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NATIONAL DAM SAFETY PROGRAM. SEVAN DAM (MO 30453), MISSISSIPPI --ETC(U)  
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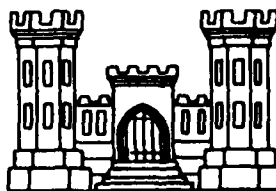
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PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

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

FOR: STATE OF MISSOURI

JANUARY 1979

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A106636	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Sevan Dam (MO 30453) Jefferson County, Missouri		5. TYPE OF REPORT & PERIOD COVERED Final Report
7. AUTHOR(s) Consoer, Townsend and Associates, Ltd.		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		8. CONTRACT OR GRANT NUMBER(s) 151 DACW43-78-C-0160
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 1472
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) National Dam Safety Program. Sevan Dam (MO 30453), Mississippi - Kaskaskia - St. Louis Basin, Jefferson County, Missouri. Phase I Inspection Report.		12. REPORT DATE January 1979
		13. NUMBER OF PAGES Approximately 65
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. <input checked="" type="checkbox"/> Approved for release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety, Lake, Dam Inspection, Private Dams		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

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

IN REPLY REFER TO

SUBJECT: Sevan Dam (Mo. 30453),  
Phase I Inspection Report

This report presents the results of field inspection and evaluation of Sevan Dam (Mo. 30453).

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

The St. Louis District has classified this dam as unsafe because of a large seep on the downstream embankment slope near the left abutment contact, and a seriously inadequate spillway that will pass only 32 percent of the Probable Maximum Flood.

SUBMITTED BY: **SIGNED** **8 MAR 1979**  
Chief, Engineering Division (Date)

APPROVED BY: **SIGNED** **8 MAR 1979**  
Colonel, CE, District Engineer (Date)

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PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Sevan Dam, Missouri Inv. No. 30453  
State Located: Missouri  
County Located: Jefferson  
Stream: Dulin Creek  
Date of Inspection: October 1, 1978

Assessment of General Condition

Sevan Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of Federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. Two houses, five farmhouses, and three improved road crossings would be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Sevan Dam is in the small size classification since it is less than 40 feet high and impounds less than 1,000 acre-feet of water.

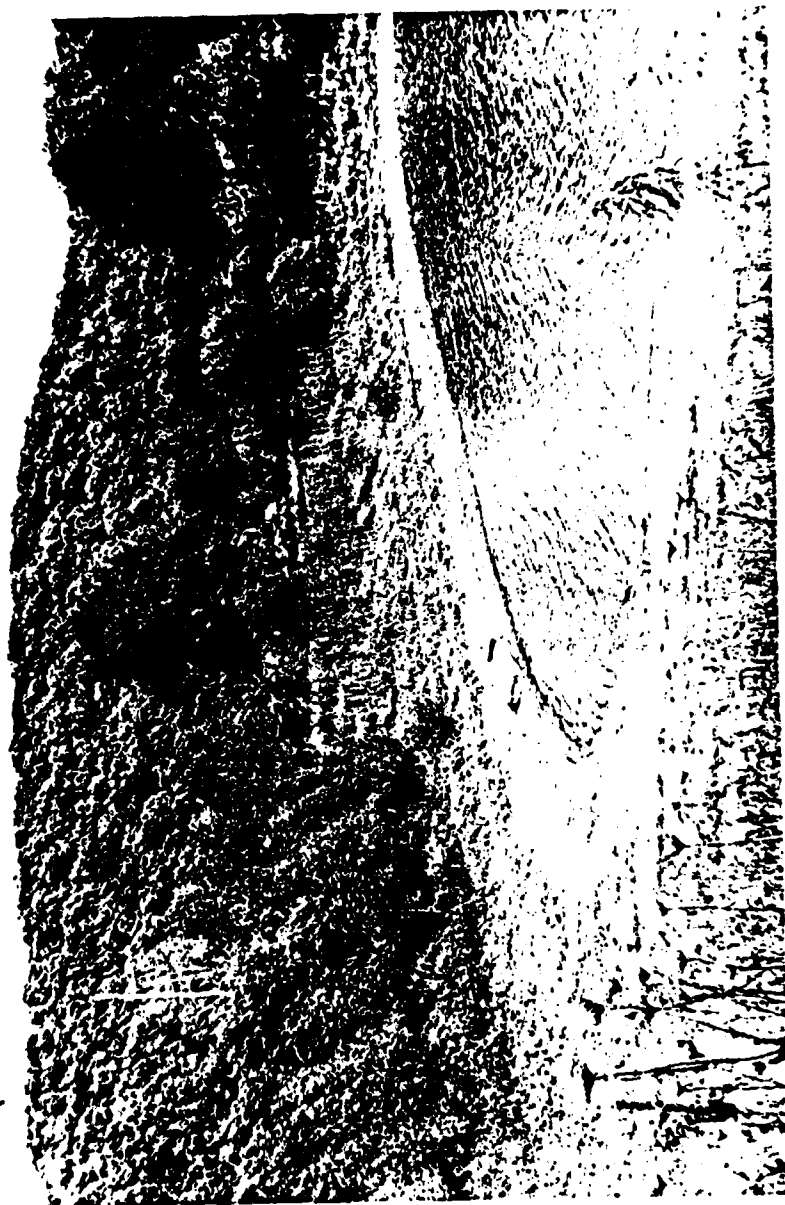
Our inspection and evaluation indicates that the spillway of Sevan Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Sevan Dam is a small size dam with a high hazard potential required by the guidelines to pass from one-half Probable Maximum Flood to the Probable Maximum Flood without overtopping. Since there are houses immediately downstream of the dam, the Probable Maximum Flood is the appropriate Spillway Design Flood (SDF). It was determined that the spillway will pass 32 percent of the Probable Maximum Flood without overtopping the dam. Also, our evaluation indicates that the spillway will not pass the 100-year flood; that is, a flood having a 1 percent chance of being equalled or exceeded in any given year.

The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

Other deficiencies noted by the inspection team were a need for periodic inspection by a qualified engineer; lack of a maintenance schedule; a large seepage flow occurring on the downstream slope at the left side of the dam; large brush and trees growing on the embankment section; and heavy vegetation growing in the spillway channel. The lack of stability and seepage analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above.





SEVAN DAM

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

Sevan Dam, I.D. No. 30453

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PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

SEVAN DAM, Missouri Inv. No. 30453

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for the Sevan Dam was carried out under Contract DACW 43-78-C-0160 to the Department of the Army, St. Louis District, Corps of Engineers, by the engineering firms of Consoer, Townsend & Associates Ltd., and Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of the Sevan Dam was made on October 1, 1978. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project; presents a summary of visual observations made during the field inspection; presents an evaluation of hydrologic and hydraulic conditions at the site; presents an evaluation as to the structural adequacy of the various project features; and assesses the general condition of the dam with respect to safety.

It should be noted that reference in this report to left or right abutments is as viewed looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to west abutment or side, and right to the east abutment or side.

d. Evaluation Criteria

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in the "Recommended Guidelines for Safety Inspection of Dams", Appendix D. 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 the Project

a.      Description of Dam and Appurtenances

It should be noted that design drawings are not available for the dam or appurtenant structures. The following description is based exclusively on observations and measurements made during the visual inspection.

The dam embankment is a homogeneous earthfill structure. The crest of the embankment has a width of 20 feet and a length of approximately 300 feet. The crest elevation is set at 621.0 feet above MSL, and the maximum height of the embankment is 39 feet above the minimum streambed elevation along the centerline of the dam.

The embankment section has side slopes of 1V to 3H upstream and 1V to 2H downstream. No riprap is provided for protection of the upstream embankment slope.

Visual inspection of the embankment material found a low plastic clay with a trace of sand and gravel. The soil would be classified as CL by the Unified Soil Classification System.

Bedrock at the site and within the vicinity is composed of limestones and shales of Mississippian age. The rolling hills adjacent to the site are mantled by a residual clay, a weathered product of the bedrock. Alluvial deposits are encountered along the stream courses of the area.

At the site, limestone bedrock crops out in the ridge slopes that confine the reservoir, and in the excavation for the spillway. The abutments for the dam appear to be founded in residual clays, but it is suspected that a portion of the abutments are also founded in limestone. Limestone exposures in the spillway indicate the unit is hard, with near horizontal bedding planes, or parting surfaces, spaced 2 inches to 1-1/2 feet apart. The embankment across the narrow valley is possibly placed on alluvial deposits or residual soils.

Data is not available to describe the procedures followed for the foundation preparation previous to placement of the embankment.

The spillway of Sevan Dam is a natural depression located near the east end of the dam embankment. The crest is a 16-inch wide, 30-foot long, and 2-foot high concrete weir. A 2-foot high fence with 1/2 inch by 1/2 inch wire mesh is constructed across the spillway above the concrete crest.

No outlet works or low level drain pipe is provided for releases of reservoir water through the dam.

The reservoir at Sevan Dam impounds .82 acre-feet of water from a drainage area of approximately 0.38 square miles.

b. Location

Sevan Dam is located on Dulin Creek, a tributary of the Big River, Jefferson County, Missouri. The nearest downstream community is House Springs, which is roughly 2 miles away. Immediately downstream of the lake are two houses and a number of improved road crossings. The dam and

reservoir are shown on the House Springs Quadrangle Sheet (7.5 minute series) in Section 35, Township 43 North, Range 4 East.

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection of Dams", by the U.S. Department of the Army, Office of the Chief Engineer, the dam is classified in the dam size category as being "Small" since its storage is less than 1,000 acre-feet. The dam is also classified as "Small" in dam height category because its height is less than 40 feet. The overall size classification is, accordingly, "Small" in size.

d. Hazard Classification

The dam has been classified as having "High" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. Our findings concur with the classification. The estimated damage zone extends four miles downstream of the dam. Immediately downstream of the dam are two houses. Also within the damage zone are five farmhouses and associated buildings and three improved road crossings. There is no immediate damage threat to House Springs in the event of failure of Sevan Dam. (See the map showing the drainage area maps in Appendix D.)



e. Ownership

Sevan Dam is owned by Mr. George Winter, of 13098 Gravois Road, St. Louis, Missouri.

f. Purpose of Dam

The purpose of the dam is for recreation.

g. Design and Construction History

The dam was built by Jules Haag, a member of Local 88 of the Meat Cutters Union, (the former owners) without any engineering plans or design. The dam was originally constructed in 1966.

h. Normal Operational Procedures

Sevan Dam is used to impound water for recreational purposes. The water level is controlled by rainfall, runoff, and evaporation. The lake is used solely for recreation and there are no operating facilities at the damsite.

