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NATIONAL DAM SAFETY PROGRAM. IRON MOUNTAIN LAKE DAM (MO 30057), --ETC(U)

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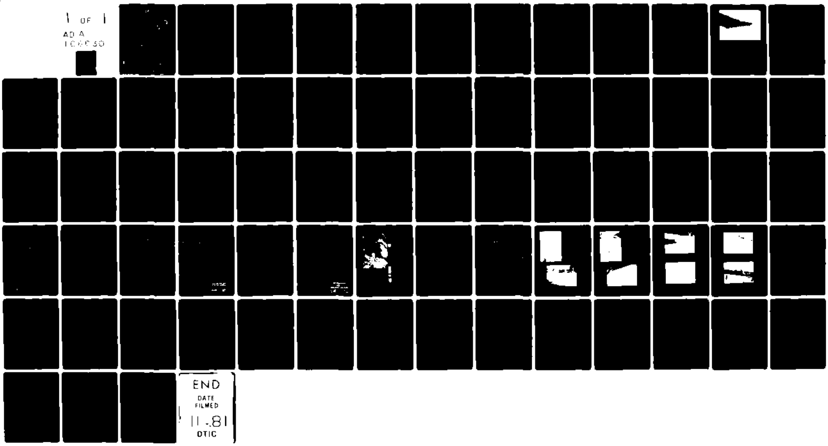

LEVEL II

MISSISSIPPI - ST FRANCIS BASIN

IRON MOUNTAIN LAKE DAM
ST FRANCOIS COUNTY, MISSOURI
MO 30057

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

United States Army
Corps of Engineers
...Serving the Army
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St. Louis District

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

FOR: STATE OF MISSOURI

APRIL 1981

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

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

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

REPLY TO
ATTENTION OF

SUBJECT: Iron Mountain Lake Dam, MO 30057

This report presents the results of field inspection and evaluation of the Iron Mountain Lake Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

It is recommended that the owner initiate immediate action to improve the structural stability of the dam and provide an adequate spillway system. If these recommendations are not implemented, the very poor embankment condition along with the potential for overtopping could result in failure of the dam.

SUBMITTED BY: SIGNED — Chief, Engineering Division — 7 JUL 1981 Date

APPROVED BY: SIGNED — Colonel, CE, Commanding — 7 JUL 1981 Date

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IRON MOUNTAIN LAKE DAM

St. Francois County, Missouri

Missouri Inventory Number 30057

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

April 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	Iron Mountain Lake Dam
State Located	Missouri
County Located	St Francois
Stream	Indian Creek
Date of Inspection	23 February 1981

Iron Mountain Lake Dam, Missouri Inventory No. 30057, was inspected by Richard Berggreen (engineering geologist), Jean-Yves Perez (geotechnical engineer), and Sean Tseng (hydrologist). The dam is an earth dam used 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, US Army, Washington, DC, 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.

Iron Mountain Lake Dam is in the small size classification based on its maximum height of 16.5 ft, and reservoir storage volume of approximately 882 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 significant hazard potential. The hazard zone length estimated by the SLD extends approximately one mile downstream of the dam. Within this zone are only one or two occupied homes which may be damaged by failure of this dam. The guidelines require a small size dam in the significant hazard catagory to pass a spillway design flood between the 100 yr flood and 50 percent of the Probable Maximum Flood (PMF). Due to the relatively large storage capacity for this small dam, 882 ac-ft, it is recommended that 50 percent of the PMF 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 meteorological and hydrologic conditions that are reasonably possible for the region.

The dam breached in 1978, probably as a result of piping along decaying tree roots. In 1979, extensive seepage through another section of the embankment required immediate repair. No evidence or record of overtopping of the dam was noted during the visual inspection.

Based on the visual inspection and analysis of available data, the dam is judged to be in very poor condition. This assessment is based primarily on the history of the recent breach and seepage which developed at this dam, possibly along piping paths resulting from decaying root systems. The size of the trees on the embankment and the number of stumps where trees have been cut down indicate that similar seepage areas will likely continue to appear and pose a hazard of dam failure. Extensive remedial work would be required to safely remove the stumps and roots in a safe manner. Continued and frequent inspection of the embankment is recommended to allow emergency measures to be taken when and if seepage develops on the dam.

Hydraulic/hydrologic analyses of the dam and appurtenant structures indicate the dam will be overtopped by a flood greater than 10 percent of the Probable Maximum Flood (PMF). The 1 percent probability-of-occurrence flood (occurs on the average once every 100 years) will overtop the dam by 0.7 ft. The relatively narrow embankment section and moderately erodible soil used in construction of the dam suggest overtopping would likely produce an effective breach of this dam.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. This is considered a deficiency which should be rectified.

Based on our inspection of Iron Mountain Lake Dam, the recommendations listed below should be addressed immediately.

1. An evaluation should be made of the feasibility and modifications necessary to allow removal of the trees and stumps on the embankment, and subsequent repairs to the dam.

2. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" should be performed and made a matter of record. Such analyses should consider all appropriate loading conditions, including seismic loads, and should be made by an engineer experienced in the design and construction of earth dams.

3. A detailed hydraulic/hydrologic analysis should be performed to design a spillway and discharge channel system capable of passing the spillway design flood (50 percent of PMF) without overtopping the dam. The modifications to the spillways and discharge channels should be designed to prevent erosion.

4. A procedure for a flood warning system should be formalized to facilitate the timely alerting of downstream residents in the event emergency conditions develop at this dam.

5. In lieu of the above recommendations, it may be necessary to breach the dam in a controlled manner, to mitigate the hazard posed by this dam.

In view of the condition of this dam and the history of problems, it is recommended that a program of periodic inspections and maintenance be initiated immediately by or under the supervision of an engineer experienced in the design, construction and maintenance of earth dams. The following items should be included, as a minimum, in this program.

1. Inspect the embankment and area adjacent to the toe for evidence of seepage. This inspection should note any change in the amount of seepage, or evidence of turbidity (soil) in the seepage water.

2. Inspect the embankment for evidence of slope instability such as cracking or slumping.

3. Inspect and repair the upstream slope where erosion or slumping of the rock cover has occurred.

4. Remove brush from the downstream slope of the dam to facilitate inspection of the embankment. Removal of large trees should only be done under the supervision of an engineer experienced in design, construction, and maintenance of earth dams. Indiscriminate removal of large trees could jeopardize the safety of the dam.

WOODWARD-CLYDE CONSULTANTS

Richard G. Berggreen

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Vice President

OVERVIEW
IRON MOUNTAIN LAKE DAM

MISSOURI INVENTORY NUMBER 30057

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
IRON MOUNTAIN LAKE DAM - MISSOURI INVENTORY NO. 30057
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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
IRON MOUNTAIN LAKE DAM, MISSOURI INVENTORY NO. 30057

SECTION 1
PROJECT INFORMATION

1.1 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 Iron Mountain Lake Dam, Missouri Inventory Number 30057.

b. **Purpose of Inspection.** "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," and 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.** Iron Mountain Lake Dam is an earth dam impounding a reservoir for recreational purposes. The dam is quite long, over 1500 ft, but not tall, about 16.5 ft. The embankment is constructed of locally-obtained silty clay soil. Coarse rock, from several inches to 1 ft in diameter, has been placed for erosion control along the upstream slope of the dam.

The dam is quite old, reported to have been constructed in 1847. Trees in excess of 2 ft in diameter are growing on the embankment. The embankment also has a cover of brush and grass. Some of the large trees have been cut down and only stumps remain. Some of the stumps have been burned to or below the embankment surface.

Two spillways were identified at this dam. The main spillway is located at the left end of the dam (as the observer faces downstream). This spillway consists of a base of large limestone blocks, capped by a 4-ft high concrete weir. Two 22-in. diameter ports through the concrete cap are blocked at the upstream end with removable steel plates. Concrete and stone walls form wing walls along the upstream and downstream channels. The discharge channel for this spillway flows beneath a bridge immediately downstream of the dam.

The auxiliary spillway is located at the right (east) end of the dam. This spillway consists of a broad grass-covered area adjacent to the lake, an unpaved road at the control section for the spillway, and a concrete-covered slope on the downstream side of the road. The discharge channel for this spillway is moderately overgrown with brush and small trees and could become obstructed during flood flows. The roadway was reported to be impassible during heavy flood flows through this auxiliary spillway.

b. **Location.** The dam and reservoir are located within the community of Iron Mountain Lake, on Indian Creek in St Francois County, Missouri. The dam is located in Section 32, T35N, R4E, on the USGS Iron Mountain Lake, Missouri 7.5-minute quadrangle map (1968).

c. **Size classification.** The dam is classified small size based on its height of 16.5 ft and storage capacity of 882 ac-ft. The small size classification criteria are: height between 25 and 40 ft, or storage capacity between 50 and 1000 ac-ft.

d. **Hazard classification.** The St Louis District (SLD), Corps of Engineers, has classified this dam as having a significant hazard potential; we concur with this classification. The damage zone length estimated by the SLD extends approximately one mile downstream of the dam. Within this estimated damage zone are only one or two occupied dwellings which could be damaged by failure of this dam. The contents of the damage zone were verified by aerial reconnaissance.

e. **Ownership.** The dam is reportedly owned by the Iron Mountain Lake Property Owners Association. Correspondence should be sent to the attention of the President of the Association, Mr Robert Becker, Route 2, Box 232, Bismarck, Missouri 63624.

f. **Purpose of dam.** The lake impounded by the dam is used primarily for recreational purposes.

g. **Design and construction history.** The dam was reported by Mr Robert Becker to have been constructed in 1847 by the Iron County Iron Company. No records are available of the original design and construction of the dam.

Mr Becker described some recent modifications which have been made on the dam. These include the addition of a 4 ft concrete cap to the main spillway weir, repair to a breach of the embankment which occurred in 1978, and emergency repair of a seepage area in 1979.

The modifications to the spillway were made in 1950 following a flood which washed out a bridge which was used as a crossing at the spillway. Two fish ladders at the spillway were also washed out by this flood event.

In 1978 a breach of the embankment drained the lake. This breach apparently developed by piping and internal erosion of the embankment at a decomposing tree stump. When the piping started, steel sheet piles were driven into the dam and straw was stuffed into the piping area. This reduced the flow for several days, but the seepage and piping eventually developed into a breach of the dam. The breach was filled with compacted clay.

As the lake was being refilled following repair of the breach, another area of seepage developed near a decaying tree stump at the right end of the dam. This area was repaired with steel sheet piles and seepage has not reappeared. However, the lake level has not risen to the level of the spillway crest since refilling began following the breach.

h. Normal operating procedures. No operating records or formal operating procedures were found for this dam. Mr Becker reported that the steel plates at the upstream end of the 22-in. ports through the spillway weir are removed manually when flow over the spillway reaches 4 to 6 in. deep. The person must stand on a narrow ledge (4-in. wide) on the downstream side of the weir and pry off the steel plates. This practice appears to be very hazardous to the person attempting to remove the plates. Alternate methods should be developed to allow opening these ports.

1.3 Pertinent Data

a. Drainage area. 12.4 mi^2

b. Discharge at damsite.

Maximum known flood at damsite	Approximately 1 ft over main spillway weir.
Warm water outlet at pool elevation	N/A (Not applicable)
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	3800 ft^3/sec (2600 main, 1200 auxil.)
Total spillway capacity at maximum pool elevation	3800 ft^3/sec (2600 main, 1200 auxil.)

c. **Elevation (ft above MSL).**

Top of dam	1059.9 to 1060.4
Maximum pool - design surcharge	N/A
Full flood control pool	N/A
Recreation pool	1055.3
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	1043.9

d. **Reservoir.**

Length of maximum pool	7000 ft
Length of recreation pool	3500 ft
Length of flood control pool	N/A

e. **Storage (acre-feet).**

Recreation pool	280
Flood control pool	N/A
Design surcharge	N/A
Top of dam	882

f. **Reservoir surface (acres).**

Top of dam	200
Maximum pool	200
Flood control pool	N/A
Recreation pool	70
Spillway crest	70

g. **Dam.**

Type	Earth
Length	1525 ft
Height	16.5 ft
Top width	8 - 14 ft
Side slopes	Upstream, unknown Downstream, 2.0-2.8(H) to 1(V)
Zoning	Unknown; probably homogeneous embankment
Impervious core	Unknown
Cutoff	Unknown
Grout curtain	Unknown; probably none

h. **Diversion and regulating tunnel.**

Type	None
Length	N/A
Closure	N/A
Access	N/A
Regulating facilities	N/A

i. **Spillway.**

	Main	Auxiliary
Type	Stone foundation with concrete weir. Concrete stone, and block wing walls upstream and downstream of weir.	Grass-covered adjacent to reservoir, unpaved roadway at control section, concrete-covered slope on downstream side of road.
Length of weir	75 ft	Approx. 130 ft at elevation of minimum top of dam.
Crest elevation	1055.3	1055.9
Gates	Two 22 in. diameter ports through weir. Manually opened.	None
Downstream channel	Bedrock-lined channel crossed by wood plank bridge.	Soil and rock-lined channel overgrown with brush and small trees.

j. **Regulating outlets.** None.

SECTION 2
ENGINEERING DATA

2.1 Design

No design plans or data are available for this dam.

2.2 Construction

No records of the dam construction are available. Mr Robert Becker, President of the Iron Mountain Lake Property Owners Association provided the following information.

The dam is reported to have been constructed in 1847 by the Iron County Iron Company. It is believed the dam is a homogeneous embankment constructed with gravelly to silty clay (CL) and clayey silt (ML). The spillway at the left (west) abutment is made of large limestone blocks with no mortar. The limestone blocks are crowned by a 4-ft high concrete weir. This concrete weir was added in 1950. This spillway was provided with two fish ladders that were destroyed by previous floods, (date unknown). The spillway also served as a crossing point (bridge) in the past. This bridge was washed out about 1950.

Mr Becker said a breach developed in the dam 3 years ago (1978) during spring runoff. The breach occurred on the east side of the main spillway. To repair the breach, the reservoir was drained. The breach was repaired using steel sheet piles and clay borrowed from the drained reservoir area. According to Mr Becker, the breach was caused by seepage through a decayed tree stump.

In 1979, a new seep developed 150 ft west of the right (east) abutment, also in the vicinity of a decaying stump. Water was observed seeping through the embankment and also upward through the road at the toe of the dam. The seep was repaired by driving sheet piles near the stump.

No other records of construction were available for this dam.

2.3 Operation

The only facilities requiring operation are two 22-in. diameter ports through the concrete portion of the spillway weir. Mr Becker reported these ports are opened by removing steel plates which are placed against the upstream end of the ports. These plates are removed when the spillway weir is overtopped by 4 to 6 inches.

No other operating facilities were recognized at this dam.

2.4 Evaluation

a. **Availability.** No engineering data or design reports were available for this dam. Information on recent construction was obtained from interviews with Mr Becker of the Iron Mountain Lake Property Owners Association.

b. **Adequacy.** The available engineering data are insufficient to evaluate the adequacy of design of Iron Mountain Lake Dam.

   Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" are not on record; this is considered a deficiency which should be rectified. These analyses should be performed by an engineer experienced in the design and construction of earth dams.

c. **Validity.** The information obtained from Mr Becker appears to be in general agreement with the findings of the visual inspection. However, the information is incomplete.

2.5 Project Geology

The dam site is located near the crest of the Ozark structural dome. Bedrock in the area is mapped as Precambrian age volcanic rock of the St Francois Mountain Volcanic Supergroup, and Cambrian age Elvins Group and Bonneterre Formation (Fig. 4). The Bonneterre Formation apparently does not outcrop in the the vicinity of the dam.

The Precambrian volcanic rocks underlie the ridges surrounding the drainage basin and consist of rhyolite and felsite volcanic flows and ash flow tuffs. This material is the host formation for the iron ore mined in the vicinity.

The Cambrian age sedimentary unit (Elvins Group) consists of the Derby-Doerun Dolomite and Davis formation. The Derby-Doerun Dolomite consists primarily of thin- to medium-bedded light gray dolomite with interbedded glauconitic siltstone and shale. This appears to be the bedrock exposed in the discharge channel below the spillway. The Davis Formation is a dolomitic shale underlying the Derby-Doerun Formation; it apparently does not outcrop at the dam site.

The soil at the dam site is a light gray to grayish-brown gravelly to silty clay (CL) and clayey silt (ML). This appears to be the soil used in the dam construction. Two soils are described in this area in the Missouri General Soils Map and Soil Association Descriptions (1979). The igneous bedrock in the area has a residual soil developed by weathering of the Precambrian units. This soil is mapped as Knobtop-Irondale-Delassus-Syenite Soil Association. The carbonate sedimentary units have developed a residual soil mapped as Peridge-Cantwell-Gasconade Soil Association.

Several faults are mapped in the area surrounding the dam site. The Cedar Creek Fault is mapped approximately 3 mi north of the dam. This fault is a part of the Palmer Fault System, a branching network of faults approximately 45 mi long, trending east-west through southern Crawford and Washington Counties. Displacement on the fault system is typically south side up.

Other small faults in the area are the Stone Mountain Faults, a series of 3 short faults, the closest of which is approximately 3 mi northeast of the dam, and the Ironton Fault, approximately 4 mi west. These faults, like most others in the Ozark region are within Precambrian and Paleozoic formations, and are likely Paleozoic in age. The area is not seismically active and these faults are not considered to pose an unusual hazard to the dam.

The dam is located approximately 90 mi northwest of the line of epicenters for the very large New Madrid earthquakes of 1811 and 1812. A recurrence of an earthquake of the magnitude of the New Madrid events could cause damage to this dam, but an assessment of this risk is beyond the scope of this Phase I investigation.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. **General.** Iron Mountain Lake Dam was inspected 23 February 1981. Mr Bob Becker, President of the Iron Mountain Lake Property Owners Association, met with the inspection team following the inspection.

b. **Dam.** The dam is an earth embankment approximately 1525 ft long and 16.5 ft high at the maximum section. The dam crest is typically narrow, ranging from 8 to 14 ft wide.

Based on limited exposures, the dam appears to have been constructed of locally-obtained gravelly to silty clay (CL) and clayey silt (ML). This material is judged to be moderately to highly erodible in the event of overtopping of the dam. The upstream slope of the dam has a mantle of coarse rock for erosion protection ranging in size from several inches to 1 ft in diameter (Photo 1). Some wave erosion has occurred above the rock cover, producing near-vertical slopes of 1 to 2 ft near the crest of the dam. Eroded portions of the rock cover and gully erosion on the dam crest and upstream slope are periodically repaired by dumping additional rock in the eroded areas. The rock is waste from a local iron ore mine and is generally quite dense.

Erosion protection is also afforded by the vegetation growing on the upstream slope of the dam from the crest to the lake level. Some erosion is anticipated to continue in areas not protected by the rock cover.

The crest and downstream slope of the dam are vegetated with grass, brush and large trees (Photo 2). The trees have grown to substantial size, some as large as 24 to 30 in. in diameter. Some trees of this size have been cut down and the stumps (Photo 3) have begun decaying. Efforts have also been made to burn the stumps out. The presence of trees of this size, and particularly the trees that have been cut down, is considered a deficiency. The decay of the root systems associated with these large trees and stumps could provide piping paths through the embankment. It was reported to the inspection team that the area of the breach which developed in 1978, and the seepage reported in 1979 may have been associated with piping along decaying root systems (see Sections 2 and 6).

Mr Becker indicated a plan is underway to vegetate the dam crest and downstream slope with grass. When completed, this should provide some measure of erosion protection in the event of overtopping. However, this protection could not be evaluated at the time of the visual inspection.

No evidence was noted during the visual inspection of displacement of the vertical or horizontal alignment of the dam crest. However, Mr Becker reported that in 1978 the dam had been breached, apparently by internal erosion along a decayed tree root. As the breach developed, siphons were installed over the spillway to attempt to lower the lake level. These siphons were eventually used to lower the lake below the breach in order to facilitate repairs. The siphons are no longer in place. A notch was cut 30 ft wide at the level of the dam crest and approximately 6 ft wide at the base of the dam. This area was backfilled with locally-obtained compacted clay. More trees were cut from the dam following this breach.

No seepage was noted at the toe of the embankment during the visual inspection. A swampy area of standing water is located approximately 40 ft downstream of the toe of the dam. This standing water was reported to be a permanent feature, independent of seasonal precipitation. It could be the result of natural seepage and springs, or seepage from the reservoir. No rate of flow could be determined and no soil was noted in the seepage water.

It was reported that an area of seepage developed near the east end of the dam as the water level was rising following the repair of the breach of the dam. Water was seeping through the embankment and rising through the road at the toe of the dam. It was reported this occurred in the vicinity of a decaying tree stump and may have been the result of piping and internal erosion. Steel sheet piles were placed on the upstream side of the dam crest in this area and appear to have controlled the seepage at present.

Erosion of the embankment appears limited to the wavecut notch on the upstream slope. No significant erosion was noted at the junction of the abutments and embankment or on the downstream slope.

No sinkhole development or animal burrows were noted on the embankment or in the vicinity of the dam during the visual inspection.

c. Appurtenant structures.

1. Main spillway. The main spillway for Iron Mountain Lake Dam is a stone and concrete structure located near the left (west) abutment (Fig. 3A). The lower portion of the spillway consists of large, apparently unmortared limestone blocks (Photo 4), reported to be 6 ft long. A 4-ft high concrete weir has been constructed on top of the stone portion of the spillway. The concrete portion has two 22-in. diameter ports (Photo 5) which are closed at the upstream end with removable steel plates. It was reported these plates are removed to increase discharge when the spillway overflows to a depth of 4 to 6 in. Stone and concrete wingwalls have been built upstream and downstream of the spillway and form the upstream and downstream channels.

The upstream wingwall to the left (west) of the spillway continues along the upstream slope of the dam to the left abutment. Although this area is slightly lower than the crest of the rest of the dam, overtopping of this area is not considered to pose a hazard to the dam due to the erosion resistance of the concrete wall.

Some minor cracking was noted in the concrete portion of the spillway, specifically above the outlet ports. This cracking appeared to be old and may have been due to shrinkage following the construction. It did not appear to pose a hazard to the stability of the concrete weir. Some seepage was occurring through the rock portion of the spillway wall, but did not appear to pose an unusual hazard to the dam.

There did not appear to be a significant potential for obstructing the spillway during flood flows.

2. **Auxiliary spillway.** The auxiliary spillway is located at the right (east) end of the embankment (Photo 6). It consists of a broad grass-covered area, an unpaved road, and a concrete-covered slope (Photo 7) on the downstream side of the road. The auxiliary spillway was reported by Mr Becker to have overflowed periodically during heavy spring rains. No erosion is anticipated in this area due to the flat gradient and concrete slope-cover adjacent to the roadway. The roadway crossing the auxiliary spillway was reported to be impassible during heavy flood flows.

d. **Reservoir area.** The slopes surrounding the reservoir are relatively flat, and no signs of unstable slopes were identified during the visual inspection. The area immediately surrounding the reservoir has scattered residential development (Overview Photo) and sedimentation is not anticipated to be significant. The reservoir was drained following the breach which occurred in 1978. Mr Becker reported that very little sediment had accumulated in the reservoir area.

The drainage basin above the reservoir consists of predominantly wooded hills and pastureland. Sedimentation from this drainage basin is not anticipated to be significant.

e. **Downstream channel.** The downstream channel for the main spillway flows beneath a wooden plank bridge (Photo 8) and into the natural stream channel. Rocky pinnacles and pieces of concrete and rock from a bridge that used to cross the spillway are present as minor obstructions in the downstream channel, but do not appear sufficient to significantly retard flood flows. It was reported by Mr Becker that flood flows have reached nearly to the base of the bridge. Flows of sufficient depth to reach the bridge would likely be capable of damaging or destroying the bridge, which could result in obstruction of the channel.

The downstream channel for the auxiliary spillway is moderately to densely overgrown with brush and small trees and would likely be subject to some obstruction. The banks of this channel appear subject to erosion by flood flows. However, the distance of this channel downstream of the dam embankment indicates erosion in this area will not pose a significant hazard to the dam.

3.2 Evaluation

Based on the findings of the visual inspection of this dam and appurtenant structures, the dam is judged to be in very poor condition.

The dam breached in 1978, probably as a result of piping along decaying roots. The area of seepage that developed near the right end of the dam and required installation of sheet piles may have also been occurring along decaying root channels. The number of large trees that have been cut from the embankment leaving root systems to provide potential piping paths suggest similar conditions will continue to develop at this dam. The lake level has not reached the normal operating level since refilling began following the draining of the lake through the breach. As the lake level rises, seepage pressures will rise and the potential for seepage and piping will increase. Frequent and careful inspection of the dam will be necessary to assess the condition of the dam as filling progresses.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

No records of formal operational procedures were identified for this facility. Mr Becker reported that the 22 in. ports through the spillway weir are opened manually when flow over the spillway weir reaches 4 to 6 in. deep. This operation involves someone walking on a very narrow ledge on the downstream side of the weir and prying the steel plates off the upstream end of the ports. This procedure is judged extremely hazarous during times of flow over the spillway. It is recommended that alternate methods of opening these ports be designed and implemented.

4.2 Maintenance of the Dam

No formal maintenance program was identified at this dam. The visual inspection and interview with Mr Becker identified several maintenance practices which are being done at this facility.

A number of large trees have been cut from the embankment. These have apparently been cut without any guidance from an engineer experienced in maintenance of dams. It was reported by Mr Becker that the breach of the dam and the area of heavy seepage were both associated with a decaying stump and roots. This demonstrates the need for engineering guidance in removal of trees. Indiscriminate removal of trees can jeopardize the safety of the dam.

Mr Becker reported a program is underway to vegetate the dam with grasses. This program had just begun and the success of this program could not be evaluated at the time of the visual inspection.

It was also reported that repairs are made periodically to the rock cover erosion protection on the upstream slope. Waste rock from a nearby iron mine is dumped onto the upstream slope where needed to fill eroded or washed out portions of the rock cover.

No other evidence or records of maintenance were found for this dam.

4.3 Maintenance of Operating Facilities

No records were available of maintenance performed on the operating facilities at this dam.

4.4 Description of Any Warning System in Effect

The visual inspection did not identify any warning system at this dam. However, Mr Becker reported that as the dam began to fail in 1978, warnings of possible flooding downstream were published in local papers and broadcast over local radio stations. It is thus apparent that a program to alert downstream residents could be implemented for the facility.

4.5 Evaluation

A program of maintenance procedures is in effect at this facility. However, some of these procedures appear ill-advised, such as the indiscriminate cutting of trees from the embankment. It is recommended that this program of maintenance be reviewed and revised as needed by an engineer experienced in the design, construction and maintenance of earth dams.

SECTION 5
HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design data. No hydraulic or hydrologic 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 relevent data were measured in the field or estimated from topographic maps. The maps used in the analyses were the USGS Iron Mountain Lake, Ironton, and Graniteville, Missouri, 7.5-minute quadrangle maps.

b. Experience data. No recorded rainfall, runoff, discharge, or pool stage historical data were found for this reservoir. No record or evidence of overtopping of the dam was found during the visual inspection.

c. Visual observation.

1. Watershed. There is some residential development in the area immediately around the lake; otherwise, the watershed is undeveloped and covered with forest and pastureland. The reservoir area at normal pool elevation is about 1 percent of the total drainage area of 12.4 mi^2.

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. Spillway. The main spillway, located close to the west end of the dam, is a drop spillway with a level concrete crest. The spillway is made of stone, masonry and concrete and has a 15 ft vertical drop.

The 22-in. diameter ports through the spillway weir were considered closed for the overtopping analysis.

The auxiliary open-channel spillway lies on the grass-lined natural ground at the east end of the dam. A roadway along the toe of the dam crosses the spillway.

d. <u>Overtopping potential</u>. One of the primary considerations in the evaluation of Iron Mountain Lake Dam is the assessment of the potential for overtopping and consequent failure by erosion of the embankment. Since the auxiliary spillway of this dam is grass-covered earth, some erosion at the control section of the spillway due to high velocity discharge can be expected. However, this spillway is located away from the maximum section of the dam and erosion is not anticipated to pose a significant hazard to the safety of the dam. Erosion is not anticipated to be significant at the rock and concrete-lined main spillway. The lowest portion of the dam crest, which is near the middle of the dam, was considered to be the top of dam for the purpose of evaluating the overtopping potential.

Hydrologic analyses 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. The results of the analyses indicate that a flood of greater than 10 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 spillways will not be able to 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 occurs on the average once every 100 years. The combined total spillway capacity at maximum pool elevation (minimum top of dam) is approximately 3800 ft^3/sec (2600 ft^3/sec main spillway, 1200 ft^3/sec auxiliary spillway).

The following overtopping data for various flood events were computed for the dam, assuming no erosion of the spillways or the embankment.

Precipitation Event	Maximum Reservoir Elevation, ft (MSL)	Maximum Depth Over Dam, ft	Maximum Outflow, ft^3/sec	Duration of Overtopping, hrs
1% Prob	1060.6	0.7	6700	3.2
10% PMF	1059.7	0.0	3500	0
50% PMF	1062.2	2.3	21,000	8.8
100% PMF	1063.7	3.8	42,500	14.5

The "Recommended Guidelines for Safety Inspection of Dams" require significant hazard dams in the small size classification to pass a spillway design flood between the 1 percent probability-of-occurrence (100 year) flood and 50 percent of the PMF. On the basis of the large impounded volume for this small dam, 50 percent of the PMF is the recommended spillway design flood.

It should be noted that at 100 percent of the PMF the depth of overtopping may reach 3.8 ft and the dam may be overtopped for 14.5 hours. Overtopping for this duration and depth is judged sufficient to develop a breach of this dam. At the maximum pool level of 1059.9, the velocity of flow in the auxiliary spillway may reach 7.2 ft/sec which may be erosive to the unlined portion of the auxiliary spillway.

