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BALK (KENNETH) AND ASSOCIATES INC ST LOUIS MO
NATIONAL DAM SAFETY PROGRAM. SEE TAL LAKE DAM (MO 30668). UPPER--ETC(U)
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(See Tal Lake Dam (MO 30668).
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St. Louis Basin. Gasconade County, Missouri.
Phase I Inspection Report.

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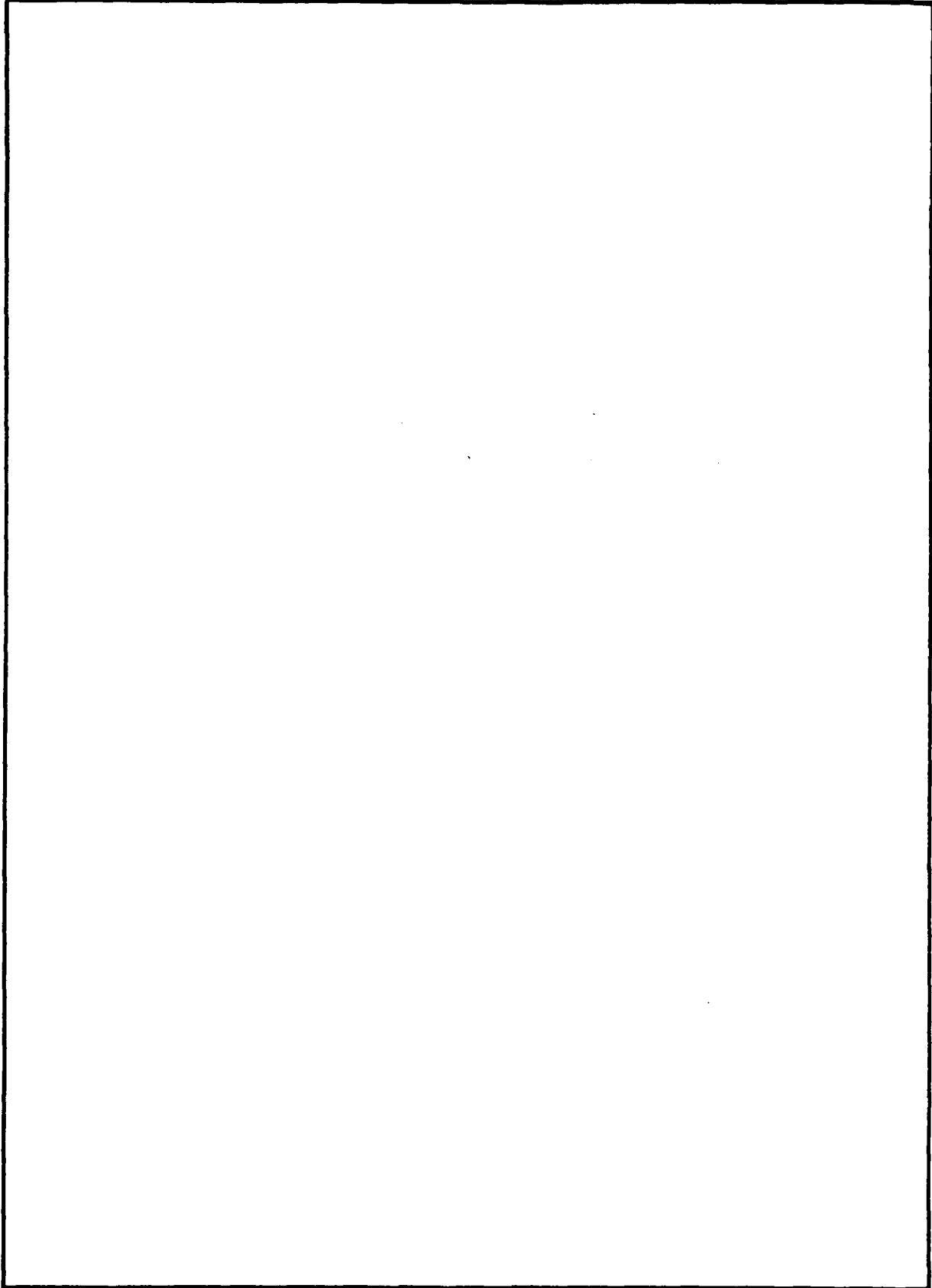
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety, Lake, Dam Inspection, Private Dams		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the 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: See Tal Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the See Tal Lake Dam.

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

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

- 1) Spillway will not pass 50 percent of the Probable Maximum Flood
- 2) Overtopping could result in dam failure.
- 3) Dam failure significantly increases the hazard to loss of life downstream

SUBMITTED BY: SIGNED
 Chief, Engineering Division

26 FEB 1979
 Date

APPROVED BY: SIGNED
 Colonel, CE, District Engineer

26 FEB 1979
 Date

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DISTRIBUTION STATEMENT A
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SEE TAL LAKE DAM
(Formerly Glennon Epple Dam)
GASCONADE COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30668

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY

Kenneth Balk & Associates, Inc.
St. Louis, Missouri
Shannon & Wilson, Inc.
St. Louis, Missouri

PREPARED FOR

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

NOVEMBER, 1978

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam	See Tal Lake
State Located	Missouri
County Located	Gasconade County
Stream	Tributary To Frene Creek
Date of Inspection	August 24, 1978

See Tal Lake Dam, No. 30668 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.

See Tal Lake Dam was visually inspected by an interdisciplinary team of engineers from Kenneth Balk & Associates, Inc. and Shannon & Wilson, Inc. The purpose of the inspection was to make a preliminary assessment of the general condition of the dam with respect to safety in order to determine if, in the opinion of the interdisciplinary team, the dam poses recognizable hazards to human life or property. This assessment is based solely upon data made available and visual evidence observed during the site visit.

To make a complete assessment of the safety of the dam would require detailed studies and engineering analyses beyond the scope of this preliminary assessment.

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. The estimated damage zone extends two miles downstream of the dam. Within the first half mile below the dam, where the tributary joins Frene Creek, are three homes and associated buildings as well as a crossing of Missouri Highway 19. Frene Creek, thence traverses the town of Hermann, Missouri, to the Missouri River at a distance approximately 2 miles below the dam. Within the town of Hermann, there are numerous road crossings, structures, and public use areas located in the floodplain of Frene Creek. See Tal Lake Dam is in the intermediate size classification since it is greater than 40 feet high but less than 100 feet high.

The inspection and evaluation indicate that the spillway of See Tal Lake does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. See Tal Lake Dam is an intermediate size dam with a high hazard potential, required by the guidelines to pass the PMF. Considering the high hazard potential to loss of life and property downstream of the dam, the outlet facilities of See Tal Lake Dam should be able to pass the PMF without overtopping the dam. However, it was determined that the spillway will only pass approximately 35 percent of the PMF without overtopping the dam.