1.3 Pertinent Data

(All dam elevations are assumed elevations based on the U.S.G.S. 7.5 minute Quadrangle topographic map named House Springs, Missouri.)

a. Drainage Area (Acres):

240

b. Discharge at Damsite

Estimated experienced maximum flood (cfs):	100
Estimated ungated spillway capacity at maximum pool elevation (cfs):	925

c. Elevation (Feet above MSL)

Top of dam:	621.0
Spillway crest:	617.0
Minimum streambed elevation at centerline of dam:	582.0
Maximum tailwater:	Unknown

d. Reservoir

Length of maximum pool (feet):	1,700
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e. Storage (Acre-Feet)

Top of dam:	117
Spillway crest:	82

f. Reservoir Surface (Acres)

Top of dam:	10
Spillway crest:	8

g. Dam

Type:	Rolled Earthfill
Length:	300 feet
Height (maximum):	39 feet
Top width:	20 feet
Side slopes:	
Downstream	1V to 2H
Upstream	1V to 3H
Zoning:	Unknown
Impervious core:	Unknown
Cutoff:	Unknown
Grout curtain:	Unknown

h. Diversion and Regulating Tunnel

None

i. Spillway

Type:

Uncontrolled

Length of weir:

30 feet

Crest Elevation:

617 feet MSL

j. Regulating Outlets

None

## SECTION 2: ENGINEERING DATA

### 2.1 Design

Design drawings are not available for the dam or appurtenant structures.

### 2.2 Construction

The dam was constructed in 1966. No construction data is available.

### 2.3 Operation

No operation data is available for the dam or appurtenant structures. No operating facilities are located at the damsite.

### 2.4 Evaluation

#### a. Availability

No design drawings, design computations, construction data or operation data is available.

In addition, no pertinent data was available for review of hydrology spillway capacity, flood routing through the reservoir, outlet capacity, slope stability, seepage analysis, or foundation conditions.

b. Adequacy

The available engineering data is inadequate to aid in evaluating the hydraulic and hydrologic capabilities and stability of the dam for Phase I investigations.

The lack of engineering data did not allow for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluating design, operation and construction data, but is based primarily on visual inspection, past performance history, and sound engineering judgment.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

No engineering data is available.

### SECTION 3: VISUAL INSPECTION

#### 3.1 Findings

##### a. General

A visual inspection of Sevan Dam was made on October 1, 1978. The following persons were present during the inspection:

<u>Name</u>	<u>Affiliation</u>	<u>Disciplines</u>
Yin Au-Yeung	Engineering Consultants, Inc.	Project Engineer, Hydraulics and Hydrology
David Bramwell	Engineering Consultants, Inc.	Geology
Jon Diebel	Engineering Consultants, Inc.	Soils
John Ismert	Engineering Consultants, Inc.	Mechanical
Kevin Blume	Consoer, Townsend & Assoc., Ltd.	Civil & Structural

Specific observations are discussed below.

##### b. Dam

No problems were observed with the crest of the embankment. The crest is used infrequently for travel.

The upstream slope of the embankment is provided with a light vegetative cover. Minor sloughing was observed on the slope near the normal high water mark. Some trees and large brush were observed growing on the slope near the crest of the embankment.

The downstream slope is overgrown with trees and large brush. This vegetation made proper inspection of the slope impossible. Some rodent activity was observed on the downstream slope.

A large seep, estimated to have a flow of 5 to 10 gpm, is breaking out on the embankment slope approximately 5 vertical feet up from the base of the dam near the left abutment contact. This seepage has formed a pond, having a size of approximately 50 feet by 100 feet, which stores water adjacent to the downstream toe of the dam. The pond appears to have been present at its location for several years. A pipe has been constructed to transport water from this pond to a downstream drainage channel. The seepage flows mostly through a single hole in the embankment section, however, moisture was observed on the embankment slope adjacent to the hole. The water was seen to be clear at the time of the inspection.

c. Appurtenant Structures

(1) Spillway

The approach channel to the spillway crest is obstructed by several trees and thick brush. There is a 2-foot high wire mesh fence constructed on top of the concrete weir. Only minor cracks and erosion were noted on the concrete weir. Vegetative growth is very dense upstream of and at the concrete weir. However, downstream from the concrete weir into the spillway discharge channel, vegetative growth was so dense as to make the area impassable. Hydraulic efficiency of the spillway is extremely poor if this overgrowth of vegetation in the spillway remains uncleared.

(2) Outlet Works

No outlet works or low level drain is provided for at the damsite.

d. Reservoir Area

The water level was at elevation 606.00 feet above MSL at the time of the inspection. The reservoir appeared to be continuously losing water. The water level in the reservoir at the time of the inspection appeared to be lower than the normal level.

The reservoir shore in the immediate area of the dam showed no sign of instability.

e. Downstream Channel

The downstream channel is a well defined, trapezoidal, unlined open channel which has a bottom width of 8 feet and side slope of 1V to 1-1/2H on both sides. Dense vegetative growth was also observed in the channel.

3.2 Evaluation

The following deficiencies were observed which could affect the safety of the dam, or which will require maintenance within a reasonable period of time.



1. The 5 to 10 gpm seepage flow breaking out on the embankment slope. A pond is formed adjacent to the dam embankment from the seepage.
2. The trees and large brush growing on the upstream and downstream embankment slopes.
3. The obstructions in the spillway channel.

## SECTION 4: OPERATIONAL PROCEDURES

### 4.1 Procedures

The dam impounds water for recreational use only. There is no method or procedures for the operation of this lake and, consequently, the water level is controlled by rainfall, runoff, evaporation and leakage.

### 4.2 Maintenance of Dam

Based on the present conditions, it appears that no maintenance has been performed in several years at the damsite. Items observed at the dam which require maintenance include clearing of trees from the upstream and downstream slopes, and clearing of brush and trees from the entrance and exit channels of the spillway.

### 4.3 Maintenance of Operating Facilities

There are no facilities present at the damsite which require maintenance.

### 4.4 Description of Any Warning System in Effect

The inspection team is not aware of any existing warning system in effect.

#### 4.5      Evaluation

Based on the condition of the damsite at the time of inspection, it would appear that the operation and maintenance for the dam is seriously inadequate. The items which require maintenance within a reasonable length of time are listed in Section 7.2.

## SECTION 5: HYDRAULIC/HYDROLOGIC

### 5.1 Evaluation of Features

#### a. Design

No design data is available.

Sevan Lake has a watershed of approximately 240 acres. The lake is located off Dulin Creek, which is a tributary of Big Creek.

Elevations within the watershed range from approximately 615 feet above MSL at the damsite to over 890 feet above MSL in the upper portion of the watershed.

The watershed is approximately 90 percent covered by woodlands, with the remainder being covered by grass and brush. A drainage map showing the watershed area is included in Appendix B.

Evaluation of the hydraulic and hydrologic features of Sevan Dam was based on criteria set forth in the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Precipitation (PMP) using the methods outlined in the U.S. Weather Bureau Publication, Hydrometeorological Report No. 33. The probable maximum storm duration was set at 24 hours, and storm rainfall distribution was based on criteria given in EM 1110-2-1411 (Standard Project Storm). The SCS triangular

hydrograph, transformed to a curvilinear hydrograph, was adopted for developing the unit hydrograph. The derived unit hydrograph is presented in Appendix B.

Initial and infiltration loss rates were applied to the PMP to obtain rainfall excesses. The rainfall excesses were then applied to the unit hydrograph to obtain the PMF hydrograph, utilizing the Corps of Engineers' computer program HEC-1 (Dam Safety Version), which was prepared specifically for dam safety analysis. The computed peak discharge of the PMF and one-half of the PMF are 4,673 cfs and 2,336 cfs, respectively.

Both the PMF and one-half of the PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method, also utilizing the HEC-1 (Dam Safety Version) computer program. The peak outflow discharges for the PMF and one-half of the PMF are 4,299 cfs and 1,893 cfs, respectively. Both the PMF and one-half of the PMF, when routed through the reservoir, resulted in overtopping of the dam.

The stage-outflow relation for the spillway was prepared from field notes and sketches. The reservoir stage-capacity data were based on the U.S.G.S. quadrangle topographic maps. Reservoir storage capacity included surcharge levels exceeding the top of the dam, and the spillway rating curve assumed that the dam remains intact during routing. The spillway rating curve and the reservoir capacity curve are also presented in Appendix B.

b. Experience Data

No records of reservoir stage or spillway discharge are maintained for this site.

c. Visual Observations

The spillway crest structure and discharge channel are well defined, but has no maintenance. The entire spillway area is full of very heavy vegetative growth. The downstream channel is also well defined with no riprap along discharge channel banks, and thick with vegetative growth. The spillway and exit channel are located at the furthest right abutment. The entire spillway is in an abandoned state. No drawdown facilities are available to evacuate the reservoir. Spillway releases will not endanger the structural integrity of the dam. Reservoir water surface was about 11 feet below the spillway crest at the time of inspection.

d. Overtopping Potential

As indicated in Section 5.1-a., both the Probable Maximum Flood and one-half of the Probable Maximum Flood, when routed through the reservoir, resulted in overtopping of the dam. The PMF and one-half of the PMF overtopped the dam crest by 1.83 feet and 0.73 feet, respectively. The total duration of embankment overflow is 1.33 hours during the PMF, and 0.50 hours during one-half of the PMF. The spillway of the Sevan Dam is capable of passing a flood equal to approximately 32 percent of the PMF just before overtopping of the dam. The 32 percent PMF has a frequency occurrence less than a 100-year frequency flood. Since the PMF is the minimum Spillway Design Flood (SDF) for Sevan Dam, according to the Recommended Guidelines for Safety Inspection of Dams by the Corps, the spillway capacity of the dam is considered "Inadequate".

1

The effect from rupture of the dam could extend approximately four miles downstream of the dam. Within this area are five farmhouses with associated farm buildings, two houses and three improved road crossings.

## SECTION 6: STRUCTURAL STABILITY

### 6.1 Evaluation of Structural Stability

#### a. Visual Observations

The large seepage flow breaking out on the downstream embankment slope indicates a potential hazard to the structural stability of the embankment. The quantity of flow from a single hole, and its location, demonstrates a situation which definitely warrants further study.

The pond adjacent to the downstream toe, causing saturation of the embankment and foundation materials, is also a condition which should be eliminated. It is noted that the seepage has apparently been occurring for several years.

The large number and size of the trees on the embankment slope also is a potential hazard to the embankment which should be repaired.

No signs of structural instability or distress were observed in the spillway.

#### b. Design and Construction Data

No design or construction data relating to the structural stability of the dam or appurtenant structures were found.



c. Operating Records

No operating records are available relating to the stability of the dam or appurtenant structures. No operating facilities exist at the damsite.

d. Post Construction Changes

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

e. Seismic Stability

In general, projects located in Seismic Zones 0, 1 and 2 can be assumed to present no hazard from earthquake, provided the static stability conditions are satisfactory and conventional safety margins exist. Sevan Dam is located in Seismic Zone 1. A detailed seismic analysis is not felt to be necessary for this embankment.