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 inspection.** The visual observations and discussion with Mr Becker identified a deficiency which could affect the structural stability of the embankment. This deficiency is the presence of large trees and stumps on the embankment. The reports by Mr Becker that the breach of the dam in 1978 and the extensive seepage in 1979 were associated with tree stumps suggest that similar problems may develop in the vicinity of other stumps. The decaying roots from the stumps could provide piping paths through the dam. The number of stumps identified on the dam and the trees still standing indicate this potential is a major cause for concern regarding the stability of the embankment.

The reservoir has not risen to its normal operating level, the main spillway crest elevation, since draining the lake through the breach in 1978. As the lake level rises, seepage pressures and hydraulic head will increase and areas of seepage could develop. Evidence from past performance indicates this seepage could produce piping and internal erosion and jeopardize the stability of the embankment. The presence of dense brush on the downstream slope may obscure evidence of this potential seepage. It is recommended that the downstream slope be cleared of brush that could inhibit the inspection of the dam.

The spillways and discharge channels appear to be in generally good condition. Erosion is unlikely in the main spillway due to the concrete lining and exposed bedrock. The concrete lining and flat gradient of the auxiliary spillway indicate significant erosion is unlikely in the area. Some erosion could occur along the banks of the downstream channels, but will not pose a hazard to the dam due to the distance from the embankment.

b. **Design and construction data.** The dam was constructed in 1847. No records were available regarding design or construction of the dam. Seepage and stability analysis as per the "Recommended Guidelines for Safety Inspection of Dams" were not available which is considered a deficiency.

c. **Operating records.** No records were available of operations, historical water levels, or flood discharges at this dam. Mr Becker reported a breach which occurred near the main spillway and drained the lake, and the development of an extensive seepage area near the east end of the dam.

In 1978, during spring flooding, an area of heavy seepage developed to the right of the main spillway in the vicinity of a decaying tree stump. Efforts to stop the seepage included driving steel sheet piles into the dam. Seepage increased several days later and a breach of the dam developed. Siphons were eventually used to lower the lake below the bottom of the breach. The breach was widened to about 30 ft at the top and 6 ft at the bottom. This area was then backfilled with compacted clay. The reconstructed portion of the dam is slightly wider than the remainder of the dam section.

As the lake was being refilled in 1979, following the repair of the breach, another area of seepage developed about 150 feet west of the east end of the dam, again in the vicinity of a decaying tree stump. Seepage was described by Mr Becker as coming through the embankment and later, rising through the road at the toe of the dam. Repairs were again made by driving steel sheet piles into the dam in the vicinity of the stump. This appears to have cut off the seepage. No evidence of seepage was noted at the time of the visual inspection. However, the lake has not risen to the spillway crest elevation since refilling began following the breach.

d. **Post construction changes.** In addition to the repair of the breach and sheet pile remedial work described above, post construction changes have been made to the main spillway. A bridge and two fish ladders were washed away from the main spillway in approximately 1950. At that time, a 4-ft high concrete weir was added to the crest of the spillway. The concrete slope cover on the downstream side of the auxiliary spillway also appears to be a recent feature but no construction data were available.

e. <u>Seismic stability</u>. The dam is located in Seismic Zone 2, to which the guidelines assign a moderate damage potential. During a seismic event, liquefaction of the embankment materials is unlikely. However, without knowledge of the static stability of the dam or the soil properties of the embankment materials, the seismic stability cannot be evaluated.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

a. **Safety.** Based on the visual inspection and analysis of available data, the dam is judged to be in very poor condition. This assessment is based primarily on the history of the breach and seepage which developed at this dam, possibly along piping paths resulting from decaying root systems. The size of the trees on the embankment and the number of stumps where trees have been cut down indicate that similar seepage areas will likely continue to appear and pose a hazard of dam failure. Extensive remedial work would be required to remove the stumps and roots in a safe manner. Continued and frequent inspection of the embankment is recommended to allow emergency measures to be taken when and if seepage develops on the dam.

Hydraulic/hydrologic analyses of the dam and appurtenant structures indicate the dam will be overtopped by a flood greater than 10 percent of the Probable Maximum Flood (PMF). The 1 percent probability-of-occurrence flood (occurs on the average once every 100 years) will overtop the dam by 0.7 ft. The relatively narrow embankment section and moderately erodible soil used in construction of the dam suggest overtopping would likely produce an effective breach of this dam. Based on the relatively large storage capacity for ths dam, 50 percent of the PMF is recommended as the spillway design flood for this small, significant hazard dam.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. This is considered a deficiency which should be rectified.

b. **Adequacy of information.** The visual inspection and analysis of data obtained on this dam provided sufficient information to support the conclusions presented in this Phase I inspection report. Seepage and stability analyses comparable to the recommended guidelines are not on record. This is considered a deficiency which should be rectified.

c. <u>Urgency</u>. The deficiencies described in this report for Iron Mountain Lake Dam have already resulted in a breach of the dam in 1978. Continued deteoriation of the dam is likely. Remedial measures to correct these deficiencies should be initiated immediately.

d. <u>Necessity for Phase II</u>. 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 immediately 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. <u>Alternatives</u>. 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 listed below.

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 spillway design flood (50 percent of PMF) 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. <u>Recommendations</u>. Based on our inspection of Iron Mountain Lake Dam, the recommendations listed below should be addressed immediately.

1. An evaluation should be made immediately of the feasibility of, and modifications necessary, to allow removal of the trees and stumps on the embankment, and subsequent repairs to the dam.

2. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" should be performed and made a matter of record. Such analyses should consider all appropriate loading conditions, including seismic loads, and should be made by an engineer experienced in the design and construction of earth dams.

3. A detailed hydraulic/hydrologic analysis should be performed to design a spillway and discharge channel system capable of passing the spillway design flood without overtopping the dam. The modification to the spillways and discharge channels should be designed to prevent erosion.

4. A procedure for a flood warning system should be formalized to facilitate the timely alerting of downstream residents in the event emergency conditions develop at this dam.

5. In lieu of these recommendations, it may be necessary to breach the dam in a controlled manner, to mitigate the hazard posed by this dam.

c. <u>O & M procedures</u>. In view of the condition of this dam and the history of problems, it is recommended that a program of periodic inspections and maintenance be initiated immediately. The following items should be included, as a minimum, in this program.

1. Inspect, at frequent intervals, the embankment and area adjacent to the toe for evidence of seepage. This inspection should note any change in the amount of seepage, or evidence of turbidity (soil) in the seepage water.

2. Inspect the embankment for evidence of slope instability such as cracking or slumping.

3. Inspect and repair the upstream slope where erosion or slumping of the rock cover has occurred.

4. Remove brush from the downstream slope of the dam to facilitate inspection of the embankment. Removal of large trees should only be done under the supervision of an engineer experienced in the design, construction, and maintenance of earth dams. Indiscriminate removal of large trees could jeopardize the safety of the dam.

All remedial measures should be performed by or under the supervision of an engineer experienced in the design, construction and maintenance of earth dams.

REFERENCES

Allgood, F. P., and Persinger, I. D., 1979, Missouri General Soil Map and Soil Association Descriptions: US Department of Agriculture, Soil Conservation Service and Missouri Agricultural Experiment Station.

Department of the Army, Office of the Chief of Engineers, 1977, EC 1110-2-188, Engineering and Design National Program of Inspection of Non-Federal Dams.

Department of the Army, Office of the Chief of Engineers, 1979, ER 1110-2-106, Engineering and Design National Program of Inspection of Non-Federal Dams.

Hydrologic Engineering Center, US Army Corps of Engineers, 1978, Flood Hydrograph Package (HEC-1) Users Manual for Dam Safety Investigations.

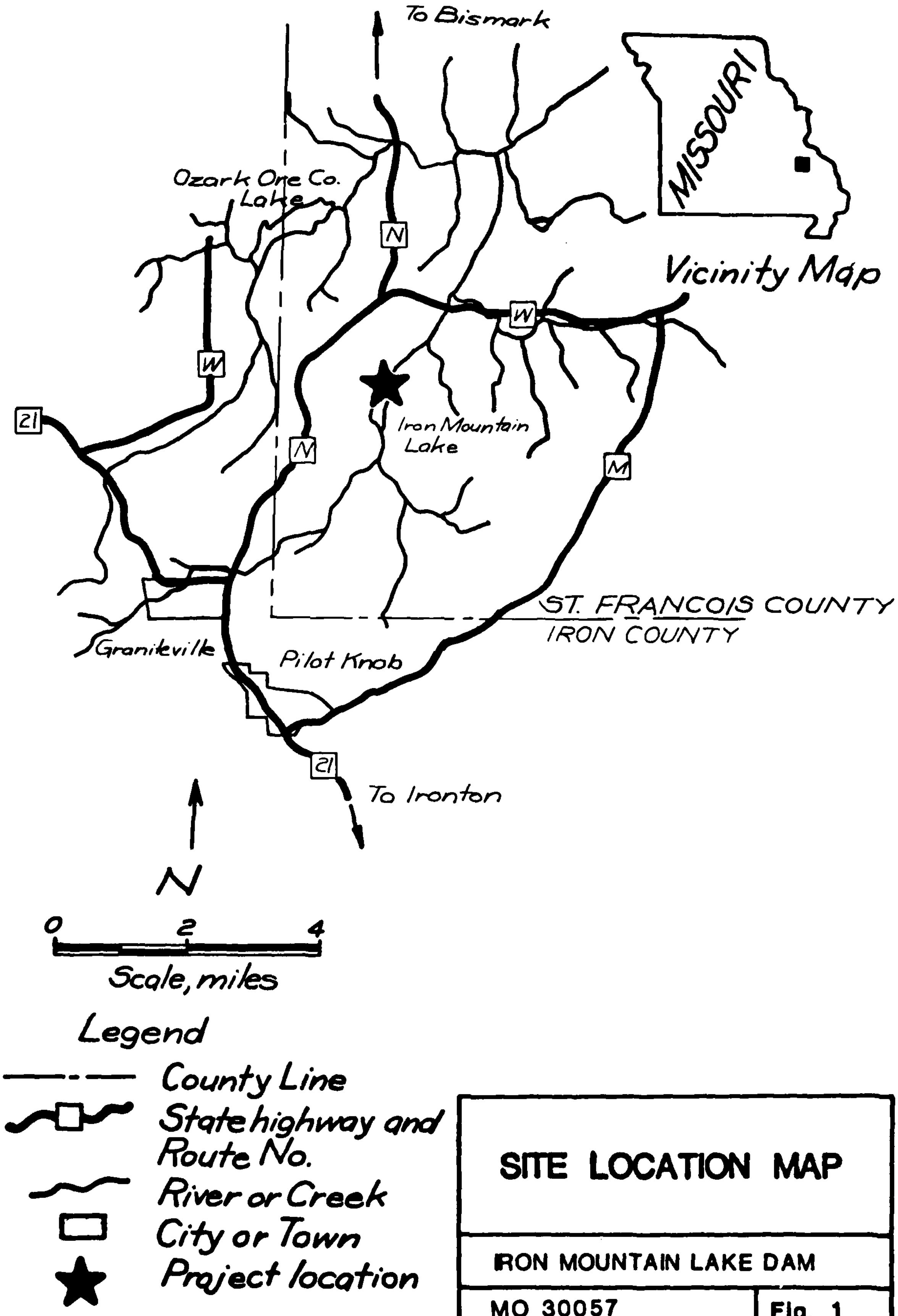
McCracken, M. H., 1971, Structural Features Map of Missouri: Missouri Geological Survey, scale 1:500,000.

Missouri Geological Survey, 1979, Geologic Map of Missouri: Missouri Geological Survey, scale 1:500,000.

St Louis District, US Army Corps of Engineers, 1979, Hydrologic/Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams.

US Department of Agriculture, Soil Conservation Service, 1971, Hydrology: National Engineering Handbook, Section 4.

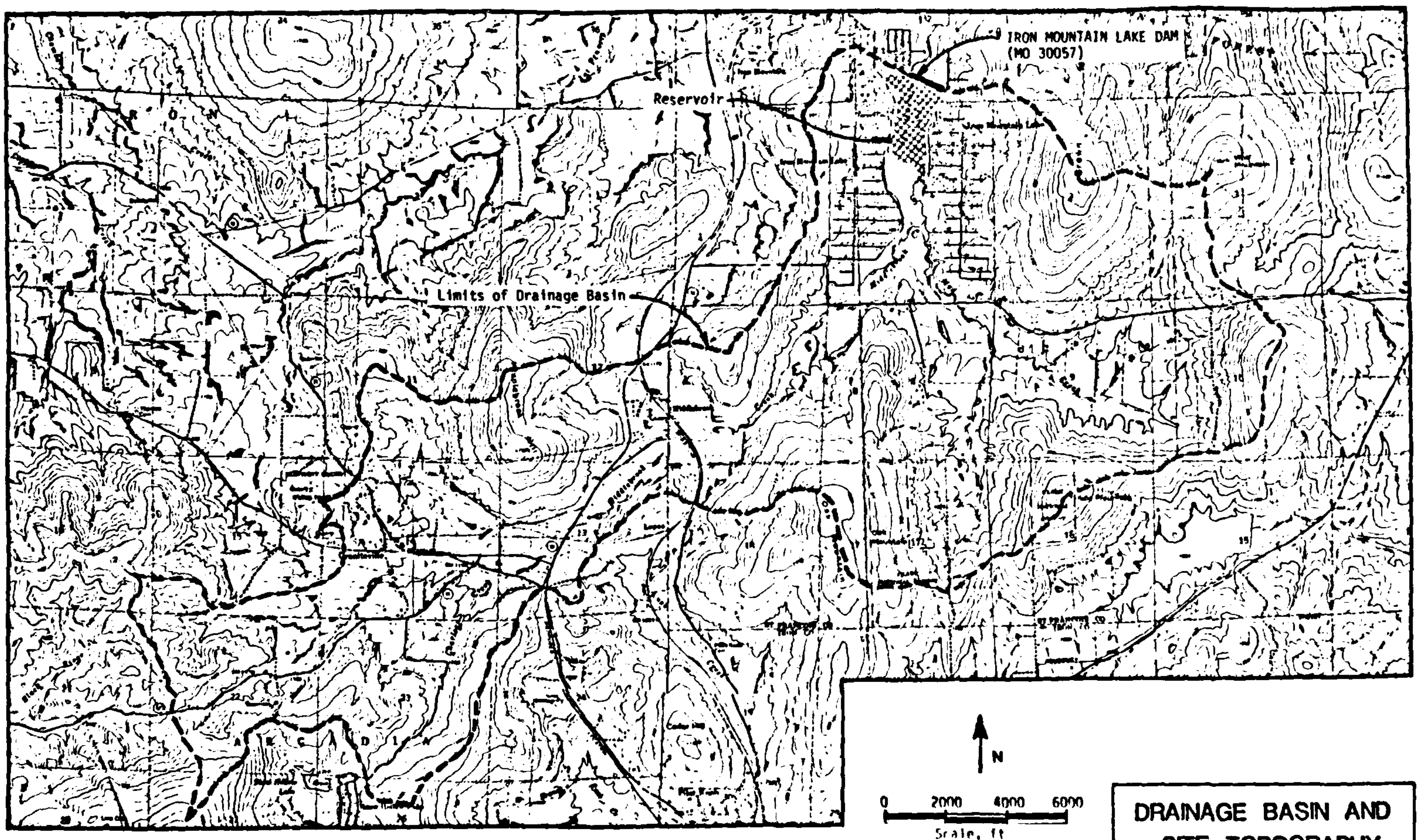
US Department of Commerce, US Weather Bureau, 1956, Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24 and 48 Hours, Hydrometeorological Report No. 33.



