cutoff - Unknown.

(9) Grout curtain - Unknown.

(10) Internal drainage system - None.

h. Diversion and Regulating Tunnel - None.

i. Spillway.

(1) Type - Chute spillway with rectangular cross section.

(2) Bottom width of channel - 12 feet.

(3) Channel side slopes - Vertical.

(4) Crest elevation - 904.6 feet m.s.l.

(5) Gates - None.

(6) Upstream channel - Not applicable.

(7) Downstream channel - Concrete lined channel which discharges through a concrete box culvert into Kernodle Lake No. 1.

j. Regulating Outlets.

(1) Type - Siphon pipe and valve.

(2) Size of pipe - 8 inch cast iron.

(3) Inlet elevation - Unknown.

(4) Outlet elevation - Unknown.

(5) Downstream channel - Not applicable.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data were unavailable.

2.2 CONSTRUCTION

The dam was constructed in 1954 by James Gould Construction Company. Further construction data were unavailable.

2.3 OPERATION

Documentation of past floods was unavailable.

2.4 GEOLOGY

Design drawings, construction records, and geologic reports for the dam and reservoir sites were not available. The geologic conditions were determined from existing general data on the site and from visual observations made during the inspection of the dam.

The dam is located in a broad valley formed in interbedded limestones and shales that are overlain by soils derived from bedrock and loess. Alluvial soils are present along the streams. The bedrock in the area consists of Pennsylvanian age shales and limestones of the Desmoinesian Series, Kansas City Group, Linn and Zarah subgroups. The surficial soils have been mapped by the Soil Conservation Service as Sharpsburg, on the ridges and interstream divides, and as a Polo-Sogn soil association complex on the slopes and in the valleys.

The Sharpsburg soil is developed from loess and the Polo-Sogn soil association is developed from loess or residuum over shales or weathered limestones. The alluvial soils consist of sand, gravel, and various size fragments of weathered bedrock along, and within, the stream channel.

The foundation and the abutments of the dam are anticipated to be Polo-Sogn soil overlying interbedded limestone and shale units. It is anticipated that pervious alluvial soils were removed from the foundation prior to construction. The spillway is constructed at the left abutment in limestone and shale beds. The limestone consists of thin-bedded units approximately six inches thick. The bedding is horizontal with closed bedding planes. The unit, where exposed, is approximately eight feet thick. Water was discharging from the reservoir through the spillway and the presence of seepage through the unit could not be determined.

2.5 EVALUATION

a. Availability. No engineering data could be obtained.

b. Adequacy. No engineering data were available upon which to make a detailed assessment of the design, construction, and operation. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions, including earthquake loads, and made a matter of record.

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

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Dam No. 2 was made on 6 September 1979. The inspection team included professional engineers with experience in dam design and construction, hydrology, hydraulic engineering, and geotechnical engineering. This dam appeared to be in generally good condition. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed that the dam appeared to be in generally good condition with no visible stability problems. Dense vegetal growth indicated a possible area of slow seepage located near a large willow tree downstream of the toe on the right abutment.

The only erosion observed was at several isolated spots in the riprap slope protection on the upstream face where clay (CL) material was being eroded. The upstream face is covered with a heavy growth of brush and small trees which hindered the inspection. The upstream face near the right abutment is protected by a concrete wall extending 1 to 2 feet above normal pool level with a sand beach area downstream and to the right of the wall. No evaluation could be made of erosion protection on the upstream face in those areas where observations were hindered.

The crest of the dam is well protected with grass cover. Some evidence of mole paths were observed both on the crest and on the downstream face. The upper portion of the downstream face is covered with grass, some brush and small trees. One large willow tree is growing downstream of the toe on the right abutment.

There is no evidence that the dam has ever been overtopped nor is there evidence of sliding, cracking, settlement, or sinkholes. Mr. Kernodle confirmed that to his knowledge the structure has not been overtopped.

c. Appurtenant Structures. The inspection team observed the following items pertaining to appurtenant structures. A concrete chute spillway which was constructed near the left abutment appears in good condition. The spillway will act as a broad-crested weir. The sides of the spillway are protected by vertical concrete block retaining walls. The right retaining wall protects the embankment. The height of the left retaining wall decreases from about 3 feet high at the upstream side to one concrete block high at the downstream side near the culvert. The spillway discharge flows through a concrete box culvert.

An 8-inch diameter cast iron siphon which discharges into Kernodle Lake No. 1 is located near the left center of the dam. Several feet of the siphon riser pipe, which were observable, appeared to be in good condition. The remainder of the siphon pipe and the inlet and outlet ends could not be observed. There are no existing toe drains or relief wells.

d. Reservoir Area. No slides or excessive erosion due to wave action were observed along the shore of the reservoir.

e. Downstream Channel. The concrete chute spillway discharges at an overfall. The concrete channel resumes at the lower end of the overfall and carries the discharge into a concrete culvert. The channel downstream of the culvert consists of a concrete bottom with rocks and brush on each side. The channel discharges into Kernodle Lake Dam No. 1.

3.2 EVALUATION

Several minor deficiencies were observed during the inspection. Although they are not believed to be an immediate safety hazard they do warrant monitoring and control. Areas of erosion were observed along the upstream slope in the riprap slope protection. If not corrected, wave action will continue to erode the embankment and could lead to slope stability problems. A heavy growth of brush and small trees covered the upstream slope, with a less dense growth on the upper portion of the downstream slope. The roots of trees can loosen the embankment material and also can leave voids through which water can pass. Brush on the dam prevents inspection of the embankment and kills the smaller grasses whose roots are more effective in protecting the surface soil of the slope from erosion. Some evidence of mole paths were observed on the crest and downstream face of the dam. The brush and tall uncut grass provides a habitat for burrowing animals which can damage the embankment.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, transpiration, capacity of the uncontrolled spillway, and the operation of the 8-inch siphon.

4.2 MAINTENANCE OF DAM

A portion of the crest and the lower half of the downstream slope are mowed periodically.

4.3 MAINTENANCE OF OPERATING FACILITIES

Maintenance performed was unknown.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no existing system or preplanned scheme for warning occupants of the hazard zone below this dam.

4.5 EVALUATION

The maintenance program should be expanded to repair riprap in the areas of erosion and to control brush and tree growth on the embankment. Mowing of the embankment should be continued to discourage animal burrowing.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data pertaining to hydrology and hydraulics were unavailable.

b. Experience Data. The drainage area and lake surface area are developed from the USGS Grandview Quadrangle Map. The dam layout is from a survey made during the inspection.

c. Visual Observations.

(1) The spillway is in good condition with no evidence of erosion at the time of the inspection. Water several inches deep was flowing through the spillway at the time of the inspection. There were no obstructions to flow in the downstream channel.

(2) Large discharges through the spillway could cause erosion above the left wall over the entire length of the spillway. Large discharges through the spillway are not expected to erode the embankment.

(3) The siphon pipe provides a possible means for evacuating the pool. The alinement and inlet/outlet elevations of the siphon pipe will determine its actual usefulness in evacuating the pool.

d. Overtopping Potential. The spillway will not pass the 10-year flood but will pass 5 percent of the probable maximum flood without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of small size should pass 50 to 100 percent of the probable maximum flood. Considering the small volume of water impounded, the characteristics of upstream reservoirs, and the downstream hazard zone, 50 percent of the probable maximum flood is the appropriate spillway design flood. The spillway has the capacity to discharge 146 cfs when the reservoir level is at top of dam. The portion of the estimated peak discharge of 50 percent of the probable maximum flood overtopping the dam would be 2,200 cfs of the total discharge from the reservoir of 2,700 cfs. The estimated duration of overtopping is 12.1 hours with a maximum height of 3.3 feet. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 4,900 cfs of the total discharge from the reservoir of 5,500 cfs. The estimated duration of overtopping is 16.4 hours with a maximum height of 4.2 feet. Hydraulic data for impoundments upstream of Dam No. 2 were not obtained due to denial of access by the owner of the upstream property. An estimated inflow hydrograph was developed and added to the hydrograph of the runoff directly flowing into Dam No. 2. The estimate was based upon adjusting the 200 square mile, 24 hour, Probable Maximum Precipitation Index to reflect experienced outflow/inflow ratios of similar impoundments and drainage areas. The time difference between the inflow and outflow peaks was also analyzed for these impoundments. The resultant estimated hydrograph is developed in the output for HEC-1.