## SECTION 7: ASSESSMENT/REMEDIAL MEASURES

### 7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is also 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 continued care and inspection can there be any chance that an unsafe condition could be detected.

#### a. Safety

The spillway capacity of Sevan Dam was found to be inadequate. The spillway was found to be capable of passing only 32 percent of the PMF without overtopping.

The large seepage flow breaking out on the downstream embankment slope is a situation which must be remedied. A flow of this magnitude breaking out of a single hole on the embankment slope indicates a condition which could seriously

jeopardize the safety of the structure. The probable existence of the condition for several years does not in itself reduce the potential consequences of the seepage.

The choked spillway severely restricts the hydraulic efficiency of the structure.

The heavy brush and tree growth on the embankment slope pose a potential hazard to the dam. The extensive growth is considered unsatisfactory in terms of dam safety for several reasons: First, trees toppled by wind expose holes that invite rapid erosion, and second, decay of large existing root systems could form channels for eventual piping.

b. Adequacy of Information

Information concerning the dam and appurtenant structures is not available. It is recommended that the following programs be initiated to help alleviate this problem:

1. Periodic inspection of the dam by a professional engineer experienced in the design and construction of earth dams.
2. Set up a maintenance schedule and log all visits to the dam for repairs and maintenance.
3. Perform seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams".

c. Urgency

The remedial measures recommended in Paragraph 7.2 should be accomplished in the near future.

Increasing the spillway capacity is of a more urgent nature than the remainder of the remedial measures. However, investigation of, and correction of, seepage conditions is needed and should, likewise, be given a high priority.

d. Necessity for Phase II Inspection

Based on results of the Phase I inspection, and if the remedial measures recommended in Paragraph 7.2 are undertaken as soon as possible, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

Possible alternatives for increasing the spillway capacity include:

1. Lowering the spillway crest elevation.
2. Widening the spillway crest.
3. Raising the dam embankment.

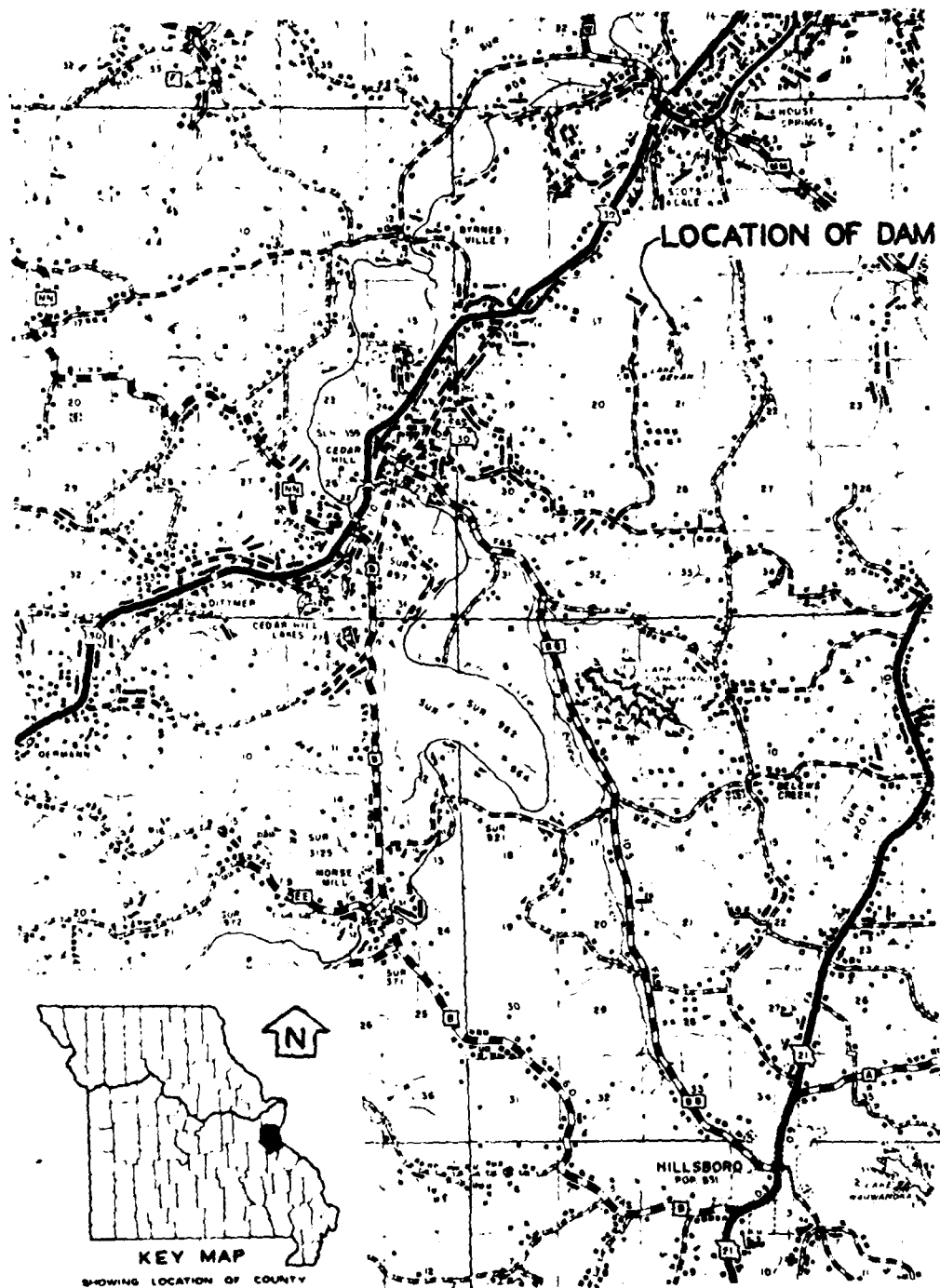
b. The large seepage flow occurring on the downstream embankment slope at the left side of the dam should be controlled. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams. Seepage control measures should be designed and constructed, based on these analyses.

c. O & M Maintenance Procedures

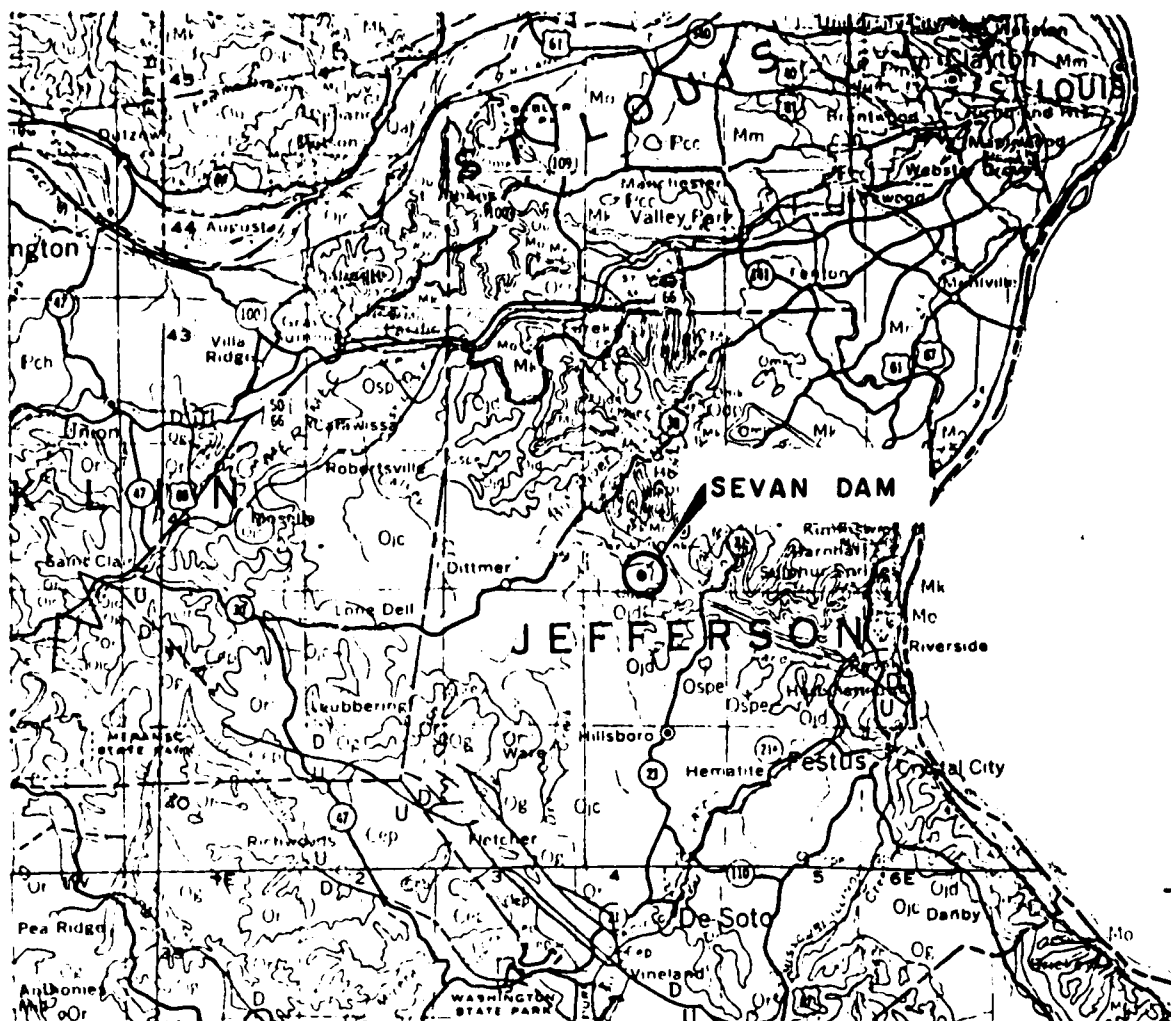
The owner should initiate the following programs:

1. Periodic inspection of the dam by a professional engineer experienced in the design and construction of earth dams.
2. Set up a maintenance schedule and log all visits to the dam for repairs and maintenance.
3. Clear the heavy vegetative growth obstructing the spillway channel.
4. The crest and embankment slopes should be cleared of all trees and large brush. Future growth should be prevented. Removal should be accomplished under the direction of a professional engineer.
5. Remove the wire fence trashrack on the crest of the spillway.

**PLATES**



LOCATION MAP  
SEVAN DAM  
JEFFERSON COUNTY, MISSOURI



General Geologic Map

### Explanation

#### Mississippian System

M<sub>o</sub> - cherty and crinoidal limestone, with some shale.

M<sub>k</sub> - intercalated limestones and shales.

#### Ordovician System

O<sub>mk</sub> - shale and limestone.