SITE LOCATION MAP

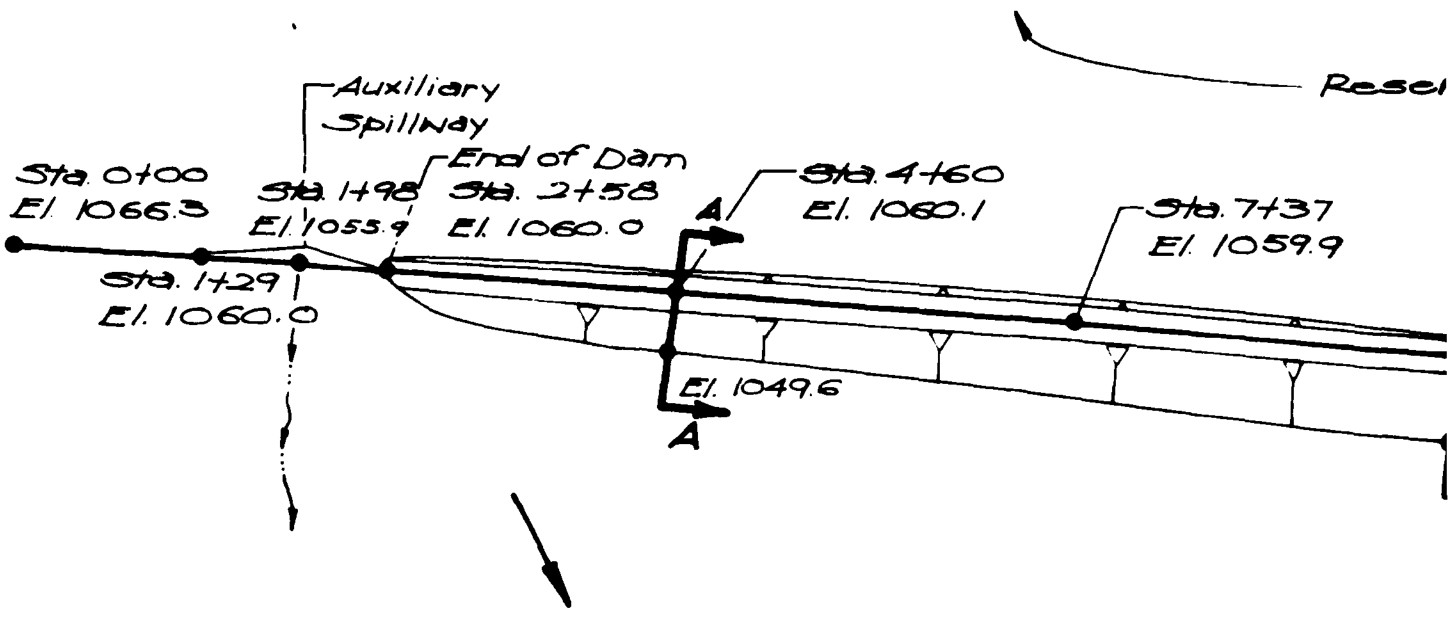
IRON MOUNTAIN LAKE DAM

MO 30057	Fig. 1

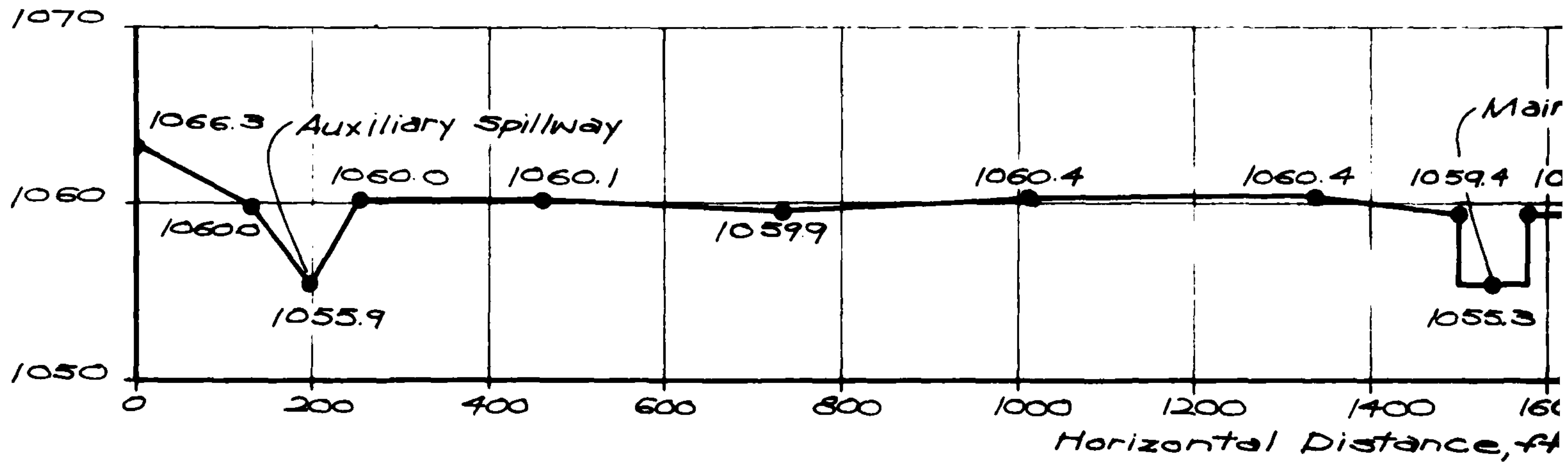


Note:
Topography from USGS Graniteville (1968) and Iron Mountain Lake (1968) 7.5-minute quadrangle maps. (Scale changed)

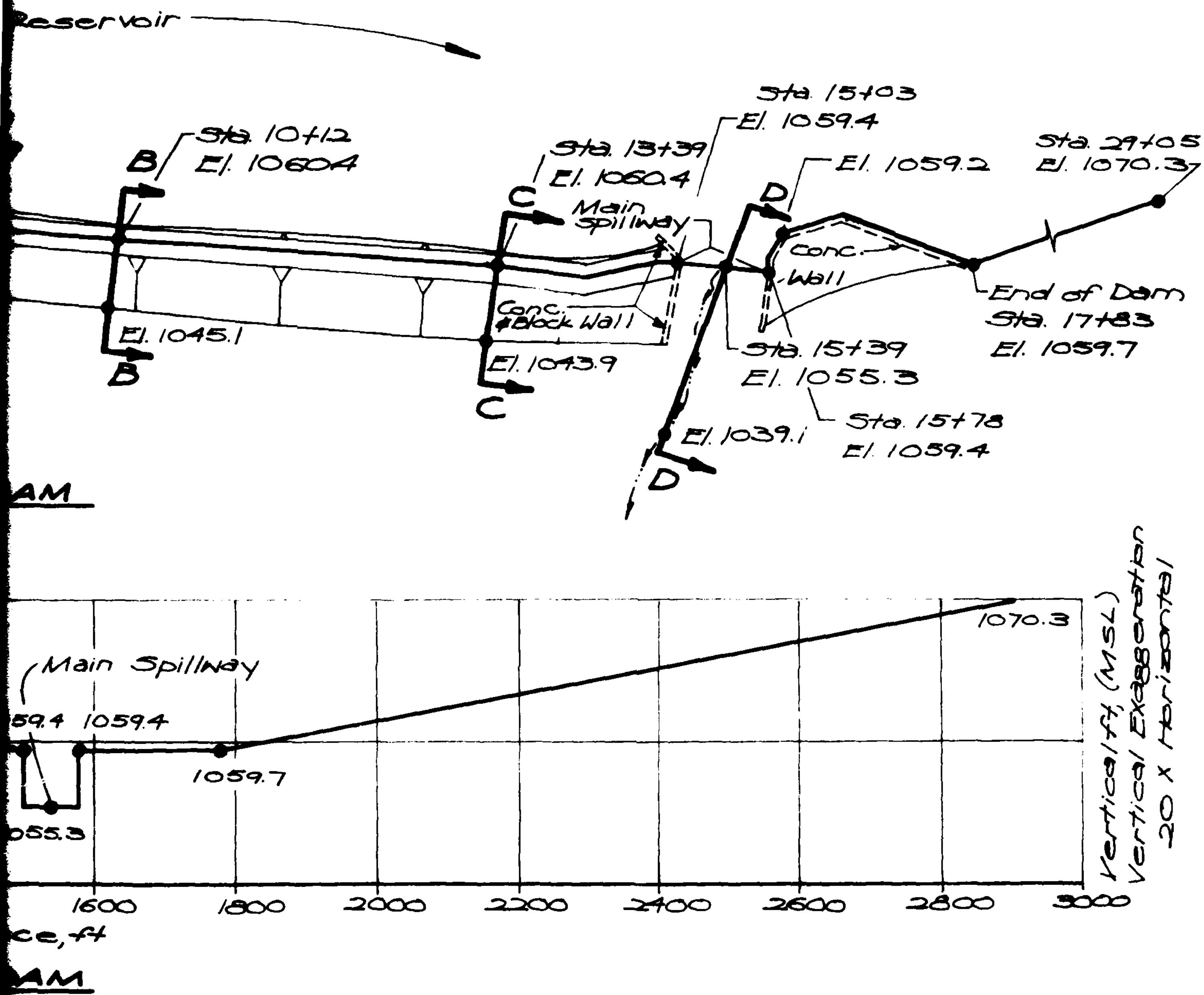
DRAINAGE BASIN AND SITE TOPOGRAPHY	
IRON MOUNTAIN LAKE DAM	
MO 30057	Fig. 2



PLAN OF DAM



PROFILE OF DAM



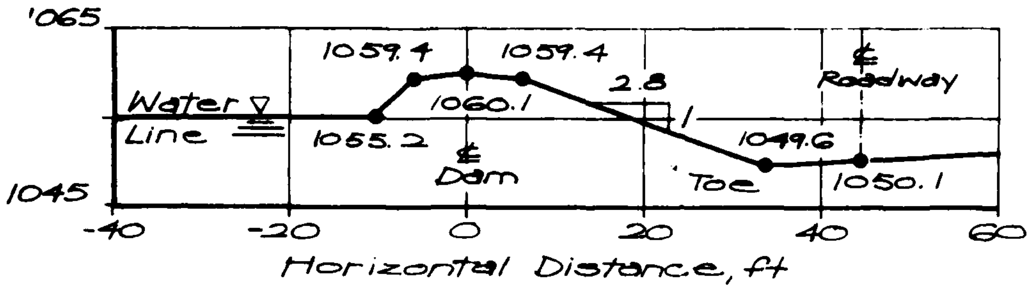
Note:
Surveyed 19 Mar. 81 by
James F. McCaul, III
and Associates.
Consulting Engineers/
Land Surveyors.
Potosi, Mo. 63664

