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NATIONAL DAM SAFETY PROGRAM, WRIGHT LAKE DAM (NO 31062), MISSISS-ETC(U)

JAN 81 R G BERGGREEN, L M KRAZYNSKI

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WRIGHT LAKE DAM
BOLLINGER COUNTY, MISSOURI
MO 31062

PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY INSPECTION



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



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

REPLY TO
ATTENTION OF

SUBJECT: Wright Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Wright Lake Dam (MO 31062).

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

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

- a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.
- b. Overtopping of the dam could result in failure of the dam.
- c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY:

SIGNED

Chief, Engineering Division

02 APR 1981

Date

APPROVED BY:

SIGNED

Colonel, CE, District Engineer

03 APR 1981

Date

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WRIGHT LAKE DAM
Bollinger County, Missouri
Missouri Inventory No. 31062

Phase I Inspection Report
National Dam Safety Program

Prepared by

Woodward-Clyde Consultants
Chicago, Illinois

Under Direction of
St Louis District, Corps of Engineers

for
Governor of Missouri
January 1981

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D. C., 20314. The purpose of a Phase I investigation is not to provide a complete evaluation of the safety of the structure nor to provide a guarantee on its future integrity. Rather the purpose of the program is to identify potentially hazardous conditions to the extent they can be identified by a visual examination. The assessment of the general condition of the dam is based upon available data (if any) and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies. In view of the limited nature of the Phase I studies no assurance can be given that all deficiencies have been identified.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with any data which may be available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action removes the normal load on the structure, as well as the reservoir head along with seepage pressures, and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, so that corrective action can be taken. Likewise continued care and maintenance are necessary to minimize the possibility of development of unsafe conditions.

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam	Wright Lake Dam
State Located	Missouri
County Located	Bollinger
Stream	Unnamed Tributary of Gimlet Creek
Date of Inspection	13 November 1980

↓
Wright Lake Dam, Missouri Inventory No. 31062, was inspected by Richard Berggreen (engineering geologist), Leonard Krazynski (geotechnical engineer), and Sean Tseng (hydrologist). The dam is an earth dam constructed for recreational purposes.

The dam inspection was made following the guidelines presented in the "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines represent a consensus of the engineering profession. These guidelines are intended to provide for an expeditious identification of those dams which may pose hazards to human life or property, based on available data and a visual inspection. In view of the limited scope of the study, no assurance can be given that all deficiencies have been identified.

Wright Lake Dam is in the small size classification based on its maximum height of 27 ft and on its reservoir storage volume is approximately 110 ac-ft. The small dam classification includes dams between 25 and 40 ft in height or having storage capacities between 50 and 1000 ac-ft.

✓
The St Louis District (SLD), Corps of Engineers has classified this dam as having a high hazard potential; we concur with this classification. The hazard zone length estimated by the SLD extends approximately two and one-half miles downstream of the dam. Within this zone are Reed Lake Dam (MO 30859) and more than six occupied dwellings. Due to the small distance to the nearest downstream residences and Reed Lake Dam and the potential for damage due to outflow during overtopping, it is recommended that 100 percent of the Probable Maximum Flood (PMF) should be used as the spillway design flood. The PMF is defined as the flood event that may be expected to occur from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

↑

Our inspection and evaluation indicate the dam embankment is in generally good condition. The inadequate capacity of the main spillway is the item of primary concern for this facility. Our hydrologic analyses indicate that a flood greater than 42 percent of the Probable Maximum Flood (PMF) will overtop the dam. The PMF is defined above. The dam will not be overtopped by the 1 percent probability-of-occurrence (100 year) flood event. The 1 percent probability-of-occurrence event is defined as the flood event that has 1 percent probability of occurring in any year, or once in every 100 years. In these analyses, the 7-in. diameter outlet pipe (supplementary spillway) was assumed to be obstructed, due to the lack of a trash rack at the inlet end. Calculation has shown that, in any event, this outlet pipe is capable of discharging only 5 to 10 ft³/sec during overtopping.

The dam did not exhibit any lateral or vertical displacement or signs of slope instability. No evidence was noted of serious erosion, detrimental settlement, animal burrows or movement at or beyond the toe of the dam. Seepage was noted from around the wall surface of the 7-in. diameter outlet pipe at a rate of less than 1 to 2 gal/min. Seepage and stability analyses comparable to the requirements of the recommended guidelines were not on record, which is considered a deficiency.

Based on our evaluation of the information obtained from the visual inspection and other available information, the following specific recommendations should be acted on without undue delay:

1. Preparation of a more detailed hydrologic analysis and a design of a spillway and downstream channel capable of passing 100 percent of the PMF without overtopping the embankment. The spillway should be protected to prevent erosion.
2. Confinement of the discharge channel to a point downstream of the main spillway where significant outflow from the spillway will pass down the hillside beyond the toe of the dam, and will not cause erosion at the toe of the dam.

The following recommendations should be addressed as soon as practical:

3. Investigation of the feasibility of a warning system to alert downstream residents should potentially hazardous conditions develop at the dam during periods of heavy precipitation.

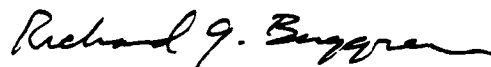
4. Preparation of static and seismic stability analyses and a seepage analysis for the existing structure to meet the "Recommended Guidelines for Safety Inspections of Dams."

5. Implementation of a program of periodic inspections and maintenance. This program should include but not be limited to the following:

- a. Checking for evidence of slope instability such as cracking or deformation on the embankment, or excessive settling of the dam crest;
- b. Inspection of the dam for any changes in conditions, such as changes in the amount or turbidity of seepage water;
- c. Maintaining the spillway and discharge channel free of potential obstructions such as trees and bushes, and keeping the slopes of the dam face clear of detrimental vegetation such as large trees.

These recommendations should be performed under the guidance of an engineer experienced in the design, construction and maintenance of earth dams. Records should be kept of all design, construction, inspections and maintenance.

WOODWARD-CLYDE CONSULTANTS



Richard G. Berggreen
Registered Geologist



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Vice President



OVERVIEW WRIGHT LAKE DAM

MISSOURI INVENTORY NUMBER 31062

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
WRIGHT LAKE DAM - MISSOURI INVENTORY NO. 31062
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3-B.	Sections of Dam and Spillway
4.	Regional Geologic Map

APPENDICES

A	Figure A-1: Photo Location Sketch
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Photographs

1. Downstream hazards. Wright Lake Dam in center of photo. Note downstream Reed Lake Dam, Missouri Inventory No. 30859, and houses, all in hazard zone. Looking west. Dam in background is over drainage divide and does not flow into Wright Lake.
2. Crest and downstream face of dam. Note lack of bushes and trees and the abundance of large gravel. Looking north.
3. Downstream face of dam. Note steepness and uniformity of slope. Also note the seepage pool at discharge pipe outlet to the left of the tree. Looking north.
4. Spillway at left (north) abutment. Looking east.
5. Discharge pipe inlet near the maximum section of the dam. Note apparent high water mark on pipe and lag gravel on upstream face of dam. Looking north.
6. Outlet of discharge pipe at toe of dam. Source of water from around the pipe. Looking west.

B	Hydraulic/Hydrologic Data and Analyses
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**PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
WRIGHT LAKE DAM, MISSOURI INVENTORY NO. 31062**

**SECTION I
PROJECT INFORMATION**

I.1 General

- a. **Authority.** The National Dam Inspection Act, Public Law 92-367, provides for a national inventory and inspection of dams throughout the United States. Pursuant to the above, an inspection was conducted of the Wright Lake Dam, Missouri Inventory Number 31062.
- b. **Purpose of investigation.** "The primary purpose of the Phase I investigation program is to identify expeditiously those dams which may pose hazards to human life or property... The Phase I investigation will develop an assessment of the general condition with respect to safety of the project based upon available data and a visual inspection, determine any need for emergency measures and conclude if additional studies, investigations and analyses are necessary and warranted" (Chapter 3, "Recommended Guidelines for Safety Inspection of Dams").
- c. **Evaluation criteria.** The criteria used to evaluate the dam were established in the "Recommended Guidelines for Safety Inspection of Dams," Engineering Regulation No. 1110-2-106 and Engineering Circular No. 1110-2-188, "Engineering and Design National Program for Inspection of Non-Federal Dams," prepared by the Office of Chief of Engineers, Department of the Army, and "Hydrologic/Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams," prepared by the St Louis District (SLD), Corps of Engineers. 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. Wright Lake Dam is an earth dam impounding a lake used for recreational purposes. The dam crest varies in elevation from 665.9 to 666.5 ft (MSL) and is grass covered. The main spillway is at the left (north) abutment and along the natural hillside. The spillway is grass-lined. The main spillway discharge channel joins the natural streambed about 50 ft downstream from the toe of the dam. Reed Lake Dam (MO 30859) is approximately 400 ft downstream of the dam. There are no control structures for regulating spillway flows. There is a discharge pipe, acting as a supplementary spillway, at the right one-third of the dam crest, which is near the maximum measured section of the dam. This pipe was assumed to be blocked in the hydraulic/hydrologic analyses, all flow being assumed to pass over the main spillway.
- b. Location. The dam is located on an unnamed tributary of Gimlet Creek, approximately three miles southwest of the town of Glenallen in Bollinger County, Missouri, Section 5, T30N, R9E. It is located on the USGS Glenallen (1980) 7.5-minute quadrangle map (Fig 1).
- c. Size classification. The dam is classified as small due to its 27 ft height and its 110 ac-ft storage capacity. The small size classification is based on a 25 to 40 ft height or 50 to 1000 ac-ft storage volume.
- d. Hazard classification. The St Louis District (SLD), Corps of Engineers, has classified this dam as having a high hazard potential; we concur with this classification. The SLD estimated damage zone length extends approximately two and one-half miles downstream. Located in this zone is Reed Lake Dam (MO 30859) and more than six occupied dwellings. Of significant note are the locations and apparent elevations of the residences on the shore of Reed Lake. A sudden failure of the Wright Lake Dam could pose a hazard to these downstream residents and structures.
- e. Ownership. The dam is reportedly owned by Mrs Virginia Wright. All correspondence is to be directed to Mrs Wright, Rte. 1, Glenallen, Missouri 63751.

- f. Purpose of dam. The reservoir created by the dam is used for recreational purposes.
- g. Design and construction history. No design or construction reports were found for Wright Lake Dam. Design and construction information has been obtained from interviews with Mr Rubin Reed, who owns Reed Lake Dam (MO 30859), immediately downstream of Wright Lake Dam. Mr Reed has lived in Nevada for the last seven months (telephone: (702) 482-6916). Further information was obtained from an interview with Mr George Mouser, Rte. 1, Marquand, Missouri, the constructor of the dam.