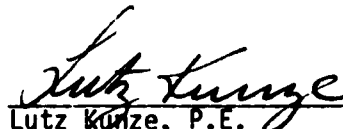
The evaluation of See Tal Lake also indicated that the spillway will pass the 100-year flood; that is, a flood having a 1 percent chance of being equalled or exceeded during any given year.

Deficiencies visually observed by the inspection team were seepage at the toe, erosion, brush and small trees on the downstream slope and a small tree on the upstream slope of the embankment. Other deficiencies found were the lack of seepage records, operational records, seepage and stability analyses comparable to the requirements of the Recommended Guidelines, and seismic stability analyses.

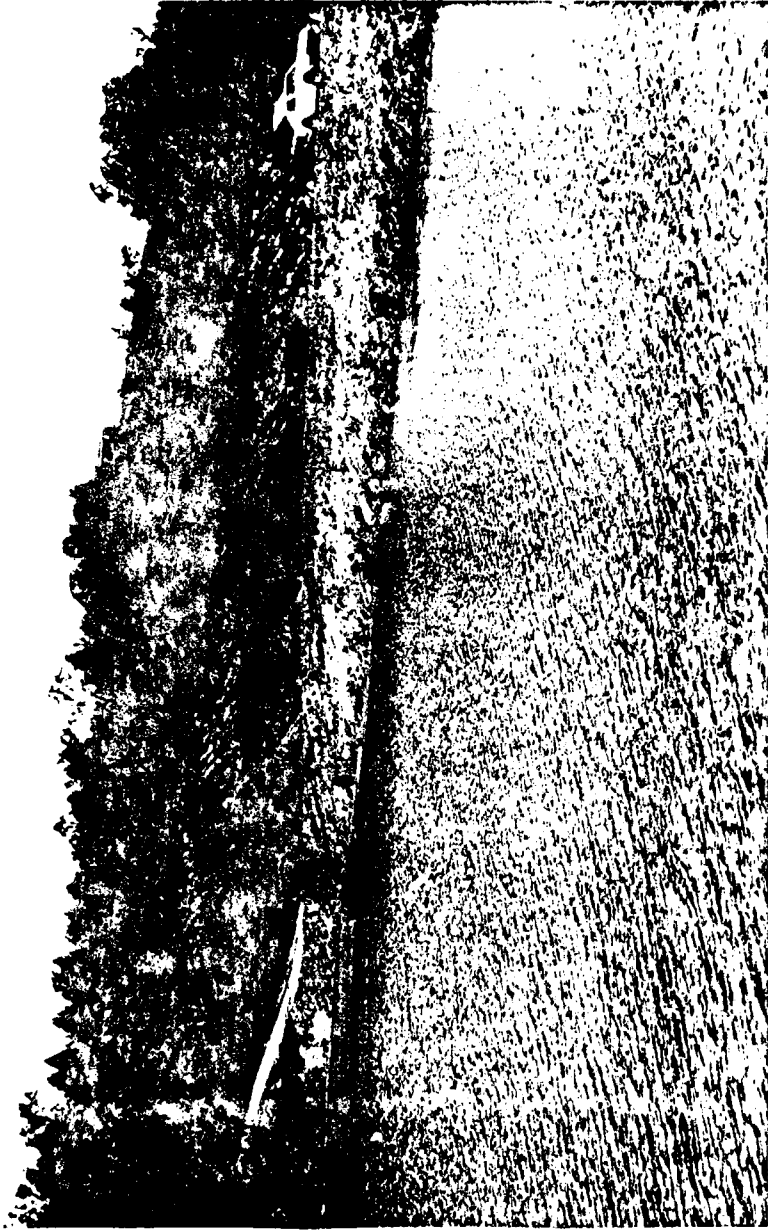
It is recommended that action be taken in the near future to correct or control the deficiencies described.



Ervin H. Baumeyer, P.E.
Principal-In-Charge
Kenneth Balk and Associates, Inc.
St. Louis, Missouri



Lutz Kunze, P.E.
Principal Engineer
Shannon & Wilson, Inc.
St. Louis, Missouri



Overview of Lake and Dam

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
SEE TAL LAKE DAM - ID NO. 30668

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

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

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

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

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) Dam is an earthen structure built in a steep sided valley in the northern part of Gasconade County, Missouri. Topography adjacent to the valley is rolling to steep and is shown on Plate 1.

(2) The principal spillway consists of two 29" x 18" CMP arch-pipe culverts and is located on the right abutment. The spillway outlet channel is cut in bedrock consisting mainly of dolomite and is riprapped on the lower portion. There is an emergency overflow spillway, consisting of low ground approximately 60 feet wide, located above the arch-pipe spillway. No controls for regulating flows were found.

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

b. Location. The dam is located in the northeastern portion of Gasconade County, Missouri, as shown on Plate 2. The lake formed by the dam is on the Missouri Gasconade County Hermann quadrangle sheet in the NW 1/4 of Section 1, T45N, R5W.

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

d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph c. Based on referenced guidelines, the Corps of Engineers has determined that this dam is in the High Hazard Classification and thus has been selected by the Corps of Engineers for a Phase I inspection.

e. Ownership. This dam is reportedly owned by Mr. Bill Fricke, Hermann, Mo.

f. Purpose of Dam. The dam forms a recreational lake.

g. Design and Construction History: There are no known design plans or construction records. It was reported by the owner that construction of the dam was completed in 1971. According to the previous owner, the dam has a clay core and a core trench was cut into rock 15 to 20 feet. The base width of the dam is 280 feet. A diversion channel was cut into left abutment during the construction of the dam. No other details or data was available.

h. Normal Operating Procedure. No operating records were found. Outflow passes through uncontrolled spillways. Normal rainfall, spillway discharges, runoff, transpiration, and evaporation all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 174 acres.

b. Discharge at Damsite.

(1) Principal spillway 50.6 cfs. at maximum pool.

(2) Emergency spillway - 538 cfs at maximum pool.

(3) Estimated experienced maximum flood - approximately 3.5 feet below top of dam, with discharge of approximately 15 cfs.

c. Elevation (U.S.G.S.)

(1) Top of dam - 595.0_±

(2) Invert of C.M.P. arch-pipe spillway - 589.7

(3) Spillway Crest - 589.7_±.

(4) Streambed at Centerline of Dam - 550_±.

(5) Maximum tailwater - unknown.