O<sub>dp</sub> - shale with thin fossiliferous limestone beds and dense limestone.

O<sub>jd</sub> - dolomite with interbedded limestone, shale, and black limestone.

O<sub>spe</sub> - massive, cross-bedded sandstone; and dolomite, lithographic limestone with interbedded sandstone.

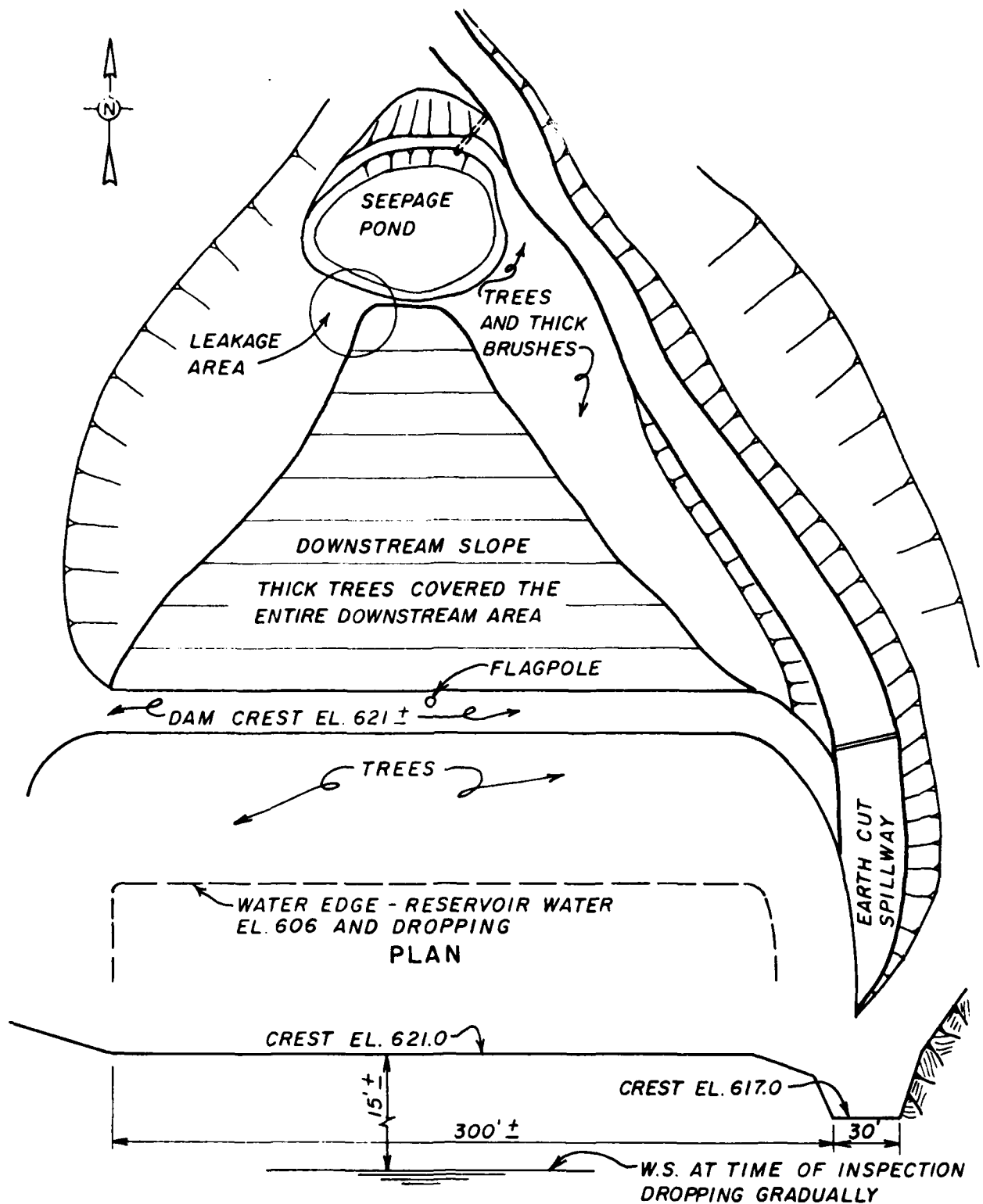
O<sub>jc</sub> - silty and cherty dolomite with oolitic chert.

O<sub>r</sub> - sandstone, chert, and interbedded dolomite.

O<sub>g</sub> - cherty dolomite with a basal sandstone.

Reference: Geologic Map of Missouri, 1961, Division of Geological Survey and Water Resources, State of Missouri.





ELEVATION - LOOKING DOWNSTREAM

SCALE:

50'	HORIZONTAL
5'	VERTICAL

SEVAN DAM  
RELATIVE ELEVATIONS

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

SEVAN DAM

- Photo 1 - View of Sevan taken at point to left of dam.
- Photo 2 - View along crest of embankment taken at right abutment.
- Photo 3 - View of upstream slope of embankment taken from right side of dam.
- Photo 4 - View of downstream slope of embankment taken at left abutment.
- Photo 5 - Picture of location of seepage and subsequent pond at left side of dam.
- Photo 6 - Picture of pond formed by seepage taken from left abutment looking downstream.
- Photo 7 - Close-up of location where seepage breaks out from embankment slope.
- Photo 8 - Close-up of sloughed area with seepage located near Photo 7.
- Photo 9 - View across spillway approach channel taken at right abutment.
- Photo 10 - Picture of concrete weir and trashrack in spillway channel.



Photo 1 - View of Sevan taken at point to left of dam.



Photo 2 - View along crest of embankment taken at right abutment.

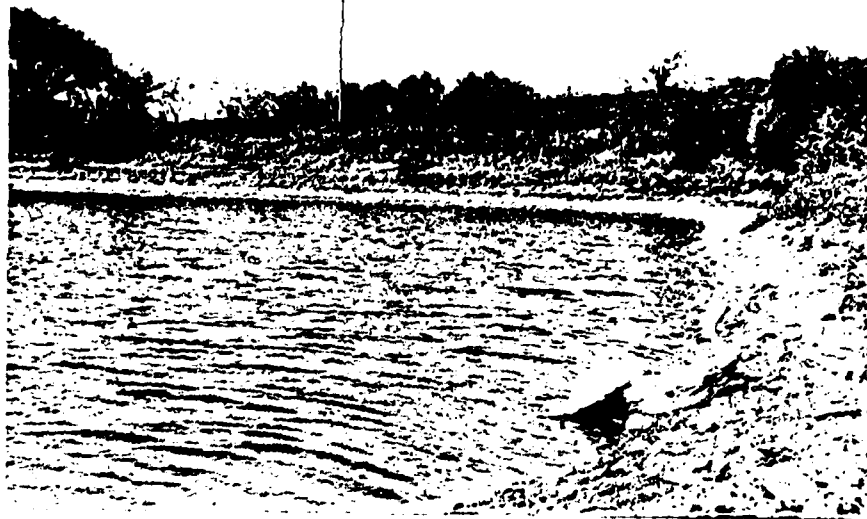


Photo 3 - View of upstream slope of embankment taken from right side of dam.



Photo 4 - View of downstream slope of embankment taken at left abutment.



Photo 5 - Picture of location of seepage and subsequent pond at left side of dam.



Photo 6 - Picture of pond formed by seepage taken from left abutment looking downstream.



Photo 7 - Close-up of location where seepage breaks out from embankment slope.



Photo 8 - Close-up of sloughed area with seepage located near Photo 7.



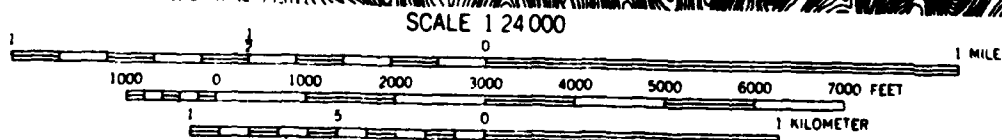
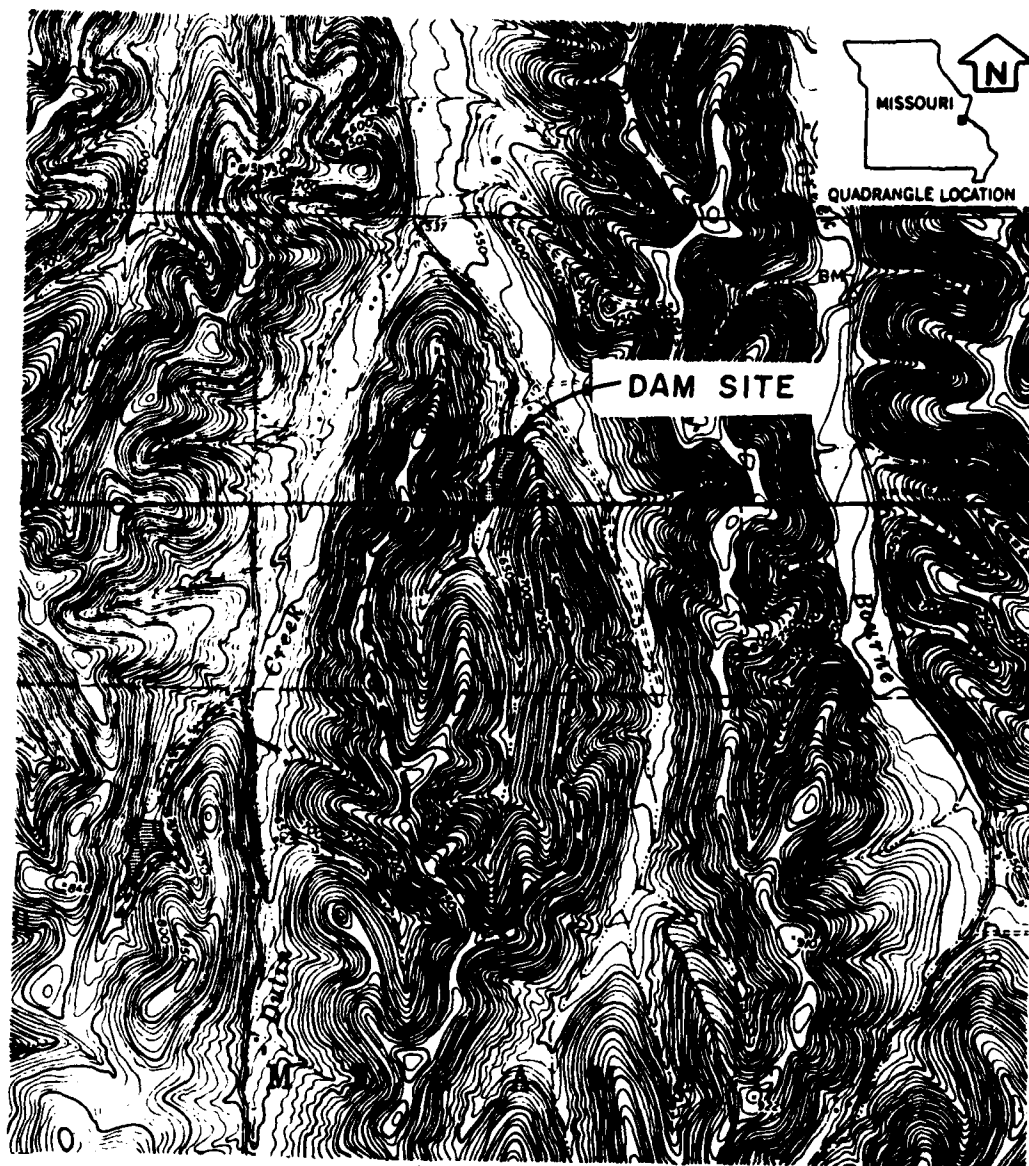
Photo 9 - View across spillway approach channel taken at right abutment.