The dam was built in 1972 by Mr George Mouser, for Mr Lester Phelps, the father of Mrs. Wright. Mr Phelps passed away shortly after the dam was built. Mr Mouser has been building dams in the area for 13-14 years. He used a Soil Conservation Service (SCS) design from the Marble Hill, Missouri, office as a guide. The foundation was excavated using a scraper and a bulldozer. A cutoff was dug to "suitable" clay, locally called "white clay." Borrow soil was obtained from in and around the reservoir area and placed and compacted with the scraper. The bulldozer was used on the upstream face, constructed at 3(H): 1(V). The downstream face was constructed at 2(H): 1(V). The field survey of 30 December 1980, indicates the upstream slope above the lake level is 3.5(H): 1(V) and the downstream slope to be 2(H) to 2.4(H): 1(V). There was a problem with construction due to January being a wet month in that the soil became muddy. A "principal" (SCS term) spillway pipe was installed and Mr Mouser was reasonably certain it had "seep-plates." The "emergency" (SCS term) spillway was constructed at the left abutment. Mr Mouser indicated that he thought the dam was built approximately 1 ft higher than the SCS design indicated. No springs were noted during the excavating. The dam does not appear to have undergone significant changes since the time of construction.

- h. Normal operating procedures. No operating records or procedures were found. Flood flows pass over the uncontrolled main spillway at the left (north) abutment or through the 7-in. diameter supplementary spillway discharge pipe.

1.3 Pertinent Data

- a. Drainage area. Approximately 0.06 mi²
- b. Discharge at dam site.
- | | |
|---|---|
| Maximum known flood at damsite | Mr Reed reported that the dam was overtopped only once for a depth of one to two inches |
| Warm water outlet at pool elevation | Not applicable (N/A) |
| Diversion tunnel low pool outlet at pool elevation | N/A |
| Diversion tunnel outlet at pool elevation | N/A |
| Gated spillway capacity at pool elevation | N/A |
| Gated spillway capacity at maximum pool elevation | N/A |
| Ungated spillway capacity at maximum pool elevation | 115 ft ³ /sec |
| Total spillway capacity at maximum pool elevation | 115 ft ³ /sec |
- c. Elevations (ft above MSL).
- | | |
|---|----------------|
| Top of Dam | 665.9 to 666.5 |
| Maximum pool-design surcharge | N/A |
| Full flood control pool | N/A |
| Recreation pool | 664.1 |
| Spillway crest (gated) | N/A |
| Upstream portal invert diversion tunnel | N/A |
| Downstream portal invert diversion tunnel | N/A |
| Streambed at centerline of dam | Unknown |
| Maximum tailwater | Unknown |
| Toe of dam at maximum section | 639.1 |
- d. Reservoir.
- | | |
|---------------------------------------|--------|
| Length of maximum pool (estimated) | 450 ft |
| Length of recreation pool (estimated) | 400 ft |
| Length of flood control pool | N/A |

e. Storage (acre-feet).

Recreation pool	91
Flood control pool	N/A
Design surcharge	N/A
Top of dam	110

f. Reservoir surface (acres).

Top of dam	10.9
Maximum pool	10.9
Flood-control pool	N/A
Recreation pool	10.1
Spillway crest	10.1

g. Dam.

Type	Earth fill, compacted by construction equipment (Information from Mr Reed)
Length	445 ft
Height	27 ft
Top width	16 ft
Side slopes	Upstream; 3.4(H): 1(V), on exposed portion Downstream; 2.0(H) to 2.4(H): 1(V)
Zoning	None (reportedly homogeneous embankment by Mr Reed and Mr Mouser)
Impervious core	None (reportedly homogeneous embankment by Mr Reed and Mr Mouser)
Cutoff	Constructed to white clay soil, depth not uniform (Information from Mr Mouser)
Grout curtain	None

h. Diversion and regulating tunnel.

None

i. Spillway.

1. Main Spillway

Type	Broad, shallow "V" notch, grass-lined on gravelly clay
Length of weir	Approximately 45 ft at elevation of top of dam
Crest elevation	664.1 ft (MSL)
Gates	None
Upstream channel	None
Downstream channel	Insitu clay, grass-lined

2. Supplementary Spillway

Type	7-in. diameter iron pipe, no valve
Length of pipe	80 ft (approximate)
Upstream invert elevation	661.0 ft (MSL)
Downstream invert elevation	644.9 ft (MSL)
Gates	None

j. Regulating outlets.

None

SECTION 2 ENGINEERING DATA

2.1 Design

No design drawings or reports have been found for this dam. It was reported that a Soil Conservation Service design exists for this dam but it could not be located.

2.2 Construction

There were no construction reports located for this dam. Mr Mouser constructed the dam according to a Soil Conservation Service (SCS) design which could not be located at the time of issuing this report. The embankment soil is comprised of a gravelly clay (CL) excavated from the reservoir area. It is not known how the muddy condition of the soil at the time of construction affected the permeability or strength characteristics of dam embankment. The inspection did not indicate any adverse conditions from the high moisture content. Seepage was noted from around the discharge pipe and is discussed in Section 3.1c. Further details of construction are noted in Section 1.2g.

2.3 Operation

There are no facilities that require operation at this dam.

2.4 Evaluation

- a. Availability. Engineering data was obtained through personal interviews with Mr Reed and Mr Mouser.
- b. Adequacy. The available engineering data and information is insufficient to evaluate the design of the Wright Lake Dam. Seepage and stability analyses comparable to the guidelines were not found. This is a deficiency which should be rectified. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter

of record. These analyses should be performed by an engineer experienced in the design and construction of earth dams.

- c. **Validity.** The information provided by Mr Reed and Mr Mouser correlated well and there is no reason to question the validity of the information obtained.

2.5 **Project Geology**

The dam is located on the southeast flank of the Ozark structural dome. The regional dip of the bedrock is to the southeast. The bedrock in the vicinity of the dam is mapped on the Geologic Map of Missouri (1979) as Ordovician age Roubidoux Formation (Fig. 4). The Roubidoux Formation consists of sandstone, dolomitic sandstone and cherty dolomite. The sandstone is typically medium to fine quartz sand; the dolomite is finely crystalline, thinly- to thickly-bedded. The formation is typically gray to light brown in color. No well-exposed bedrock outcrops were noted in the vicinity of the dam.

The soil at the dam site consists of stoney to sandy clay (CL). This soil appears to be a residual soil developed by weathering of the dolomitic bedrock. The soil was sampled and classified in the field. The stoney fraction appears to be predominantly chert and quartz druse. The finer fraction appears to be sand and insoluble clay residuum from solution weathering. This soil appears to be the soil used in the dam construction. Soils in the vicinity of the dam are classified on the General Soils Map of Missouri (1979) as Union-Goss-Gasconade-Peridge Soil Association.

Several faults have been mapped in the vicinity of the Wright Lake Dam. The nearest are several short (one mile long) faults at Glenallen (three miles northeast) and Marble Hill (six miles northeast). These faults are associated with what are termed "anomalous structures" on the Structural Features Map of Missouri (1971), and may be remnants of ancient meteorite impact craters. They do not appear to be tectonic features and are not considered to pose any hazard to the dam.

The Grenville Fault, located approximately 8 miles northwest of the dam, has a mapped length of approximately 43 miles, trending northeast-southwest, and has a mapped displacement of northwest side up. This fault, like most others in the Ozark region, is not considered seismically active and is not considered to pose a significant hazard to the dam.

It should be noted the dam is located only 55 to 60 miles north of the line of epicenters for the very large 1811-1812 New Madrid earthquakes. Substantial damage could occur in the event of a recurrence of an earthquake of the magnitude of the New Madrid events.

SECTION 3 VISUAL INSPECTION

3.1 Findings

- a. General. A field inspection was made of the Wright Lake Dam on 13 November 1980 without the owner's representative present. The inspection indicated the dam embankment is currently in generally good condition.
- b. Dam. The dam is constructed of a reddish-brown, very gravelly clay (CL) or a poorly graded, clayey to silty gravel (GP). The soil has a significant portion consisting of rocks larger than 3 in. (Photos 2, 3, 4, 5). The dam embankment has a moderate erosion potential due to the amount of large-sized sub-angular gravel and small cobbles in a cohesive soil matrix, and also due to the uniform grass cover. There was no riprap on the upstream face of the dam. The upstream face of the dam shows some winnowing of the fine-grained fraction from the soil due to the fluctuating reservoir elevation (Photo 5). Due to the short fetch of the reservoir, and the gravel on the upstream slope, significant wave erosion is not expected.

The dam crest did not exhibit any lateral spreading, shifting or vertical settlement (Photo 2). No evidence of sinkhole development was observed during the inspection. The dam embankment has a good, uniform grass cover, without any trees or bushes. The slopes did not appear to have undergone any detectable deformation. No significant erosion was noted on the downstream face of the dam.

Seepage from around the 7-in. diameter discharge pipe was indicated by a small pool at the discharge end of the pipe (Photo 6). The rate of seepage was less than one gallon per minute and the seepage water did not appear to be transporting any soil particles.

There were no animal burrows noted on the dam embankment or around the embankment. There was no evidence of cracking at or beyond the toe of the dam.

c. Appurtenant structures.

1. Main Spillway. The broad, shallow, approximately triangular main spillway is located at the left (north) abutment. It is grass-lined and unobstructed (Photo 4). There was no evidence of previous erosion or instability noted in the spillway. The soil in the spillway is the undisturbed residual soil of the area, which is the soil used in construction of the dam embankment. The spillway has a moderate erosion potential due to the soil type and vegetative cover.

2. Supplementary Spillway. There is a 7-in. diameter iron discharge pipe that passes through the dam near the maximum section of the dam (Photo 5). The pipe has undergone some corrosion but at present appears to be in good condition. There is no screen or trash rack to prevent blockage, and no means to control flow through the pipe. There is seepage exiting from around the surface of the discharge end of the pipe. According to Mr Mouser who built the dam, he was reasonably certain that antiseep collars were on the discharge pipe. This could not be verified. The seepage does not presently pose a hazard to the safety of the dam, but it is recommended that this seepage be monitored. The upstream end of the pipe extends several feet beyond the embankment (Photo 5) and is unsupported for this length.

d. Reservoir area. The slopes surrounding the reservoir are vegetated by mature trees and grass (Photos 1, 2, 3). The slopes are approximately 5(H) to 1(V) or flatter. The beach face of the reservoir has been eroded by the fluctuation of the water surface and small wave erosion. Some minor erosion gullies were noted. The soil used to construct the dam embankment was excavated from the vicinity of the reservoir area.

There have apparently been no changes in the reservoir drainage basin, such as road or building construction, since the construction of the dam. Sedimentation records were not kept on the reservoir. However, the generally well vegetated slopes surrounding the reservoir indicate sedimentation will not be significant.