- d. Reservoir. Length of maximum pool - 1200 feet ±.
- e. Storage (Acre-feet).
 - (1) Normal - 158
 - (2) Maximum - 231.6
- f. Reservoir Surface (Acres).
 - (1) Top of dam - 14.
 - (2) Spillway crest - 12.
- g. Dam.
 - (1) Type - earth embankment.
 - (2) Length - 600 feet.
 - (3) Height - 50 feet maximum.
 - (4) Top width - 24 feet.
 - (5) Side Slopes - (Measured by slope meter/inclinometer in degrees and converted to ratios.)
 - (a) Downstream - 2.75 H to 1 V.
 - (b) Upstream - 3.75 H to 1 V to waterline.
 - (6) Zoning - unknown)Except as reported in
 - (7) Impervious core - unknown)Section 1.2 (g)
 - (8) Cutoff - unknown)
 - (9) Grout curtain - unknown)
- h. Diversion and Regulating Tunnel. - None
- i. Principal Spillway.
 - (1) Type - Two corrugated metal arch-pipes, laid on a slope of approximately 0.32%, 29" x 18" with rock outlet channel.
 - (2) Crest elevation - 589.7 U.S.G.S.
- j. Emergency Overflow Spillway
 - (1) Type - Earthen channel, generally triangular in section.
 - (2) Invert at lakeside 592.2 (USGS).

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were found to be readily available.

2.2 CONSTRUCTION

The dam was constructed in 1971 according to the previous owner. No construction data were available.

2.3 OPERATION

No record of the maximum loading on the dam was available.

2.4 EVALUATION

a. Availability. No engineering design available. Some geologic information was made available by the Engineering Geology Section of the Missouri Department of National Resources.

b. Adequacy. No engineering data was made available to make a detailed assessment of the design, construction, and operation. The lack of seepage and stability analyses comparable to the requirements of the Recommended Guidelines is considered a deficiency which should be corrected.

c. Validity. No engineering data were available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General. A visual inspection of Glennon Epple Dam, now known as See Tal Dam, was made on August 24, 1978. Personnel making the inspection were employees of Kenneth Balk and Associates, Inc. and Shannon and Wilson, Inc. of St. Louis and included civil, geotechnical and structural engineers and an engineering geologist. Specific observations are discussed below.

B. Dam. The inspection team observed the following at the dam. The dam is an earth embankment with a gravel road running across the crest. Upstream slope erosion protection consists of a cover of grass. No detrimental cracking, animal burrows, settlement, depression or slope instability were noticed.

The left portion of the downstream slope had been cleared of vegetation, however, at the time of inspection, the remaining portion of the slope was covered with small trees and brush. One small tree is growing on the upstream slope. Trees and cattails were growing at the toe of the dam but no standing water was observed.

Five small erosion channels were found in the upper half of downstream face near right abutment and one 10 inch by 10 inch hole along with an erosion channel in the lower half of embankment. Three erosion channels 17 inches wide and 24 inches deep were observed near the left abutment. These erosion channels may be due to run off from a road which comes down the left abutment and crosses the embankment crest. No seepage was noticed at the time of the dam inspection.

C. Appurtenant Structures. The principal spillway consists of two 29 x 18 inch corrugated metal arch-pipes embedded at the junction of right abutment and the dam embankment. The spillway outlet channel is cut in bedrock and is riprapped at the lower end. A number of small trees were growing in the outlet channel. Spillway discharges will not endanger the integrity of the dam.

An emergency overflow spillway, an earthen channel, generally triangular in shape, is located over the twin corrugated metal arch-pipes, and discharge from the spillway presents no problem to the integrity of the dam.

D. Reservoir Area. No evidence of wave wash, excessive erosion or slides were observed along the shore of the reservoir.

E. Damsite Geology. Outcrops at the damsite mainly consist of different formations of the Ordovician system of rocks and are discussed below.

1. Right Abutment. From top to bottom the following have been observed:

Dolomite: Light gray and medium gray, weathered crystalline, moderately hard, thin bedded dolomite with chert nodules locally present. The thickness of the bed is about 1-1/2 feet. At the base it contains grayish brown shale, arenaceous dolomite interbedded with thin beds of sandstone. The bed is approximately 5 feet thick.

Shale and Dolomite: Gray to light brown, weathered, very weak alternating beds of dolomite and shale. The dolomite is moderately weathered; medium crystalline and medium hard. The shale is slightly argillaceous in nature and soft.

Joints: Most of the joints are along planes or are perpendicular with a north south strike. The entire formation is moderately jointed. The following is a summary of the structural characteristics of the dolomite beds.

Dip 90° Strike: NS

Joint Spacing: Moderate

Joint Width: 1/8" to 3"

Joint Filling: Argillaceous and calictic material

Percentage: Open joints 30%, closed joints 70%

2. Left Abutment: The left abutment is covered with a thick blanket of colluvial soils consisting of gray-brown clayey silt containing small pieces of dolomite. No exposed bedrock was observed.

Spillway Outlet Channel: The spillway outlet channel is cut in the dolomite beds described in the right abutment.

3.2 EVALUATION:

The inspection team observed no conditions which require immediate remedial action. The erosion channels and the hole, the cause of which is undetermined, in the embankment are deficiencies which should be corrected in the near future. The drainage pattern in the vicinity of the embankment should be redesigned to prevent the road run-off from flowing onto the embankment. The erosion protection on the upstream slope appears adequate for this dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no controlled outlet works at this dam; therefore, no regulating procedures exist for this structure. The lake level is controlled by rainfall, run off, evaporation and the capacity of uncontrolled spillway.

4.2 MAINTENANCE OF DAM

No maintenance records were available, however, according to the owner of the dam, vegetation on the dam downstream embankment slope is cut twice a year.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

In our opinion, a regular program of vegetation control and maintenance should be initiated. The remaining trees and brush on the dam are deficiencies which should be corrected.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. There were no hydraulic and hydrological data made available.

b. Experience Data. The drainage area, lake surface area, and stage-storage relationship are developed from USGS Hermann Mo. Quadrangle sheet, 7.5 minute series, dated 1974. The spillway and dam layout are from surveys made during the inspection.

c. Visual Observations.

(1) The spillway and exit channel are located at the farthermost right or east abutment. Spillway discharges will not endanger the integrity of the dam.

d. Overtopping Potential. The principal and overflow spillways have been found to be inadequate to pass the Probable Maximum Flood (PMF) without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

For the PMF, the dam would be overtopped to a maximum height of approximately 2.0 feet with a duration of overtopping of approximately 3.2 hours with a maximum discharge rate of approximately 2697 cfs. In our opinion, failure of the dam may be expected to occur as a result of overtopping for this length of time.

For 50% of the P.M.F., the dam would be overtopped to a maximum height of approximately 0.9 feet, with a duration of overtopping of approximately 1 hour, with a maximum discharge rate of approximately 868 cfs.

The spillways have been found to be adequate to pass a flood of approximately thirty five percent (35%) of the PMF.