There is evidence that the soils typical of the embankment surfaces tend to erode. Although the inspection team found no visual evidence of overtopping of the embankment, prolonged overtopping of the embankment could potentially create an erosion condition leading to failure.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

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

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

c. Operating Records. No operational records exist.

d. Post Construction Changes. No record was available of post construction changes. The date which was observed on the clubhouse would indicate that it was constructed after the embankment.

e. Seismic Stability. The dam is located in Seismic Zone 1 which is a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservatism should pose no serious stability problems during earthquakes in this zone.

Adequate descriptions of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the stability analysis required by the guidelines.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. The primary concern is the danger of overtopping the dam due to the hydraulic inadequacy of the spillway. Several items noted during the visual inspection by the inspection team should be monitored or controlled. These are erosion of the upstream face, areas of brush and small trees growing through the riprap on the upstream face and on the upper portion of the downstream face, the area of possible seepage on the right abutment, and mole paths on the crest and on the downstream face of the embankment. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

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

c. Urgency. It is the opinion of the inspection team that a program should be developed to implement remedial measures recommended in paragraph 7.2b as soon as possible. The items recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam nor does it identify any serious dangers that would require a Phase II investigation.

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

7.2 REMEDIAL MEASURES

a. Alternatives. According to the estimated hydrologic/hydraulic analysis, the present spillway has the capacity to pass a discharge of 5 percent of the probable maximum flood without overtopping the embankment. A detailed hydrologic/hydraulic analysis should be performed subsequent to data collection on the upstream impoundments and hydraulic structures.

The estimated analysis provided in this inspection is not adequate for proper alternative determinations. In order to pass 50 percent of the probable maximum flood as required by the Recommended Guidelines, the spillway size and/or height of dam would need to be increased, or the lake level would need to be lowered, to increase storage capacity.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures are recommended:

(1) Erosion protection should be maintained on the upstream slope of the dam to prevent erosion of embankment material due to wave action.

(2) An improved maintenance program to remove and control the growth of brush and trees on the embankment should be developed by an engineer experienced in the maintenance of earth dams. Grass cover on the embankments should be cut periodically.

(3) The possible seepage area noted during the visual inspection should be closely monitored. If seepage flows are observed, the dam should immediately be inspected and the condition evaluated by an engineer experienced in the design and construction of earthen dams.

(4) Measures should be implemented to maintain control of burrowing animals. An engineer experienced in earth dam maintenance should be consulted to provide guidance in the repair of existing animal burrows.

(5) Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of dams.

(6) A detailed inspection of the dam should be made periodically by an engineer experienced in design and construction of dams. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increases.

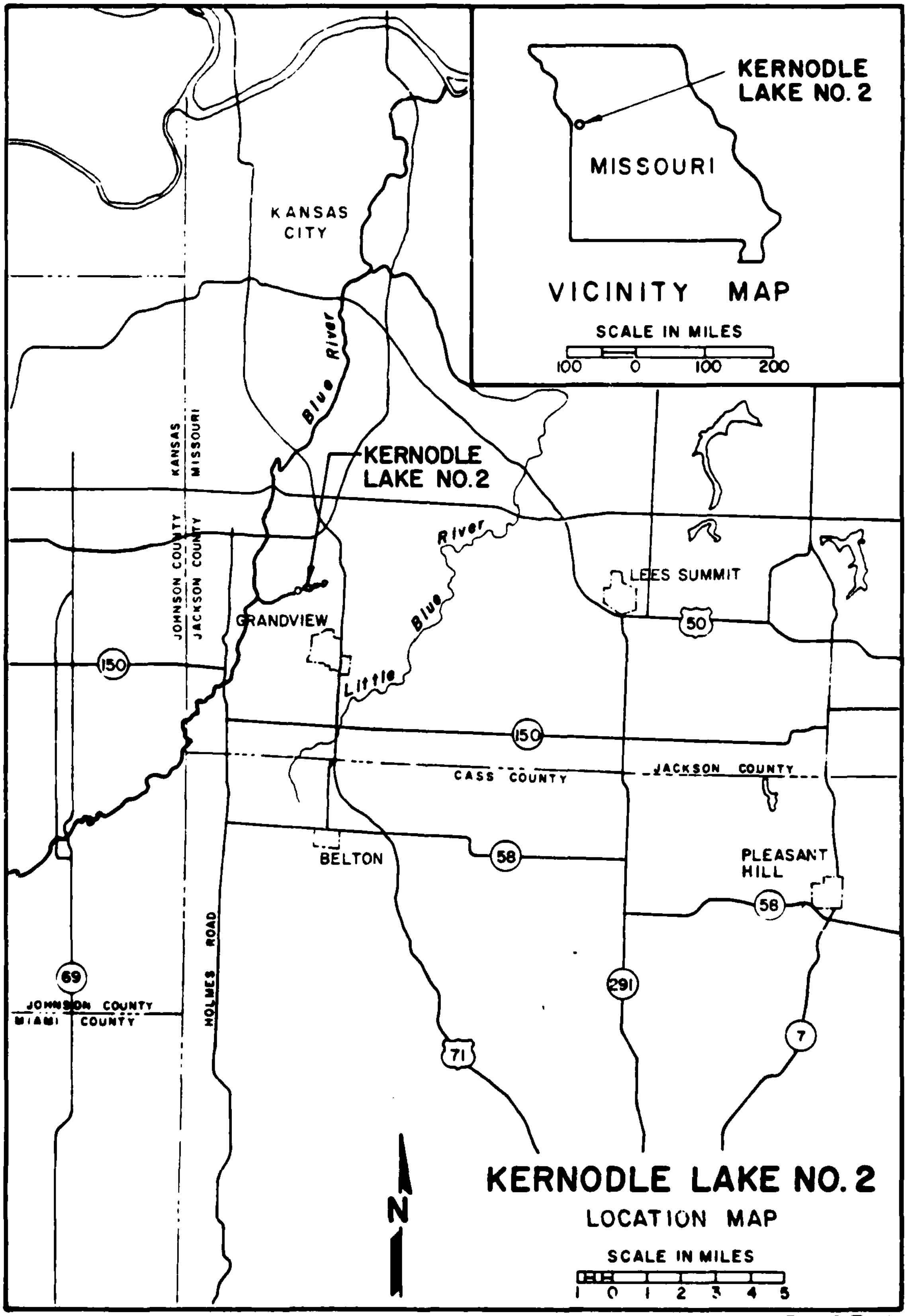

KERNODLE
LAKE NO. 2
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
KANSAS
CITY
Blue River
KERNODLE
LAKE NO. 2
KANSAS
MISSOURI
JOHNSON COUNTY
JACKSON COUNTY
River
Blue
Little
GRANDVIEW
LEES SUMMIT
50
150
150
CASS COUNTY
JACKSON COUNTY
58
BELTON
PLEASANT
HILL
58
69
JOHNSON COUNTY
MIAMI COUNTY
HOLMES ROAD
291
7
71
N
KERNODLE LAKE NO. 2
LOCATION MAP
SCALE IN MILES
1 0 1 2 3 4 5