- e. **Downstream channel.** The channel downstream of the main spillway is grass-lined and does not appear to have undergone previous flow. The channel is in local residual soil of the reservoir area and has a moderate erosion potential. The channel follows the natural hillside for approximately 50 ft and then runs down the hillside to the natural streambed. Because the channel is not well contained (Fig 3-B, Section D-D), significant overtopping could cause erosion in the channel and a redirection of flow along the toe of the dam. High velocity or turbulent flow is capable of causing erosion at the toe of the dam.

There are some trees up to 8-in. diameter on the hillsides which form the discharge channel downstream of the dam (Photos 1, 4) and immediately beyond the toe of the dam (Photo 3). The trees could obstruct flow during flooding, and it is felt that they should be removed from the channel immediately downstream of the main spillway.

3.2 **Evaluation**

The visual inspection indicated the dam embankment is in generally good condition. The channel immediately downstream of the dam should be better confined as there is currently a potential for erosion and migration of the channel toward the toe of the dam. Large trees in the channel should be removed as they could obstruct flow during significant storm events.

SECTION 4 OPERATIONAL PROCEDURES

4.1 Procedures

No facilities requiring operation were identified at this dam site. Water level in the reservoir is controlled by flow through the ungated supplementary spillway pipe, near the maximum section, and main spillway at the left abutment.

4.2 Maintenance of the Dam

No records of maintenance were identified for this dam. The only identifiable maintenance performed on the dam was the cutting of grass on the dam crest.

4.3 Maintenance of Operating Facilities

No facilities requiring operation exist at this dam.

4.4 Description of Any Warning System in Effect

No warning system was identified in the inspection of this dam.

4.5 Evaluation

There is no formal maintenance program in effect for this dam. As there are several homes and Reed Lake Dam immediately downstream from the dam, the development of a maintenance program and an evaluation of a practical and effective warning system are recommended for this facility.

SECTION 5 HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

- a. Design data. No hydrologic or hydraulic information was available for evaluation of the dam or reservoir; however, dimensions of the dam were surveyed in the field. The survey data were furnished by James F. McCaul III and Associates of Potosi, Missouri. Other relevant data were measured during the field inspection or estimated from topographic maps. The map used in the analyses was the USGS Glenallen, Missouri, 7.5-minute quadrangle map (1980).
- b. Experience data. No recorded rainfall, runoff, discharge or pool stage historical data were found for this reservoir.
- c. Visual observation.
 1. Watershed. The watershed consists of residence and yard areas and natural woods, forested with mixed hardwoods and softwoods. The area of the reservoir is approximately 25 percent of the total drainage area of 0.06 mi².
 2. Reservoir. The reservoir and dam are described in Section 3 of this report and by the maps and photographs enclosed herewith. The primary use of this impoundment is for recreation.
 3. Spillways. The ungated, grass-lined main spillway is located at the north end of the dam abutting the natural hillside. The nature of the discharge channel below the spillway indicates that the spillway acts as the control section for flow. There is no trash rack on the 7-in. diameter supplementary spillway pipe. It is assumed to be clogged in the hydraulic/hydrologic analysis.
 4. Seepage. The magnitude of seepage through this dam is very small and not hydrologically significant to the overtopping potential.

- d. **Overtopping potential.** One of the primary considerations in the evaluation of Wright Lake Dam is the assessment of the potential for overtopping and consequent failure by erosion of the embankment. Since the main spillway of this dam is grass-lined earth, erosion at the control section of the main spillway due to high velocity discharge is expected to be a major consideration. The lowest portion of the dam, which is near the south end of the embankment, was considered to be the top of dam for the purpose of determining the overtopping potential.

Hydrologic analysis of this dam for the 1 and 10 percent probability-of-occurrence and Probable Maximum Floods (PMF) were all based on initial water surface elevations equal to the main spillway crest elevation. This is based on the assumption that the 7-in. diameter pipe supplementary spillway is blocked. Calculation has shown that, in any event, the unobstructed pipe is capable of discharging only 5 to 10 ft³/sec during overtopping. The results of the analyses indicate that a flood of greater than 42 percent of the PMF will overtop the dam. The PMF is defined as the flood event that may be expected to occur from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The analysis also indicates that the main spillway will pass the 1 percent probability-of-occurrence (100 year) flood event without overtopping the dam. The 1 percent probability-of-occurrence flood event is the precipitation event that has a 1 percent chance of occurring in any year, or will occur on the average once in every 100 years. The total main spillway capacity at maximum pool elevation (top of dam) is approximately 115 ft³/sec.

The following overtopping data for various precipitation events were computed for the dam:

Precipitation Event	Maximum Reservoir Elevation, ft, MSL	Maximum Depth Over Dam, ft	Maximum Outflow, ft ³ /sec	Duration of Overtopping, hrs
42% PMF	665.9	0	115	0
50% PMF	666.1	0.2	170	0.8
100% PMF	666.5	0.6	570	3.5

It should be noted that at 100 percent of the PMF the depth of overtopping may reach 0.6 feet and the dam may be overtopped for 3½ hours. This duration and depth of overtopping is judged to be sufficient to cause serious erosion of the embankment, perhaps leading to failure of the dam.

Due to the short distance to the nearest downstream residences and Reed Lake Dam, and the potential for damage in the event of a sudden failure of the dam, it is recommended that the spillway design flood be 100 percent of the PMF.

Input data and output summaries for the hydrologic and hydraulic analyses are presented in the attached Appendix B.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

- a. Visual observations. The visual inspection of Wright Lake Dam indicated the dam embankment to be in generally good condition. There were no evidence noted of slope instability, settlement or cracking. The small amount of seepage noted does not appear to pose a hazard to the stability of the dam at this time but should be periodically checked to detect any increase in flow or transporting of soil.

The erosion potential of the dam and main spillway is judged to be moderate. Further discussion of the structural features of the dam are found in Sections 2 and 3.

- b. Design and construction data. No design or construction records were available for this dam. All information on the construction of the dam was obtained through interviews with Mr Rubin Reed, owner of the downstream dam, and Mr George Mouser, the constructor of the dam, and is recorded in Sections 1.2g, 2.1 and 2.2 of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available.
- c. Operating records. There are no features requiring operation at this dam. Water level or depth records were not found for this dam.
- d. Post construction changes. There have been no apparent post construction changes on this dam other than the growth of grass on the dam face and discharge channel.
- e. Seismic stability. The dam is in Seismic Zone 2 to which the guidelines assign a moderate damage potential. During a seismic event, liquefaction of the gravelly, silty clay dam material is unlikely. However, without knowledge of soil properties of the embankment materials the seismic stability of the dam cannot be evaluated.

SECTION 7 ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

- a. **Safety.** Based on the visual inspection, the dam embankment appears to be in good condition. Seepage and stability analyses comparable to the requirements in the guidelines are not on record, which is a deficiency. The inadequate spillway capacity is the item of primary concern for this facility. The hydraulic/hydrologic analyses of the spillway, dam, and the reservoir storage indicate that the dam will pass 42 percent of the PMF without overtopping. The relative locations and apparent elevations of the occupied dwellings in the hazard zone downstream, indicate 100 percent of the PMF should be used as the spillway design flood.
- b. **Adequacy of information.** The visual inspection provided sufficient information to support the recommendations presented in this Phase I investigation. Design documents such as seepage and stability analyses were not found. This precludes an evaluation of the stability of the dam. This is a deficiency which should be corrected.
- c. **Urgency.** The deficiencies described in this report could affect the safety of the dam. The recommendations in Section 7.2b concerning the spillway and downstream discharge channel should be acted on without undue delay. All other recommendations in Sections 7.2b and 7.2c should be acted on as soon as practical.
- d. **Necessity for Phase II.** In accordance with the "Recommended Guidelines for Safety Inspection of Dams," the subject investigation was a minimum study. This study revealed that additional in-depth investigations are needed to complete the assessment of the safety of the dam. Those investigations which should be performed without undue delay are described in Section 7.2b. It is our understanding from discussions with the SLD that any additional investigations are the responsibility of the owner.

7.2 Remedial Measures

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

1. Remove the dam, or breach it to prevent storage of water.
2. Increase the height of dam and/or spillway size to pass the recommended spillway design flood without overtopping the dam.
3. Purchase downstream land that would be adversely impacted by dam failure, and restrict human occupancy.
4. Provide a highly reliable flood warning system (generally does not prevent damage but diminishes chances for loss of life).

- b. **Recommendations.** Based on our inspection of the Wright Lake Dam, it is recommended that the following topics be evaluated without undue delay:

1. Prepare a more detailed hydraulic/hydrologic analysis and design a spillway and discharge channel capable of passing 100 percent of the PMF without overtopping the embankment. The spillway should be protected to prevent erosion.
2. The discharge channel should be confined to a point downstream of the main spillway, where discharge flow down the hillside will not cause erosion at the toe of the dam.

The following recommendations should be addressed as soon as practical:

3. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" should be performed.

4. Investigation of the feasibility of a warning system to alert downstream residents should potentially hazardous conditions develop during periods of heavy precipitation.

5. A trash rack should be provided for the 7-in. diameter supplementary spillway pipe. The upstream end of the pipe should be supported from the point where it leaves the embankment.

All remedial measures should be evaluated and performed under the guidance of an engineer experienced in the design and construction of earth dams.

