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NATIONAL DAM SAFETY PROGRAM. VATTEROTT LAKE DAM (MO 30429), UPP--ETC(U)
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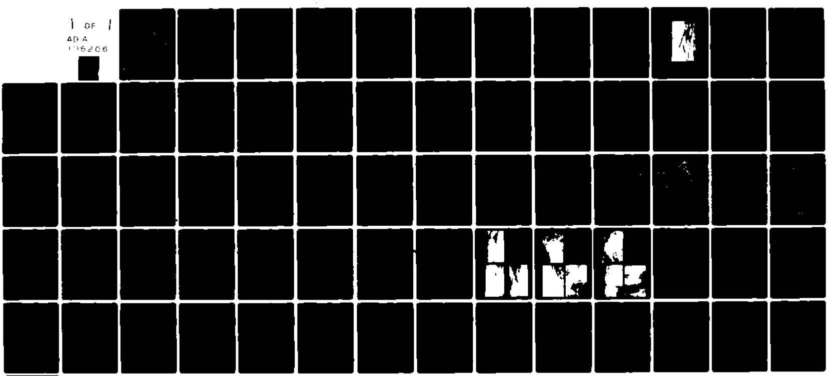

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UPPER MISSISSIPPI - KASKASKIA - ST. LOUIS BASIN

VATTEROTT LAKE DAM
JEFFERSON COUNTY, MISSOURI
MO 30429

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
FOR: STATE OF MISSOURI

MARCH 1981

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REPORT DOCUMENTATION PAGE

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National Dam Safety Program
Vatterott Lake Dam (MO 30429)
Jefferson County, Missouri

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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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UPPER MISSISSIPPI - KASKASKIA - ST. LOUIS BASIN

VATTEROTT LAKE DAM

JEFFERSON COUNTY, MISSOURI

MO 30429

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

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

FOR: STATE OF MISSOURI

MARCH 1981

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

REPLY TO
ATTENTION OF

LMSED-P

SUBJECT: Vatterott Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Vatterott Lake Dam (MO 30429):

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 without overtopping the dam.

2) Overtopping of the dam could result in failure of the dam.

3) Dam failure significantly increases the hazard to loss of life downstream.

SIGNED

SUBMITTED BY: ______________________ 10 apr 81
Chief, Engineering Division — Date

SIGNED

APPROVED BY: ______________________ 14 apr 81
Colonel, CE, District Engineer — Date

VATTEROTT LAKE DAM

MISSOURI INVENTORY NO. 30429

JEFFERSON COUNTY, MISSOURI

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

HORNER & SHIFRIN, INC.

5200 OAKLAND AVENUE

ST. LOUIS, MISSOURI 63110

FOR

U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

CORPS OF ENGINEERS

MARCH 1981

HS-8088

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Vatterott Lake Dam
State Located:	Missouri
County Located:	Jefferson
Stream:	Tributary of Sandy Creek
Date of Inspection:	6 November 1980

The Vatterott Lake Dam, which according to the St. Louis District, Corps of Engineers, is of high hazard potential, was visually inspected by engineering personnel of Horner & Shifrin, Inc., Consulting Engineers, St. Louis, Missouri. The purpose of this inspection was to assess the general condition of the dam with respect to safety and, based upon this inspection and available data, determine if the dam poses an inordinate danger to human life or property. Evaluation of this dam was performed in accordance with the "Phase I" investigation procedures prescribed in "Recommended Guidelines for Safety Inspection of Dams", dated May 1975.

The following summarizes the findings of the visual inspection and the results of certain hydrologic/hydraulic investigations performed under the direction of the inspection team. Based on the visual inspection and the results of these hydrologic/hydraulic investigations, the present general condition of the dam is considered to be less than satisfactory. Deficiencies observed during the inspection which are considered to have an adverse effect on the overall safety and future operation of the dam include such items as seepage, erosion of the embankment, trees and dense brush on the dam, possible dam settlement, an obstructed spillway approach, a badly eroded spillway outlet channel, and a large marshy area just downstream of the dam that could be detrimental to the stability of the embankment.

According to the criteria set forth in the recommended guidelines, the magnitude of the spillway design flood for the Vatterott Lake Dam, which according to Table 1 of the guidelines, is classified as intermediate in size, is specified, according to Table 3 of the guidelines for a high hazard dam of intermediate size, to be the Probable Maximum Flood (PMF). The Probable Maximum Flood (PMF) is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

Results of a hydrologic/hydraulic analysis indicated that the spillway is inadequate to pass lake outflow resulting from a storm of PMF magnitude or the outflow resulting from the 1 percent (100-year frequency) flood without overtopping the dam. The spillway is capable, however, of passing lake outflow resulting from the ten percent chance (10-year frequency) flood and the outflow corresponding to about 11 percent of the PMF. According to the St. Louis District, Corps of Engineers, the length of the downstream damage zone, should failure of the dam occur, is estimated to be three miles. Accordingly, within the possible damage zone are six dwellings, including three mobile homes, a sewage treatment lagoon, State Highway 21, and a covered bridge at Lemay Ferry Road and the stream crossing.