PLATE I

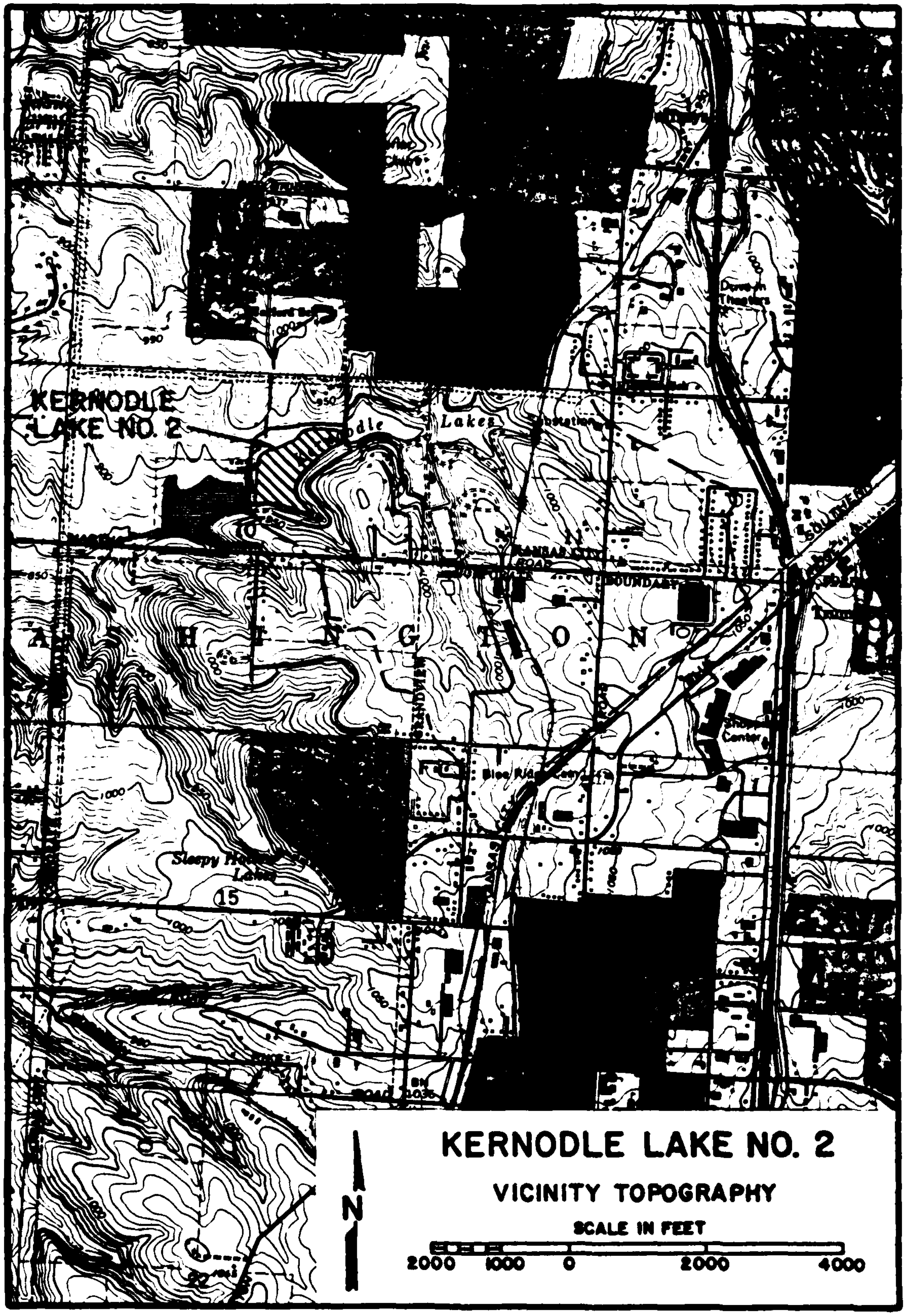
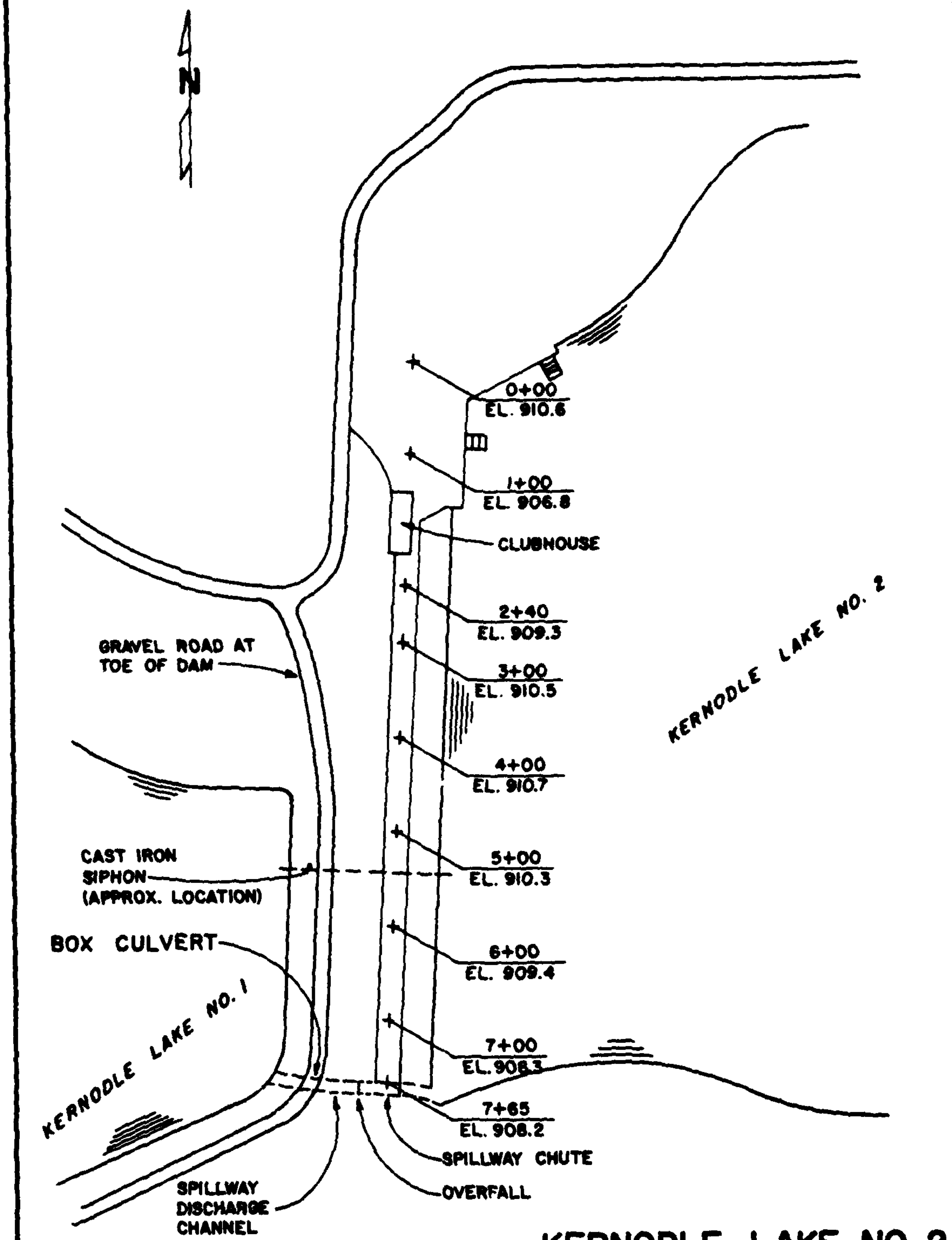
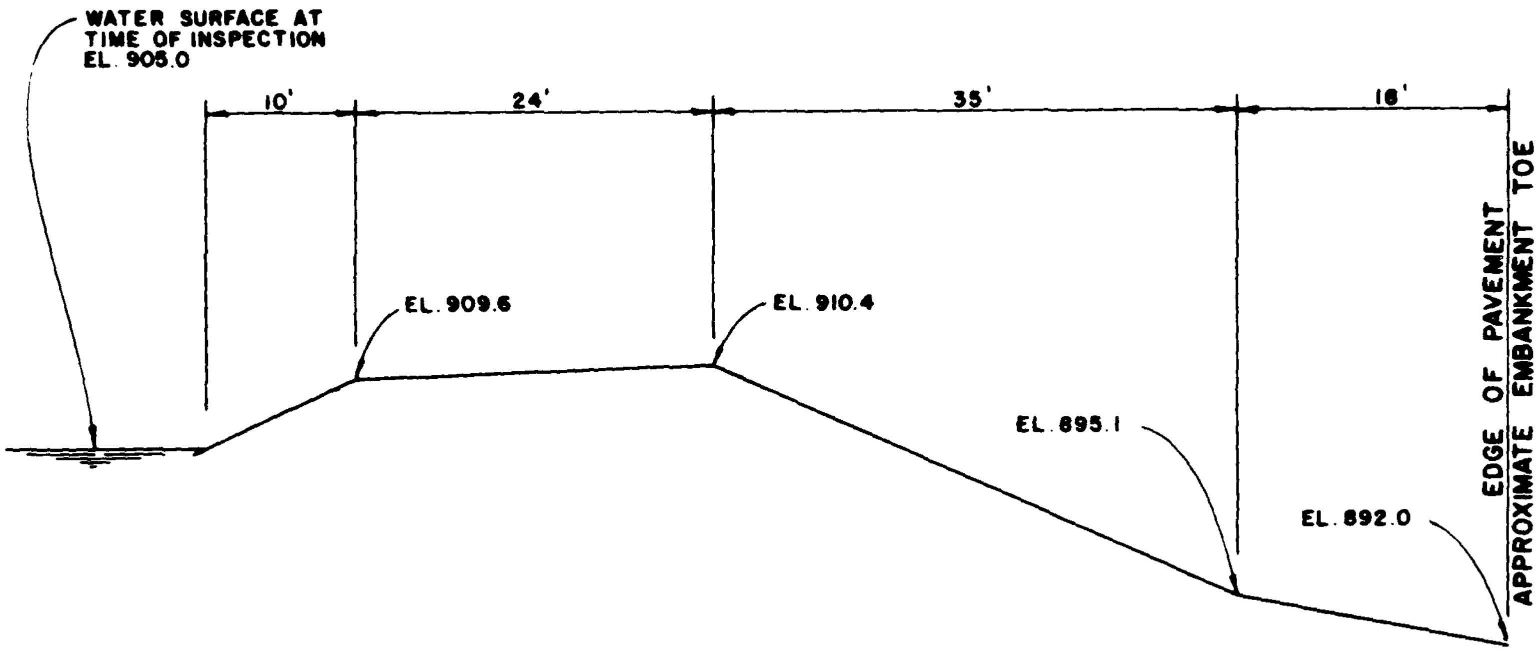