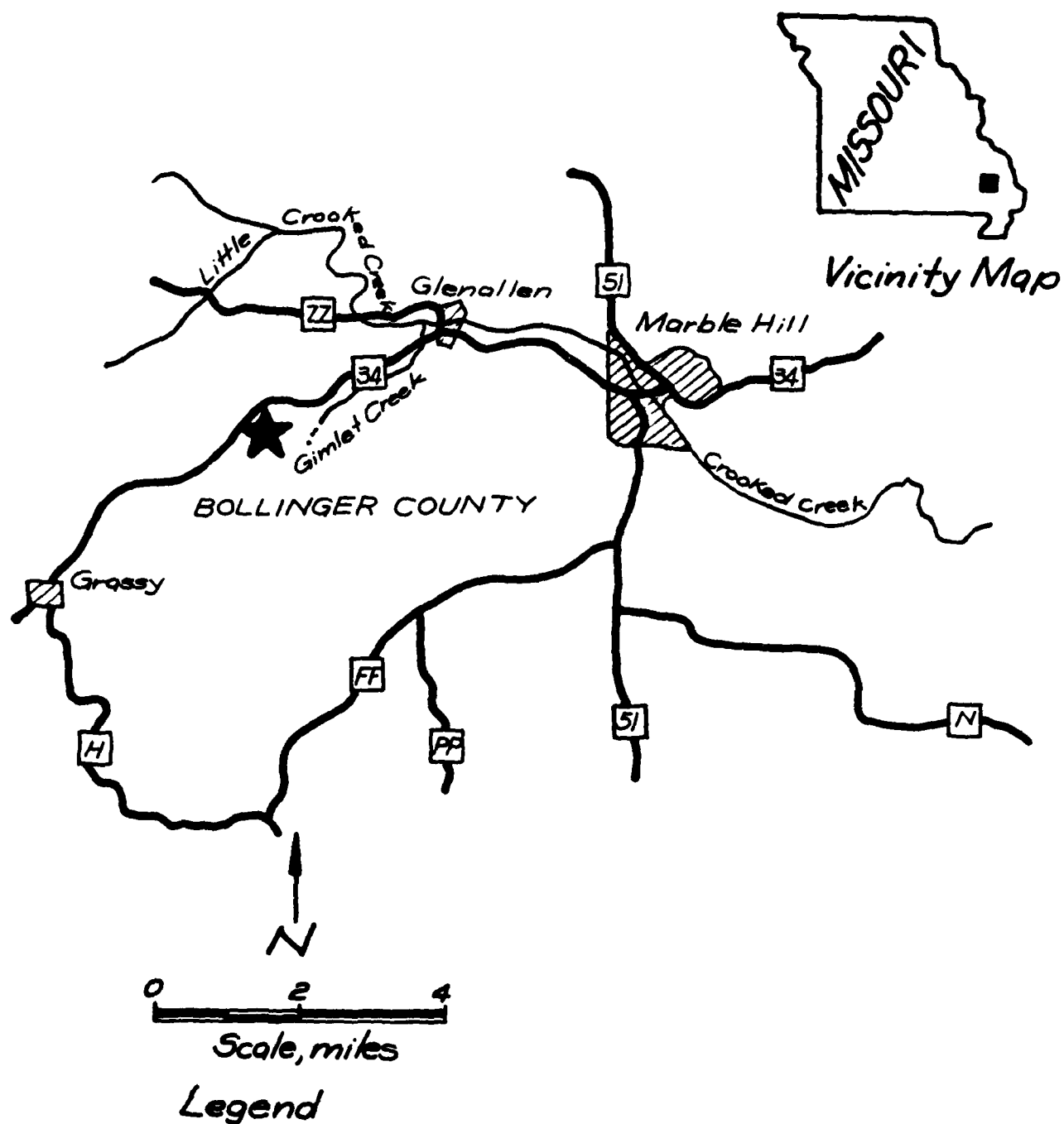
- c. O & M procedures. As there are no operating facilities per se, it is recommended that a program of periodic inspections and maintenance be developed and implemented as soon as practical. This program should include, as a minimum:

1. Inspection for evidence of slope instability such as cracking or deformation in the embankment, or excessive settlement of the dam crest;
2. Identification of changes in conditions such as increased seepage volume or turbidity in the seepage water;
3. Maintaining the spillway and discharge channel free of potential obstructions such as trees and bushes, and keeping the slopes of the dam free of detrimental vegetation such as large trees.

All inspections and maintenance should be evaluated and/or performed by an engineer experienced in the design and construction of earth dams. Records should be kept on all inspections and maintenance.

REFERENCES

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- Hydrologic Engineering Center, US Army Corps of Engineers, 1978, "Flood Hydrograph Package (HEC-1) Users Manual for Dam Safety Investigations."
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- St Louis District, US Army Corps of Engineers, 1979, "Hydrologic/Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams."
- US Department of Commerce, US Weather Bureau, 1956, "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24 and 48 Hours," Hydrometeorological Report No. 33.
- US Soil Conservation Service, 1971, "National Engineering Handbook," Section 4, Hydrology, 1971.

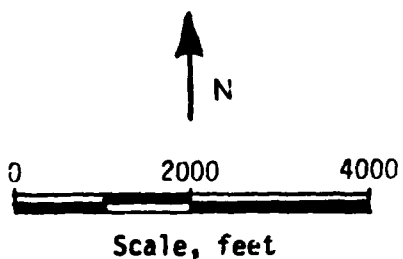
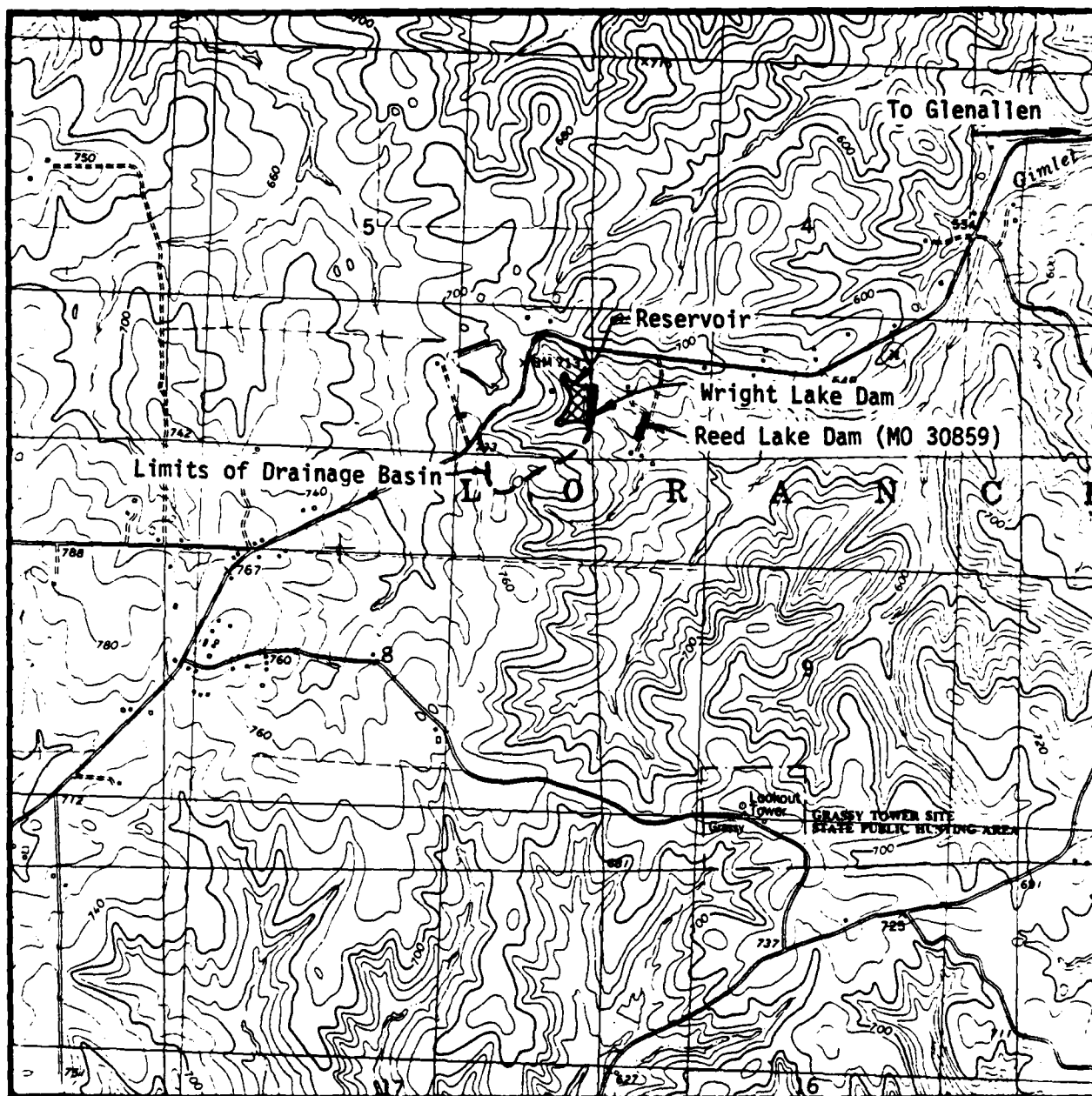