The spillways have been found to be adequate to pass the 100-year flood, which has a 1% chance of being equalled or exceeded at least once during any given year.

The estimated damage zone extends two miles downstream of the dam. Within the first mile downstream of the dam are three houses and associated buildings and four improved road crossings.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visually observed conditions which can affect the structural stability of this dam have been discussed in Section 3.

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam were found except that discussed in Section 1.2.

c. Operating Records. No appurtenant structures requiring operation exist at this dam; therefore, no records are available.

d. Post-Construction Changes. No post-construction changes are known or apparent.

e. Seismic Stability. The location of See Tal Lake Dam is in Seismic Zone I. Since no engineering design data was available, an evaluation of the seismic stability of the dam could not be made. However to our knowledge, an earthquake of the magnitude that may be expected in Seismic Zone 1 has not caused a structural collapse of a dam of this size.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Corrective measures, in our opinion, should be taken for the deficiencies visually observed by the inspection team, i.e. erosion and growth of trees on the embankment and in the spillway outlet channel. Inadequate spillway capacities are also considered to be a deficiency.

b. Adequacy of Information. Due to insufficient engineering design and construction data, except that discussed in Section 1, the conclusions of this report are based on performance and external visual conditions. Some geologic information was made available by the Engineering Geology Section of the Missouri Department of Natural Resources. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the requirements of the recommended guidelines (including seismic analyses) were not available and this is considered a deficiency which should be rectified.

7.2 REMEDIAL MEASURES

a. Operation And Maintenance Procedures. The following O&M procedures are recommended:

(1) Trees and excessive vegetation should be removed from the upstream and downstream slopes and the spillway outlet channel.

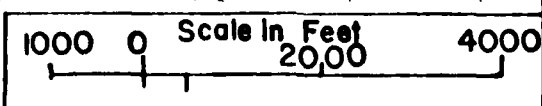
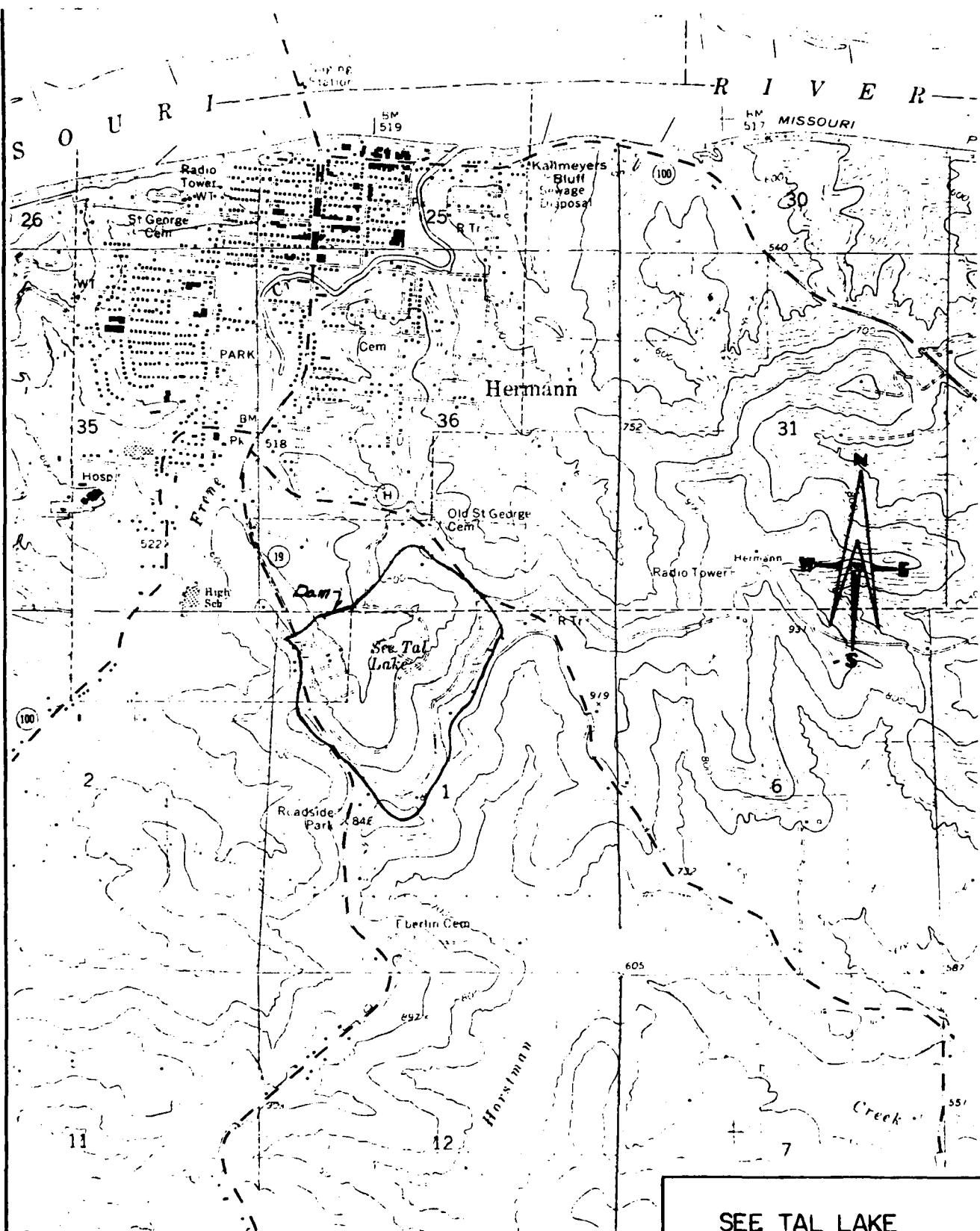
(2) Erosion channels and the hole on the downstream slope should be filled and run off from the road controlled.

(3) Up-to-date records of all future maintenance and repairs should be kept.