DAM AND SPILLWAY PLAN AND PROFILE

IRON MOUNTAIN LAKE DAM

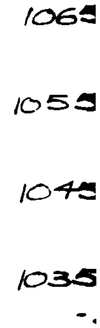
MO 30057	Pl. 3-A

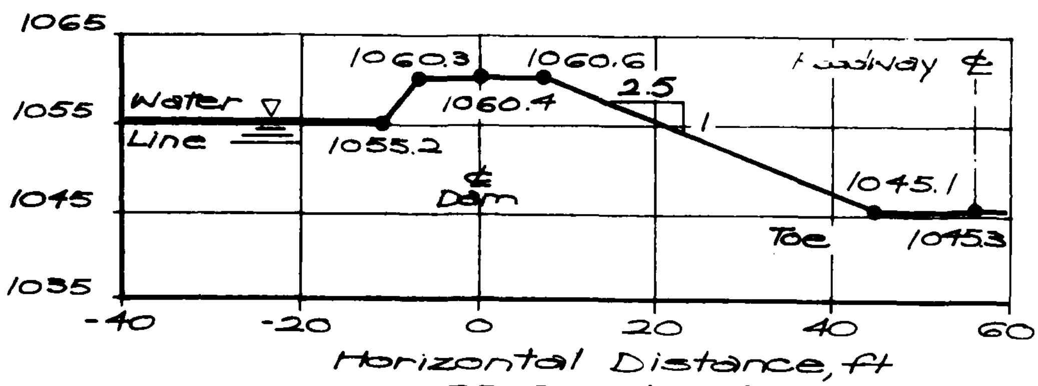
2



SECTION A-A

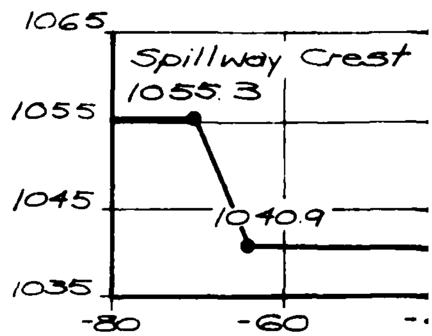
Dam Section

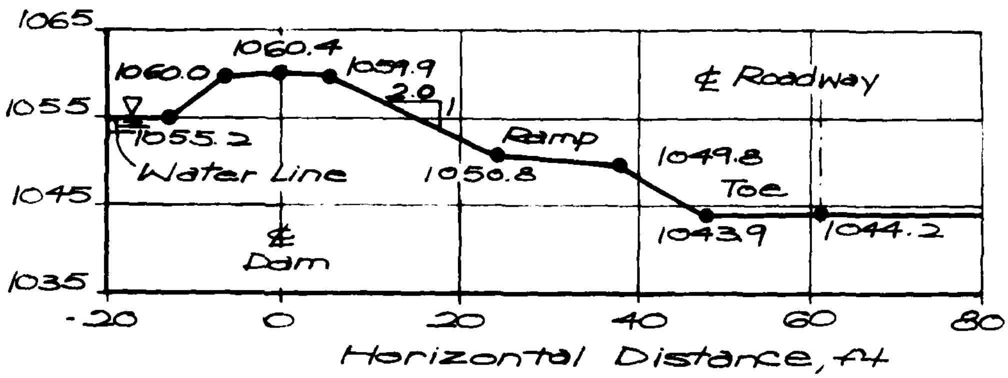




SECTION B-B

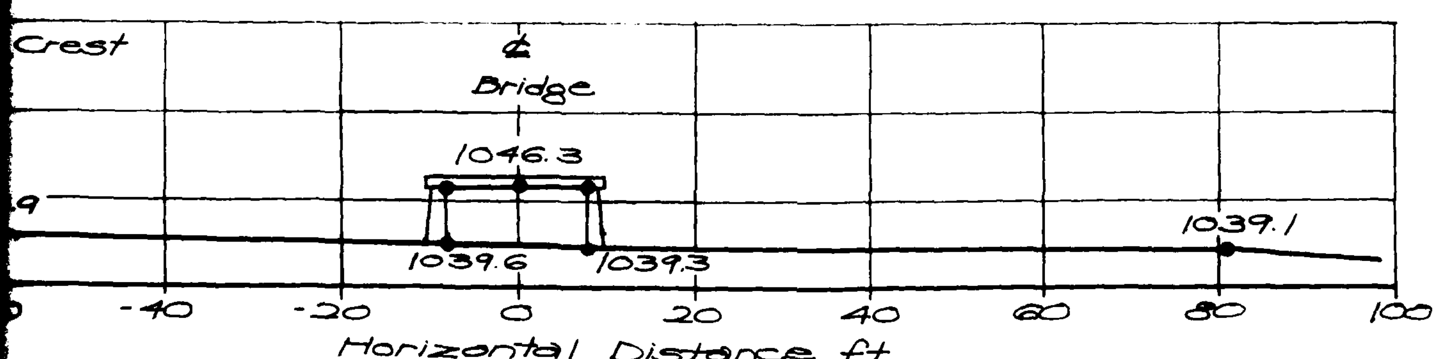
Dam Section





SECTION C-C

Maximum Dam Section



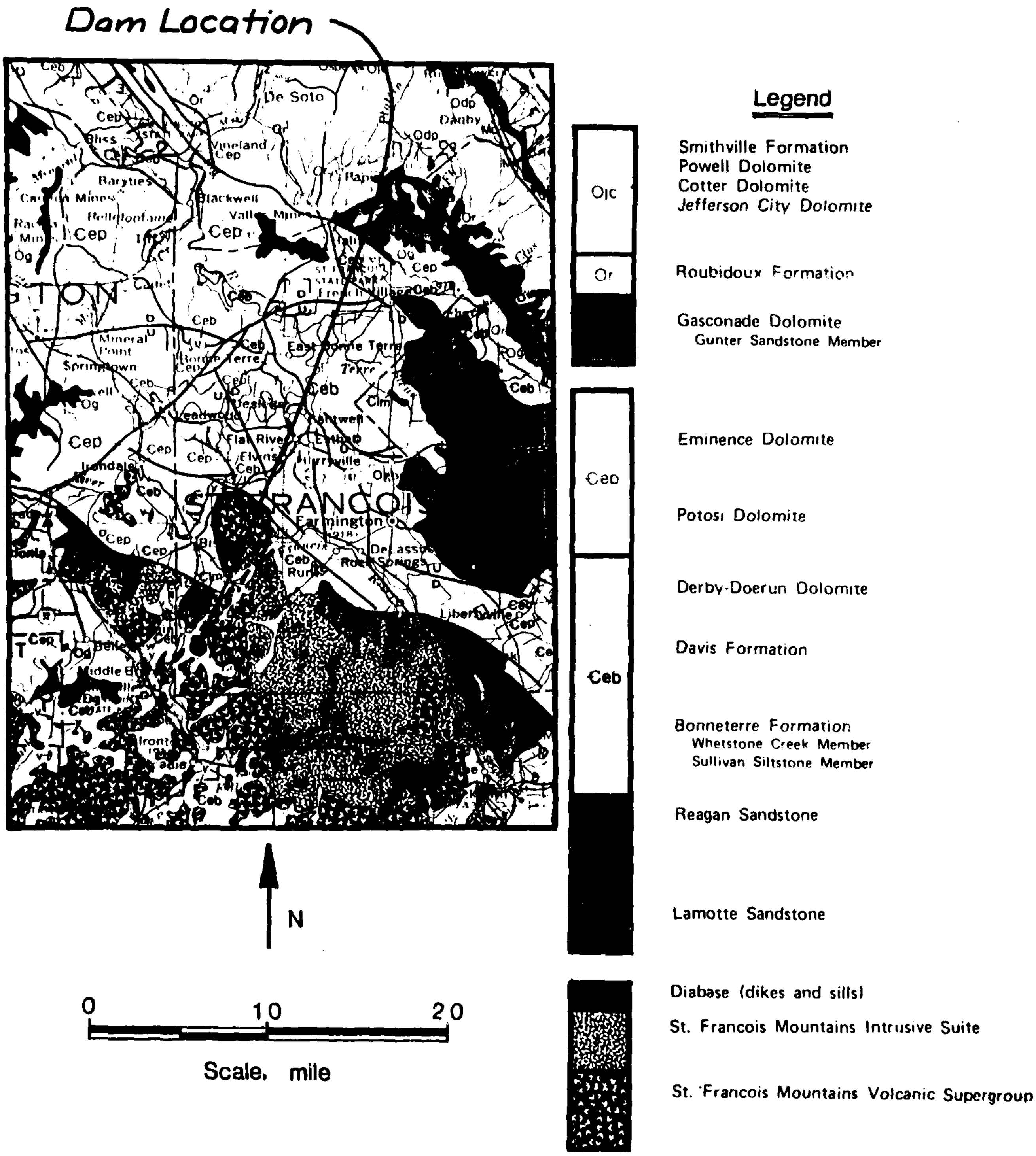
SECTION D-D

Main Spillway Section

Note:
Surveyed 19 Mar. 81 by
James F. M^c Caul, III
and Associates.
Consulting Engineers/
Land Surveyors.
Potosi, Mo. 63664

DAM SECTIONS AND SPILLWAY SECTION	
IRON MOUNTAIN LAKE DAM	
MO 30657.	Fig. [illegible]

1 2



REGIONAL GEOLOGIC MAP	
IRON MOUNTAIN LAKE DAM	
MO 30057	Fig. 4

APPENDIX A

Photographs

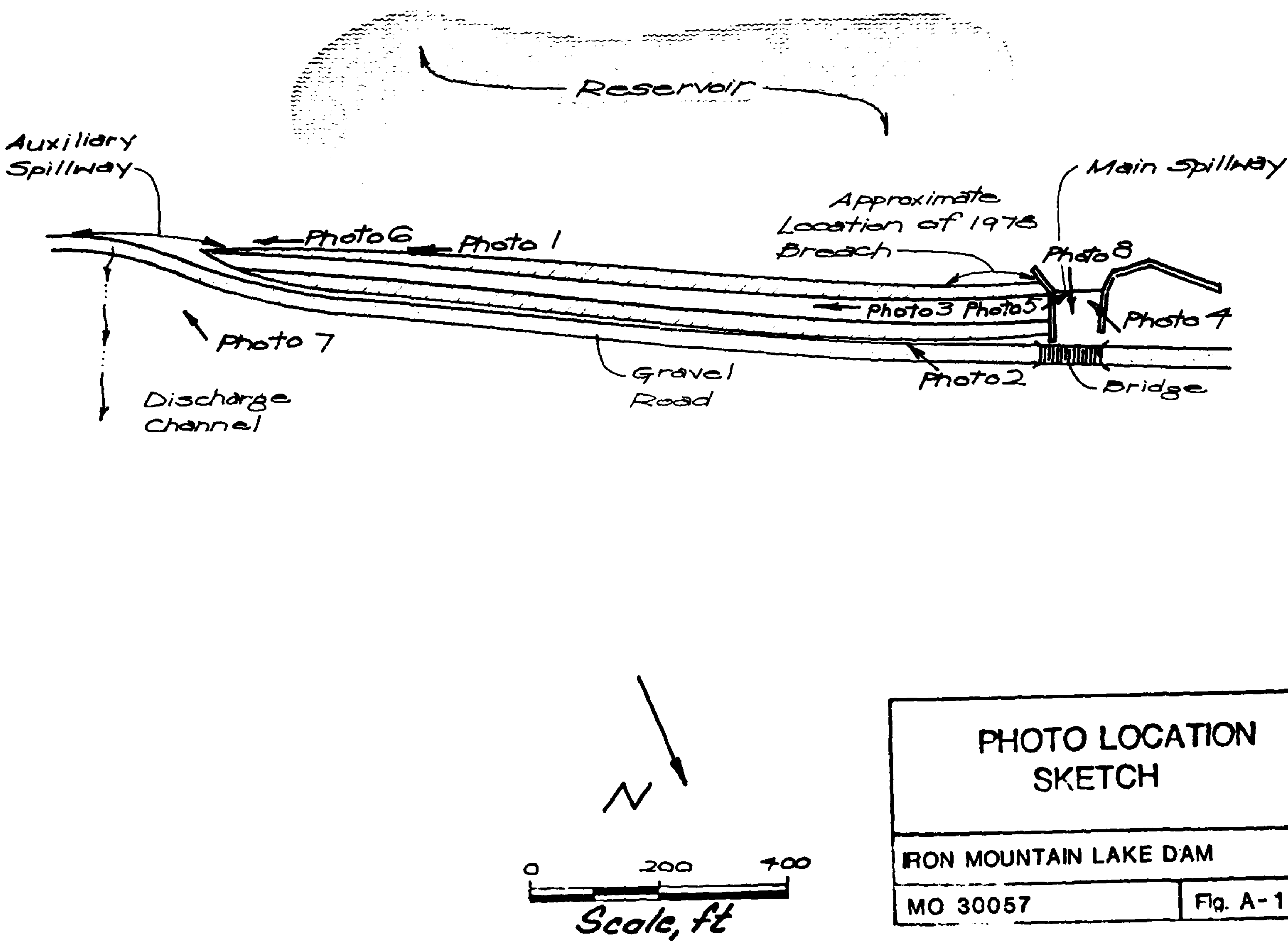
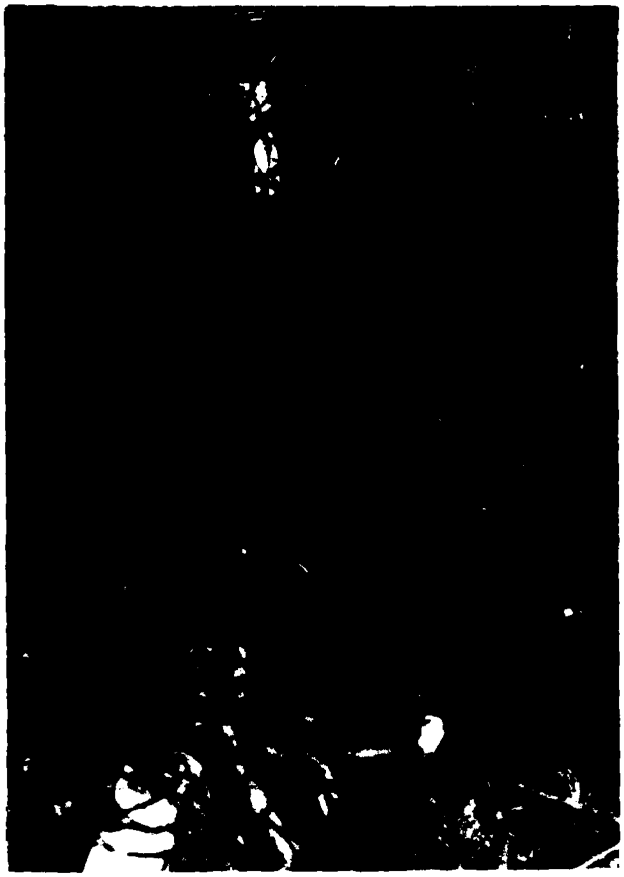


PHOTO LOCATION SKETCH

IRON MOUNTAIN LAKE DAM

MO 30057

Fig. A-1



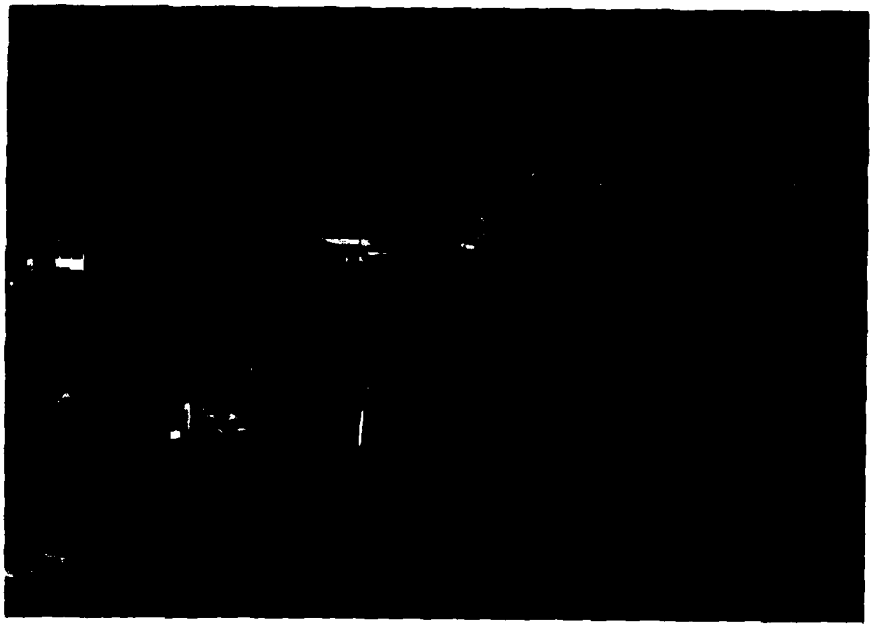
1. Upstream slope of Iron Mountain Lake Dam. Note rock for erosion control and steep eroded portion above top of rock. Also note trees growing on dam. Reservoir is out of the picture to the right. Looking east.

2. Downstream slope of dam. Note large trees on the embankment. Looking southeast.

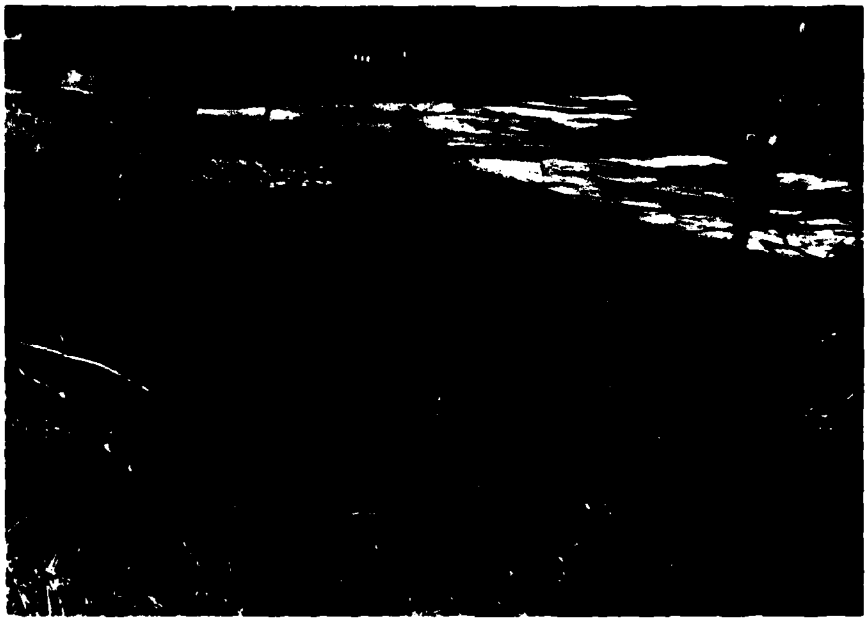
3. Stump of tree which has been cut from embankment. Clipboard is approximately 12-in. long. Looking east along downstream slope of dam.