SITE LOCATION MAP

WRIGHT LAKE DAM

MO 31062

Fig. 1



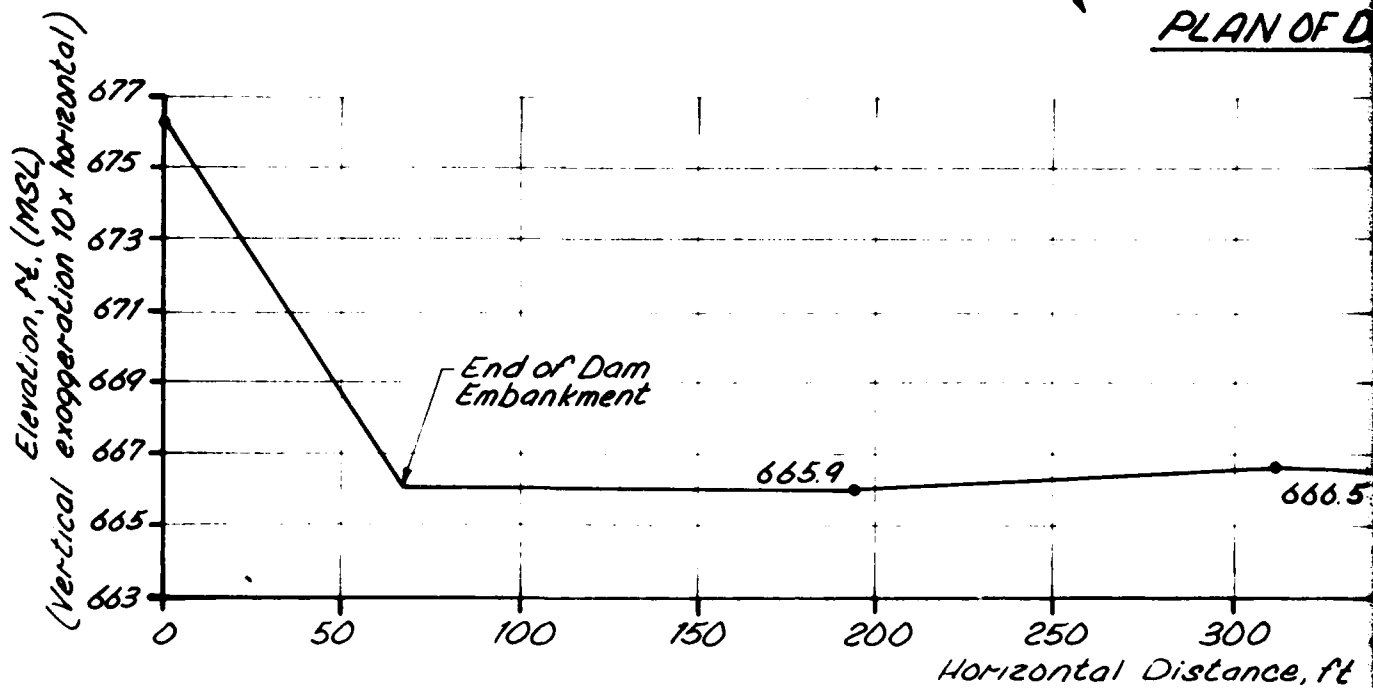
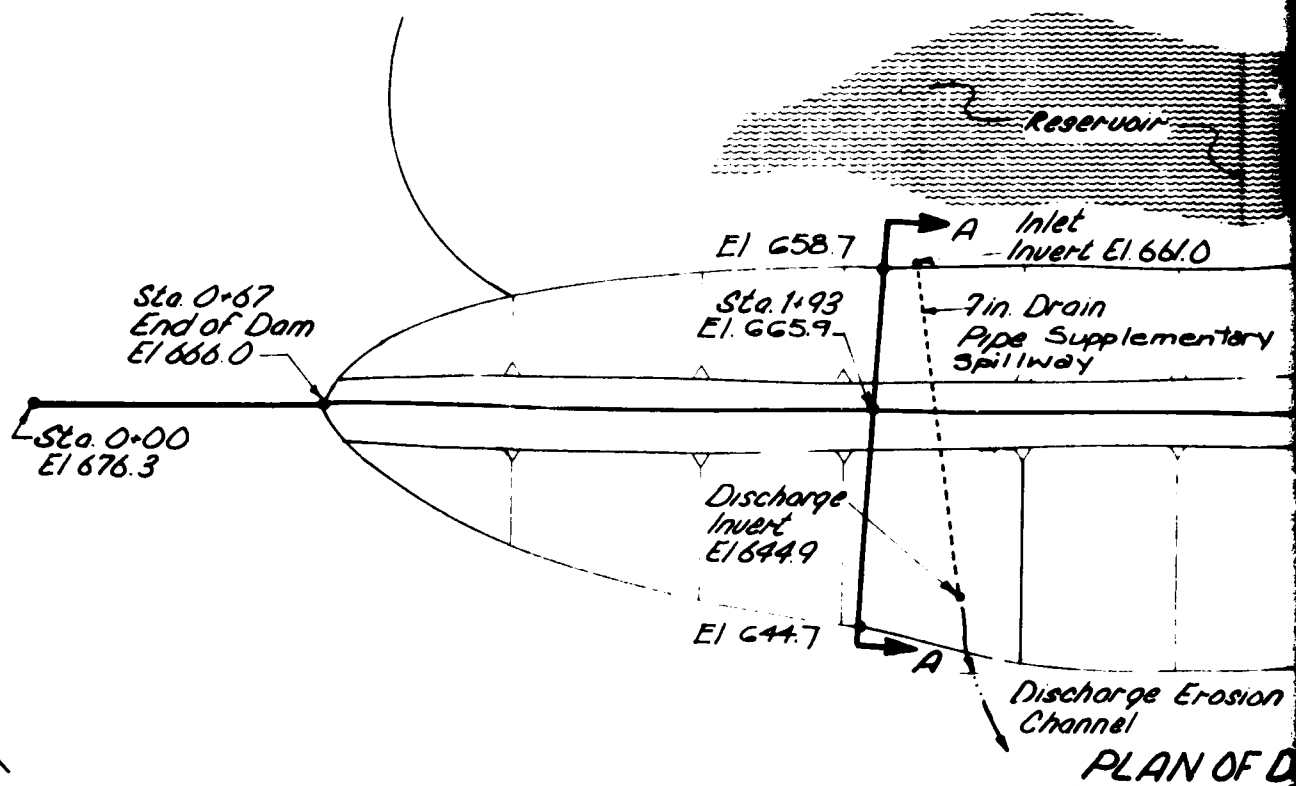
NOTE:
Topography from USGS
Glenallen, MO(1980)7.5-
minute quadrangle map.

DRAINAGE BASIN AND SITE TOPOGRAPHY

WRIGHT LAKE DAM

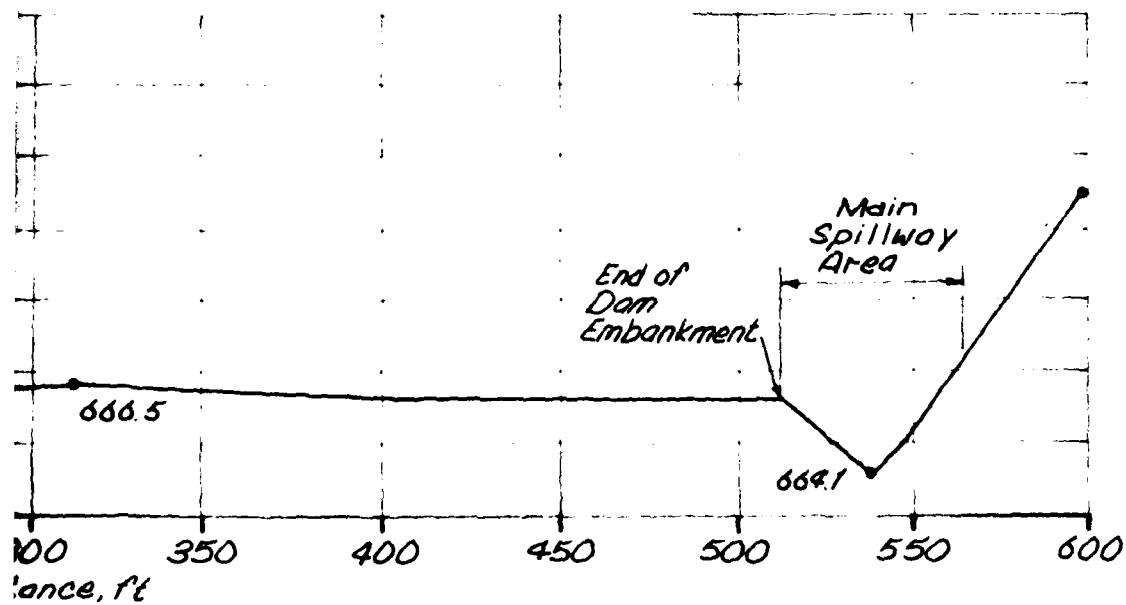
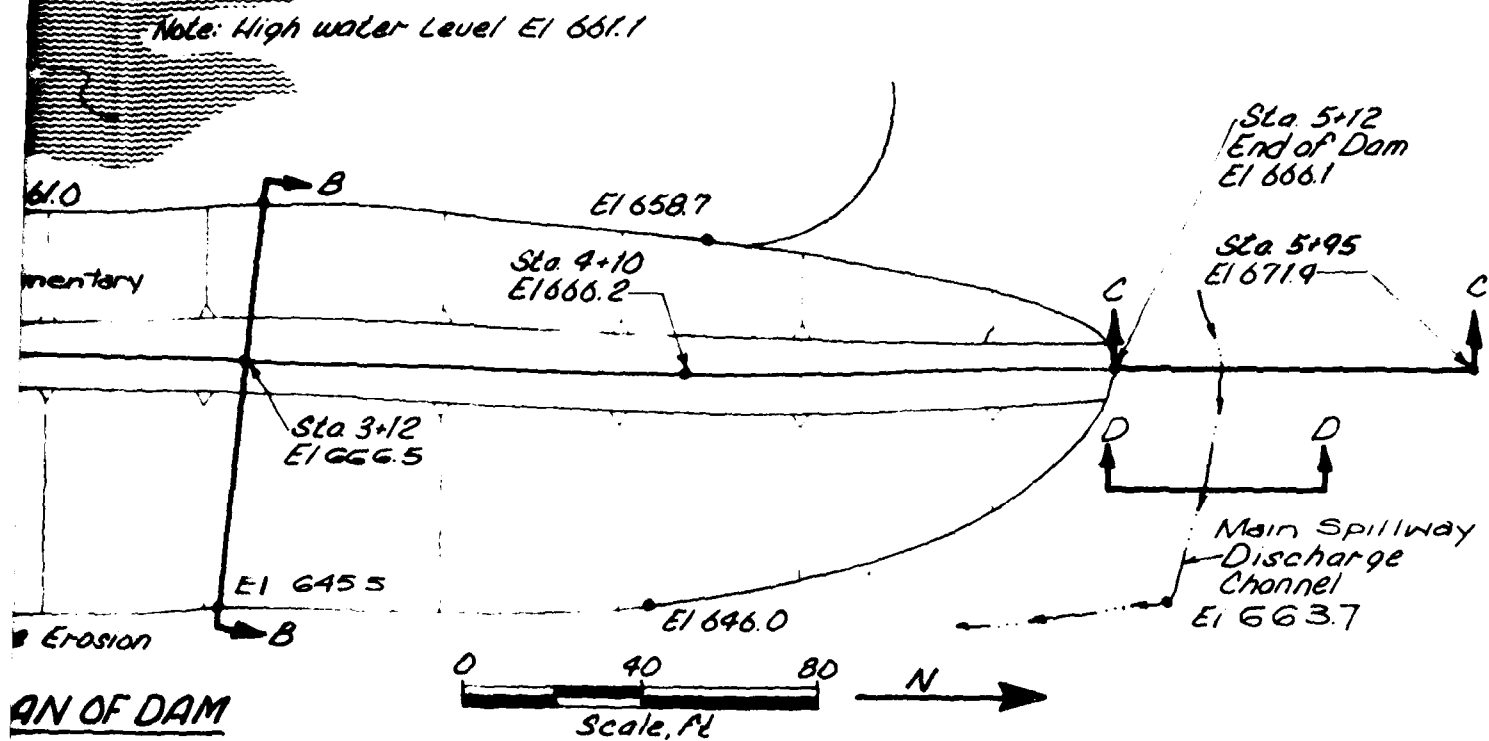
MO 31062

Fig. 2



Note:

Survey data supplied by James F. McC... and Associates, Engineers/Land Potosi, Mo. 6366... Date of Survey 3...



data supplied
by F. McCaul, III
McCaul & Associates, Consulting
Engineers/Surveyors
No. 63664
Survey 30 December 1980