A review of available data did not disclose that seepage or stability analyses of this dam were performed. This is considered a deficiency and should be rectified.

It is recommended that the Owner take the necessary action in the near future to correct or control the deficiencies and safety defects reported herein. The provision of additional spillway capacity should be pursued on a high priority basis since the existing spillways are considered to be seriously inadequate.

Ralph E. Sauthoff
P. E. Missouri E-19090

Albert B. Becker, Jr.
P. E. Missouri E-9168

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
VATTEROTT LAKE DAM - MO 30429

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PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

VATTEROTT LAKE DAM - MO 30429

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, dated 8 August 1972, 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, directed that a safety inspection of the Vatterott Lake Dam be made.

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

c. Evaluation Criteria. This evaluation was performed in accordance with the "Phase I" investigation procedures as prescribed in "Recommended Guidelines for Safety Inspection of Dams," Appendix D to "Report to the Chief of Engineers on the National Program of Inspection of Non-Federal Dams," dated May 1975.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances. The Vatterott Lake Dam is an earthfill type embankment rising approximately 40 feet above the downstream toe of the barrier at its lowest point of foundation surface. This low point ordinarily occurs at the location of the original stream crossing, but in this case, was found to be near the center of the dam where a low area exists, which, according to the Owner, was present prior to construction of the dam. The embankment has an upstream slope of approximately 1v on 1.9h which extends from the dam crest to a 12-foot wide berm located about 1 foot below the normal waterline. Below the berm, the upstream slope is unknown. Above the berm, the upstream face of the dam is protected by limestone riprap. The slope of the downstream face of the dam varies somewhat, but appears to be no steeper than 1v on 2.5h. The width of the dam crest is on the order of 30 feet and a roadway surfaced with crushed limestone traverses the top of the dam. The length of the dam is approximately 650 feet. A plan and profile of the dam is shown on Plate 3, and cross-sections of the dam at the location of the original stream and the low area to the left of the original stream, are shown on Plate 4. An overview photograph of the dam is shown following the preface at the front of the report. At normal pool elevation, the reservoir impounded by the dam occupies approximately 14 acres.

The dam has both a principal and an emergency spillway. The principal spillway is a culvert type consisting of three 24-inch diameter corrugated metal pipes and is located at the right, or west, abutment. The pipes are uncontrolled. A concrete slab protects the top of the dam at the location of the spillway pipes. The slab also serves as the invert for a shallow trapezoidal section which will function as an emergency spillway if required. Just downstream of the spillway pipes, the spillway outlet channel, which is common to both spillways, is protected for about 30 feet with concrete pavement. However, erosion has badly undermined the pavement and it is broken into numerous large sections exposing the subgrade in many places. Beyond the paved section, sandstone bedrock is exposed in the channel invert. The outlet channel joins a natural draw at a point about 350 feet downstream of the center of the dam; the draw, in turn, joins the original stream channel about 400 feet downstream of the dam center. A cross-section of the two spillways and a profile of the spillway channel are shown on Plate 5.

b. Location. The dam is located on an unnamed tributary of Sandy Creek, about 1.5 miles north and 0.5 mile west of the junction of Glade Chapel Road and State Highway 21; approximately 1.5 miles northwest of the community of Goldman, Missouri, as shown on the Regional Vicinity Map, Plate 1. The dam is located within the southeast one-quarter of Section 2, Township 41 North, Range 4 East, in Jefferson County.

c. Size Classification. The size classification based on the height of the dam and storage capacity, is categorized as intermediate. (Per Table 1, Recommended Guidelines for Safety Inspection of Dams.)

d. Hazard Classification. The Vatterott Lake Dam, according to the St. Louis District, Corps of Engineers, has a high hazard potential, meaning that if the dam should fail, there may be loss of life, serious damage to homes, or extensive damage to agricultural, industrial and commercial facilities, important public utilities, main highways, or railroads. The estimated flood damage zone, should failure of the dam occur, as determined by the St. Louis District, extends three miles downstream of the dam. Within the possible damage zone are six dwellings, including three mobile homes, a sewage treatment lagoon, State Highway 21, and a covered bridge at Lemay Ferry Road and the stream crossing. Those features lying within the downstream damage zone reported by the Corps of Engineers, St. Louis District, were verified by the inspection team.

e. Ownership. The lake and dam are owned by Harvey Vatterott, Sr. Mr. Vatterott's address is: Vatterott Realty & Building Company, Box 10637, St. Louis, Missouri 63129.