KERNODLE LAKE NO. 2
Kernodle Lakes
Sleepy Hollow Lake
KERNODLE LAKE NO. 2
VICINITY TOPOGRAPHY
SCALE IN FEET
2000 1000 0 2000 4000
N

PLATE 2



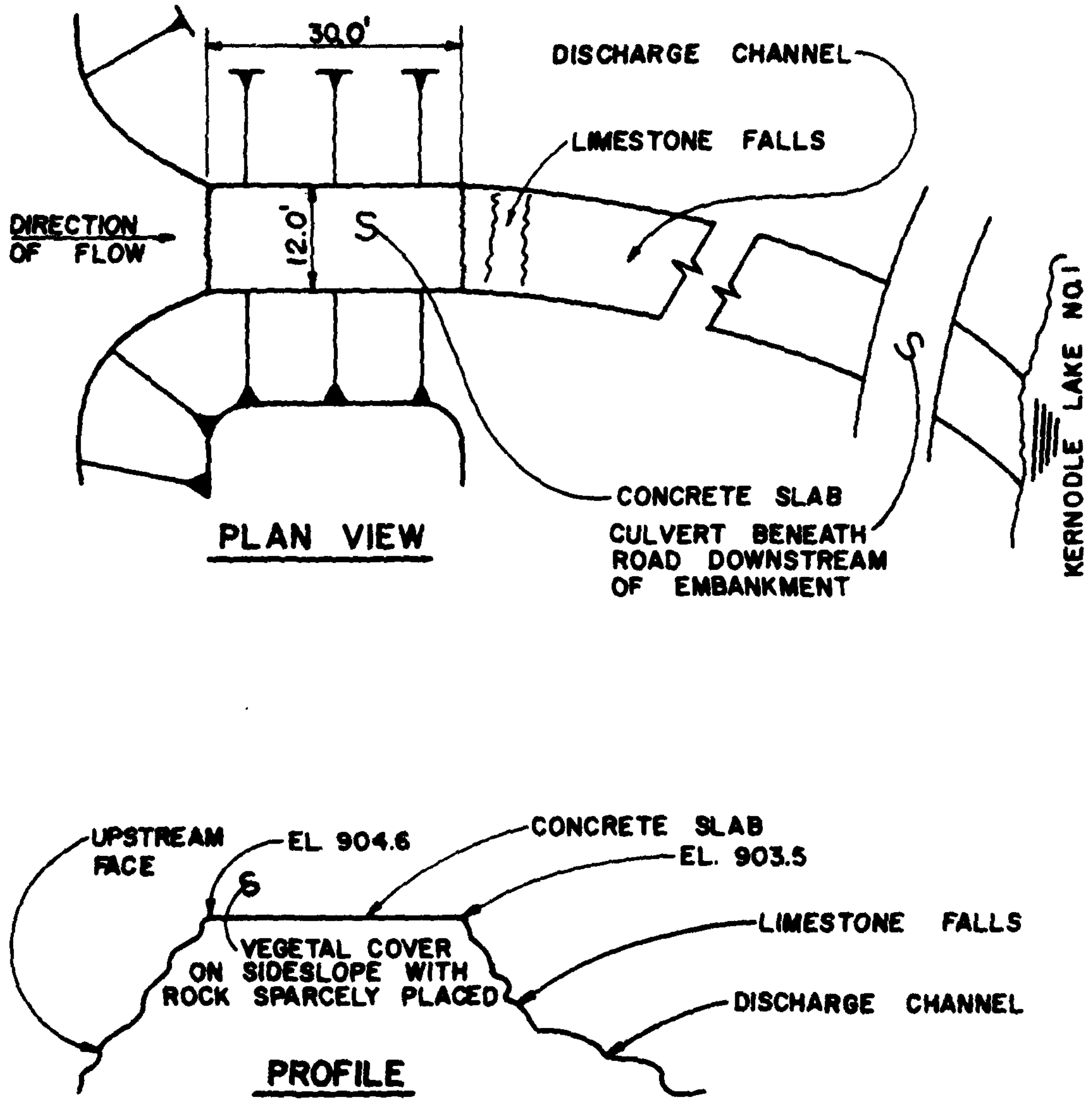
KERNODLE LAKE NO. 2
PLAN

PLATE 3



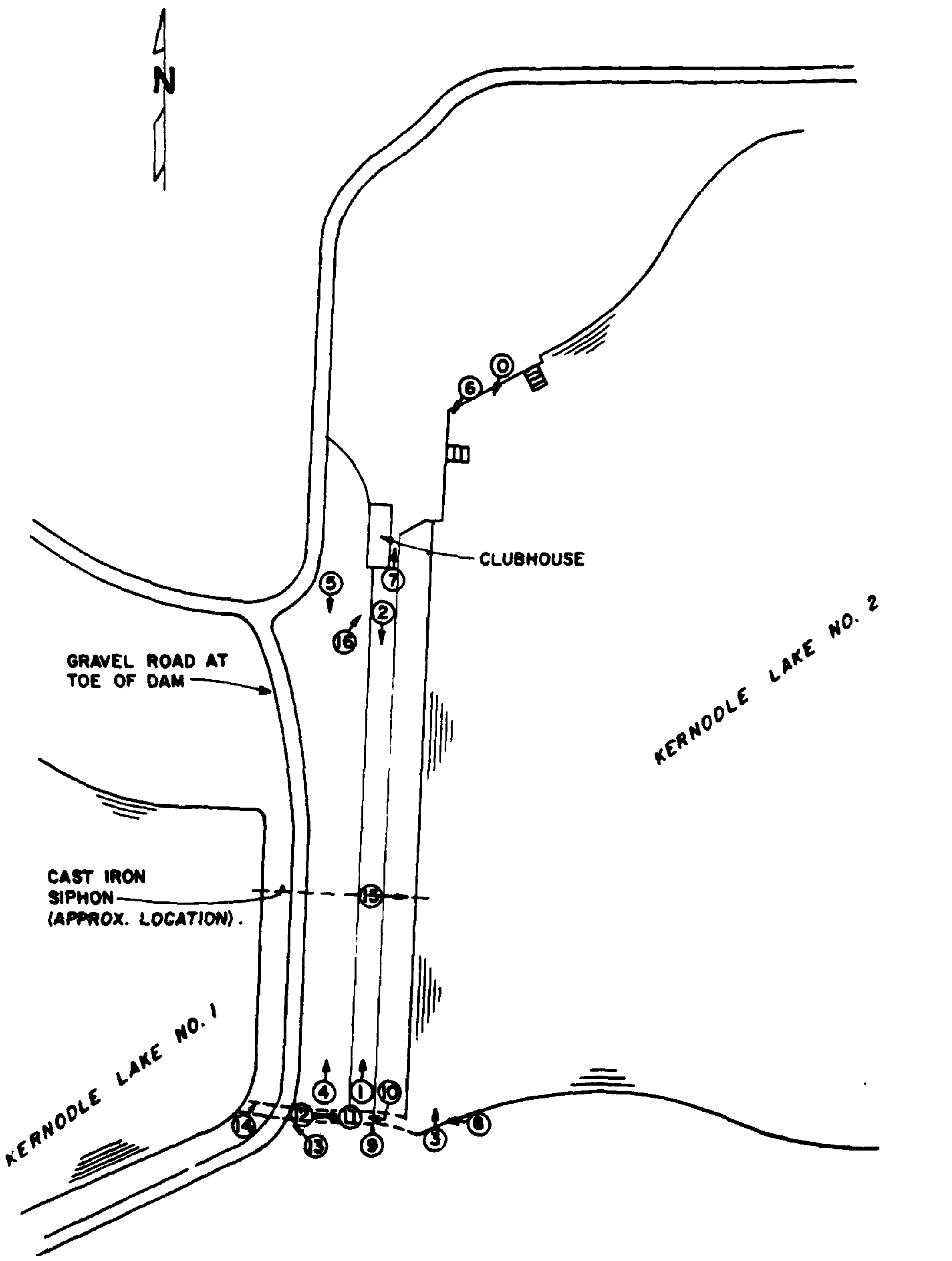
SECTION DATA OBTAINED
FROM FIELD SURVEY

KERNODLE LAKE NO. 2
EMBANKMENT CROSS SECTION



KERNODLE DAM NO. 2
SPILLWAY PLAN AND PROFILE

PLATE 5



KERNODLE LAKE NO. 2
PHOTO INDEX

PLATE 6

PHOTO 1: CREST OF DAM LOOKING NORTH

PHOTO 2: CREST OF DAM LOOKING SOUTH

PHOTO 3: FACE OF DAM

PHOTO 4: BACK FACE OF DAM

PHOTO 5: OVERVIEW OF BACK SIDE OF DAM

PHOTO 6: VIEW OF POOL AREA AT ABUTMENT

PHOTO 7: *CREST OF DAM/ABUTMENT IN FRONT OF CLUBHOUSE*
CONCRETE WALL EXTENDS ONE STORY BELOW CREST

PHOTO 8: SPILLWAY APPROACH AT LEFT ABUTMENT

PHOTO 9: SPILLWAY CREST

PHOTO 10: CONCRETE CHUTE BELOW CREST

PHOTO 11: SPILLWAY CHUTE OVERFALL LOOKING DOWNSTREAM

PHOTO 12: SPILLWAY CHUTE OVERFALL LOOKING UPSTREAM

PHOTO 13: CULVERT BELOW SPILLWAY CHUTE OVERFALL

PHOTO 14: OUTLET END OF CULVERT. FLOW INTO KERNODLES NO. 1

PHOTO 15: SIPHON RISER PIPE ON FRONT FACE OF DAM

PHOTO 16: POSSIBLE SEEPAGE AREA AT RIGHT ABUTMENT - EMBANKMENT INTERFACE

APPENDIX A

HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

1. The Soil Conservation Service (SCS) dimensionless unit hydrograph and HEC-1 (1) were used to develop the inflow hydrographs, and hydrologic inputs as follows:

a. Twenty-four hour, probable maximum precipitation determined from U.S. Weather Bureau Hydrometeorological Report No. 33.

200 square mile, 24 hour rainfall inches	- 24.8
10 square mile, 6 hour percent of 24 hour 200 square mile rainfall	- 101%
10 square mile, 12 hour percent of 24 hour 200 square mile rainfall	- 120%
10 square mile, 24 hour percent of 24 hour 200 square mile, rainfall	- 130%

Because the hydraulic data for impoundments upstream of Dam No. 2 were unavailable, an estimated inflow hydrograph was developed and added to the hydrograph of the runoff directly flowing into Dam No. 2. The outflow and inflow peaks were determined for impoundments of similar size and drainage area. The outflow/inflow ratios and the time difference between the peak inflow and peak outflow were determined for each of these impoundments. An analysis of the results showed that the outflow/inflow ratio was approximately 0.90 for 50 percent and 100 percent of the probable maximum precipitation and 0.80 for smaller percentages of the probable maximum precipitation. The 200 square mile, 24 hour, Probable Maximum Precipitation Index was multiplied by these ratios. The analysis of the similar impoundments showed that the change in the time between the peak inflow and peak outflow was small. Therefore we did not adjust the lag from the value found by assuming that the upstream impoundments did not exist.

b. Drainage area = 784 acres (includes 660 acres of drainage area above several upstream impoundments).

c. Time of concentration:

$$T_c = (1.67)\ L$$

$$L = \frac{\ell^{0.8}(S+1)^{0.7}}{1{,}900Y^{0.5}}$$

L = lag in hours

ℓ = hydraulic length of watershed in feet

$S = \frac{1,000}{CN} - 10$ (where CN is the retardance factor and is equivalent to the runoff curve number)

Y = average watershed land slope in percent

T_c = 0.37 hours (for Dam No. 2 only)

= 1.42 hours (for the area above the upstream dams) (2).

d. The hydrologic soil groups in the basin were B (65%) and D (35%). Land uses were characterized by pasture (60%), woods (8%), commercial (7%), residential (15%), and streets (10%). A curve number of 73 was determined from the above conditions with antecedent moisture condition II. Losses were determined in accordance with SCS methods for determining runoff using a curve number of 87 and antecedent moisture condition III. (2 and 3).

e. The soil associations in this watershed are mainly Sharpsburg and Polo-Sogn. (4)

2. Spillway release rates are based on the condition of the spillway approach and the level weir equation:

$$Q = CLH^{1.5} \text{ (C = 2.63, L = 12 feet) (5).}$$

Discharge rates over the top of the dam are based on the unlevel weir equation:

$$Q = \frac{2Cb}{5(h_b - h_a)} (h_b^{2.5} - h_a^{2.5})$$

(C = 2.60 = weir coefficient, b = the length of flow normal to the weir in feet, h_b = the head on the low end of the weir in feet, and h_a = the head on the high end of the weir in feet.) (6).