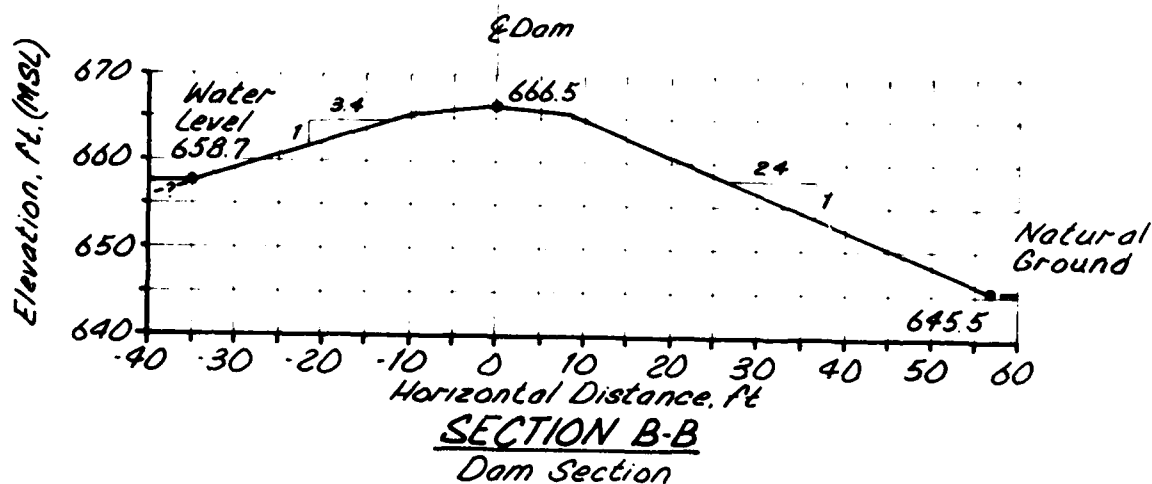
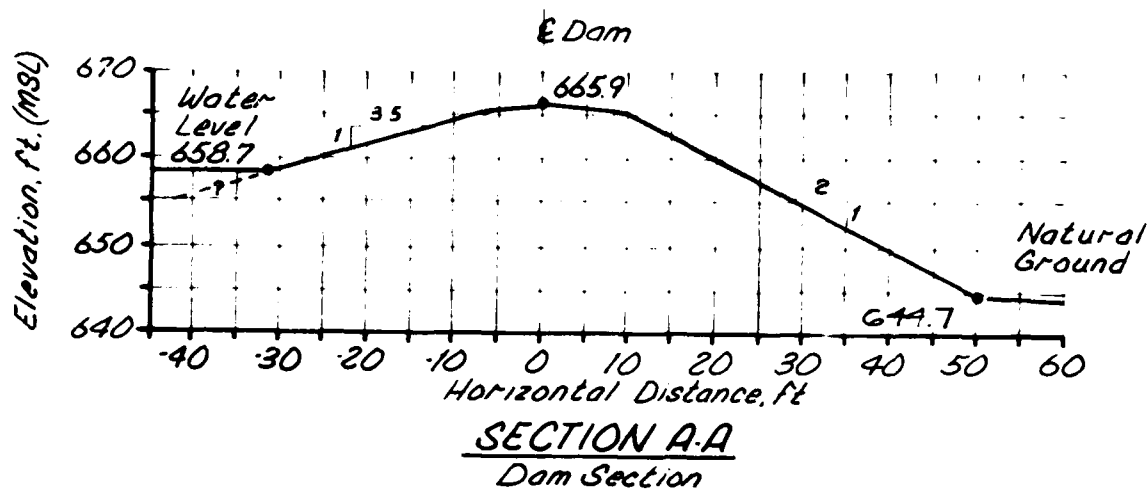
**PLAN OF DAM
AND PROFILE OF
DAM CREST**

WRIGHT LAKE DAM

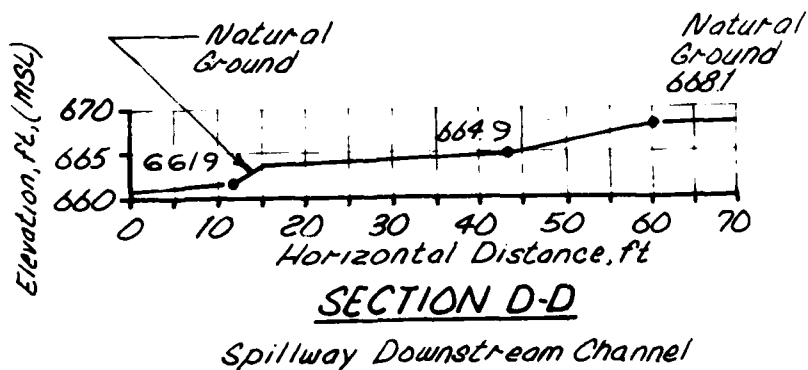
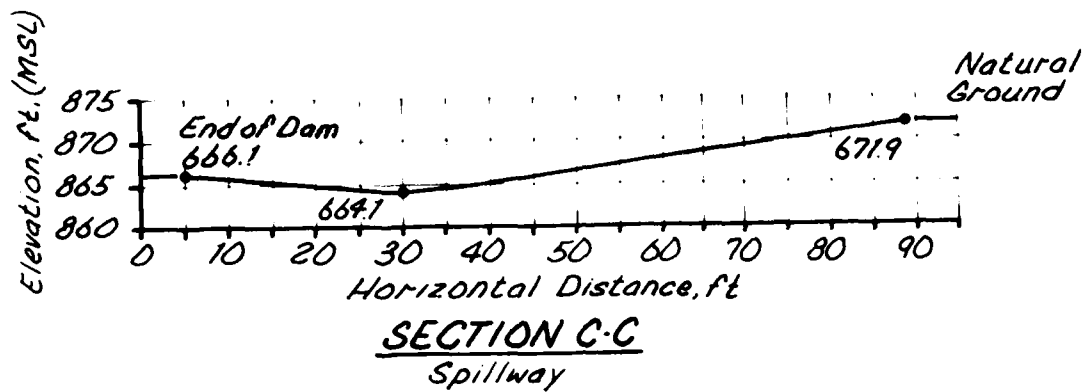
MO 31082

Fig. 3-A

2



Notes:
 1. Survey done
 by James A.
 and Assoc.
 Engineers,
 Potosi, Mo.
 Date of S



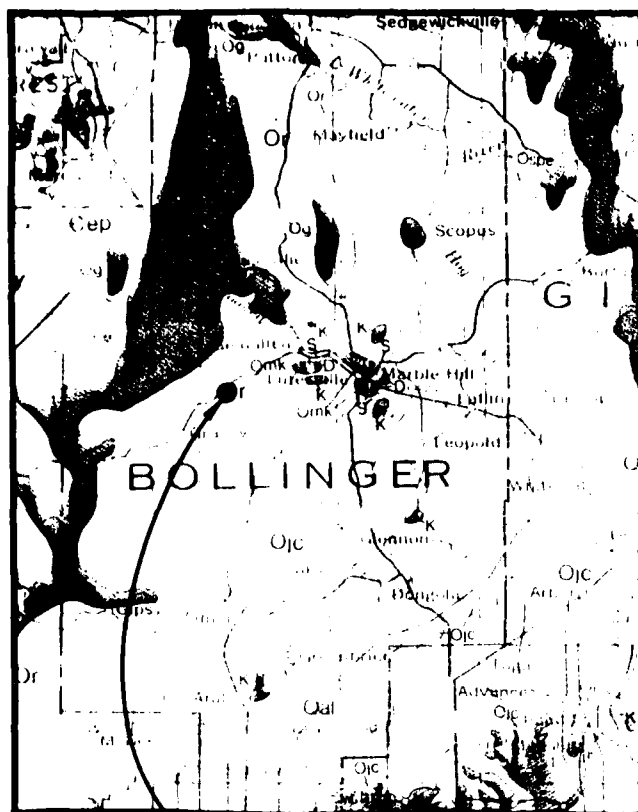
Survey data supplied
by James F. McCaul, III
and Associates, Consulting
Engineers/Land Surveyors
Potosi, Mo. 63664
Date of Survey 30 December 1980