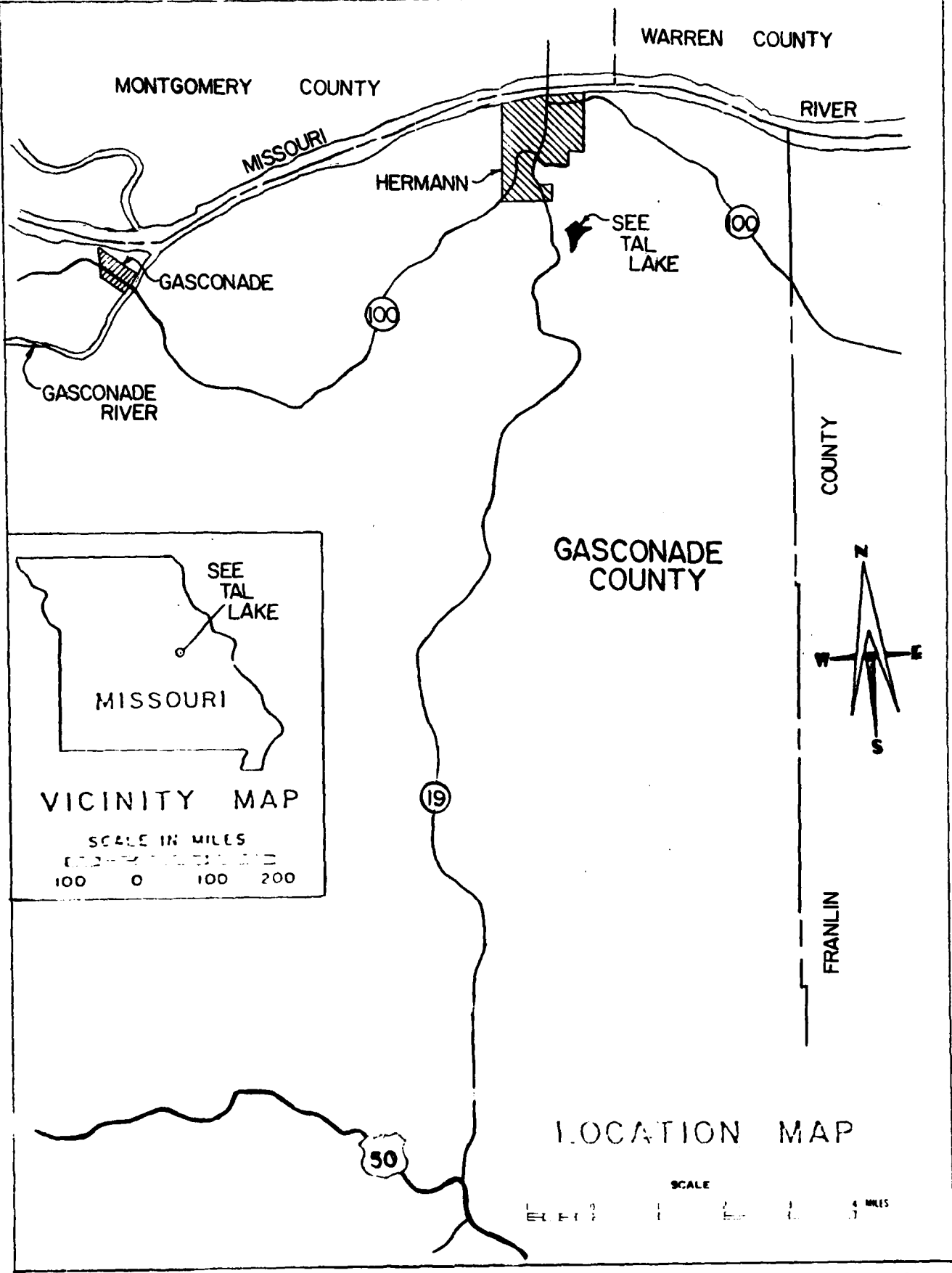
(4) Spillway capacity and/or height of dam should be increased to pass 100 percent (100%) of the Probable Maximum Flood.

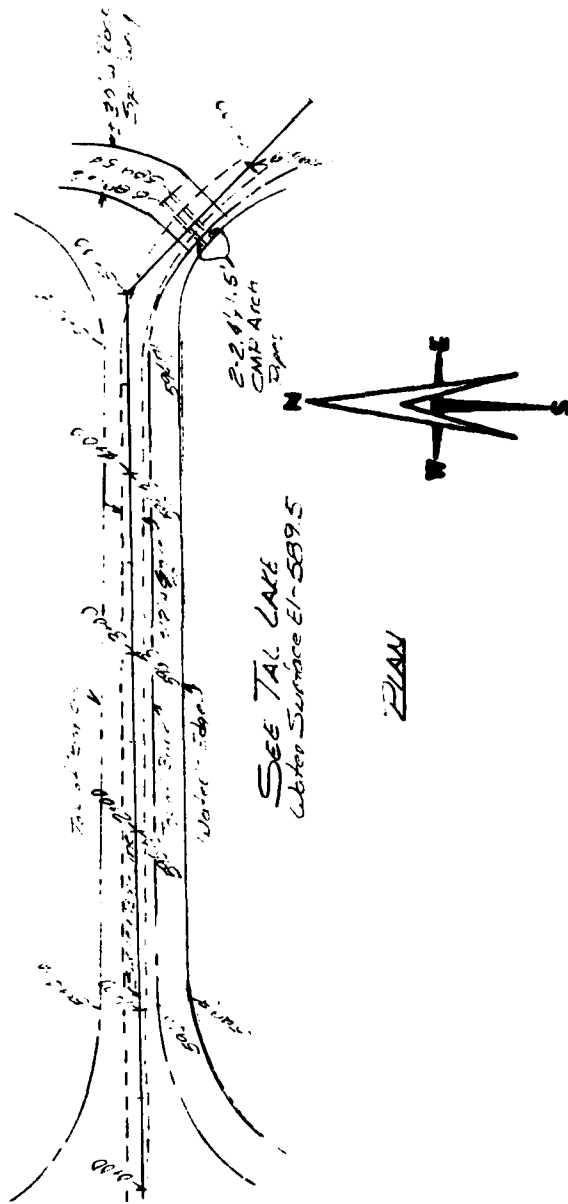
(5) The dam should be periodically inspected by an engineer experienced in the design and construction of dams and records kept of these inspections.

(6) Stability and seepage analyses should be performed by a professional engineer experienced in the design and construction of dams.