4. Main spillway wall. Lower portion consists of stone blocks, upper portion is 4 ft tall concrete weir. Looking southeast.

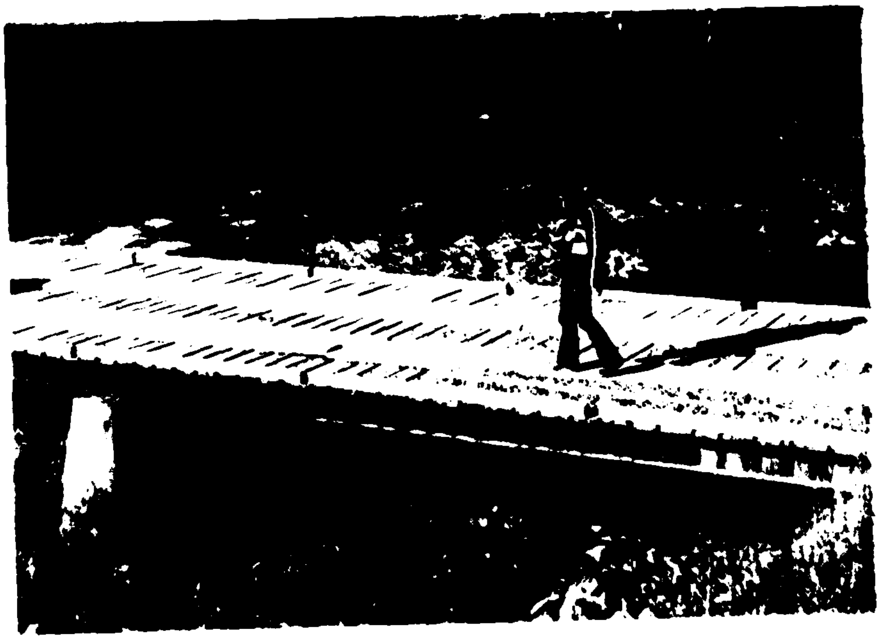
5. Concrete spillway weir. Note two 22-in. ports through concrete portion of spillway. Looking southwest from east side of spillway. Note stone wingwall upstream of spillway.



6. Auxiliary spillway at right (east) end of dam. Looking east.



7. Concrete-covered slope below auxiliary spillway. Looking southeast from left bank of downstream channel.



8. Plank bridge over main spillway discharge channel. Looking downstream (north).

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). The PMP distribution was computed by the HEC-1 program using the standard EM-1110-1411 method.

c. Unit hydrograph. The Soil Conservation Services (SCS) Dimensionless Unit Hydrograph method (SCS, 1971, Hydrology: National Engineering Handbook, Section 4) was used in the analysis. This method was selected because of its simplicity, applicability to drainage areas less than 10 mi^2, and its easy availability within the HEC-1 computer program.

Due to the unusual shape of the watershed and the large drainage area, the entire drainage area was divided into the following two smaller watersheds.

1. Mud Creek Watershed (4.65 square miles)
2. Middlebrook Creek Watershed (7.75 square miles)

For the purpose of computing the time of travel, each subarea was further subdivided into two parts. The SCS "Curve Number Method" was used to calculate time of travel for the upper portion of the subareas where the overland flow predominates, whereas the time of travel for the lower portion of the subarea was computed assuming average velocity of flow of 2.5 ft/sec in the channel. The two time of travels, thus computed, for the upper and lower portions were added to compute the total time of concentration for the subarea.

The following empirical relationship was used to calculate the lag time using the SCS "Curve Number Method".

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

where: L = lag in hours
ℓ = hydraulic length of the watershed in feet
$s = \frac{1000}{CN} - 10$
CN = AMC II hydrologic soil curve number as indicated in Section B.2e.
Y = average watershed land slope in percent.

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 travel as follows:

$$T^u_t = \frac{L}{0.6} \qquad \text{(Equation 15-3)}$$

where: T^u_t = time of travel in hours, upper portion of subarea.

The time of travel for the lower portion of the subarea was computed using the following relationship:

$$T^l_t = \frac{\ell}{3600v} \qquad \text{(Equation 15-1)}$$

where: ℓ = hydraulic length in ft
v = velocity of flow in ft/sec.

The total time of concentration, T_c, was computed adding the two time of travels as follows:

$$T_c = T^u_t + T^l_t$$

The empirical relationship ($T_c = \frac{L}{0.6}$) was used to calculate the total lag time for the basin.

Mud Creek Watershed
Upper Area:

ℓ = 4400 ft
CN = 63
s = 5.9

Y = 9.5

Lower Area:

hydraulic length = 14,000 ft
velocity of flow = 2.5 ft/sec

Middlebrook Creek Watershed
Upper Area:

ℓ = 6000 ft

CN = 70

s = 4.3

Y = 12.5

Lower Area:

hydraulic length = 30,000 ft
velocity of flow = 2.5 ft/sec

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

$$\Delta D = 0.133 T_c \qquad \text{(Equation 16-12)}$$

where: ΔD = duration of unit excess rainfall
T_c = time of concentration in hours.

The final duration was selected to provide at least three discharge ordinates prior to the peak discharge ordinate of the unit hydrograph. For this dam, a unit hydrograph duration of 15 minutes was used.

d. Infiltration losses. The infiltration losses were computed by the HEC-1 computer program internally using the SCS loss function. The curve number of SCS loss rate procedure was established taking into consideration the variables of: (a) antecedent moisture condition, (b) hydrologic soil group classification, (c) vegetative cover and (d) present land usage in the watershed. In addition, the computed basin loss was reduced proportional to the impervious area in the drainage basin.

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 - main spillway crest elevation of 1055.2 ft

(2) Probable Maximum Storm - main spillway crest elevation of 1055.2 ft

f. Spillway Rating Curve. The basic weir equation was utilized to compute the main spillway rating curve. The weir equation is as follows:

$$Q = CLH^{3/2}$$

where Q = discharge in cubic feet per second
L = effective length of spillway in feet = 72.5 ft
C = coefficient of discharge = 3.33
H = total head over spillway in feet

The HEC-2 computer program was used to compute the auxiliary spillway rating curve using the spillway cross section and assuming critical depth over the spillway.

B.2 Pertinent Data

a. Drainage area. 12.4 mi^2.

b. Storm duration. A unit hydrograph was developed by the SCS method option of HEC-1 program. The design storm of 48 hours duration was divided into equal intervals equal to the unit hydrograph duration of 15 minutes.

c. Lag time. 1.5 hours (Mud Creek); 2.5 hours (Middlebrook Creek)

d. Hydrologic soil group. B & C (Mud Creek); C (Middlebrook Creek)

e. SCS curve numbers.

1. For PMF- AMC III - Curve Number 80 (Mud Creek), 85 (Middlebrook Creek)
2. For 1 and 10 percent probability-of-occurrence events - AMC II - Curve Number 63 (Mud Creek), 70 (Middlebrook Creek)

f. Storage. Elevation-area data were developed by planimetering areas at various elevation contours on the USGS Iron Mountain Lake 7.5-minute quadrangle map. 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 main spillway rating curve was computed using the weir formula. The auxiliary spillway rating curve was developed from the cross section data of the spillway, using the HEC-2 backwater program. The rating curves for both spillways were combined. The results of the above were entered on the Y4 and Y5 cards of the HEC-1 program.

i. Reservoir elevations. For the 50 and 100 percent of the PMF events, the starting reservoir elevation was 1055.2 ft, the spillway crest elevation. For the 1 and 10 percent probability-of-occurrence events, the starting reservoir elevation was also 1055.2 ft, the main 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 results summaries are included, not the intermediate output. Complete copies of the HEC-1 output are available in the project files.

```
********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
********************************
    1            A1     IRON MOUNTAIN LAKE, DAM NO. 30057
    2            A2     WOODWARD- CLYDE CONSULTANTS, HOUSTON JOB NO. 80C224T100
    3            A3     PROBABLE MAXIMUM FLOOD (PMF) ANALYSIS
    4            B    200       0      15       0       0       0       0       0       0       0
    5            B1     5
    6            J      1       2       1
    7            J1   .50     1.0
    8            K      0   AREA1                                       1
    9            K1     INFLOW HYDROGRAPH FOR SUBAREA-1
   10            M      1       2    4.65                     1.0
   11            P             26     102     120     130     140
   12            T                                                     -1     -80              0.
   13            W2           1.5
   14            X     -1    -.05       5
   15            K      0   AREA2                                       1
   16            K1     INFLOW HYDROGRAPH FOR SUBAREA-2
   17            M      1       2    7.75                     1.0
   18            P             26     102     120     130     140
   19            T                                                     -1     -85             .02
   20            W2           2.5
   21            K     -1    -.05       5
   22            K      2    LAKE                                       1
   23            K1     COMBINE HYDROGRAPH AT LAKE
   24            K      1     DAM                                       1
   25            K1     FLOOD ROUTING AND OVERTOPPING ANALYSES
   26            Y                              1       1
   27            Y1     1                                       -1055.2      -1
   28            Y41055.2  1055.5  1055.9  1056.5  1057.0  1058.0  1059.0  1060.0  1061.0  1062.0
   29            Y41063.0  1064.0
   30            Y5    0.    40.0   140.0   365.0   620.0   1350.  2370.0  3720.0  5440.0  7490.0
   31            Y59960.0 12700.0
   32            SA    0.    20.0    80.0   212.0   404.0   652.0
   33            SE1041.0  1050.0  1056.0  1060.0  1070.0  1080.0
   34            SS1055.2
   35            SD1059.9     2.8     1.5
   36            SL   0.0   150.0   210.0   210.0   560.0  1200.0  1310.0  1330.0  1453.0
   37            SV1059.3  1059.5  1059.7  1059.9  1060.0  1060.4  1060.6  1060.9  1061.5
   38            K     99
```

Input Data
Various PMF Events
Iron Mountain Lake Dam
MO 30057
B6

Output Summary
Various PMF Events
Iron Mountain Lake Dam
MO 30057
B7

```
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION        JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************

RUN  DATE? 81/04/07.
     TIME? 16.28.28.

                    IRON MOUNTAIN LAKE, DAM NO. 30057
                    WOODWARD- CLYDE CONSULTANTS, HOUSTON JOB NO. 80C224T100
                    PROBABLE MAXIMUM FLOOD (PMF) ANALYSIS

                                    JOB SPECIFICATION
          NO    NHR    NMIN   IDAY    IHR   IMIN   METRC   IPLT   IPRT  NSTAN
         200      0      15      0      0      0       0      0      0      0
                              JOPER    NWT  LROPT   TRACE
                                  5      0      0       0

                          MULTI-PLAN ANALYSES TO BE PERFORMED
                               NPLAN= 1 NRTIO= 2 LRTIO= 1
          RTIOS=     .50   1.00

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

                              SUB-AREA RUNOFF COMPUTATION

            INFLOW HYDROGRAPH FOR SUBAREA-1

                  ISTAQ   ICOMP   IECON   ITAPE   JPLT   JPRT   INAME  ISTAGE  IAUTO
                  AREA1       0       0       0      0      0       1       0      0

                                    HYDROGRAPH DATA
        IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO  ISNOW  ISAME  LOCAL
            1      2    4.65    0.00    4.65    1.00   0.000      0      0      0

                                      PRECIP DATA
               SPFE     PMS      R6     R12     R24     R48     R72     R96
               0.00   26.00  102.00  120.00  130.00  140.00    0.00    0.00

                                       LOSS DATA
     LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
         0    0.00    0.00    1.00    0.00    0.00    1.00   -1.00  -80.00    0.00    0.00

      CURVE NO =  -80.00  WETNESS =   -1.00  EFFECT CN =   80.00

                                 UNIT HYDROGRAPH DATA
                             TC=  0.00     LAG=  1.50

                                    RECESSION DATA
                     STRTQ=   -1.00    QRCSN=    -.05    RTIOR= 5.00

       UNIT HYDROGRAPH 32 END OF PERIOD ORDINATES, TC=    0.00 HOURS, LAG=   1.50  VOL= 1.00
        94.      275.      564.      946.     1238.     1371.     1371.     1255.     1095.      876.
       646.      501.      387.      309.      241.      186.      145.      113.       88.       68.
        53.       41.       32.       25.       19.       15.       13.       10.        8.        5.
         3.        1.

    0                                   END-OF-PERIOD FLOW
 MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS   COMP Q
```

Output Summary
Various PMF Events
Iron Mountain Lake Dam
MO 30057
B8

590.	501.	387.	309.	241.	186.	145.	113.	89.	6[illegible].
53.	41.	32.	25.	19.	15.	13.	10.	8.	5.
3.	1.								