3. The elevation-storage relationship above normal pool elevation was constructed by planimetering the area enclosed within each contour above normal pool. Storage at various elevations was computed utilizing the conic method for computation of reservoir volume provided in HEC-1(1).

4. Floods are routed through the spillway using HEC-1, modified Puls to determine the capability of the spillway.

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

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

(3) U.S. Department of Agriculture, Soil Conservation Service, Technical Release No. 55, Urban Hydrology for Small Watersheds, January, 1975.

(4) Mid-America Regional Council, Regional Soils Guide, March 1976.

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

(6) U.S. Department of the Interior, Geological Survey, Techniques of Water-Resources Investigations, Book 3, Chapter A5, Measurement of Peak Discharge at Dams by Indirect Methods, by Harry Hulsing, 1967.

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**********   ********************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
*********************************
                    A1MISSOURI DAM INSPECTION PROGRAM
                    A2ST LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
                    A3KERNODLE LAKE DAM NOS. 1 & 2
                    B    288       0       5       0       0
                    B1     5
                    J      1       2       1
                    J1   .50     1.0
                    K      0       1                               3       1
                    K1   ESTIMATED ROUTED INFLOW FROM UPSTREAM IMPOUNDMENTS
                    M      1       2    1.04                       1
                    P            22.3     101     120     130
                    T                                                     -1     -.7
                    W2            .65
                    X                              1
                    K      0       2                               3       1
                    K1   INFLOW TO KERNODLE LAKE NO. 2
                    M      1       2     .19                       1
                    P            24.9     101     120     130
                    T                                                     -1     -57
                    W2            .22
                    X                              1
                    K      2       7                                       1
                    K1   COMBINE INFLOW HYDROGRAPHS
                    K      1       4                               3       1
                    K1   ROUTE THROUGH KERNODLE LAKE NO. 2
                    Y                                      1       1
                    Y1     1                                  -905.59     -1
                    Y4904.59905.13  906.13  907.13  907.63  908.13  909.13  910.13  912.13
                    Y50.    14.     75.     165.    319.    573.    1231.   2775.   9335.
                    $A0.    17.9    27.4    32.9
                    $E872.  904.6   920.    930.
                    $$904.59
                    $D906.79
                    K      0       5                               3       1
                    K1   INFLOW TO KERNODLE LAKE NO. 1
                    M      1       2     .23                       1
                    P            24.9     101     120     130
                    T                                                     -1     -59
                    W2            .20
                    X                              1
                    K      2       6                                       1
                    K1   COMBINE NO. 1 & NO. 2 HYDROGRAPHS
                    K      1       7                                       1
                    K1   ROUTE THROUGH KERNODLE LAKE NO. 1
                    Y                                      1       1
                    Y1     1                                  -887.13     -1
                    Y4887.13888.32  888.13  889.13  890.63  891.13  892.13  894.13  896.13
                    Y50.    4.      6.      46.     256.    900.    1645.   1460.   30304.
                    $A0.    .8      3.3     14.     20.9    30.4    37.
                    $E855.  860.    870.    880.    890.    900.    910.
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MIVVPOJ.   10/10/79. UNITED COMPUTING 66. APEX/SL 9.3.3