SEE TAL LAKE
VICINITY TOPOGRAPHY



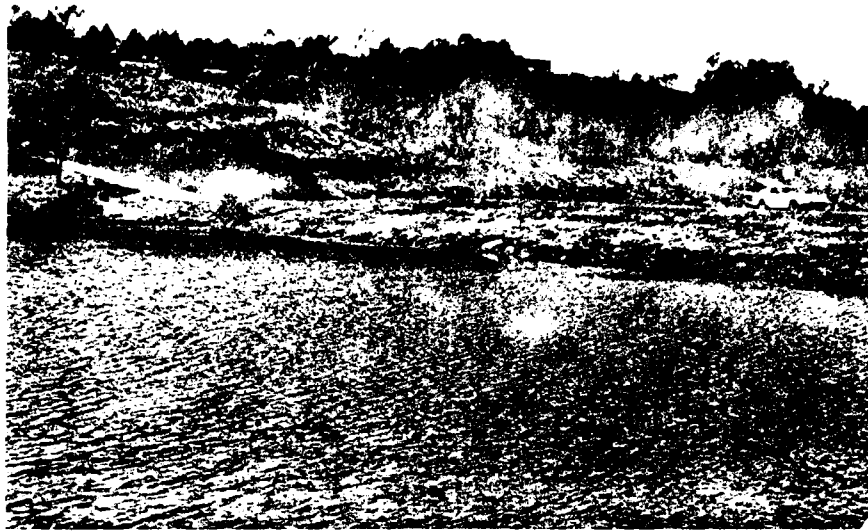


PLAN

SEE TAL LAKE

TOP OF DAM
ELEVATIONS

SCALE: 1"=100' PLATE 3



1947 - 1948 - 1949 - 1950 - 1951 - 1952 - 1953 - 1954 - 1955 - 1956 - 1957 - 1958 - 1959 - 1960 - 1961 - 1962 - 1963 - 1964 - 1965 - 1966 - 1967 - 1968 - 1969 - 1970 - 1971 - 1972 - 1973 - 1974 - 1975 - 1976 - 1977 - 1978 - 1979 - 1980 - 1981 - 1982 - 1983 - 1984 - 1985 - 1986 - 1987 - 1988 - 1989 - 1990 - 1991 - 1992 - 1993 - 1994 - 1995 - 1996 - 1997 - 1998 - 1999 - 2000 - 2001 - 2002 - 2003 - 2004 - 2005 - 2006 - 2007 - 2008 - 2009 - 2010 - 2011 - 2012 - 2013 - 2014 - 2015 - 2016 - 2017 - 2018 - 2019 - 2020 - 2021 - 2022 - 2023 - 2024 - 2025



1947 - 1948 - 1949 - 1950 - 1951 - 1952 - 1953 - 1954 - 1955 - 1956 - 1957 - 1958 - 1959 - 1960 - 1961 - 1962 - 1963 - 1964 - 1965 - 1966 - 1967 - 1968 - 1969 - 1970 - 1971 - 1972 - 1973 - 1974 - 1975 - 1976 - 1977 - 1978 - 1979 - 1980 - 1981 - 1982 - 1983 - 1984 - 1985 - 1986 - 1987 - 1988 - 1989 - 1990 - 1991 - 1992 - 1993 - 1994 - 1995 - 1996 - 1997 - 1998 - 1999 - 2000 - 2001 - 2002 - 2003 - 2004 - 2005 - 2006 - 2007 - 2008 - 2009 - 2010 - 2011 - 2012 - 2013 - 2014 - 2015 - 2016 - 2017 - 2018 - 2019 - 2020 - 2021 - 2022 - 2023 - 2024 - 2025



PHOTO 3 Spillway Entrance



PHOTO 4 Outlet Channel Right Abutment

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSIS METHODOLOGY

HYDROLOGIC AND HYDRAULIC ANALYSIS METHODOLOGY

1. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for a reservoir routing. The Probable Maximum Precipitation is derived and determined from regional charts prepared by the National Weather Service in "Hydro-meteorological Report No. 33." Reduction factors have not been applied. A 24-hour storm duration is assumed with the total rainfall depth distributed over 6-hour periods in accordance with procedures outlined in EM 1110-2-1411 (SPF Determination). The maximum 6-hour rainfall period is then distributed to hourly increments by the same criteria. Within-the-hour distribution is based upon NOAA Technical Memorandum NWS HYDRO-35. The nonpeak 6-hour rainfall periods are distributed uniformly. All distributed values are arranged in a critical sequence by the SPF criteria. The final inflow hydrograph is produced by utilizing the Soil Conservation Service dimensionless unit hydrograph using Hydrologic Soils Groups "B", Antecedent Moisture Condition III, and SCS CN 82 used to determine rainfall excess.

Lag time was estimated using methods outlined in "Design of Small Dams", by the United States Department of The Interior, Bureau of Reclamation. Using this source, lag time is taken as 60% of the time of concentration.

Time of concentration was estimated utilizing methods outlined in the source quoted above, supplemented by data obtained during field investigation. The results of the field investigation and the computations indicated that a time of 15 minutes was appropriate. For this lake, a lag time of 0.15 hours was therefore selected.

2. The reservoir routing is accomplished by using Modified Puls routing techniques wherein the flood hydrograph is routed through lake storage. Hydraulic capacities of the outlet works, spillway, and crest of dam are used as outlet controls in the routing. Storage in the pool area is defined by an elevation-storage capacity curve. The hydraulic capacity of the outlet works, spillway, and top of dam are defined by elevation-discharge curves.

3. Dam overtopping analysis has been conducted by hydrologic methods for this dam and lake. This computation determines the percentage of the PMF hydrograph that the reservoir can contain without the dam being overtopped. An output summary in the hydrologic appendix displays this information as well as other characteristics of the simulated dam overtopping.

4. The above methodology has been accomplished for this report using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The numeric parameters estimated for this site are listed in the attached computer printout. Definitions of these variables are contained in the "User's Manual" for the computer program.

5. The inflow hydrograph was routed through the reservoir using HEC-1's Modified Puls option. Releases were calculated for: 1) the principal spillway, 2) the overflow spillway, and 3) the flow over the top of the dam. These releases were then combined at each of their respective elevations.

Flow through the principal spillway, twin 29 inch by 18 inch corrugated metal arch-pipes, approximately 31 feet long, was obtained by considering them to be short tubes.

The Bernoulli equation was then written between the water surface in the lake and the energy gradient at the outlet. The datum plane was taken as the lake water surface and velocity of approach was assumed to be equal to zero.

This results in the general equation:

$$H = h_e + h_f + h_o$$

Where H = difference between the lake water surface and the energy gradient elevation at the outlet.

h_e = entrance loss, or $k_e \frac{v^2}{2g}$, where

$$k_e = 0.5$$

h_f = friction loss through the pipe calculated by using the Manning Formula

h_o = outlet loss; or $k_o \frac{v^2}{2g}$, with

k_o taken as zero, since the outlet is unsubmerged

For the lower flows, when the pipe is flowing less than full and at normal depth, the equation can be simplified to:

$$\text{Stage} = \text{U.E.} + d_f + 1.5 \frac{v^2}{2g}$$

Where: U.E. = Upstream invert elevation, taken as 589.7

d_f = normal flow depth for given discharge rate, obtained through the Manning Equation

For full and more than full flow:

$$\text{Stage} = \text{D.E.} + 1.5 + \frac{v^2}{2g} + \left(\frac{Q}{K_c}\right)^2 \times 31 + \frac{0.5}{2g} v^2$$

Where:

D.E. = Downstream invert elevation, taken as 589.6

K_c = Conveyance coefficient, calculated to be 101.199

Since $V = \frac{Q}{A}$, the equation can be further simplified

as follows:

$$\text{Stg} = 591.1 + .006 Q^2$$

$$\text{or } Q = \left(\frac{\text{Stg-591.1}}{.006} \right)^{1/2}$$

Flow through the overflow spillway and over the top of dam was calculated using the weir flow equation:

$$Q = CL(H)^{1.5}$$

where: C = Varies with head as outlined in "Handbook of Hydraulics" by Horace Williams King, revised by Ernest F. Brater.