SECTIONS OF DAM AND SPILLWAY

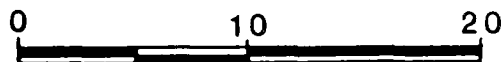
WRIGHT LAKE DAM

MO 31062

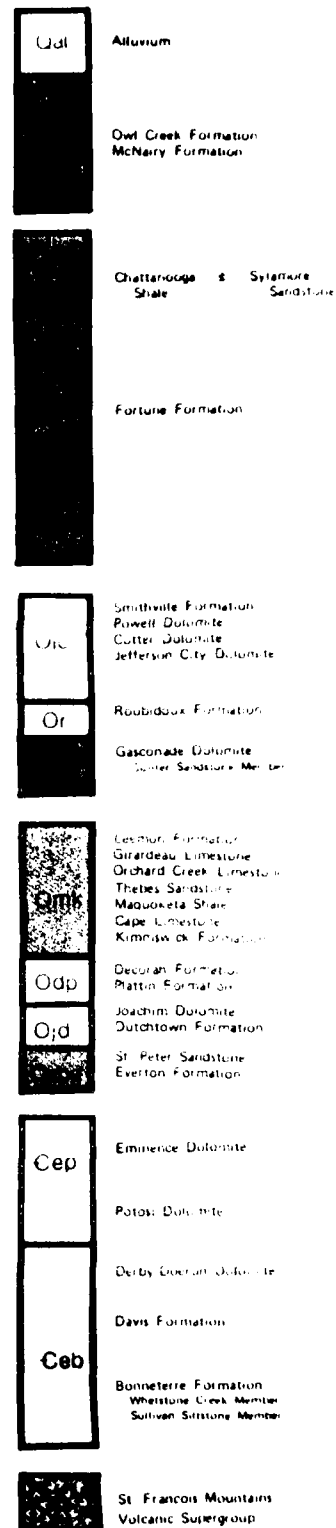
Fig. 3-B



Dam Location



Scale, mile



REGIONAL GEOLOGIC MAP

WRIGHT LAKE DAM

MO 31062

Fig. 4

APPENDIX A

Photographs

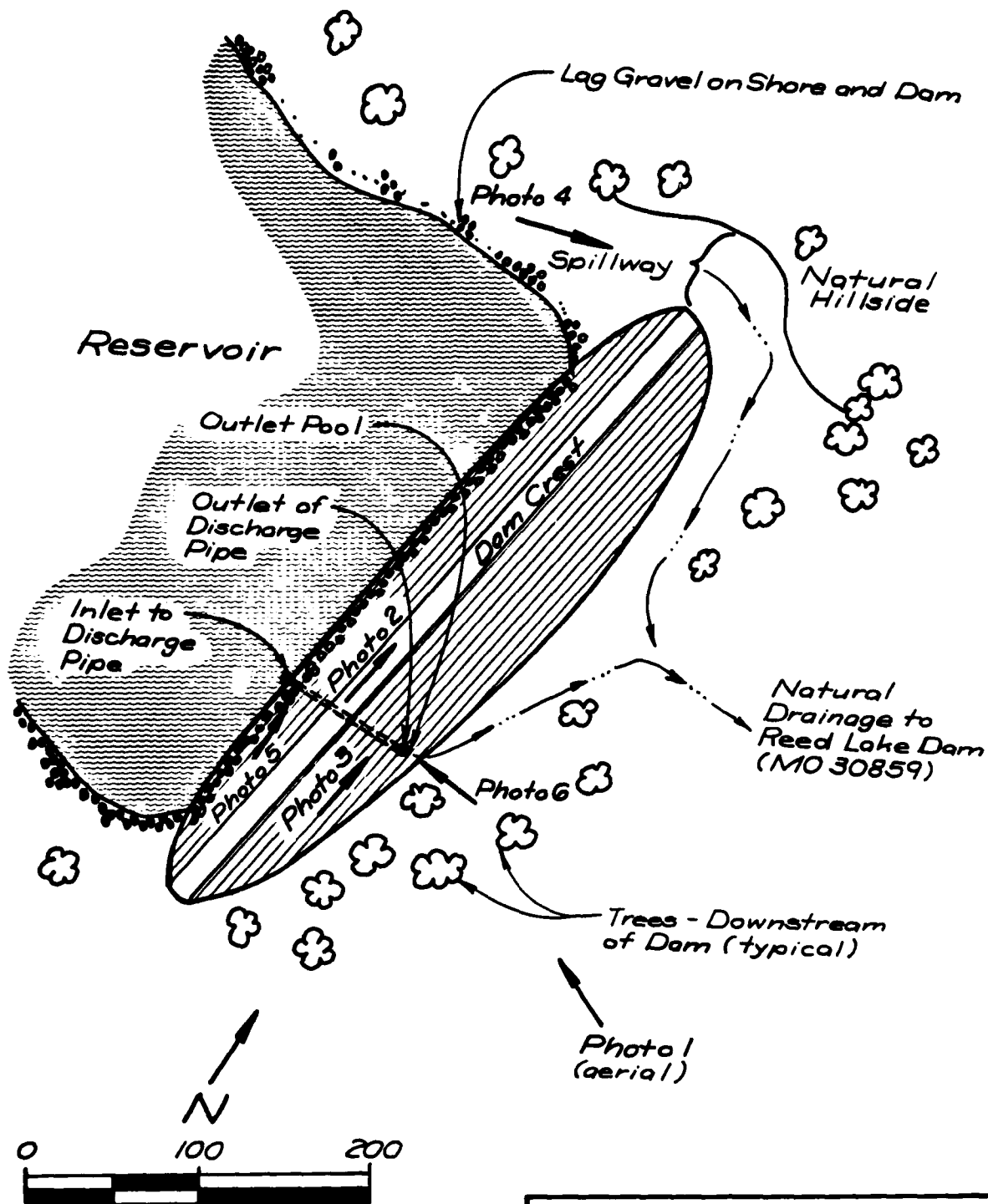


PHOTO LOCATION SKETCH

WRIGHT LAKE DAM

MO 31062

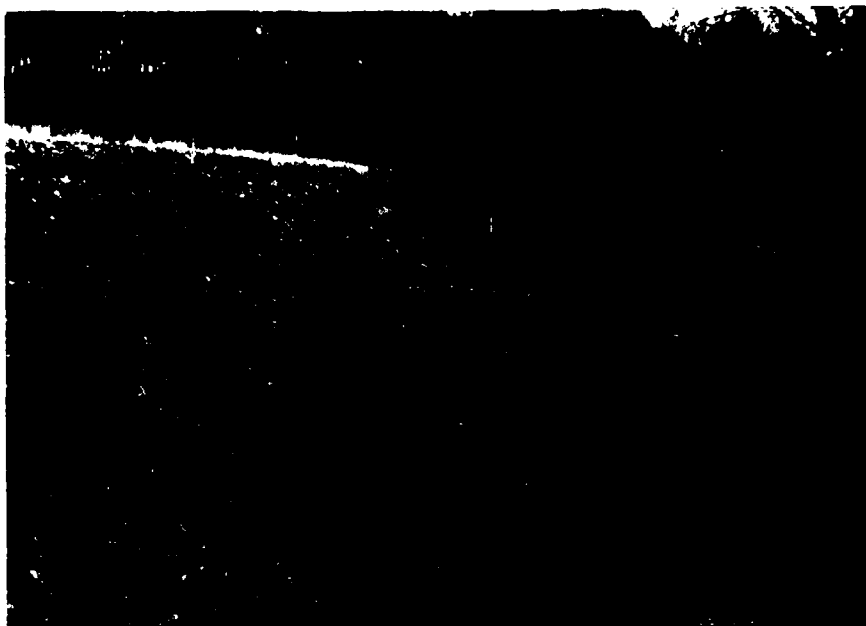
Fig. A-1



1. Downstream hazards. Wright Lake Dam in center of photo. Note downstream Reed Lake Dam, Missouri Inventory Number 30859, and houses, all in hazard zone. Looking west. Dam in background is over drainage divide and does not flow into Wright Lake.



2. Crest and downstream face of dam. Note lack of bushes and trees and the abundance of large gravel. Looking north.



3. Downstream face of dam. Note steepness and uniformity of slope. Also note the seepage pool at the discharge pipe outlet, to the left of the tree. Looking north.



4. Spillway at left (north) abutment. Looking east. Dam embankment to the right of the photo.



5. Discharge pipe inlet near the maximum section of the dam. Note apparent high water mark on pipe and lag gravel on upstream face of dam. Looking north.



6. Outlet of discharge pipe at toe of dam. Source of water from around the pipe. Looking west.

APPENDIX B

Hydraulic/Hydrologic Data and Analyses

APPENDIX B

Hydraulic/Hydrologic Data and Analyses

B.1 Procedures

- a. General. The hydraulic/hydrologic analyses were performed using the "HEC-1, Dam Safety Version (1 Apr 80)" computer program. The inflow hydrographs were developed for various precipitation events by applying them to a synthetic unit hydrograph. The inflow hydrographs were subsequently routed through the reservoir and appurtenant structures by the modified Puls reservoir routing option.
- b. Precipitation events. The Probable Maximum Precipitation (PMP) and the 1 and 10 percent probability-of-occurrence events were used in the analyses. The total rainfall and corresponding distributions for the 1 and 10 percent probability events were provided by the St. Louis District, Corps of Engineers. The Probable Maximum Precipitation was determined from regional curves prepared by the US Weather Bureau (Hydrometeorological Report Number 33, 1956, reprinted 1967).
- c. Unit hydrograph. The Soil Conservation Services (SCS) Dimensionless Unit Hydrograph method (National Engineering Handbook, Section 4, Hydrology, 1971) was used in the analysis. This method was selected because of its simplicity, applicability to drainage areas less than 10 mi², and its easy availability within the HEC-1 computer program.

The watershed lag time was computed using the SCS "curve number method" by an empirical relationship as follows:

$$L = \frac{l^{0.8} (s+1)^{0.7}}{1900 Y^{0.5}} \quad (\text{Equation 15-4})$$

where: L = lag in hours
 l = hydraulic length of the watershed in feet = 1500
 $s = \frac{1000}{CN} - 10 = 3.70$

CN = hydrologic soil curve number as indicated in Section B.2e.
 Y = average watershed land slope in percent = 5.8.

This empirical relationship accounts for the soil cover, average watershed slope and hydraulic length.

With the lag time thus computed, another empirical relationship is used to compute the time of concentration as follows:

$$T_c = \frac{L}{0.6} \quad (\text{Equation 15-3})$$

where: T_C = time of concentration in hours

L = lag in hours.

Subsequent to the computation of the time of concentration, the unit hydrograph duration was estimated utilizing the following relationship:

$$\Delta D = 0.133T_C \quad (\text{Equation 16-12})$$

where: ΔD = duration of unit excess rainfall

T_C = time of concentration in hours.

The final interval was selected to provide at least three discharge ordinates prior to the peak discharge ordinate of the unit hydrograph. For this dam, a time interval of 5 minutes was used.

- d. Infiltration losses. The infiltration losses were computed by the HEC-1 computer program internally using the SCS curve number method. The curve numbers were established taking into consideration the variables of: (a) antecedent moisture condition, (b) hydrologic soil group classification, (c) degree of development, (d) vegetative cover and (e) present land usage in the watershed.

Antecedent moisture condition III (AMC III) was used for the PMF events and AMC II was used for the 1 and 10 percent probability events, in accordance with the guidelines. The remaining variables are defined in the SCS procedure and judgements in their selection were made on the basis of visual field inspection.

- e. Starting elevations. Reservoir starting water surface elevations for this dam were set as follows:

- (1) 1 and 10 percent probability events - spillway crest elevation, 664.1 ft
- (2) Probable Maximum Storm - spillway crest elevation, 664.1 ft.

Because the discharge pipe is of small diameter, it was assumed that it was blocked and did not pass any amount of the flood.

- f. Spillway Rating Curve. The HEC-2 computer program was used to compute the spillway rating curve using discharge channel cross-sections and conveyance characteristics.

B.2 Pertinent Data

- a. Drainage area. 0.06 mi².

- b. Storm duration. A unit hydrograph was developed by the SCS method option of HEC-I program. The design storm of 24 hours duration was divided into 5 minute intervals in order to develop the inflow hydrograph.

- c. Lag time. 0.22 hr.
- d. Hydrologic soil group. C.
- e. SCS curve numbers.
 - 1. For PMF- AMC III - Curve Number 87
 - 2. For 1 and 10 percent probability-of-occurrence events - AMC II - Curve Number 73.
- f. Storage. Elevation-area data were developed by planimetering areas at various elevation contours on the USGS Glenallen 7.5-minute quadrangle map (1980). The data were entered on the \$A and \$E cards so that the HEC-1 program could compute storage volumes.
- g. Outflow over dam crest. As the profile of the dam crest is irregular, flow over the crest was computed according to the "Flow Over Non-Level Dam Crest" supplement to the HEC-1 User's Manual. The crest length-elevation data and hydraulic constants were entered on the \$D, \$L, and \$V cards.
- h. Outflow capacity. The spillway rating curve was developed from the cross section data of the spillway and the downstream channel, using the HEC-2 backwater program. The results of the above were entered on the Y4 and Y5 cards of the HEC-1 program.
- i. Reservoir elevations. For 50 and 100 percent of the PMF events, the starting reservoir elevation was 664.1 ft, the spillway crest elevation. For the 1 and 10 percent probability-of-occurrence events, the starting reservoir elevation was also 664.1 ft, the spillway crest elevation.

B.3 Results

The results of the analyses as well as the input values to the HEC-1 program follow in this Appendix. Only the result summaries are included, not the intermediate output. Complete copies of the HEC-1 output are available in the project files.

 PLUMB HYDROGRAPH PACKAGE (HEC-1)
 MAR 30P275 VERSION JULY 1978
 CASE MODIFICATION 01 APR 80

DATE: 07-JAN-81
 TIME: 06:52.03

WRIGHT LAKE, DAM NO. 31062, BOLLINGER COUNTY, MISSOURI.
 EDWARD-CLOYE CONSULTANTS, CUSTON JOB 80C224.
 PROBABLE MAXIMUM FLOODS.

JOB SPECIFICATION
 NO MHR MPIN IDAY IHR IPIN METRC IPLY IPRY MSTAM
 288 0 5 -0 -0 -0 -0 -0 -0
 JOPER MWI LROPT TRACE
 5 -0 -0 -0

MULTI-PLAN ANALYSES TO BE PERFORMED
 MPLAN= 1 MHYIO= 2 LNTIC= 1
 #105+ .50 1.00

SUB-AREA RUNOFF COMPUTATION

WRIGHT LAKE INFLOW COMPUTATIONS, PMF.