O

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.15	1	.00	0.00	.00	4.	1.02	1.15	101	.04	.03	.01	129.
1.01	.30	2	.00	0.00	.00	3.	1.02	1.30	102	.04	.03	.01	166.
1.01	.45	3	.00	0.00	.00	3.	1.02	1.45	103	.04	.03	.01	204.
1.01	1.00	4	.00	0.00	.00	2.	1.02	2.00	104	.04	.03	.01	239.
1.01	1.15	5	.00	0.00	.00	2.	1.02	2.15	105	.04	.03	.01	270.
1.01	1.30	6	.00	0.00	.00	2.	1.02	2.30	106	.04	.03	.01	296.
1.01	1.45	7	.00	0.00	.00	2.	1.02	2.45	107	.04	.03	.01	315.
1.01	2.00	8	.00	0.00	.00	1.	1.02	3.00	108	.04	.03	.01	331.
1.01	2.15	9	.00	0.00	.00	1.	1.02	3.15	109	.04	.03	.01	344.
1.01	2.30	10	.00	0.00	.00	1.	1.02	3.30	110	.04	.03	.01	354.
1.01	2.45	11	.00	0.00	.00	1.	1.02	3.45	111	.04	.03	.01	363.
1.01	3.00	12	.00	0.00	.00	1.	1.02	4.00	112	.04	.03	.01	370.
1.01	3.15	13	.00	0.00	.00	1.	1.02	4.15	113	.04	.03	.01	376.
1.01	3.30	14	.00	0.00	.00	0.	1.02	4.30	114	.04	.03	.01	381.
1.01	3.45	15	.00	0.00	.00	0.	1.02	4.45	115	.04	.03	.01	386.
1.01	4.00	16	.00	0.00	.00	0.	1.02	5.00	116	.04	.03	.01	390.
1.01	4.15	17	.00	0.00	.00	0.	1.02	5.15	117	.04	.03	.01	393.
1.01	4.30	18	.00	0.00	.00	0.	1.02	5.30	118	.04	.03	.01	396.
1.01	4.45	19	.00	0.00	.00	0.	1.02	5.45	119	.04	.03	.01	399.
1.01	5.00	20	.00	0.00	.00	0.	1.02	6.00	120	.04	.03	.01	402.
1.01	5.15	21	.00	0.00	.00	0.	1.02	6.15	121	.20	.16	.04	416.
1.01	5.30	22	.00	0.00	.00	0.	1.02	6.30	122	.20	.16	.03	452.
1.01	5.45	23	.00	0.00	.00	0.	1.02	6.45	123	.20	.16	.03	524.
1.01	6.00	24	.00	0.00	.00	0.	1.02	7.00	124	.20	.16	.03	649.
1.01	6.15	25	.02	0.00	.02	0.	1.02	7.15	125	.20	.17	.03	803.
1.01	6.30	26	.02	0.00	.02	0.	1.02	7.30	126	.20	.17	.03	980.
1.01	6.45	27	.02	0.00	.02	0.	1.02	7.45	127	.20	.17	.03	1160.
1.01	7.00	28	.02	0.00	.02	0.	1.02	8.00	128	.20	.17	.02	1327.
1.01	7.15	29	.02	0.00	.02	0.	1.02	8.15	129	.20	.17	.02	1476.
1.01	7.30	30	.02	0.00	.02	0.	1.02	8.30	130	.20	.17	.02	1600.
1.01	7.45	31	.02	0.00	.02	0.	1.02	8.45	131	.20	.17	.02	1696.
1.01	8.00	32	.02	0.00	.02	0.	1.02	9.00	132	.20	.18	.02	1774.
1.01	8.15	33	.02	0.00	.02	0.	1.02	9.15	133	.20	.18	.02	1838.
1.01	8.30	34	.02	0.00	.02	0.	1.02	9.30	134	.20	.18	.02	1891.
1.01	8.45	35	.02	0.00	.02	0.	1.02	9.45	135	.20	.18	.02	1936.
1.01	9.00	36	.02	0.00	.02	0.	1.02	10.00	136	.20	.18	.02	1974.
1.01	9.15	37	.02	0.00	.02	0.	1.02	10.15	137	.20	.18	.02	2009.
1.01	9.30	38	.02	0.00	.02	0.	1.02	10.30	138	.20	.18	.01	2032.
1.01	9.45	39	.02	0.00	.02	0.	1.02	10.45	139	.20	.18	.01	2056.
1.01	10.00	40	.02	0.00	.02	0.	1.02	11.00	140	.20	.18	.01	2076.
1.01	10.15	41	.02	0.00	.02	0.	1.02	11.15	141	.20	.18	.01	2093.
1.01	10.30	42	.02	0.00	.02	0.	1.02	11.30	142	.20	.18	.01	2109.
1.01	10.45	43	.02	0.00	.02	0.	1.02	11.45	143	.20	.18	.01	2122.
1.01	11.00	44	.02	0.00	.02	0.	1.02	12.00	144	.20	.18	.01	2134.
1.01	11.15	45	.02	0.00	.02	0.	1.02	12.15	145	.66	.63	.04	2187.
1.01	11.30	46	.02	0.00	.02	0.	1.02	12.30	146	.66	.63	.03	2319.
1.01	11.45	47	.02	0.00	.02	0.	1.02	12.45	147	.66	.63	.03	2579.
1.01	12.00	48	.02	0.00	.02	0.	1.02	13.00	148	.66	.64	.03	3010.
1.01	12.15	49	.05	0.00	.05	0.	1.02	13.15	149	.80	.77	.03	3584.
1.01	12.30	50	.05	.00	.05	0.	1.02	13.30	150	.80	.77	.02	4243.
1.01	12.45	51	.05	.00	.05	0.	1.02	13.45	151	.80	.77	.02	4902.
1.01	13.00	52	.05	.00	.05	2.	1.02	14.00	152	.80	.78	.02	5642.
1.01	13.15	53	.06	.01	.05	4.	1.02	14.15	153	.99	.97	.02	6328.
1.01	13.30	54	.06	.01	.05	9.	1.02	14.30	154	.99	.97	.02	6972.
1.01	13.45	55	.06	.01	.05	17.	1.02	14.45	155	.99	.98	.02	7572.
1.01	14.00	56	.06	.01	.05	28.	1.02	15.00	156	.99	.98	.02	8166.
1.01	14.15	57	.08	.02	.06	43.	1.02	15.15	157	1.01	.99	.01	8747.
1.01	14.30	58	.08	.02	.05	[illegible]							

1.01	13.45	55	.06	.01	.05	17.	1.02	14.45	155	.99	.98	.02	7572.
1.01	14.00	56	.06	.01	.05	28.	1.02	15.00	156	.99	.98	.02	8166.
1.01	14.15	57	.08	.02	.06	43.	1.02	15.15	157	1.01	.99	.01	8747.
1.01	14.30	58	.08	.02	.05	61.	1.02	15.30	158	2.02	1.99	.03	9387.
1.01	14.45	59	.08	.03	.05	83.	1.02	15.45	159	5.64	5.59	.05	10488.
1.01	15.00	60	.08	.03	.05	109.	1.02	16.00	160	1.41	1.40	.01	12077.
1.01	15.15	61	.08	.03	.05	137.	1.02	16.15	161	.93	.92	.01	14219.
1.01	15.30	62	.16	.07	.09	171.	1.02	16.30	162	.93	.92	.01	16659.
1.01	15.45	63	.43	.23	.21	227.	1.02	16.45	163	.93	.92	.01	18480.
1.01	16.00	64	.11	.06	.04	306.	1.02	17.00	164	.93	.92	.01	19324.
1.01	16.15	65	.07	.04	.03	412.	1.02	17.15	165	.73	.73	.00	19298.
1.01	16.30	66	.07	.04	.03	536.	1.02	17.30	166	.73	.73	.00	18987.
1.01	16.45	67	.07	.05	.03	639.	1.02	17.45	167	.73	.73	.00	17442.
1.01	17.00	68	.07	.05	.03	704.	1.02	18.00	168	.73	.73	.00	15934.
1.01	17.15	69	.06	.04	.02	733.	1.02	18.15	169	.07	.06	.00	14313.
1.01	17.30	70	.06	.04	.02	732.	1.02	18.30	170	.07	.06	.00	12964.
1.01	17.45	71	.06	.04	.02	711.	1.02	18.45	171	.07	.06	.00	11648.
1.01	18.00	72	.06	.04	.02	671.	1.02	19.00	172	.07	.06	.00	10299.
1.01	18.15	73	.00	.00	.00	621.	1.02	19.15	173	.07	.06	.00	8854.
1.01	18.30	74	.00	.00	.00	577.	1.02	19.30	174	.07	.06	.00	7449.
1.01	18.45	75	.00	.00	.00	529.	1.02	19.45	175	.07	.06	.00	6160.
1.01	19.00	76	.00	.00	.00	476.	1.02	20.00	176	.07	.06	.00	5039.
1.01	19.15	77	.00	.00	.00	414.	1.02	20.15	177	.07	.06	.00	4086.
1.01	19.30	78	.00	.00	.00	352.	1.02	20.30	178	.07	.06	.00	3327.
1.01	19.45	79	.00	.00	.00	293.	1.02	20.45	179	.07	.06	.00	2761.
1.01	20.00	80	.00	.00	.00	241.	1.02	21.00	180	.07	.06	.00	2322.
1.01	20.15	81	.00	.00	.00	197.	1.02	21.15	181	.07	.06	.00	1984.
1.01	20.30	82	.00	.00	.00	161.	1.02	21.30	182	.07	.06	.00	1719.
1.01	20.45	83	.00	.00	.00	135.	1.02	21.45	183	.07	.06	.00	1501.
1.01	21.00	84	.00	.00	.00	114.	1.02	22.00	184	.07	.06	.00	1339.
1.01	21.15	85	.00	.00	.00	98.	1.02	22.15	185	.07	.06	.00	1216.
1.01	21.30	86	.00	.00	.00	86.	1.02	22.30	186	.07	.06	.00	1117.
1.01	21.45	87	.00	.00	.00	76.	1.02	22.45	187	.07	.06	.00	1037.
1.01	22.00	88	.00	.00	.00	68.	1.02	23.00	188	.07	.06	.00	973.
1.01	22.15	89	.00	.00	.00	63.	1.02	23.15	189	.07	.06	.00	920.
1.01	22.30	90	.00	.00	.00	58.	1.02	23.30	190	.07	.06	.00	878.
1.01	22.45	91	.00	.00	.00	54.	1.02	23.45	191	.07	.06	.00	848.
1.01	23.00	92	.00	.00	.00	51.	1.03	0.00	192	.07	.06	.00	829.
1.01	23.15	93	.00	.00	.00	49.	1.03	.15	193	0.00	0.00	0.00	809.
1.01	23.30	94	.00	.00	.00	47.	1.03	.30	194	0.00	0.00	0.00	780.
1.01	23.45	95	.00	.00	.00	46.	1.03	.45	195	0.00	0.00	0.00	734.
1.02	0.00	96	.00	.00	.00	45.	1.03	1.00	196	0.00	0.00	0.00	666.
1.02	.15	97	.04	.03	.01	47.	1.03	1.15	197	0.00	0.00	0.00	581.
1.02	.30	98	.04	.03	.01	53.	1.03	1.30	198	0.00	0.00	0.00	499.
1.02	.45	99	.04	.03	.01	68.	1.03	1.45	199	0.00	0.00	0.00	421.
1.02	1.00	100	.04	.03	.01	94.	1.03	2.00	200	0.00	0.00	0.00	359.

SUM 36.40 33.56 2.84 401673.
(925.)(852.)(72.)(11374.)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	19324.	11945.	4056.	2007.	401491.
CMS	547.	338.	115.	57.	11369.
INCHES		23.90	32.46	33.47	33.47
MM		606.96	824.44	850.04	850.04
AC-FT		5923.	8046.	8295.	8295.
THOUS CU M		7306.	9924.	10232.	10232.

HYDROGRAPH AT STA AREA1 FOR PLAN 1, RTIO 1

2.	2.	1.	1.	1.	1.	1.	1.	1.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0				
0									

Output Summary
Various PMF Events
Iron Mountain Lake Dam
MO 30057
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 .50	RATIO 2 1.00
				RATIOS APPLIED TO FLOWS	
HYDROGRAPH AT	AREA1	4.65	1	9662.	19324.
		(12.04)		(273.59)(	547.19)(
HYDROGRAPH AT	AREA2	7.75	1	12895.	25791.
		(20.07)		(365.16)(	730.31)(
2 COMBINED	LAKE	12.40	1	21451.	42903.
		(32.12)		(607.43)(	1214.87)(
ROUTED TO	DAM	12.40	1	21199.	42575.
		(32.12)		(600.29)(	1205.60)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1055.20	1055.20	1059.90
STORAGE	280.	280.	882.
OUTFLOW	0.	0.	3779.

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	1062.18	2.28	1405.	21199.	8.75	41.75	0.00
1.00	1063.73	3.83	1811.	42575.	14.50	41.75	0.00

Output Summary
Various PMF Events
Iron Mountain Lake Dam
MO 30057
B10

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 .09	RATIO 2 .10	RATIO 3 .11	RATIO 4 .12	RATIO 5 .13
HYDROGRAPH AT	AREA1	4.65	1	1739.	1932.	2126.	2319.	2512.
	(	12.04)	(	49.25)(	54.72)(	60.19)(	65.66)(	71.13)(
HYDROGRAPH AT	AREA2	7.75	1	2321.	2579.	2837.	3095.	3353.
	(	20.07)	(	65.73)(	73.03)(	80.33)(	87.64)(	94.94)(
2 COMBINED	LAKE	12.40	1	3861.	4290.	4719.	5148.	5577.
	(	32.12)	(	109.34)(	121.49)(	133.64)(	145.78)(	157.93)(
ROUTED TO	DAM	12.40	1	3082.	3477.	3881.	4374.	4873.
	(	32.12)	(	87.28)(	98.46)(	109.90)(	123.86)(	137.98)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1055.20	1055.20	1059.90
STORAGE	280.	280.	882.
OUTFLOW	0.	0.	3779.

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
.09	1059.51	0.00	805.	3082.	0.00	43.00	0.00
.10	1059.74	0.00	850.	3477.	0.00	43.00	0.00
.11	1059.95	.05	892.	3881.	1.00	42.75	0.00
.12	1060.12	.22	929.	4374.	2.00	42.75	0.00
.13	1060.26	.36	958.	4873.	2.50	42.50	0.00

Output Summary
Various PMF Events
Iron Mountain Lake Dam
MO 30057
B11

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*********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
 LAST MODIFICATION  01 APR 80
*********************************
A1      IRON MOUNTAIN LAKE, DAM NO. 30057
A2      WOODWARD- CLYDE CONSULTANTS, HOUSTON JOB NO. 80C224T100
A3      PROBABILISTIC FLOOD  100-YEAR
B     200      0     15      0      0      0      0      0      0      0
B1      3
K       0   AREA1                                  1
K1      INFLOW HYDROGRAPH FOR SUBAREA-2 , LESTERVILLE RAINFALL
M       0      2   4.65                     1.0
O     192  8.838             DA =   5.00
O1   .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
O1   .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
O1   .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
O1   .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
O1   .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
O1   .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
O1   .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
O1   .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
O1   .016   .016   .016   .015   .016   .016   .016   .016   .016   .016
O1   .016   .016   .016   .016   .016   .016   .021   .021   .021   .021
O1   .021   .021   .021   .021   .021   .021   .021   .021   .021   .021
O1   .021   .021   .021   .021   .021   .021   .021   .021   .021   .021
O1   .041   .041   .041   .041   .042   .042   .042   .042   .042   .042
O1   .042   .042   .042   .042   .042   .042   .042   .042   .042   .042
O1   .042   .041   .041   .041   .075   .076   .076   .076   .076   .076
O1   .102   .102   .178   .180   .424   .769  1.685   .431   .181   .179
O1   .102   .102   .076   .076   .076   .076   .076   .076   .021   .021
O1   .021   .021   .021   .021   .021   .021   .021   .021   .021   .021
O1   .021   .021   .021   .021   .021   .021   .021   .021   .021   .021
O1   .021   .021
T                                                -1    -63             0.
W2            1.5
X      -1   -.05      5
K       0   AREA2                                  1
K1      INFLOW HYDROGRAPH FOR SUBAREA-2 , LESTERVILLE RAINFALL
M       0      2   7.75                     1.0
O    -192
T                                                -1    -70           .02
W2            2.5
X      -1   -.05      5
K       2   LAKE                                   1
K1      COMBINE HYDROGRAPH AT LAKE
K       1   DAM                                    1
K1      FLOOD ROUTING AND OVERTOPPING ANALYSES
Y                                1
Y1      1                                    -1055.2     -1
Y41055.2  1055.5  1055.9  1056.5  1057.0  1058.0  1059.0  1060.0  1061.0  1062.0
Y41063.0  1064.0
Y5     0.   40.0   140.0   365.0   620.0   1350.  2370.0  3720.0  5440.0  7490.0
Y59960.0 12700.0
$A     0.   20.0    80.0   212.0   404.0   652.0
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Input Data
1% Probability Event
Iron Mountain Lake Dam
MO 30057
B12

Input Data
1% Probability Event
Iron Mountain Lake Dam
MO 30057
B13

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51      $E1041.0  1050.0  1056.0  1060.0  1070.0  1080.0
52      $$1055.2
53      $D1059.9     2.8     1.5
54      $L    0.0   150.0   210.0   210.0   560.0  1200.0  1310.0  1330.0  1453.0
55      $V1059.3  1059.5  1059.7  1059.9  1060.0  1060.4  1060.6  1060.9  1061.5
56      K      99
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************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  01 APR 80
************************************

RUN  DATE? 81/04/07.
     TIME? 16.28.24.