Photo 10 - Picture of concrete weir and trashrack in spillway channel.



APPENDIX B  
HYDROLOGIC COMPUTATIONS



CONTOUR INTERVAL 10 FEET  
NATIONAL GEODETIC VERTICAL DATUM OF 1929

DRAINAGE BOUNDARY — — — — —

SEVAN DAM  
DRAINAGE AREA



MAP SHOWING THE POSSIBLE  
AFFECTED AREAS IN THE EVENT  
OF FAILURE OF SEVAN DAM.

DAM SAFETY INSPECTION / MISSOURI

SHEET NO. 1 OF 2

SEVAN DAM

JOB NO. 1223-001

RESERVOIR AREA CAPACITY

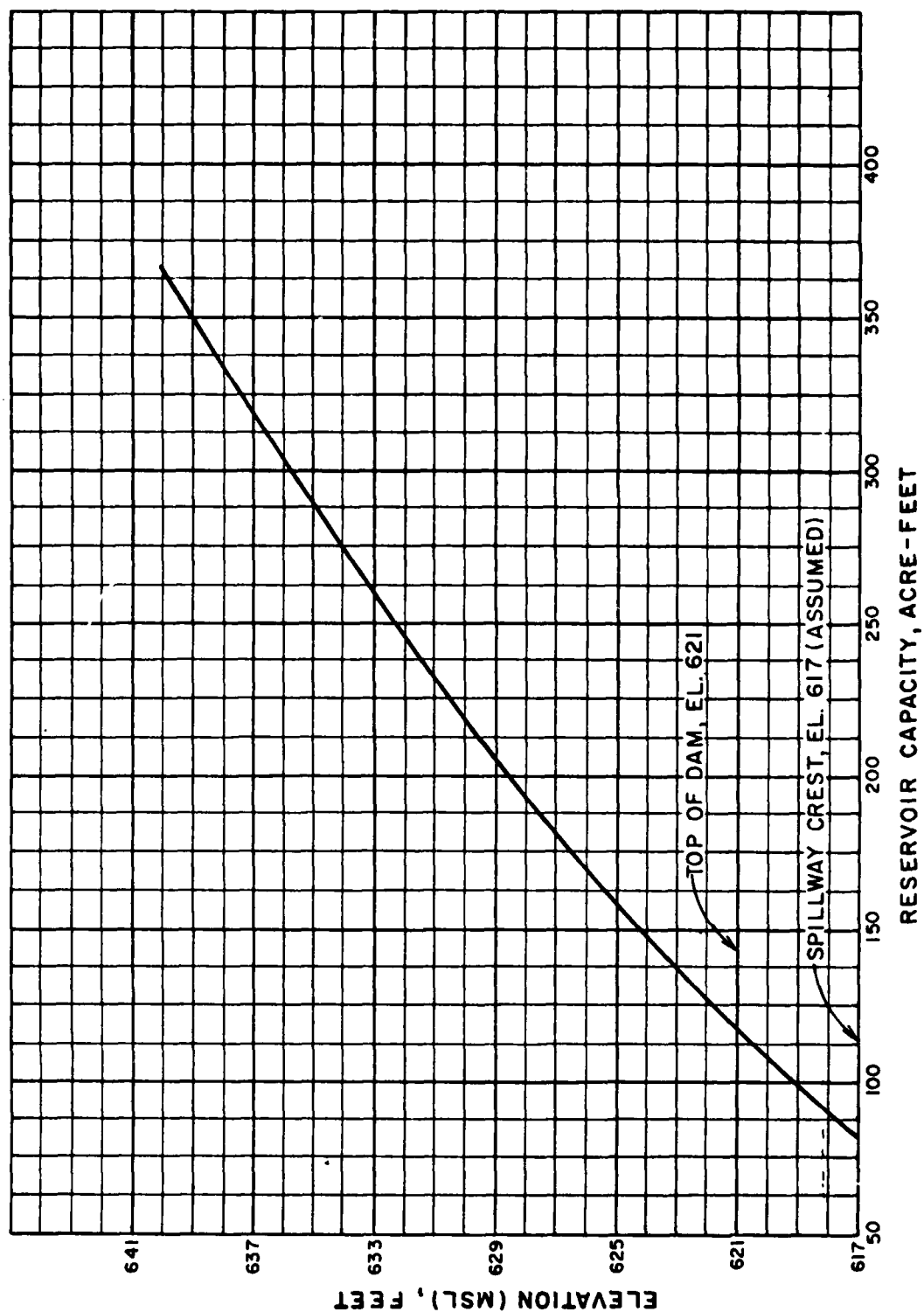
BY JAS DATE 11/21/77

SEVAN DAMRESERVOIR AREA CAPACITY

Elevation Crest (Feet)	Reservoir Surface area (acres)	Incremental Volume (acre-feet)	Total Volume (acre-feet)	Remarks
617	8*	82*	82*	Normal vol. of 82 A-F & Normal surface of 8 Ac are assumed at Spillway Crest
621	9.5	35	117	Top of dam
630	13	101	218	
640	13	101	368	