51	88.87.13
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53	[illegible] 99

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 1
RUNOFF HYDROGRAPH AT

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 .50	RATIO 2 1.00
HYDROGRAPH AT	1	1.04	1	2513.	5026.
	(	2.69)	(	71.16)(	142.31)(
HYDROGRAPH AT	2	.19	1	994.	1997.
	(	.49)	(	28.21)(	56.53)(
2 COMBINED	3	1.23	1	2777.	5553.
	(	3.19)	(	78.63)(	157.26)(
ROUTED TO	4	1.23	1	2730.	5526.
	(	3.19)	(	77.32)(	156.47)(
HYDROGRAPH AT	5	.23	1	1260.	2519.
	(	.60)	(	35.67)(	71.34)(
2 COMBINED	6	1.46	1	3181.	6857.
	(	3.78)	(	90.08)(	194.16)(
ROUTED TO	7	1.46	1	3060.	6730.
	(	3.78)	(	86.65)(	190.59)(

SUMMARY OF DAM SAFETY ANALYSIS

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	904.59	904.59	[illegible]
STORAGE	167.	167.	[illegible]
OUTFLOW	0.	[illegible]	146.

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
.50	910.09	3.31	278.	[illegible]	12.0[illegible]	16.50	[illegible]
1.00	910.97	4.17	297.	552[illegible]	15.75	16.42	[illegible]

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************
            A1MISSOURI DAM INSPECTION PROGRAM
            A2ST LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
            A3KERNODLE LAKE DAM NOS. 1 & 2
            B   288       0       5       0       0       0         0       0       0
            W1    5
            J     1       4       1
            J1.20     .15     .10     .05
            K     0       1                                 7       1
            K1   ESTIMATED ROUTED INFLOW FROM UPSTREAM IMPOUNDMENTS
            M     1       2    1.04                         1
            P          19.9     101     120     130
            T                                                      -1     -37
            W2         .85
            X                     1
            K     0       2                                 3       1
            K1   INFLOW TO KERNODLE LAKE NO. 2
            M     1       2     .19                         1
            P          24.9     101     120     130
            T                                                      -1     -37
            W2         .22
            X                     1
            K     2       3                                         1
            K1   COMBINE INFLOW HYDROGRAPHS
            K     1       4                                 3       1
            K1   ROUTE THROUGH KERNODLE LAKE NO. 2
            Y                                     1       1
            Y1    1                                   -904.59      -1
            Y4904.59905.13  906.13  907.13  907.63  908.13  909.13  910.13  912.13
            Y50.    14.     75.     185.    319.    513.    1261.   2775.   9335.
            $A0.    18.9    27.4    32.9
            $E875.  904.6   920.    930.
            $$904.59
            $D906.78
            K     0       5                                 3       1
            K1   INFLOW TO KERNODLE LAKE NO. 1
            M     1       2     .23                         1
            P          24.8     101     120     130
            T                                                      -1     -69
            W2         .20
            X                     1
            K     2       6                                         1
            K1   COMBINE NO. 1 & NO. 2 HYDROGRAPHS
            K     1       7                                         1
            K1   ROUTE THROUGH KERNODLE LAKE NO. 1
            Y                                     1       1
            Y1    1                                   -887.13      -1
            Y4887.13888.02  888.13  889.13  890.63  891.13  892.13  894.13  896.13
            Y50.    4.      6.      45.     284.    930.    3645.   14670.  33304.
            $A0.    .2      3.3     14.     20.2    30.4    37.
            $E855.  860.    870.    880.    890.    900.    910.
```

51	55987.13
52	50390.05
53	K 59

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .20	RATIO 2 .15	RATIO 3 .10	RATIO 4 .05
HYDROGRAPH AT	1	1.04	1	891.	563.	445.	[illegible]
	(	2.69)	(	25.23)(	15.92)(	12.61)(	[illegible])(
HYDROGRAPH AT	2	.19	1	399.	299.	199.	1[illegible].
	(	.49)	(	11.29)(	8.46)(	5.64)(	2.[illegible])(
2 COMBINED	3	1.23	1	997.	748.	499.	249.
	(	3.19)	(	28.23)(	21.17)(	14.12)(	7.[illegible])(
ROUTED TO	4	1.23	1	933.	673.	374.	131.
	(	3.19)	(	26.43)(	19.05)(	10.60)(	3.72)(
HYDROGRAPH AT	5	.23	1	504.	378.	253.	126.
	(	.60)	(	14.27)(	10.70)(	7.17)(	3.57)(
2 COMBINED	6	1.46	1	1041.	752.	427.	185.
	(	3.79)	(	29.49)(	21.30)(	12.09)(	5.24)(
ROUTED TO	7	1.46	1	1037.	728.	341.	97.
	(	3.78)	(	29.36)(	20.61)(	9.67)(	2.75)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	904.59	904.59	906.[illegible]
STORAGE	167.	167.	2[illegible].
OUTFLOW	0.	0.	14[illegible].

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
.20	90[illegible]	1.93	248.	[illegible]	[illegible]	16.58	0.00
.15	9[illegible].34	1.56	241.	67[illegible].	[illegible].75	16.67	0.00
.10	907.77	.99	229.	374.	4.[illegible]	16.92	0.00
.05	906.64	0.00	206.	131.	[illegible]	17.[illegible]	0.00

SUMMARY OF DAM SAFETY ANALYSIS

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************
    1              A1MISSOURI DAM INSPECTION PROGRAM
    2              A2ST LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
    3              A3KERNODLE LAKE DAM NOS. 1 & 2 * 100-YEAR FLOOD
    4              B    288       0       5       0       0
    5              B1
    6              K      0       1                               3       1
    7              K1   ESTIMATED ROUTED INFLOW FROM UPSTREAM IMPOUNDMENTS
    8              M      0       2    1.04                       1
    9              O    288
   10              O1  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
   11              O1  .006    .005    .006    .005    .005    .005    .006    .006    .006    .006
   12              O1  .006    .006    .005    .006    .006    .006    .006    .005    .006    .005
   13              O1  .006    .005    .006    .006    .006    .006    .006    .006    .006    .006
   14              O1  .006    .006    .006    .005    .006    .005    .006    .006    .006    .006
   15              O1  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
   16              O1  .006    .006    .005    .005    .006    .006    .006    .006    .006    .006
   17              O1  .005    .006    .015    .015    .015    .015    .015    .015    .015    .015
   18              O1  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
   19              O1  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
   20              O1  .015    .015    .015    .015    .015    .015    .015    .015    .025    .028
   21              O1  .028    .028    .028    .023    .028    .028    .028    .029    .029    .029
   22              O1  .028    .028    .028    .028    .028    .029    .029    .029    .029    .029
   23              O1  .029    .029    .065    .065    .065    .065    .065    .065    .152    .152
   24              O1  .152    .290    .290    .573    .547    .290    .290    .152    .152    .152
   25              O1  .065    .065    .065    .055    .065    .065    .029    .029    .029    .029
   26              O1  .029    .029    .028    .025    .025    .029    .029    .029    .029    .028
   27              O1  .028    .028    .028    .025    .028    .029    .029    .025    .025    .028
   28              O1  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
   29              O1  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
   30              O1  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
   31              O1  .015    .015    .015    .015    .015    .015    .006    .006    .006    .006
   32              O1  .006    .006    .006    .005    .006    .006    .006    .006    .006    .006
   33              O1  .006    .006    .006    .006    .006    .005    .006    .006    .006    .006
   34              O1  .006    .005    .006    .005    .006    .006    .006    .006    .006    .006
   35              O1  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
   36              O1  .006    .005    .006    .005    .005    .006    .006    .006    .006    .006
   37              O1  .006    .005    .006    .006    .006    .006    .005    .006    .006    .006
   38              O1  .006    .005    .006    .006    .006    .005    .006    .006
   39              T                                                 -1     -73
   40              W2           2.66
   41              X                    1
   42              K      0       2                               3       1
   43              K1   INFLOW TO KERNODLE LAKE NO. 2
   44              M      0       2     .19                       1
   45              O    288
   46              O1  .006    .006    .005    .006    .006    .005    .006    .006    .006    .006
   47              O1  .006    .006    .006    .005    .006    .006    .006    .006    .006    .006
   48              O1  .006    .006    .006    .006    .005    .006    .006    .006    .006    .006
   49              O1  .005    .006    .006    .006    .005    .006    .006    .006    .005    .006
   50              O1  .006    .006    .005    .006    .005    .006    .006    .006    .006    .006

   51              O1  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
   52              O1  .006    .005    .006    .006    .006    .006    .006    .006    .006    .006
   53              O1  .006    .005    .015    .015    .015    .015    .015    .015    .015    .015
```