ISTAQ ICOMP IECOM ITAPE JPLY JPRY INAPE ISTAGE IAUTC
 INFLOW 0 -0 -0 -0 -0 -0 1 -0 -0

HYDROGRAPH DATA
 INYDC IUNG YAREA SNAP TRSDA TRSDC RATIO ISNOW ISAME LOCAL
 1 2 .00 -0.00 .00 1.00 0.00 -0.00 -0.00 -0.00

PRECIP DATA
 SPEE PHS R6 R12 R24 R48 R72 R96
 0.00 26.00 102.00 120.00 136.00 -0.00 -0.00 -0.00

LOSS DATA
 LROPT STARR OLTRK RTIOL ERAIN STARS RTIOL STRTL CNSTL ALSHX RTIMP
 -0 -0.00 1.00 1.00 -0.00 -0.00 1.00 -1.00 -87.00 -0.00 .25

CURVE PD = -87.00 WEIKNSS = -1.00 EFFECT CM = 87.00

UNIT HYDROGRAPH DATA
 IC= -0.00 LAG= .22

RECESSION DATA
 SRTQ= -1.00 ORCSN= -.05 RTIOR= 5.00

UNIT HYDROGRAPH 17 END OF PERIOD ORIGINATES, IC= -0.00, HOURS, LAG= .22 VOL= 1.00
 24. 80. 131. 98. 63. 36. 22. 13. 8. 5.
 3. 1. 6. 1. 1. 1. 1. 1. 1. 1.

END-OF-PERIOD FLOW

Output Summary
 Various PMF Events
 Wright Lake Dam
 MO 31062

B5

Output Summary
Various PMF Events
Wright Lake Dam
MO 31062

B6

U	HR.MN	PERIOD	RAIN	EXCS	LOSS	CUMPL	PMF	HR.MN	PERIOD	RAIN	EXCS	LOSS	CUMPL
1.01	0.05	1	.01	.00	.01	0.	1.01	12.05	145	.22	.21	.01	12.
1.01	.10	2	.01	.00	.01	0.	1.01	12.10	146	.22	.21	.01	13.
1.01	.15	3	.01	.00	.01	0.	1.01	12.15	147	.22	.21	.01	14.
1.01	.20	4	.01	.00	.01	1.	1.01	12.20	148	.22	.21	.01	15.
1.01	.25	5	.01	.00	.01	1.	1.01	12.25	149	.22	.22	.01	16.
1.01	.30	6	.01	.00	.01	2.	1.01	12.30	150	.22	.22	.01	17.
1.01	.35	7	.01	.00	.01	2.	1.01	12.35	151	.22	.22	.01	18.
1.01	.40	8	.01	.00	.01	2.	1.01	12.40	152	.22	.22	.01	19.
1.01	.45	9	.01	.00	.01	2.	1.01	12.45	153	.22	.22	.01	20.
1.01	.50	10	.01	.00	.01	2.	1.01	12.50	154	.22	.22	.01	21.
1.01	.55	11	.01	.00	.01	2.	1.01	12.55	155	.22	.22	.01	22.
1.01	1.00	12	.01	.00	.01	2.	1.01	13.00	156	.22	.22	.01	23.
1.01	1.05	13	.01	.00	.01	2.	1.01	13.05	157	.27	.26	.01	24.
1.01	1.10	14	.01	.00	.01	2.	1.01	13.10	158	.27	.26	.01	25.
1.01	1.15	15	.01	.00	.01	2.	1.01	13.15	159	.27	.26	.01	26.
1.01	1.20	16	.01	.00	.01	2.	1.01	13.20	160	.27	.26	.01	27.
1.01	1.25	17	.01	.00	.01	2.	1.01	13.25	161	.27	.26	.01	28.
1.01	1.30	18	.01	.00	.01	2.	1.01	13.30	162	.27	.26	.01	29.
1.01	1.35	19	.01	.00	.01	2.	1.01	13.35	163	.27	.26	.01	30.
1.01	1.40	20	.01	.00	.01	2.	1.01	13.40	164	.27	.26	.01	31.
1.01	1.45	21	.01	.00	.01	2.	1.01	13.45	165	.27	.26	.01	32.
1.01	1.50	22	.01	.00	.01	2.	1.01	13.50	166	.27	.26	.01	33.
1.01	1.55	23	.01	.00	.01	2.	1.01	13.55	167	.27	.26	.01	34.
1.01	2.00	24	.01	.00	.01	2.	1.01	14.00	168	.27	.26	.01	35.
1.01	2.05	25	.01	.00	.01	2.	1.01	14.05	169	.33	.33	.01	36.
1.01	2.10	26	.01	.00	.01	2.	1.01	14.10	170	.33	.33	.01	37.
1.01	2.15	27	.01	.00	.01	2.	1.01	14.15	171	.33	.33	.01	38.
1.01	2.20	28	.01	.00	.01	2.	1.01	14.20	172	.33	.33	.01	39.
1.01	2.25	29	.01	.01	.01	2.	1.01	14.25	173	.33	.33	.01	40.
1.01	2.30	30	.01	.01	.01	2.	1.01	14.30	174	.33	.33	.01	41.
1.01	2.35	31	.01	.01	.01	2.	1.01	14.35	175	.33	.33	.01	42.
1.01	2.40	32	.01	.01	.01	2.	1.01	14.40	176	.33	.33	.01	43.
1.01	2.45	33	.01	.01	.01	2.	1.01	14.45	177	.33	.33	.01	44.
1.01	2.50	34	.01	.01	.01	3.	1.01	14.50	178	.33	.33	.01	45.
1.01	2.55	35	.01	.01	.01	3.	1.01	14.55	179	.33	.33	.01	46.
1.01	3.00	36	.01	.01	.01	3.	1.01	15.00	180	.33	.33	.01	47.
1.01	3.05	37	.01	.01	.01	3.	1.01	15.05	181	.20	.20	.01	48.
1.01	3.10	38	.01	.01	.01	3.	1.01	15.10	182	.40	.40	.01	49.
1.01	3.15	39	.01	.01	.01	3.	1.01	15.15	183	.40	.40	.01	50.
1.01	3.20	40	.01	.01	.01	3.	1.01	15.20	184	.60	.60	.01	51.
1.01	3.25	41	.01	.01	.01	3.	1.01	15.25	185	.71	.71	.01	52.
1.01	3.30	42	.01	.01	.01	3.	1.01	15.30	186	1.71	1.71	.01	53.
1.01	3.35	43	.01	.01	.01	3.	1.01	15.35	187	2.81	2.81	.01	54.
1.01	3.40	44	.01	.01	.01	3.	1.01	15.40	188	1.11	1.11	.01	55.
1.01	3.45	45	.01	.01	.01	3.	1.01	15.45	189	.71	.70	.01	56.
1.01	3.50	46	.01	.01	.01	3.	1.01	15.50	190	.60	.60	.01	57.
1.01	3.55	47	.01	.01	.01	3.	1.01	15.55	191	.40	.40	.01	58.
1.01	4.00	48	.01	.01	.01	3.	1.01	16.00	192	.40	.40	.01	59.
1.01	4.05	49	.01	.01	.01	3.	1.01	16.05	193	.31	.31	.01	60.
1.01	4.10	50	.01	.01	.01	3.	1.01	16.10	194	.31	.31	.01	61.
1.01	4.15	51	.01	.01	.01	4.	1.01	16.15	195	.31	.31	.01	62.
1.01	4.20	52	.01	.01	.01	4.	1.01	16.20	196	.31	.31	.01	63.
1.01	4.25	53	.01	.01	.01	4.	1.01	16.25	197	.31	.31	.01	64.
1.01	4.30	54	.01	.01	.01	4.	1.01	16.30	198	.31	.31	.01	65.
1.01	4.35	55	.01	.01	.01	4.	1.01	16.35	199	.31	.31	.01	66.
1.01	4.40	56	.01	.01	.01	4.	1.01	16.40	200	.31	.31	.01	67.
1.01	4.45	57	.01	.01	.01	4.	1.01	16.45	201	.31	.31	.01	68.
1.01	4.50	58	.01	.01	.01	4.	1.01	16.50	202	.31	.31	.01	69.
1.01	4.55	59	.01	.01	.01	4.	1.01	16.55	203	.31	.31	.01	70.
1.01	5.00	60	.01	.01	.01	4.	1.01	17.00	204	.31	.31	.01	71.

B7

[illegible]

B8

1	10.10	1.42	.07	.06	.00	28.	1.61	22.10	266	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
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PEAK FLOW AND STORAGE TEND-UP PERIODS SUMMARY FOR MULTIPLE PEAK-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 PEAK RATIO 1 RATIO 2
50 1.00

HYDROGRAPH AT INFLOW .04 1 334. 627.
161 9.4511 10.9091

ROUTED TO DAM .06 1 168. 569.
161 4.7511 16.1111

SUMMARY OF DAM SAFETY ANALYSIS

PEAK INITIAL VALUE SPILLWAY CREST TOP OF DAM
 664.10 664.10 665.90
 ELEVATION STORAGE 91. 91. 110.
 OUTFLOW 0. 0. 117.

RATIO MAXIMUM RESERVOIR DEPTH MAXIMUM STORAGE MAXIMUM OUTFLOW TYPE OF
 OF PMF W.S.ELEV OVER DAM AL-FI CFS HOURS FAILURE
 HOURS

.50 666.00 .18 112. 168. .83 16.00 0.
 1.00 666.52 .62 117. 569. 3.50 15.83 6.

Output Summary
 Various PMF Events
 Wright Lake Dam
 MO 31062

B9

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

OPERATION STATION AREA PLAN RATIO 1 RATIO 2 RATIO 3 RATIO 4
 .41 .42 .43 .44

HYDROGRAPH AT INFLUX .06 1 274. 288. 287. 294.
 .161 7.751 7.941 8.131 8.311
 ROUTED TO DAM .06 1 112. 116. 121. 126.
 .161 3.171 3.251 3.421 3.561

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 INITIAL VALUE SPILLWAY CREST TOP OF DAM
 664.10 664.10 665.90
 STORAGE 51. 91. 110.
 OUTFLOW 0. 0. 117.

RATIO OF PMF MAXIMUM DEPTH OVER DAM MAXIMUM OUTFLOW CFS DURATION OVER TOP HOURS TYPE OF FAILURE HOURS
 .41 665.07 0. 112. 0. 16.17 C.
 .42 665.90 0. 116. 0. 16.17 0.
 .43 665.92 .02 121. .25 16.17 C.
 .44 665.95 .05 126. .42 16.17 0.

Output Summary
 Various PMF Events
 Wright Lake Dam
 MO 31062

B10