\* From inventory sheet

# SEVAN DAM RESERVOIR CAPACITY CURVE



DAM SAFETY INSPECTION/MISSOURI

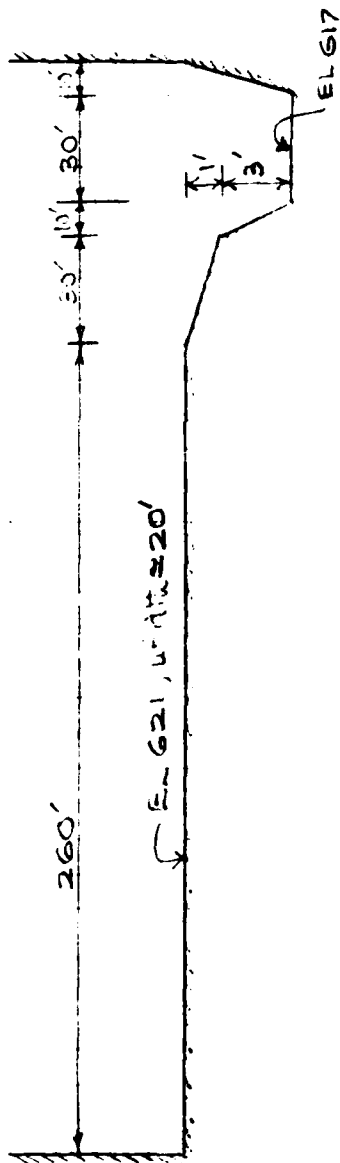
SEVAN DAM

SHEET NO. 1 OF

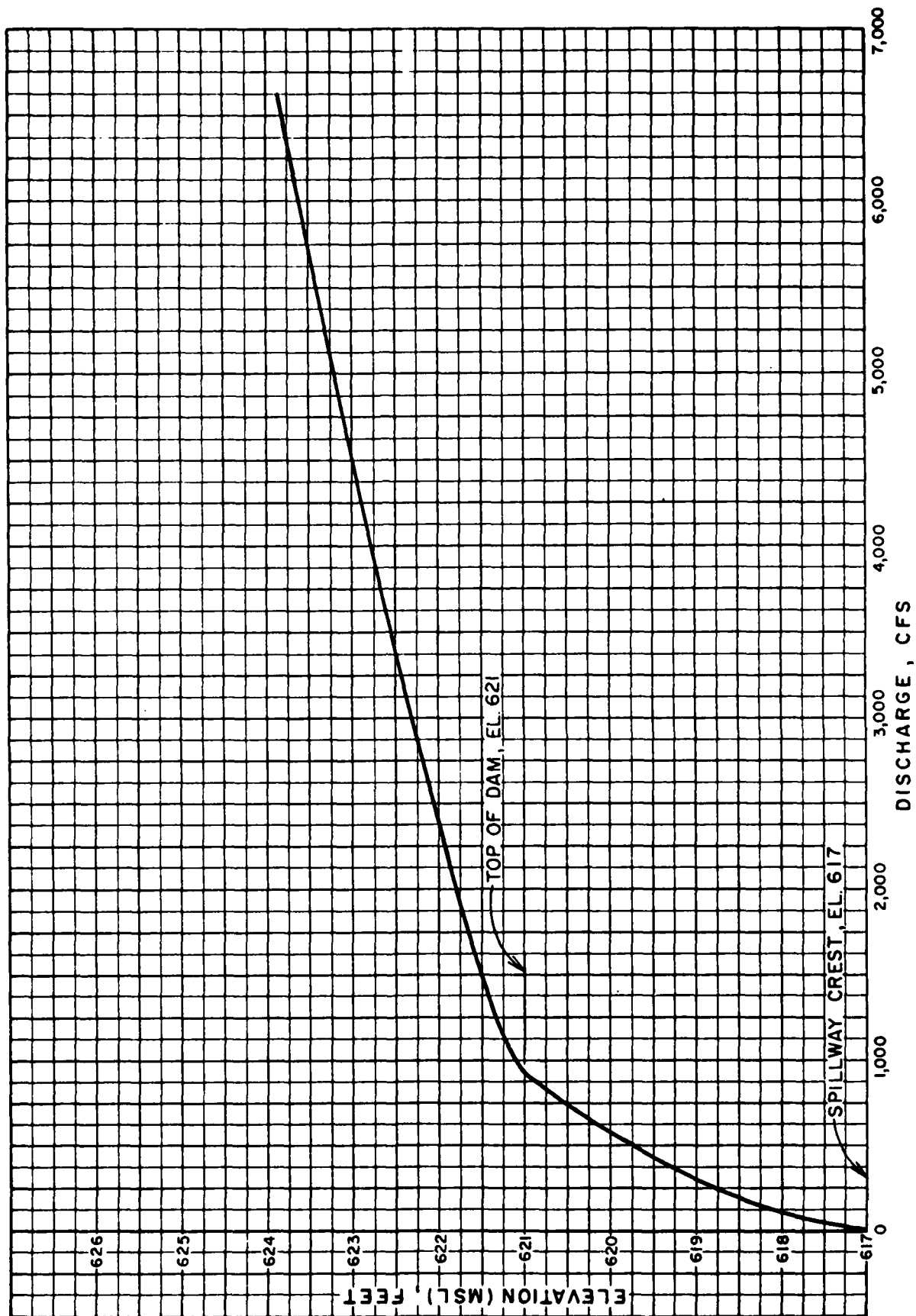
JOB NO. 1223-001

SPILLWAY &amp; OVERTOP DISCHARGE CAPACITY

BY MAS DATE 11/15/78



$Y_{c1}$	$T_{c1}$	$A_{c1}$	$Y_{c1} = \frac{V_{c1}^2}{g}$	$\frac{V_{c1}^2}{2g}$	$Q_1 = A_{c1} V_{c1}$	Upstream W.S. Elev = $617 + Y_{c1} + \frac{V_{c1}^2}{2g}$	$H_2$	$C_2$	$L_2$	$Q_2 = C_2 L_2^{1.5}$	$Q_T = Q_1 + Q_2$
1	35.83	32.92	5.43	0.46	179	618.46					179
2	41.66	71.66	7.44	0.86	533	619.86					533
3	47.50	116.25	8.87	1.22	1031	621.22	0.22	2.68	260	72	1103
3.5	63.75	164.06	9.10	1.28	1493	621.78	0.78	2.64	260	473	1966
4	80.00	220.00	9.40	1.37	2068	622.37	1.37	2.63	260	1097	3165
5	80.00	300.00	10.98	1.87	3294	623.87	2.87	2.63	260	3325	6619



SEVAN DAM  
SPILLWAY & OVERTOP RATING CURVE

## ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI  
 SEVAN DAM  
 UNIT HYDROGRAPH PARAMETERS

SHEET NO. 1 OF 3  
 JOB NO. 1223-001-1  
 BY KLB DATE 10-30-78  
 CWR

1. DRAINAGE AREA = 240 ACRES = 0.38 SQ. MI

2. LENGTH OF STREAM =  $L = \frac{2.4 \times 2000}{5280} = 0.91 \text{ MI.}$

3. DIFFERENCE IN ELEV.,  $\Delta H = 812 - 617 = 275$

4. TIME OF CONCENTRATION,

$$T_c = \left( \frac{11.9 \times L^3}{\Delta H} \right)^{0.385}$$

$$= \left( \frac{11.9 \times 0.91^3}{275} \right)^{0.385}$$

$T_c = \underline{0.27 \text{ HR}}$

5. LAG TIME,  $L_t = 0.6 \times T_c$

$= 0.6 \times 0.27 = 0.16 \text{ HR}$

6. RAINFALL UNIT DURATION,  $D$

$D \leq \frac{L_t}{4} = \frac{0.16}{4} = 0.04$

USE  $D = 5 \text{ MIN} = \underline{0.083 \text{ HR}}$

MINIMUM DURATION CRITERIA

7. TIME TO PEAK,  $T_p$

$T_p = \frac{D}{2} + 0.6 T_c$

$T_p = \frac{0.083}{2} + 0.6 \times 0.27$

$T_p = \underline{0.20}$

8.  $Q_p = \frac{484 A}{T_p} = \frac{484 \times 0.38}{0.20} = \underline{920 \text{ CFS.}}$



## DAM SAFETY INSPECTION - MISSOURI

SEVAN DAM

## UNIT HYDROGRAPH DERIVATION

SHEET NO. 2 OF 3

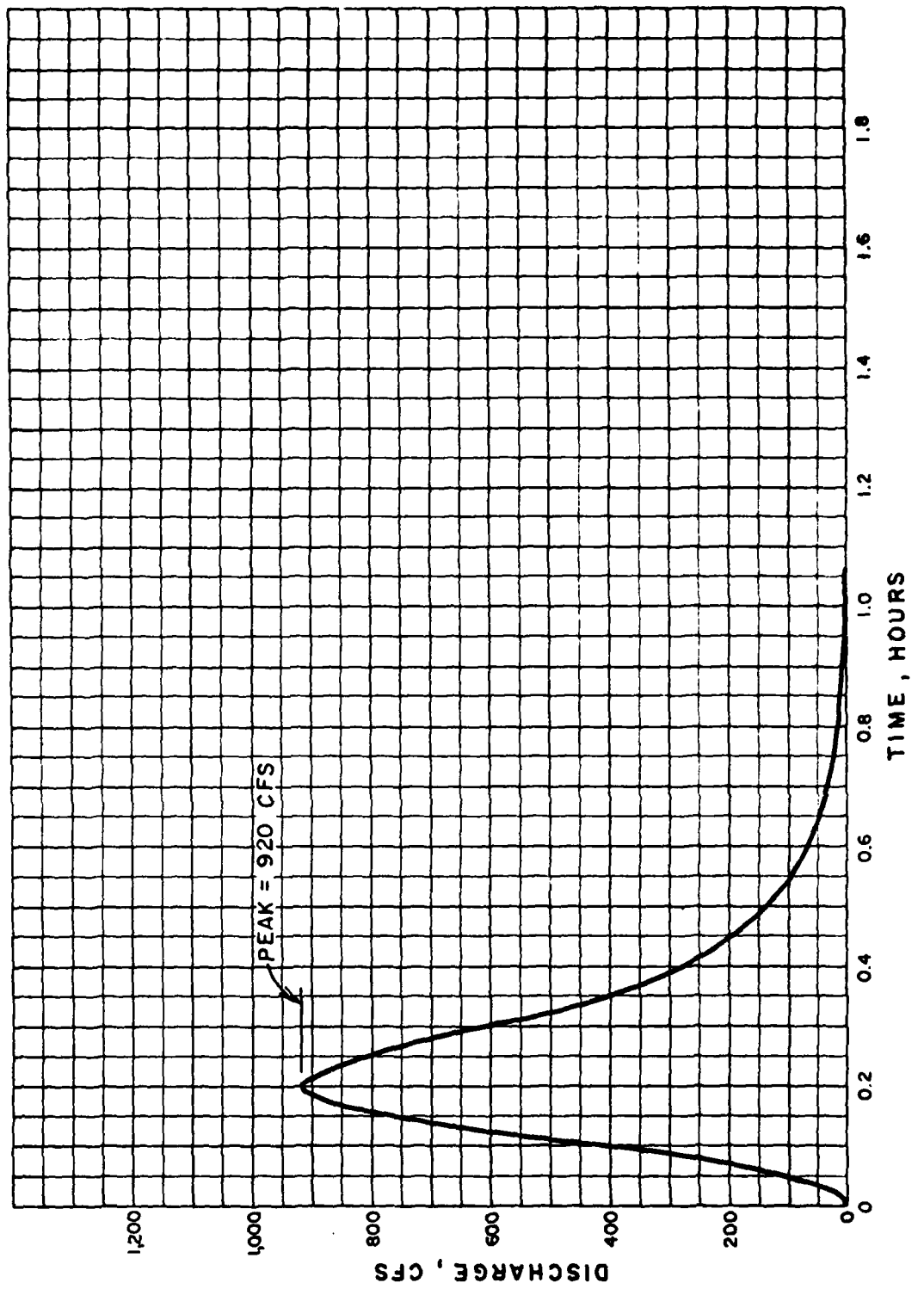
JOB NO. 1223-001-1

BY KLB DATE 10-30-78

## 1) CURVILINEAR UNIT HYDROGRAPH

TIME $T/T_p$	DISCHARGE RATIO $q/q_p$	UNIT HYDROGRAPH	
		TIME, T (HRS)	DISCHARGE (CFS)
0.0	0.000	0.00	0.00
0.1	0.015	0.02	13.80
0.2	0.075	0.04	69.00
0.3	0.16	0.06	147.20
0.4	0.28	0.08	257.60
0.5	0.45	0.10	414.00
0.6	0.60	0.12	552.00
0.7	0.77	0.14	708.40
0.8	0.89	0.16	818.80
0.9	0.97	0.18	892.40
1.0	1.00	0.20	920.00
1.1	0.98	0.22	901.60
1.2	0.92	0.24	846.40
1.3	0.84	0.26	772.80
1.4	0.75	0.28	690.00
1.5	0.66	0.30	607.20
1.6	0.56	0.32	515.20
1.8	0.42	0.36	386.40
2.0	0.32	0.40	294.40
2.2	0.24	0.44	220.80
2.4	0.18	0.48	165.60
2.6	0.13	0.52	119.60
2.8	0.098	0.56	90.16
3.0	0.075	0.60	69.00
3.5	0.036	0.70	33.12
4.0	0.018	0.80	16.56
4.5	0.009	0.90	8.28
5.0	0.004	1.00	3.68

248 CFS-HR.



SEVAN DAM  
5 MINUTE UNIT HYDROGRAPH

DAM SAFETY INSPECTION/MISSOURI

SHEET NO. 1 OF 2

SEVAN DAM

JOB NO. 1223-001

- PROBABLE MAXIMUM STORM (FMS)

BY MAS DATE 11/20/78

U.S.