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01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01  .006    .006    .015    .015    .015    .015    .015    .015    .015    .015
01  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
01  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
01  .015    .015    .015    .015    .015    .015    .015    .015    .023    .023
01  .023    .023    .023    .023    .023    .023    .023    .023    .029    .029
01  .029    .029    .029    .029    .029    .029    .029    .029    .029    .029
01  .029    .029    .029    .065    .065    .153    .065    .065    .153    .153
01  .153    .290    .290    .573    .843    .290    .290    .153    .153    .153
01  .065    .065    .065    .065    .065    .065    .029    .029    .029    .029
01  .029    .029    .023    .023    .028    .023    .029    .028    .028    .025
01  .029    .028    .028    .029    .023    .023    .023    .025    .026    .024
01  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
01  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
01  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
01  .015    .015    .015    .015    .015    .015    .006    .006    .006    .006
01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01  .006    .006    .006    .006    .006    .006    .005    .006
T                                                   -1      -77
W2          .34
X                         1
K       2       3                                   1
K1    COMBINE INFLOW HYDROGRAPHS
K       1       4                           3       1
K1    ROUTE THROUGH KERNODLE LAKE NO. 2
Y                                  1       1
Y1      1                                  -904.59       -1
Y4904.59903.13  906.13  907.13  907.63  908.13  909.13  910.13  912.13
Y55.    14.     75.     195.    319.    513.    1261.   2775.   9335.
$A0.    19.8    27.4    32.7
$E378.  904.6   920.    930.
$$904.50
$D906.78
K       0       5                           3       1
K1    INFLOW TO KERNODLE LAKE NO. 1
M       0       2      .23                  1
O     263
01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01. .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
```

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101     01 .006  .006  .015  .015  .015  .015  .015  .015  .015  .015
102     01 .015  .015  .015  .015  .015  .015  .015  .015  .015  .015
103     01 .015  .015  .015  .015  .015  .015  .015  .015  .015  .015
104     01 .015  .015  .015  .015  .015  .015  .015  .015  [illegible] [illegible]
105     01 .028  .028  .028  .028  .028  .028  .028  [illegible] [illegible] [illegible]
106     01 .028  .028  .028  .028  .028  [illegible] [illegible] [illegible] [illegible] .029
107     01 .029  .029  [illegible] .065  .065  [illegible] [illegible] .065  .153  .153
108     01 .153  [illegible] [illegible] .173  .943  [illegible] [illegible] .153  .153  .153
109     01 .065  .065  .065  .065  .065  .065  [illegible] .029  .029  .029
110     01 .029  .029  .029  .028  .028  .028  .028  .028  .028  .028
111     01 .028  .028  .028  .028  .028  .028  .028  .028  .028  .028
112     01 .015  .015  .015  .015  .015  .015  .015  .015  .015  .015
113     01 .015  .015  .015  .015  .015  .015  .015  .015  .015  .015
114     01 .015  .015  .015  .015  .015  .015  .015  .015  .015  .015
115     01 .015  .015  .015  .015  .015  .015  .006  .006  .006  .006
116     01 .006  .006  .006  .006  .006  .006  .006  .006  .006  .006
117     01 .006  .006  .006  .006  .006  .006  .006  .006  .006  .006
118     01 .006  .006  .006  .006  .006  .006  .006  .006  .006  .006
119     01 .006  .006  .006  .006  .006  .006  .006  .006  .006  .006
120     01 .006  .006  .006  .006  .006  .006  .006  .006  .006  .006
121     01 .006  .006  .006  .006  .006  .006  .006  .006  .006  .006
122     01 .006  .006  .006  .006  .006  .006  .006  .006
123     T                                              -1    -74
124     W2          .31
125     X                    1
126     K     2      6                                  1
127     K1   COMBINE NO. 1 & NO. 2 HYDROGRAPHS
128     K     1      7                                  1
129     K1   ROUTE THROUGH KERNODLE LAKE NO. 1
130     Y                                1       1
131     Y1    1                                   -327.13      -1
132     Y4327.13328.02  328.13  329.13  890.63  891.13  892.13  894.13  896.13
133     Y55.     4.     6.      45.     286.    900.    3645.   14620.  33334.
134     SA0.     .8     3.3     14.     20.9    30.4    37.
135     SE355.  360.    370.    880.    890.    900.    910.
136     $$327.13
137     $D893.05
138     K      99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT

RUNOFF SUMMARY, AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES(SQUARE KILOMETERS)

			PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1		574.	[illegible]	[illegible]	[illegible]	[illegible]
		(	16.27)(	[illegible]	[illegible]	[illegible]	[illegible]
HYDROGRAPH AT	2		407.	78.	23.	23.	.19
		(	11.52)(	2.20)(	.65)(	.65)(	.49)
2-COMBINED	3		609.	[illegible]	[illegible]	143.	[illegible]
		(	17.26)(	12.42)(	4.05)(	4.05)(	3.19)
ROUTED TO	4		568.	[illegible]	[illegible]	[illegible]	[illegible]
		(	16.08)(	10.73)(	3.58)(	3.58)(	3.19)
HYDROGRAPH AT	5		520.	96.	29.	29.	.23
		(	14.74)(	2.72)(	.81)(	.81)(	.60)
2-COMBINED	6		599.	424.	155.	155.	1.46
		(	16.95)(	12.00)(	4.39)(	4.39)(	3.78)
ROUTED TO	7		579.	[illegible]	[illegible]	[illegible]	1.46
		(	16.36)(	10.76)(	3.57)(	3.57)(	3.78)

SUMMARY OF DAM SAFETY ANALYSIS

[illegible] [illegible] TOP OF DAM

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	904.59	904.59	906.73
STORAGE	167.	167.	2[illegible].
OUTFLOW	0.	[illegible].	14[illegible].

100-YR.

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
~~.33~~	908.20	1.42	239.	56[illegible].	[illegible].08	15.50	0.00

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********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
********************************
                 A1MISSOURI DAM INSPECTION PROGRAM
                 A2ST LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
                 A3KERNODLE LAKE DAM NOS. 1 & 2 - 10-YEAR FLOOD
                 B    288      0      5      0      0      0      0      0      0      0
                 B1     3
                 K      0      1                           3      1
                 K1   ESTIMATED ROUTED INFLOW FROM UPSTREAM IMPOUNDMENTS
                 M      0      2   1.04                    1
                 O    288
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .010   .010   .010   .010   .010   .010   .010   .010
                 O1  .010   .010   .010   .010   .010   .010   .010   .010   .010   .010
                 O1  .010   .010   .010   .010   .010   .010   .010   .010   .010   .010
                 O1  .010   .010   .010   .010   .010   .010   .015   .010   .015   .015
                 O1  .015   .015   .015   .015   .015   .015   .015   .015   .015   .015
                 O1  .015   .015   .015   .015   .015   .015   .029   .029   .029   .029
                 O1  .029   .029   .050   .050   .050   .050   .050   .050   .050   .099
                 O1  .099   .187   .187   .390   .594   .271   .187   .099   .099   .099
                 O1  .050   .050   .050   .050   .050   .050   .029   .029   .029   .029
                 O1  .029   .029   .015   .015   .015   .015   .015   .015   .015   .015
                 O1  .015   .015   .015   .015   .015   .015   .015   .015   .015   .015
                 O1  .010   .010   .010   .010   .010   .010   .010   .010   .010   .010
                 O1  .010   .010   .010   .010   .010   .010   .010   .010   .010   .010
                 O1  .010   .010   .010   .010   .010   .010   .010   .010   .010   .010
                 O1  .010   .010   .010   .010   .010   .010   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005
                 T                                                -1    -77
                 W2          2.66
                 X                  1
                 K      0      2                           3      1
                 K1.  INFLOW TO KERNODLE LAKE NO. 2
                 M      0      2    .19                    1
                 O    288
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
                 O1  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
```