                    IRON MOUNTAIN LAKE, DAM NO. 30057
                    WOODWARD- CLYDE CONSULTANTS, HOUSTON JOB NO. 80C224T100
                    PROBABILISTIC FLOOD  100-YEAR

                                   JOB SPECIFICATION
            NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
           200        0       15        0        0        0        0        0        0        0
                                    JOPER      NWT    LROPT    TRACE
                                        3        0        0        0

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

                              SUB-AREA RUNOFF COMPUTATION

                  INFLOW HYDROGRAPH FOR SUBAREA-2 , LESTERVILLE RAINFALL

                         ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                         AREA1       0       0       0       0       0       1       0       0

                                       HYDROGRAPH DATA
          IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
              0       2    4.65    0.00    4.65    1.00   0.000       0       0       0

                                         PRECIP DATA
                                 NP   STORM     DAJ     DAK
                                192    8.84    0.00    0.00
                                        PRECIP PATTERN
        .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
        .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
        .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
        .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
        .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
        .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
        .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
        .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
        .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
        .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
        .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
        .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
        .04     .04     .04     .04     .04     .04     .04     .04     .04     .04
        .04     .04     .04     .04     .04     .04     .04     .04     .04     .04
        .04     .04     .04     .04     .05     .08     .08     .08     .08     .08
        .10     .10     .18     .18     .42     .77    1.69     .43     .18     .18
        .10     .10     .08     .08     .08     .08     .08     .08     .02     .02
        .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
        .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
        .02     .02

                                          LOSS DATA
```

Output Summary
1% Probability Event
Iron Mountain Lake Dam
MO 30057
B14

.02 .02

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-63.00	0.00	0.00

CURVE NO = -63.00 WETNESS = -1.00 EFFECT CN = 63.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= 1.50

RECESSION DATA

STRTQ= -1.00 QRCSN= -.05 RTIOR= 5.00

UNIT HYDROGRAPH 32 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 1.50 VOL= 1.00

94.	275.	564.	946.	1238.	1371.	1371.	1295.	1095.	876.
646.	501.	387.	309.	241.	186.	145.	113.	88.	68.
53.	41.	32.	25.	19.	15.	13.	10.	8.	5.
3.	1.								

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.15	1	.02	0.00	.02	4.	1.02	1.15	101	.02	.00	.02	20.
1.01	.30	2	.02	0.00	.02	3.	1.02	1.30	102	.02	.00	.02	22.
1.01	.45	3	.02	0.00	.02	3.	1.02	1.45	103	.02	.00	.02	24.
1.01	1.00	4	.02	0.00	.02	2.	1.02	2.00	104	.02	.00	.02	26.
1.01	1.15	5	.02	0.00	.02	2.	1.02	2.15	105	.02	.00	.02	28.
1.01	1.30	6	.02	0.00	.02	2.	1.02	2.30	106	.02	.00	.02	30.
1.01	1.45	7	.02	0.00	.02	2.	1.02	2.45	107	.02	.00	.02	31.
1.01	2.00	8	.02	0.00	.02	1.	1.02	3.00	108	.02	.00	.02	33.
1.01	2.15	9	.02	0.00	.02	1.	1.02	3.15	109	.02	.00	.02	34.
1.01	2.30	10	.02	0.00	.02	1.	1.02	3.30	110	.02	.00	.02	36.
1.01	2.45	11	.02	0.00	.02	1.	1.02	3.45	111	.02	.00	.02	37.
1.01	3.00	12	.02	0.00	.02	1.	1.02	4.00	112	.02	.00	.02	39.
1.01	3.15	13	.02	0.00	.02	1.	1.02	4.15	113	.02	.00	.02	40.
1.01	3.30	14	.02	0.00	.02	0.	1.02	4.30	114	.02	.00	.02	42.
1.01	3.45	15	.02	0.00	.02	0.	1.02	4.45	115	.02	.00	.02	43.
1.01	4.00	16	.02	0.00	.02	0.	1.02	5.00	116	.02	.00	.02	44.
1.01	4.15	17	.02	0.00	.02	0.	1.02	5.15	117	.02	.00	.02	46.
1.01	4.30	18	.02	0.00	.02	0.	1.02	5.30	118	.02	.00	.02	47.
1.01	4.45	19	.02	0.00	.02	0.	1.02	5.45	119	.02	.00	.02	48.
1.01	5.00	20	.02	0.00	.02	0.	1.02	6.00	120	.02	.00	.02	50.
1.01	5.15	21	.02	0.00	.02	0.	1.02	6.15	121	.04	.01	.03	51.
1.01	5.30	22	.02	0.00	.02	0.	1.02	6.30	122	.04	.01	.03	54.
1.01	5.45	23	.02	0.00	.02	0.	1.02	6.45	123	.04	.01	.03	58.
1.01	6.00	24	.02	0.00	.02	0.	1.02	7.00	124	.04	.01	.03	64.
1.01	6.15	25	.02	0.00	.02	0.	1.02	7.15	125	.04	.01	.03	72.
1.01	6.30	26	.02	0.00	.02	0.	1.02	7.30	126	.04	.01	.03	81.
1.01	6.45	27	.02	0.00	.02	0.	1.02	7.45	127	.04	.01	.03	90.
1.01	7.00	28	.02	0.00	.02	0.	1.02	8.00	128	.04	.01	.03	99.
1.01	7.15	29	.02	0.00	.02	0.	1.02	8.15	129	.04	.01	.03	108.
1.01	7.30	30	.02	0.00	.02	0.	1.02	8.30	130	.04	.01	.03	116.
1.01	7.45	31	.02	0.00	.02	0.	1.02	8.45	131	.04	.01	.03	123.
1.01	8.00	32	.02	0.00	.02	0.	1.02	9.00	132	.04	.01	.03	129.
1.01	8.15	33	.02	0.00	.02	0.	1.02	9.15	133	.04	.01	.03	135.
1.01	8.30	34	.02	0.00	.02	0.	1.02	9.30	134	.04	.01	.03	141.
1.01	8.45	35	.02	0.00	.02	0.	1.02	9.45	135	.04	.01	.03	146.
1.01	9.00	36	.02	0.00	.02	0.	1.02	10.00	136	.04	.02	.03	151.
1.01	9.15	37	.02	0.00	.02	0.	1.02	10.15	137	.04	.02	.03	156.
1.01	9.30	38	.02	0.00	.02	0.	1.02	10.30	138	.04	.02	.03	160.
1.01	9.45	39	.02	0.00	.02	0.	1.02	10.45	139	.04	.02	.03	164.
1.01	10.00	40	.02	0.00	.02	0.	1.02	11.00	140	.04	.02	.03	169.
1.01	10.15	41	.02	0.00	.02	0.	1.02	11.15	141	.04	.02	.03	173.

Output Summary
1% Probability Event
Iron Mountain Lake Dam
MO 30057
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Output Summary
1% Probability Event
Iron Mountain Lake Dam
MO 30057
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1.01	10.00	40	.02	0.00	.02	0.	1.02	11.00	140	.04	.02	.03	[illegible]
1.01	10.15	41	.02	0.00	.02	0.	1.02	11.15	141	.04	.02	.03	173.
1.01	10.30	42	.02	0.00	.02	0.	1.02	11.30	142	.04	.02	.02	176.
1.01	10.45	43	.02	0.00	.02	0.	1.02	11.45	143	.04	.02	.02	180.
1.01	11.00	44	.02	0.00	.02	0.	1.02	12.00	144	.04	.02	.02	184.
1.01	11.15	45	.02	0.00	.02	0.	1.02	12.15	145	.07	.03	.04	188.
1.01	11.30	46	.02	0.00	.02	0.	1.02	12.30	146	.08	.03	.04	195.
1.01	11.45	47	.02	0.00	.02	0.	1.02	12.45	147	.08	.03	.04	207.
1.01	12.00	48	.02	0.00	.02	0.	1.02	13.00	148	.08	.03	.04	224.
1.01	12.15	49	.02	0.00	.02	0.	1.02	13.15	149	.08	.04	.04	246.
1.01	12.30	50	.02	0.00	.02	0.	1.02	13.30	150	.08	.04	.04	271.
1.01	12.45	51	.02	0.00	.02	0.	1.02	13.45	151	.10	.05	.05	298.
1.01	13.00	52	.02	0.00	.02	0.	1.02	14.00	152	.10	.05	.05	327.
1.01	13.15	53	.02	0.00	.02	0.	1.02	14.15	153	.18	.09	.09	361.
1.01	13.30	54	.02	0.00	.02	0.	1.02	14.30	154	.18	.10	.08	405.
1.01	13.45	55	.02	0.00	.02	0.	1.02	14.45	155	.42	.24	.18	476.
1.01	14.00	56	.02	0.00	.02	0.	1.02	15.00	156	.76	.47	.29	611.
1.01	14.15	57	.02	0.00	.02	0.	1.02	15.15	157	1.67	1.17	.50	906.
1.01	14.30	58	.02	0.00	.02	0.	1.02	15.30	158	.43	.32	.11	1379.
1.01	14.45	59	.02	0.00	.02	0.	1.02	15.45	159	.18	.14	.04	2001.
1.01	15.00	60	.02	0.00	.02	0.	1.02	16.00	160	.18	.14	.04	2694.
1.01	15.15	61	.02	0.00	.02	0.	1.02	16.15	161	.10	.08	.02	3226.
1.01	15.30	62	.02	0.00	.02	0.	1.02	16.30	162	.10	.08	.02	3493.
1.01	15.45	63	.02	0.00	.02	0.	1.02	16.45	163	.08	.06	.02	3510.
1.01	16.00	64	.02	0.00	.02	0.	1.02	17.00	164	.08	.06	.02	3319.
1.01	16.15	65	.02	0.00	.02	0.	1.02	17.15	165	.08	.06	.02	3000.
1.01	16.30	66	.02	0.00	.02	0.	1.02	17.30	166	.08	.06	.02	2592.
1.01	16.45	67	.02	0.00	.02	0.	1.02	17.45	167	.08	.06	.02	2179.
1.01	17.00	68	.02	0.00	.02	0.	1.02	18.00	168	.08	.06	.02	1863.
1.01	17.15	69	.02	0.00	.02	0.	1.02	18.15	169	.02	.02	.00	1610.
1.01	17.30	70	.02	0.00	.02	0.	1.02	18.30	170	.02	.02	.00	1407.
1.01	17.45	71	.02	0.00	.02	0.	1.02	18.45	171	.02	.02	.00	1228.
1.01	18.00	72	.02	0.00	.02	0.	1.02	19.00	172	.02	.02	.00	1063.
1.01	18.15	73	.02	0.00	.02	0.	1.02	19.15	173	.02	.02	.00	919.
1.01	18.30	74	.02	.00	.02	0.	1.02	19.30	174	.02	.02	.00	789.
1.01	18.45	75	.02	.00	.02	0.	1.02	19.45	175	.02	.02	.00	666.
1.01	19.00	76	.02	.00	.02	0.	1.02	20.00	176	.02	.02	.00	567.
1.01	19.15	77	.02	.00	.02	0.	1.02	20.15	177	.02	.02	.00	486.
1.01	19.30	78	.02	.00	.02	0.	1.02	20.30	178	.02	.02	.00	421.
1.01	19.45	79	.02	.00	.02	0.	1.02	20.45	179	.02	.02	.00	373.
1.01	20.00	80	.02	.00	.02	1.	1.02	21.00	180	.02	.02	.00	335.
1.01	20.15	81	.02	.00	.02	1.	1.02	21.15	181	.02	.02	.00	305.
1.01	20.30	82	.02	.00	.02	2.	1.02	21.30	182	.02	.02	.00	282.
1.01	20.45	83	.02	.00	.02	2.	1.02	21.45	183	.02	.02	.00	263.
1.01	21.00	84	.02	.00	.02	3.	1.02	22.00	184	.02	.02	.00	251.
1.01	21.15	85	.02	.00	.02	4.	1.02	22.15	185	.02	.02	.00	239.
1.01	21.30	86	.02	.00	.01	5.	1.02	22.30	186	.02	.02	.00	230.
1.01	21.45	87	.02	.00	.01	6.	1.02	22.45	187	.02	.02	.00	221.
1.01	22.00	88	.02	.00	.01	7.	1.02	23.00	188	.02	.02	.00	215.
1.01	22.15	89	.02	.00	.01	7.	1.02	23.15	189	.02	.02	.00	210.
1.01	22.30	90	.02	.00	.01	8.	1.02	23.30	190	.02	.02	.00	208.
1.01	22.45	91	.02	.00	.01	9.	1.02	23.45	191	.02	.02	.00	207.
1.01	23.00	92	.02	.00	.01	10.	1.03	0.00	192	.02	.02	.00	205.
1.01	23.15	93	.02	.00	.01	11.	1.03	.15	193	0.00	0.00	0.00	203.
1.01	23.30	94	.02	.00	.01	12.	1.03	.30	194	0.00	0.00	0.00	198.
1.01	23.45	95	.02	.00	.01	13.	1.03	.45	195	0.00	0.00	0.00	188.
1.02	0.00	96	.02	.00	.01	14.	1.03	1.00	196	0.00	0.00	0.00	172.
1.02	.15	97	.02	.00	.02	15.	1.03	1.15	197	0.00	0.00	0.00	150.
1.02	.30	98	.02	.00	.02	16.	1.03	1.30	198	0.00	0.00	0.00	128.
1.02	.45	99	.02	.00	.02	17.	1.03	1.45	199	0.00	0.00	0.00	109.
1.02	1.00	100	.02	.00	.02	19.	1.03	2.00	200	0.00	0.00	0.00	93.
									SUM	8.84	4.34	4.50	51800.
										(224.)(	110.)(	114.)(	1466.98)

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	AREA1	3510.	1683.	536.	259.	4.65
		(99.40)(	47.65)(	15.18)(	7.33)(	12.04)
HYDROGRAPH AT	AREA2	4803.	3089.	1061.	520.	7.75
		(136.00)(	87.46)(	30.04)(	14.72)(	20.07)
2-COMBINED	LAKE	7676.	4739.	1597.	779.	12.40
		(217.37)(	134.20)(	45.22)(	22.05)(	32.12)
ROUTED TO	DAM	6679.	4319.	1513.	732.	12.40
		(189.14)(	122.29)(	42.84)(	20.72)(	32.12)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1055.20	1055.20	1059.90
STORAGE	280.	280.	882.
OUTFLOW	0.	0.	3779.

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
0.00	1060.61	.71	1035.	6679.	3.25	42.00	0.00

Output Summary
1% Probability Event
Iron Mountain Lake Dam
MO 30057
B17