L = Length in feet (varies with water surface)

H = Head of water in feet (varies with water surface)

Q = Discharge in cfs

UNITED COMPUTING SYSTEMS,

 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 3 AUG 78

LINE	DESCRIPTION	Q	MO.	INV.	NO.	MO.	INV.	NO.	MO.	INV.	NO.
1	AL										
2	A2										
3	A3										
4	R	2RR	-0	5	-0	-0	-0	-0	-0	-0	-0
5	R1	5									
6	J	1	6	1							
7	J1	.30	.35	.40	.45	.50	1.00				
8	K	0	INFLOW								
9	M	1	2	0.27							1
10	P	1	25.1	100	120	130					
11	T										
12	W2		.15								.05
13	X	0.54	-1	3							
14	K	1	ROUTING								
15	Y										
16	Y1	1		1	2	1					
17	Y4589.76	590.0	590.0	590.5	591.0	591.5	592.0	592.5	593.0	593.5	594.0
18	Y4	594.5	595.0	595.5	596.0	596.5	597.0	597.5	598.0	598.5	599.0
19	Y5	0	.86	5.43	10.89	14.53	23.20	38.62	58.01	118.40	226.49
20	Y5385.42	588.63	637.77	937.15	1671.51	2697.38	3974.12	5539.69	7326.26	9303.97	
21	IS	0	6.04	12.23	17.25	24.94	31.50	38.91	45.01	51.97	59.06
22	IS	64.24	73.63	81.11	88.72	96.46	104.33	112.34	120.48	128.75	137.15
23	IS589.76	590.0	590.0	590.5	591.0	591.5	592.0	592.5	593.0	593.5	594.0
24	IS	594.5	595.0	595.5	596.0	596.5	597.0	597.5	598.0	598.5	599.0
25	IS589.76										
26	IS	595.0									
27	K										

COMPUTER INPUT DATA

 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 7 AUG 78

RUN DATE 12/19/78.
 TIME 10.01.11.

SFF TAL LAKE
 NOV. 30, 1978
 NO. INV. NO. 30668

JOB SPECIFICATION
 NO NMR NMIN IDAY IHR IWIN METRC IPLT IPRT NSTAN
 286 -0 5 -0 -0 -0 -0 -4 -0
 JOPER NWT LROPT TRACE
 5 -0 -0 -0

MULTI-PLAN ANALYSES TO BE PERFORMED
 NPLAN= 1 NRATIO= 6 LRTIO= 1
 RTIOS= .30 .40 .45 .50 1.00

SUR-AREA RUNOFF COMPUTATION
 ISTAT ICOMP TECON ITAPE JPLT JPRT INAME ISTAGE IAUTO
 NFLOW 0 -0 -0 -0 3 -0 -0

HYDROGRAPH DATA

IHYG	IUNG	TARFA	SNAP	TPSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.27	1.00	-0.00	1.00	-0.000	-0	1	-0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
-0.00	25.10	100.00	120.00	130.00	-0.00	-0.00	-0.00

LOSS DATA

LROPT	STRKP	DLTKR	RTIOL	FRAIN	STRKS	RTIOK	STRIL	CNSTL	ALSMX	RTIMP
-0	-0.00	1.00	-0.00	-0.00	1.00	-1.00	-82.00	-0.00	-0.00	.05

CURVE NO # -82.00 WETNESS = -1.00 EFFECT CN # 82.00

UNIT HYDROGRAPH DATA
 TC = -0.00 LAG = .15

RECESSION DATA

STRIO# .54 ORCSN# -.10 RTIOR# 3.00

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

UNIT HYDROGRAPH II END OF PERIOD ORDINATES, TC= -0.00 HOURS, LAG= .15 VOL= 1.00
 251. 666. 587. 297. 148. 72. 35. 18. 9. 5.

INPUT UNIT HYDROGRAPH

MO,DA	HR,MIN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO,DA	HR,MIN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	1.	1.01	12.05	145	.21	.19	.02	167.
1.01	.10	2	.01	.00	.01	1.	1.01	12.10	146	.21	.19	.01	253.
1.01	.15	3	.01	.00	.01	1.	1.01	12.15	147	.21	.20	.01	330.
1.01	.20	4	.01	.00	.01	2.	1.01	12.20	148	.21	.20	.01	U.01
1.01	.25	5	.01	.00	.01	2.	1.01	12.25	149	.21	.20	.01	U.01
1.01	.30	6	.01	.00	.01	2.	1.01	12.30	150	.21	.20	.01	401.