DETERMINATION OF FMS

1. Determine drainage area of the basin

$$D.A. = 0.38 \text{ sq. mi.}$$

2. Determine PMP Index rainfall:

Location of centroid of basin:

$$\text{Long. } 90^{\circ}58'; \text{ Lat. } 38^{\circ}27'$$

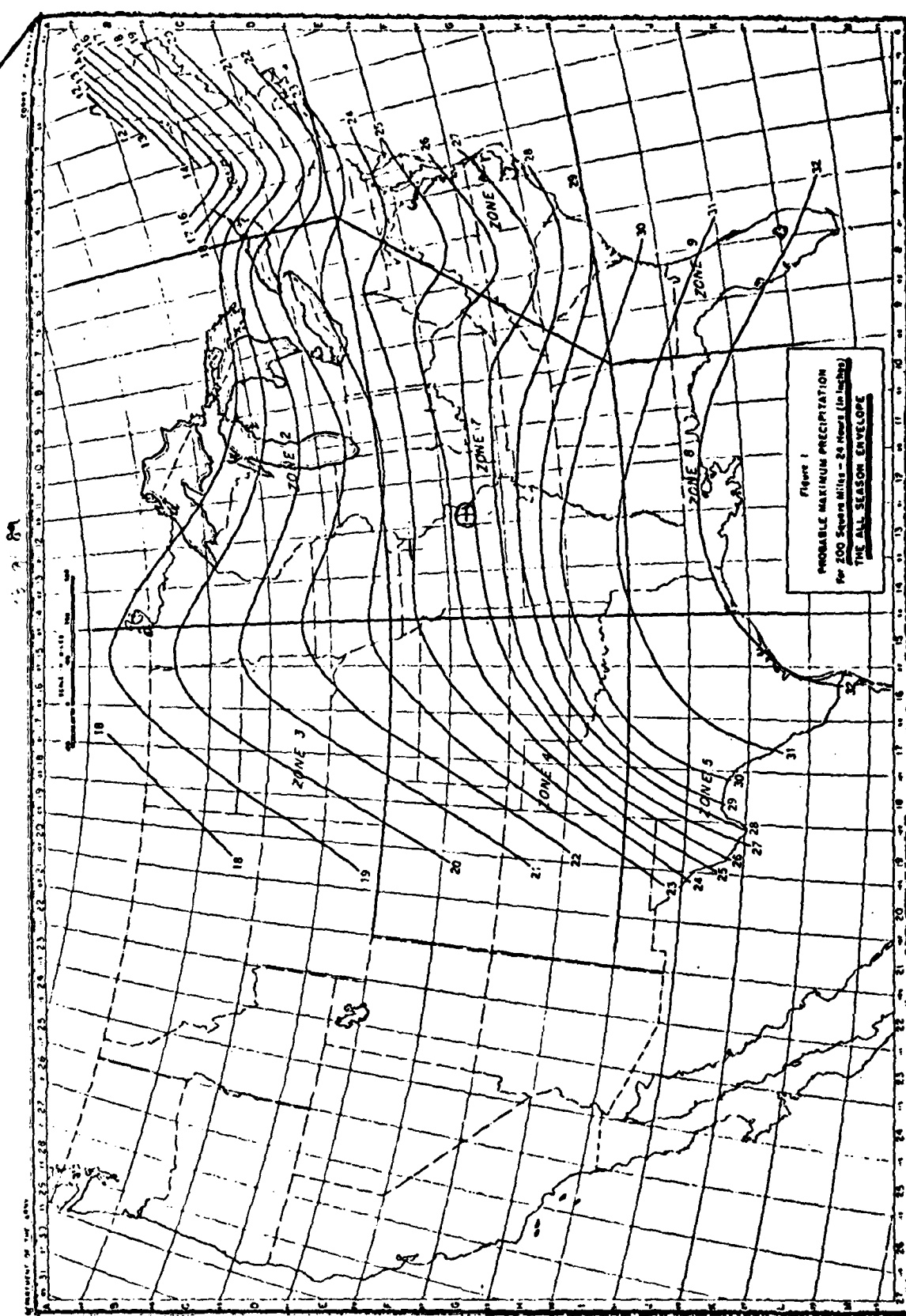
$$\rightarrow \text{PMP for } 200 \text{ sq. mi. \& 24 hrs duration} \\ = 25.6" \text{ (from Fig 1, HMR No 33)}$$

3. Determine basin rainfall in terms of percentage of PMP Index rainfall for various durations:

$$\text{Location: Long. } 90^{\circ}58'; \text{ Lat. } 38^{\circ}27'$$

 $\Rightarrow$  Zone 7

Duration (Hrs.)	Percent of Index rainfall (%)	Total rainfall (Inches)	Rainfall increments (Inches)	Duration of incre- ment (Hrs.)
6	100	25.6	25.6	6
12	120	30.7	5.1	6
24	130	33.3	2.6	12



SEVAN DAM  
 DETERMINATION OF PMP  
 25.6" 192

DAM SAFETY INSPECTION / MISSOURI

SHEET NO. 1 OF 1

SEVAN DAM

JOB NO. 1223-001

100-YEAR FLOOD BY REGRESSION EQUATION BY MAS DATE 11/15/78

SEVAN DAM100-YEAR FLOOD BY REGRESSION EQUATION

Regression equation for 100-year flood for Missouri:

$$Q_{100} = 85.1 A^{0.934} S^{-0.02} S^{0.576}$$

where,

A = drainage area in sq. mi.

S = main channel slope, ft./mi.

(Avg. slope between 0.11 & 0.85 L, L being the length of the stream)

For Sevan Dam:

$$A = 0.38 \text{ sq. mi.}$$

$$S = \frac{112}{0.75 \times 0.91} \text{ ft./mi.} = 164.10 \text{ ft./mi.}$$

$$Q_{100} = 85.1 (0.38)^{0.934} (0.38)^{-0.02} (164.10)^{0.576}$$

$$= \underline{\underline{639 \text{ cfs}}}$$

HEC1DB INPUT DATA

Wm

PLUMB HYDROGRAPH PACKAGE (HPC-1)  
JULY 1976  
OAM SAFETY VERSION  
LAST MODIFICATION 21 AUG 74

DA - SAFETY INSPECTION - MISSOURI  
SEVEN AM

PNP AND 50 PERCENT PNP DETEMINATION AND RUITING

0	5	0	0	0	0	0
2	1					
15					1	
11						
MP	INDEX	PRECIPITATION	AND	RATIOS,	INPUT	SLS
0.10	0.30	1.0				HYDROGRAPH

[illegible]

0.00  
1.00

1. *Chlorophyll a* (Chl *a*)

45	540	920	540	355	200	100
----	-----	-----	-----	-----	-----	-----

—

11

PHOTOGRAPH THROUGH SLUVE DAM

40	619.86	621.00	621.22	621.74	622.37	623.87
					6017.	-1

19	533	925	1103	1940	3145	622.37	623.07
39	536	621.00	621.22	621.76	622.31		

17	214	11.13	1.455	1.102	1.000
17	214	11.13	1.455	1.102	1.000

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1. The first step is to identify the problem or question that needs to be answered. This involves understanding the context and the specific requirements of the task.

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**THE**

**Abstract**

1. The first step in the process is to identify the problem or issue that needs to be addressed. This involves gathering information and understanding the context of the problem.

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 13  
ROUTE HYDROGRAPH TO 13  
END OF NETWORK



INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS

\*\*\*\*\*  
 PLUMB HYDROGRAPH PACKAGE (MCHS)  
 DAM SAFETY VERSION JULY 1978  
 LAST MODIFICATION 21 AUG 78  
 \*\*\*\*\*

RUN DATE: 10/11/78  
 TIME: 12.30.22

DAM SAFETY INSPECTUM - MISSOURI  
 DMS AND 90 PERCENT DMS DETERMINATION AND ROUTING

| JUN SPECIFICATION |     |      |       |     |       |       |      |      |      |
|-------------------|-----|------|-------|-----|-------|-------|------|------|------|
| NO                | NMP | NATV | TOAY  | IMR | IMTN  | MTDC  | IPLY | IPRT | MTAN |
| 300               | 0   | 5    | 0     | 0   | 0     | 0     | 0    | 0    | 0    |
|                   |     |      | JUPER | NAT | IRUPT | TRACE |      |      |      |
|                   |     |      | 5     | 0   | 0     | 0     |      |      |      |

MULTI-PLAN ANALYSES TO BE PERFORMED  
 PLANES 1 NOTION 2 LNTION 1

RTION 1.00 .50

SUB-AREA RUNOFF COMPUTATION

INPUT DMS UNDER PRECIPITATION AND RATIOS, INPUT SES (AI)  
 ISAR (COMP) (ECON) (TAPE) (PLY) (JPR) (NAME) (STAGE) (AUTO)

| HYDROGRAPH DATA |      |       |      |       |      |       |       |       |       |
|-----------------|------|-------|------|-------|------|-------|-------|-------|-------|
| INVC            | LONG | TAREA | SNAP | TRSDA | TRPC | RATIO | ISNOM | ISAME | LOCAL |
| 1               | 01   | 38    | 0.00 | 38    | 1.00 | 0.000 | 0     | 0     | 0     |

PRECIP DATA

| SPFE | DMS   | R6     | R12    | R24    | R48  | R72  | R96  |
|------|-------|--------|--------|--------|------|------|------|
| 0.00 | 25.00 | 100.00 | 100.00 | 130.00 | 0.00 | 0.00 | 0.00 |

LOSS DATA

| LAHPT | STOR | OLTH | RTOL | FRAIN | STRA | RTION | SPHIL | CNTH | ALSH | RTION |
|-------|------|------|------|-------|------|-------|-------|------|------|-------|
| 0     | 0.00 | 0.00 | 1.00 | 0.00  | 0.00 | 1.00  | 1.00  | 0.00 | 0.00 | 0.00  |