f. Purpose of Dam. The dam impounds water for recreational use.

g. Design and Construction History. According to the Owner, the dam was constructed in about 1962 by Herman Mathias, a local excavating contractor. The Owner reported that the proportions of the dam, i.e., the slopes and crest width, were selected by Ted Hurtgen, Sr., of Jefferson County Surveying Company, Hillsboro, Missouri. However, the Owner indicated that he was responsible for the design of the dam's spillway. The Owner also reported that the downstream side of the dam was pressure grouted in 1966; however, the identity of the Contractor that performed the work could not be recalled. No records of the design of the embankment or construction of the dam are known to exist.

h. Normal Operational Procedure. The lake level is unregulated. Lake outflow is governed by the capacities of three 24-inch diameter, culvert type pipes.

1.3 PERTINENT DATA

a. Drainage Area. The drainage area tributary to the lake is for the most part in a native state covered with timber. The watershed above the dam amounts to approximately 231 acres. The watershed area is outlined on Plate 2.

b. Discharge at Damsite.

(1) Estimated known maximum flood at damsite ... 63 cfs* (W.S.Elev. 587.8)
(2) Spillway capacity (principal + emergency) ... 81 cfs (W.S.Elev. 588.0)
  a. Principal ... 50 cfs
  b. Emergency ... 31 cfs

c. Elevation (Ft. above MSL). Except where noted, the following elevations were determined by survey and are based on topographic data shown on the 1954 Belew Creek, Missouri, Quadrangle Map, 7.5 Minute Series, photorevised 1968 and 1974.

(1) Observed pool ... 584.6
(2) Normal pool ... 585.0
(3) Spillway crest
  a. Principal ... 585.0
  b. Emergency ... 587.6
(4) Maximum experienced pool ... 587.8*
(5) Top of dam 588.0 (min.)
(6) Streambed at centerline of dam ... 551± (Est.)
(7) Maximum tailwater ... Unknown
(8) Observed tailwater ... None

d. Reservoir.

(1) Length at normal pool (Elev. 585.0) ... 1,600 ft.
(2) Length at maximum pool (Elev. 588.0) ... 1,700 ft.

*Approximate; Owner reported that his son-in-law had observed evidence indicating that flow had passed emergency spillway; however, actual depth of flow is unknown.

e. Storage.

(1) Normal pool ... 156 ac. ft.
(2) Top of dam ... 200 ac. ft.

f. Reservoir Surface Area.

(1) Normal pool ... 14 acres
(2) Top of dam (incremental) ... 15 acre

g. Dam. The height of the dam is defined to be the overall vertical distance from the lowest point of foundation surface at the downstream toe of the barrier to the top of the dam.

(1) Type ... Earthfill
(2) Length ... 650 ft.
(3) Height ... 40 ft.
(4) Top width ... 30 ft. (min.)
(5) Side slopes
 a. Upstream ... 1v on 1.9h (above wave berm)
 b. Downstream ... 1v on 2.5h (max.)
(6) Cutoff ... Core trench*
(7) Slope protection
 a. Upstream ... Limestone riprap
 b. Downstream ... Grass

h. Principal Spillway.

(1) Type ... Culvert, uncontrolled, three 24-inch diameter corrugated metal pipes
(2) Location ... Right abutment
(3) Crest ... Elevation 585.0 (center pipe)
(4) Approach channel ... Lake
(5) Outlet channel ... Earth cut, irregular trapezoidal section

*Per Owner.

i. <u>Emergency Spillway</u>.

(1) Type ... Uncontrolled, trapezoidal section, concrete invert

(2) Location ... Right abutment, above spillway pipes

(3) Crest ... Elevation 587.6

(4) Approach channel ... Lake

(5) Outlet channel ... Same as for principal spillway

j. <u>Lake Drawdown Facility</u> ... None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Data relative to the design of the dam were unavailable. According to the Owner, the proportions of the dam, i.e., the slopes of the dam (1v on 3h upstream and 1v on 2h downstream) and crest width, were selected by Ted Hurtgen, Sr. of Jefferson County Surveying Company, Hillsboro, Missouri. According to Ted Hurtgen, Jr. (Mr. Hurtgen, Sr. is deceased), there are no records of the design. In any event, the Owner mentioned that stability analyses of the dam were not performed. As previously indicated, the size of the spillway outlet was determined by the Owner.

2.2 CONSTRUCTION

As previously stated, the dam was constructed about 1962 by Herman Mathias, a local excavating contractor. The Owner reported that test borings were not drilled, but that the subsurface rock profile of the areas to be occupied by the dam and reservoir was determined by seismic sounding prior to construction. According to the Owner, a core trench for seepage cutoff was excavated along the axis of the dam. The average depth of the trench was approximately 5 feet, and it extended to rock throughout. The Owner stated that neither the area to be occupied by the lake nor the valley just downstream of the dam were disturbed during construction, but that the material used to backfill the core trench and construct the embankment was clay obtained from the hillsides just east and west of the dam. The Owner also recalled that the embankment material was compacted using a sheepsfoot roller. Records of the construction of the dam were unavailable. Efforts to contact Mr. Mathias were unsuccessful.