1.01	6.005	73	.07	.03	.04	17.	1.01	18.005	217	.02	.02	.00	4.01
1.01	10	74	.07	.03	.04	17.	1.01	18.010	218	.02	.02	.00	319.
1.01	6.15	75	.07	.03	.04	17.	1.01	18.015	219	.02	.02	.00	246.
1.01	6.20	76	.07	.04	.03	59.	1.01	18.020	220	.02	.02	.00	256.
1.01	6.25	77	.07	.04	.03	65.	1.01	18.025	221	.02	.02	.00	229.
1.01	6.30	78	.07	.04	.03	70.	1.01	18.030	222	.02	.02	.00	206.
1.01	6.35	79	.07	.04	.03	74.	1.01	18.035	223	.02	.02	.00	184.
1.01	6.40	80	.07	.04	.03	78.	1.01	18.040	224	.02	.02	.00	165.
1.01	6.45	81	.07	.04	.03	81.	1.01	18.045	225	.02	.02	.00	148.
1.01	6.50	82	.07	.04	.03	84.	1.01	18.050	226	.02	.02	.00	132.
1.01	6.55	83	.07	.04	.03	86.	1.01	18.055	227	.02	.02	.00	119.
1.01	7.00	84	.07	.05	.02	89.	1.01	19.000	228	.02	.02	.00	95.
1.01	7.05	85	.07	.05	.02	91.	1.01	19.005	229	.02	.02	.00	85.
1.01	7.10	86	.07	.05	.02	93.	1.01	19.010	230	.02	.02	.00	76.
1.01	7.15	87	.07	.05	.02	95.	1.01	19.015	231	.02	.02	.00	69.
1.01	7.20	88	.07	.05	.02	97.	1.01	19.020	232	.02	.02	.00	61.
1.01	7.25	89	.07	.05	.02	99.	1.01	19.025	233	.02	.02	.00	55.
1.01	7.30	90	.07	.05	.02	100.	1.01	19.030	234	.02	.02	.00	49.
1.01	7.35	91	.07	.05	.02	102.	1.01	19.035	235	.02	.02	.00	44.
1.01	7.40	92	.07	.05	.02	104.	1.01	19.040	236	.02	.02	.00	44.
1.01	7.45	93	.07	.05	.02	105.	1.01	19.045	237	.02	.02	.00	44.
1.01	7.50	94	.07	.05	.02	106.	1.01	19.050	238	.02	.02	.00	44.
1.01	7.55	95	.07	.05	.02	108.	1.01	19.055	239	.02	.02	.00	44.
1.01	8.00	96	.07	.05	.02	109.	1.01	20.000	240	.02	.02	.00	44.
1.01	8.05	97	.07	.05	.02	110.	1.01	20.005	241	.02	.02	.00	44.
1.01	8.10	98	.07	.05	.02	111.	1.01	20.010	242	.02	.02	.00	44.
1.01	8.15	99	.07	.05	.02	112.	1.01	20.015	243	.02	.02	.00	44.
1.01	8.20	100	.07	.06	.01	113.	1.01	20.020	244	.02	.02	.00	44.
1.01	8.25	101	.07	.06	.01	114.	1.01	20.025	245	.02	.02	.00	44.
1.01	8.30	102	.07	.06	.01	115.	1.01	20.030	246	.02	.02	.00	44.
1.01	8.35	103	.07	.06	.01	116.	1.01	20.035	247	.02	.02	.00	44.
1.01	8.40	104	.07	.06	.01	117.	1.01	20.040	248	.02	.02	.00	44.
1.01	8.45	105	.07	.06	.01	118.	1.01	20.045	249	.02	.02	.00	44.
1.01	8.50	106	.07	.06	.01	119.	1.01	20.050	250	.02	.02	.00	44.
1.01	8.55	107	.07	.06	.01	119.	1.01	20.055	251	.02	.02	.00	44.
1.01	9.00	108	.07	.06	.01	120.	1.01	21.000	252	.02	.02	.00	44.
1.01	9.05	109	.07	.06	.01	121.	1.01	21.005	253	.02	.02	.00	44.
1.01	9.10	110	.07	.06	.01	121.	1.01	21.010	254	.02	.02	.00	44.
1.01	9.15	111	.07	.06	.01	122.	1.01	21.015	255	.02	.02	.00	44.
1.01	9.20	112	.07	.06	.01	123.	1.01	21.020	256	.02	.02	.00	44.
1.01	9.25	113	.07	.06	.01	123.	1.01	21.025	257	.02	.02	.00	44.
1.01	9.30	114	.07	.06	.01	124.	1.01	21.030	258	.02	.02	.00	44.
1.01	9.35	115	.07	.06	.01	124.	1.01	21.035	259	.02	.02	.00	44.
1.01	9.40	116	.07	.06	.01	125.	1.01	21.040	260	.02	.02	.00	44.
1.01	9.45	117	.07	.06	.01	125.	1.01	21.045	261	.02	.02	.00	44.
1.01	9.50	118	.07	.06	.01	126.	1.01	21.050	262	.02	.02	.00	44.
1.01	9.55	119	.07	.06	.01	126.	1.01	21.055	263	.02	.02	.00	44.
1.01	10.00	120	.07	.06	.01	127.	1.01	22.000	264	.02	.02	.00	44.
1.01	10.05	121	.07	.06	.01	127.	1.01	22.005	265	.02	.02	.00	44.
1.01	10.10	122	.07	.06	.01	128.	1.01	22.010	266	.02	.02	.00	44.
1.01	10.15	123	.07	.06	.01	128.	1.01	22.015	267	.02	.02	.00	44.
1.01	10.20	124	.07	.06	.01	128.	1.01	22.020	268	.02	.02	.00	44.
1.01	10.25	125	.07	.06	.01	129.	1.01	22.025	269	.02	.02	.00	44.
1.01	10.30	126	.07	.06	.01	129.	1.01	22.030	270	.02	.02	.00	44.
1.01	10.35	127	.07	.06	.01	130.	1.01	22.035	271	.02	.02	.00	44.
1.01	10.40	128	.07	.06	.01	130.	1.01	22.040	272	.02	.02	.00	44.
1.01	10.45	129	.07	.06	.01	130.	1.01	22.045	273	.02	.02	.00	44.
1.01	10.50	130	.07	.06	.01	131.	1.01	22.050	274	.02	.02	.00	44.
1.01	10.55	131	.07	.06	.01	131.	1.01	22.055	275	.02	.02	.00	44.
1.01	11.00	132	.07	.06	.01	131.	1.01	23.000	276	.02	.02	.00	44.
1.01	11.05	133	.07	.06	.01	131.	1.01	23.005	277	.02	.02	.00	44.
1.01	11.10	134	.07	.06	.01	132.	1.01	23.010	278	.02	.02	.00	44.
1.01	11.15	135	.07	.06	.01	132.	1.01	23.015	279	.02	.02	.00	44.
1.01	11.20	136	.07	.06	.01	132.	1.01	23.020	280	.02	.02	.00	44.
1.01	11.25	137	.07	.06	.01	132.	1.01	23.025	281	.02	.02	.00	44.
1.01	11.30	138	.07	.06	.01	133.	1.01	23.030	282	.02	.02	.00	44.
1.01	11.35	139	.07	.06	.01	133.	1.01	23.035	283	.02	.02	.00	44.
1.01	11.40	140	.07	.06	.01	133.	1.01	23.040	284	.02	.02	.00	44.
1.01	11.45	141	.07	.06	.01	134.	1.01	23.045	285	.02	.02	.00	44.
1.01	11.50	142	.07	.06	.01	134.	1.01	23.050	286	.02	.02	.00	44.
1.01	11.55	143	.07	.06	.01	134.	1.01	23.055	287	.02	.02	.00	44.
1.01	12.00	144	.07	.06	.01	134.	1.02	0.000	288	.02	.02	.00	44.

INPUT UNIT
HYDROGRAPH

CORRECTING SYSTEMS, INC.

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1
 FLEVATION STORAGE 589.76 INITIAL VALUE 589.76 TOP OF DAM 595.00
 STORAGE 0. SPILLWAY CREST 0. 74.
 OUTFLOW 0. 0. 589.

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
.30	594.62	0.00	68.	433.	0.00	14.00	0.00
.35	594.96	0.00	73.	572.	0.00	15.92	0.00
.40	595.29	.29	78.	617.	.42	15.92	0.00
.45	595.62	.62	83.	711.	.75	15.92	0.00
.50	595.86	.86	87.	855.	.92	15.92	0.00
1.00	597.00	2.00	104.	2697.	3.17	15.75	0.00

COMPUTER SUMMARY ANALYSIS