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01  .005     .005     .005     .005     .005     .005     .005     .005     .005     .005
01  .005     .005     .005     .005     .005     .005     .005     .005     .005     .005
01  .005     .005     .010     .010     .010     .010     .010     .010     .010     .010
01  .010     .010     .010     .010     .010     .010     .010     .010     [illegible] .010
01  .010     .010     .010     .010     .010     .010     .010     .010     .010     .010
01  .010     .010     .010     .010     .010     .010     .010     .010     .015     .015
01  .015     .015     .015     .015     .015     .015     .015     .015     .015     .015
01  .015     .015     .015     .015     .015     .015     [illegible] [illegible] [illegible] .029
01  .029     .029     [illegible] .050  .050     .050     [illegible] [illegible] [illegible] .099
01  .099     .127     .157     .199     .576     .271     .167     .095     .069     .029
01  .050     .050     .050     .050     .050     .050     .029     .029     .029     .029
01  .029     .029     .015     .015     .015     .015     .015     .015     .015     .015
01  .015     .015     .015     .015     .015     .015     .015     .015     .015     .015
01  .010     .010     .010     .010     .010     .010     .010     .010     .010     .010
01  .010     .010     .010     .010     .010     .010     .010     .010     .010     .010
01  .010     .010     .010     .010     .010     .010     .010     .010     .010     .010
01  .010     .010     .010     .010     .010     .010     .005     .005     .005     .005
01  .005     .005     .005     .005     .005     .005     .005     .005     .005     .005
01  .005     .005     .005     .005     .005     [illegible] .005  .005     .005     .005
01  .005     .005     .005     .005     .005     [illegible] .005  .005     .005     .005
01  .005     .005     .005     .005     .005     .005     .005     .005     .005     .005
01  .005     .005     .005     .005     .005     .005     .005     .005     .005     .005
01  .005     .005     .005     .005     .005     .005     .005     .005     .005     .005
01  .005     .005     .005     .005     .005     .005     .005     .005
T                                                     -1       -77
W2           .34
A                      1
K      2        3                                     1
K1   COMBINE INFLOW HYDROGRAPHS
K      1        4                            3        1
K1   ROUTE THROUGH KERNODLE LAKE NO. 2
Y                                   1        1
Y1     1                                     -924.59           -1
Y4904.59905.13  906.13   907.13   907.63   908.13   909.13   910.13   911.13
Y50.    14.     75.      185.     319.     513.     1261.    2775.    4735.
$A0.    19.8    27.4     32.9
$E874.  904.6   920.     930.
$S904.59
$D926.78
K      0        5                            3        1
K1   INFLOW TO KERNODLE LAKE NO. 1
M      0        2        .23                 1
O    289
01  .005     .005     .005     .005     .005     .005     .005     .005     .005     .005
01  .005     .005     .005     .005     .005     .005     .005     .005     .005     .005
01  .005     .005     .005     .005     .005     .005     .005     .005     .005     .005
01  .005     .005     .005     .005     .005     .005     .005     .005     .005     .005
01  .005     .005     .005     .005     .005     .005     .005     .005     .005     .005
01  .005     .005     .005     .005     .005     .005     .005     .005     .005     .005
01  .005     .005     .005     .005     .005     .005     .005     .005     .005     .005

01  .005     .005     .010     .010     .010     .010     .010     .010     .010     .010
01  .010     .010     .010     .010     .010     .010     .010     .010     .010     .010
01  .010     .010     .010     .010     .010     .010     .010     .010     .010     .010
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01  .025   .025   .01.   .012   .010   [illegible]  [illegible]  [illegible]  [illegible]  [illegible]
01  .010   [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]
01  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]
01  .012   .012   .012   [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]
01  .015   .015   .015   [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]
01  .015   [illegible]  [illegible]  .015   [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]
01  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]
01  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]
01  .059   [illegible]  [illegible]  .050   [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]
01  .029   .029   .015   .015   .015   [illegible]  .015   .015   .015   .015
01  .015   .015   .015   .015   .015   .015   [illegible]  .015   .015   [illegible]
01  .010   .010   .010   .010   .010   [illegible]  [illegible]  [illegible]  [illegible]  [illegible]
01  .010   .010   .010   [illegible]  .010   [illegible]  [illegible]  [illegible]  [illegible]  [illegible]
01  .010   .010   .010   .010   .010   .010   [illegible]  [illegible]  [illegible]  [illegible]
01  .010   .010   .010   .010   .010   .010   [illegible]  [illegible]  [illegible]  [illegible]
01  .005   .005   .005   .005   .005   .005   [illegible]  [illegible]  [illegible]  [illegible]
01  .005   .005   .005   .005   .005   [illegible]  [illegible]  [illegible]  .005   .005
01  .005   .005   .005   .005   .005   [illegible]  .005   .005   .005   .005
01  .005   .005   .005   .005   .005   .005   [illegible]  [illegible]  .005   .005
01  .005   .005   .005   .005   .005   [illegible]  [illegible]  [illegible]  .005   [illegible]
01  .005   .005   .005   .005   .005   [illegible]  [illegible]  [illegible]  .005   .005
01  .005   .005   .005   .005   .005   .005   .005   [illegible]
T                                              -1     -74
W2          .31
A                     1
K      2      6                                1
K1    COMBINE NO. 1 & NO. 2 HYDROGRAPHS
K      1      7                                1
K1    ROUTE THROUGH FERNODLE LAKE NO. 1
Y                                  1      1
Y1     1                                -[illegible]7.13      -1
Y4887.13888.32  888.13  889.13  890.63  891.13  892.13  894.1[illegible]  896.13
Y50.    4.     6.     46.    286.   900.   3645.  14620.  3[illegible]24.
SA0.    .9     3.3    14.    20.9   33.4   37.
SE855.  860.   870.   880.   890.   900.   910.
SS887.13
SD893.05
K     99
```

RUNOFF SUMMARY, AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	315.	210.	[illegible]	[illegible]	1.[illegible]4
	(	9.00)(	5.94)(	1.[illegible])(	1.[illegible])(	[illegible])
HYDROGRAPH AT	2	223.	43.	1[illegible].	[illegible]	.19
	(	6.31)(	1.22)(	.[illegible])(	.[illegible]7)(	.4[illegible])
2-COMBINED	3	334.	24[illegible].	[illegible]	7[illegible].	1.[illegible]
	(	9.47)(	6.[illegible])(	2.[illegible])(	2.[illegible])(	3.1[illegible])
ROUTED TO	4	253.	1[illegible].	[illegible].	65.	1.[illegible]
	(	7.1[illegible])(	5.33)(	1.[illegible]5)(	1.55)(	3.19)
HYDROGRAPH AT	5	299.	[illegible]4.	1[illegible].	[illegible].	.2[illegible]
	(	[illegible].19)(	1.53)(	.4[illegible])(	.4[illegible])(	.[illegible])
2-COMBINED	6	300.	201.	[illegible].	[illegible].	1.4[illegible]
	(	8.49)(	5.69)(	2.[illegible]1)(	2.[illegible]1)(	3.7[illegible])
ROUTED TO	7	204.	175.	59.	5[illegible].	1.4[illegible]
	(	5.73)(	4.96)(	1.[illegible])(	1.[illegible])(	[illegible].7[illegible])

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

10-YR

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	904.59	[illegible]	[illegible]
STORAGE	167.	167.	[illegible]
OUTFLOW	0.	[illegible]	[illegible]

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
~~.20~~	907.30	.61	221.	[illegible]	[illegible]	[illegible]	[illegible]

SUMMARY OF DAM SAFETY ANALYSIS

DATE
FILMED