GIVEN UNIT GRAPH, NUMBER 15

200. 100. 50. 25. 12.5 6.25 3.125 1.5625

RETENTION DATA

| RTION | RTION | RTION | RTION | RTION | RTION | RTION | RTION |
|-------|-------|-------|-------|-------|-------|-------|-------|
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|------|------|----|-----|------|-----|------|-------|-----|-----|-----|-----|------|------|
| 1.01 | 1.10 | 2  | .01 | 0.00 | .01 | 1.01 | 12.40 | 152 | .51 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.15 | 3  | .01 | 0.00 | .01 | 1.01 | 12.45 | 153 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.20 | 4  | .01 | 0.00 | .01 | 1.01 | 12.50 | 154 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.25 | 5  | .01 | 0.00 | .01 | 1.01 | 12.55 | 155 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.30 | 6  | .01 | 0.00 | .01 | 1.01 | 13.00 | 156 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.35 | 7  | .01 | 0.00 | .01 | 1.01 | 13.05 | 157 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.40 | 8  | .01 | 0.00 | .01 | 1.01 | 13.10 | 158 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.45 | 9  | .01 | 0.00 | .01 | 1.01 | 13.15 | 159 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.50 | 10 | .01 | 0.00 | .01 | 1.01 | 13.20 | 160 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.55 | 11 | .01 | 0.00 | .01 | 1.01 | 13.25 | 161 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.60 | 12 | .01 | 0.00 | .01 | 1.01 | 13.30 | 162 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.65 | 13 | .01 | 0.00 | .01 | 1.01 | 13.35 | 163 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.70 | 14 | .01 | 0.00 | .01 | 1.01 | 13.40 | 164 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.75 | 15 | .01 | 0.00 | .01 | 1.01 | 13.45 | 165 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.80 | 16 | .01 | 0.00 | .01 | 1.01 | 13.50 | 166 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.85 | 17 | .01 | 0.00 | .01 | 1.01 | 13.55 | 167 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.90 | 18 | .01 | 0.00 | .01 | 1.01 | 14.00 | 168 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 1.95 | 19 | .01 | 0.00 | .01 | 1.01 | 14.05 | 169 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.00 | 20 | .01 | 0.00 | .01 | 1.01 | 14.10 | 170 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.05 | 21 | .01 | 0.00 | .01 | 1.01 | 14.15 | 171 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.10 | 22 | .01 | 0.00 | .01 | 1.01 | 14.20 | 172 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.15 | 23 | .01 | 0.00 | .01 | 1.01 | 14.25 | 173 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.20 | 24 | .01 | 0.00 | .01 | 1.01 | 14.30 | 174 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.25 | 25 | .01 | 0.00 | .01 | 1.01 | 14.35 | 175 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.30 | 26 | .01 | 0.00 | .01 | 1.01 | 14.40 | 176 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.35 | 27 | .01 | 0.00 | .01 | 1.01 | 14.45 | 177 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.40 | 28 | .01 | 0.00 | .01 | 1.01 | 14.50 | 178 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.45 | 29 | .01 | 0.00 | .01 | 1.01 | 14.55 | 179 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.50 | 30 | .01 | 0.00 | .01 | 1.01 | 15.00 | 180 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.55 | 31 | .01 | 0.00 | .01 | 1.01 | 15.05 | 181 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.60 | 32 | .01 | 0.00 | .01 | 1.01 | 15.10 | 182 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.65 | 33 | .01 | 0.00 | .01 | 1.01 | 15.15 | 183 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.70 | 34 | .01 | 0.00 | .01 | 1.01 | 15.20 | 184 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.75 | 35 | .01 | 0.00 | .01 | 1.01 | 15.25 | 185 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.80 | 36 | .01 | 0.00 | .01 | 1.01 | 15.30 | 186 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.85 | 37 | .01 | 0.00 | .01 | 1.01 | 15.35 | 187 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.90 | 38 | .01 | 0.00 | .01 | 1.01 | 15.40 | 188 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 2.95 | 39 | .01 | 0.00 | .01 | 1.01 | 15.45 | 189 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.00 | 40 | .01 | 0.00 | .01 | 1.01 | 15.50 | 190 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.05 | 41 | .01 | 0.00 | .01 | 1.01 | 15.55 | 191 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.10 | 42 | .01 | 0.00 | .01 | 1.01 | 16.00 | 192 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.15 | 43 | .01 | 0.00 | .01 | 1.01 | 16.05 | 193 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.20 | 44 | .01 | 0.00 | .01 | 1.01 | 16.10 | 194 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.25 | 45 | .01 | 0.00 | .01 | 1.01 | 16.15 | 195 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.30 | 46 | .01 | 0.00 | .01 | 1.01 | 16.20 | 196 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.35 | 47 | .01 | 0.00 | .01 | 1.01 | 16.25 | 197 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.40 | 48 | .01 | 0.00 | .01 | 1.01 | 16.30 | 198 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.45 | 49 | .01 | 0.00 | .01 | 1.01 | 16.35 | 199 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.50 | 50 | .01 | 0.00 | .01 | 1.01 | 16.40 | 200 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.55 | 51 | .01 | 0.00 | .01 | 1.01 | 16.45 | 201 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.60 | 52 | .01 | 0.00 | .01 | 1.01 | 16.50 | 202 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.65 | 53 | .01 | 0.00 | .01 | 1.01 | 16.55 | 203 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.70 | 54 | .01 | 0.00 | .01 | 1.01 | 17.00 | 204 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.75 | 55 | .01 | 0.00 | .01 | 1.01 | 17.05 | 205 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.80 | 56 | .01 | 0.00 | .01 | 1.01 | 17.10 | 206 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.85 | 57 | .01 | 0.00 | .01 | 1.01 | 17.15 | 207 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.90 | 58 | .01 | 0.00 | .01 | 1.01 | 17.20 | 208 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 3.95 | 59 | .01 | 0.00 | .01 | 1.01 | 17.25 | 209 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 4.00 | 60 | .01 | 0.00 | .01 | 1.01 | 17.30 | 210 | .01 | .01 | .01 | 1.01 | 1.01 |
| 1.01 | 4.05 | 61 | .01 | 0.00 | .01 | 1.01 | 17.35 | 211 | .01 | .01 | .01 | 1.01 | 1.01 |

|      |      |     |     |     |     |    |     |     |     |     |     |     |     |
|------|------|-----|-----|-----|-----|----|-----|-----|-----|-----|-----|-----|-----|
| 1.01 | 5.10 | 62  | .01 | .00 | .01 | 0. | .01 | 212 | .21 | .23 | .01 | .01 | .00 |
| 1.01 | 5.15 | 63  | .01 | .00 | .01 | 0. | .01 | 213 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.20 | 64  | .01 | .00 | .01 | 0. | .01 | 214 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.25 | 65  | .01 | .00 | .01 | 0. | .01 | 215 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.30 | 66  | .01 | .00 | .01 | 0. | .01 | 216 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.35 | 67  | .01 | .00 | .01 | 0. | .01 | 217 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.40 | 68  | .01 | .00 | .01 | 0. | .01 | 218 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.45 | 69  | .01 | .00 | .01 | 0. | .01 | 219 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.50 | 70  | .01 | .00 | .01 | 0. | .01 | 220 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.55 | 71  | .01 | .00 | .01 | 0. | .01 | 221 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.60 | 72  | .01 | .00 | .01 | 0. | .01 | 222 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.65 | 73  | .01 | .00 | .01 | 0. | .01 | 223 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.70 | 74  | .01 | .00 | .01 | 0. | .01 | 224 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.75 | 75  | .01 | .00 | .01 | 0. | .01 | 225 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.80 | 76  | .01 | .00 | .01 | 0. | .01 | 226 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.85 | 77  | .01 | .00 | .01 | 0. | .01 | 227 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.90 | 78  | .01 | .00 | .01 | 0. | .01 | 228 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 5.95 | 79  | .01 | .00 | .01 | 0. | .01 | 229 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.00 | 80  | .01 | .00 | .01 | 0. | .01 | 230 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.05 | 81  | .01 | .00 | .01 | 0. | .01 | 231 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.10 | 82  | .01 | .00 | .01 | 0. | .01 | 232 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.15 | 83  | .01 | .00 | .01 | 0. | .01 | 233 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.20 | 84  | .01 | .00 | .01 | 0. | .01 | 234 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.25 | 85  | .01 | .00 | .01 | 0. | .01 | 235 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.30 | 86  | .01 | .00 | .01 | 0. | .01 | 236 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.35 | 87  | .01 | .00 | .01 | 0. | .01 | 237 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.40 | 88  | .01 | .00 | .01 | 0. | .01 | 238 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.45 | 89  | .01 | .00 | .01 | 0. | .01 | 239 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.50 | 90  | .01 | .00 | .01 | 0. | .01 | 240 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.55 | 91  | .01 | .00 | .01 | 0. | .01 | 241 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.60 | 92  | .01 | .00 | .01 | 0. | .01 | 242 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.65 | 93  | .01 | .00 | .01 | 0. | .01 | 243 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.70 | 94  | .01 | .00 | .01 | 0. | .01 | 244 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.75 | 95  | .01 | .00 | .01 | 0. | .01 | 245 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.80 | 96  | .01 | .00 | .01 | 0. | .01 | 246 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.85 | 97  | .01 | .00 | .01 | 0. | .01 | 247 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.90 | 98  | .01 | .00 | .01 | 0. | .01 | 248 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 6.95 | 99  | .01 | .00 | .01 | 0. | .01 | 249 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.00 | 100 | .01 | .00 | .01 | 0. | .01 | 250 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.05 | 101 | .01 | .00 | .01 | 0. | .01 | 251 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.10 | 102 | .01 | .00 | .01 | 0. | .01 | 252 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.15 | 103 | .01 | .00 | .01 | 0. | .01 | 253 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.20 | 104 | .01 | .00 | .01 | 0. | .01 | 254 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.25 | 105 | .01 | .00 | .01 | 0. | .01 | 255 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.30 | 106 | .01 | .00 | .01 | 0. | .01 | 256 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.35 | 107 | .01 | .00 | .01 | 0. | .01 | 257 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.40 | 108 | .01 | .00 | .01 | 0. | .01 | 258 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.45 | 109 | .01 | .00 | .01 | 0. | .01 | 259 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.50 | 110 | .01 | .00 | .01 | 0. | .01 | 260 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.55 | 111 | .01 | .00 | .01 | 0. | .01 | 261 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.60 | 112 | .01 | .00 | .01 | 0. | .01 | 262 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.65 | 113 | .01 | .00 | .01 | 0. | .01 | 263 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.70 | 114 | .01 | .00 | .01 | 0. | .01 | 264 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.75 | 115 | .01 | .00 | .01 | 0. | .01 | 265 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.80 | 116 | .01 | .00 | .01 | 0. | .01 | 266 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.85 | 117 | .01 | .00 | .01 | 0. | .01 | 267 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.90 | 118 | .01 | .00 | .01 | 0. | .01 | 268 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 7.95 | 119 | .01 | .00 | .01 | 0. | .01 | 269 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 8.00 | 120 | .01 | .00 | .01 | 0. | .01 | 270 | .23 | .23 | .01 | .01 | .00 |
| 1.01 | 8.05 | 121 | .01 | .00 | .01 | 0. | .01 | 271 | .23 | .23 | .01 | .01 | .00 |





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OUTFLUX

SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING

AND  
DAM SAFETY ANALYSIS



BEAR FLOW AND STORAGE TEND UP (M3) SURFACE FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS  
 FLOWS IN CUMIC FEET PER SECOND (CUMIC METERS PER SECOND)  
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

| INTEGRATION   | STATION | AREA         | PLAN | RATIO 1            | RATIO 2           |
|---------------|---------|--------------|------|--------------------|-------------------|
|               |         |              |      | 1.00               | .50               |
| HYDROGRAPH AT | 13      | .30<br>(.80) | 1    | 4073.<br>( 137.12) | 2336.<br>( 66.16) |
| ROUTED TO     | 13      | .30<br>(.80) | 1    | 4200.<br>( 121.72) | 1893.<br>( 53.67) |

# SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1.....

INITIAL VALUE  
 617.00  
 62.00  
 0.00

SPILLWAY CREST  
 621.00  
 117.00  
 985.00

ELEVATION  
 STORAGE  
 OUTFLOW

| RATIO<br>OF<br>PHE | MAXIMUM<br>RESERVOIR<br>W.S. FLEV | MAXIMUM<br>DEPTH<br>OVER DAM | MAXIMUM<br>STORAGE<br>AC-FT | MAXIMUM<br>OUTFLOW<br>CFS | DURATION<br>OVER TOP<br>HOURS | TIME OF<br>MAX OUTFLOW<br>HOURS | TIME OF<br>FAILURE<br>HOURS |
|--------------------|-----------------------------------|------------------------------|-----------------------------|---------------------------|-------------------------------|---------------------------------|-----------------------------|
| 1.00               | 622.43                            | 1.83                         | 158.                        | 4299.                     | 1.33                          | 15.92                           | 0.00                        |
| 1.50               | 621.73                            | 1.73                         | 125.                        | 1893.                     | 1.90                          | 15.92                           | 0.00                        |