2.3 OPERATION

The lake level is uncontrolled and governed by the upstream elevation (crest) of the invert of the center pipe of three 24-inch diameter pipes. The Owner reported that the lake level is normally at or near the spillway crest; however, the level has dropped about 1 foot during very dry weather, such as occurred this past summer. No indication was found that the dam has been overtopped. The Owner reported that the dam has never been overtopped and that to his knowledge, the highest lake level experienced to date produced a depth of flow that just exceeded the crest of the concrete slab emergency spillway located just above the three 24-inch diameter pipes.

2.4 EVALUATION

a. Availability. Engineering data for assessing the design of the dam and spillways were unavailable.

b. Adequacy. No data available. 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.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Vatterott Lake Dam was made by Horner & Shifrin engineering personnel, R. E. Sauthoff, Civil Engineer, H. B. Lockett, Hydrologist, and A. B. Becker, Jr., Civil and Soils Engineer, on 6 November 1980. An examination of the dam area was also made by an engineering geologist, Jerry D. Higgins, Ph.D., a consultant retained by Horner & Shifrin for the purpose of assessing the site geology. Also examined at the time of the inspection were the areas and features below the dam within the potential flood damage zone. Photographs of the dam taken at the time of the inspection are included on pages A-1 through A-3 of Appendix A. The locations of the photographs taken during the inspection are indicated on Plate 3.

b. Site Geology. Vatterott Lake is located in a southward-flowing tributary to Sandy Creek. The topography around the lake site is moderately sloping, with relief between the lake and surrounding drainage divides ranging up to approximately 290 feet. The area is included within the northeastern part of the Ozark Plateaus Physiographic Province.

The bedrock formations consist of gently northeastward-dipping Ordovician-age sedimentary strata of the Jefferson City-Cotter and St. Peter formations. The dam and reservoir are located entirely on the Jefferson City-Cotter formation, and much of the drainage basin is underlain by the St. Peter formation. The actual formation contact is covered by colluvium. Exposures of the base of the St. Peter formation were evident along the base of the steep slope on the west side of the reservoir, and weathered sand exposures were noted near the east abutment. The Jefferson City-Cotter formation is exposed in the spillway channel. No faulting was observed or reported in the vicinity of the dam site.

The Jefferson City-Cotter formation is a light brown, medium-to-finely crystalline dolomite or argillaceous dolomite. It is thin- to medium-bedded, often argillaceous, and cherty. Solution enlargement of joints and bedding planes is common, and the contact between bedrock and the overlying soils is generally very irregular as a result of the solution weathering. These solution features are commonly the cause of reservoir leakage when the soil cover is thin. The St. Peter formation is a white, fine- to medium-grained pure quartz sandstone. It is massively bedded and, although loosely cemented, exposed rock surfaces are generally case-hardened by weathering processes. Weathered exposures around the dam site are red-brown in color and friable. Exposures on the west side of the reservoir are not highly weathered and are white in color.

The soils in the vicinity of the reservoir are composed principally of clay (CL, Unified Soil Classification System) derived from the in-place weathering of the dolomites. At the base of the valley walls, sandy colluvium has mixed with the clay residuum forming a somewhat sandy clay (CL to SC). These soils do not appear to be especially susceptible to erosion or seepage, although some minor erosion was noted in the sandy soils below the east abutment.

The most significant geologic condition noted at the site is the permeable bedrock and its susceptibility to solution weathering. At the time of inspection, it appeared that there was no excessive water loss from the reservoir. No other geologic conditions were obeserved that would be expected to adversely affect the performance of the dam embankment.

c. Dam. The visible portions of the upstream and downstream faces of the dam as well as the dam crest (see Photos 1, 2 and 3) were examined and found to be in sound condition, although an erosion gully approximately 1.5 feet deep and 3 feet wide was noticed in the downstream slope near the top of the dam in the vicinity of station 1+50, and numerous smaller gullies, on the order of 1 foot deep and up to 2 feet wide, were found just above the toe of the downstream slope. Limestone riprap, average size about 12 inches with some stones up to 24 inches, existed across the entire upstream face of the dam. The riprap extended from the wave berm to an elevation about 1.5 feet above the normal waterline. No erosion of the upstream face of the dam was noticed, although the riprap was somewhat sparse near the left end of the dam. Above the riprap and across almost the entire upstream face of the dam, small willow trees up to 2 inches in diameter and sprouting willow tree stumps up to 6 inches in diameter were observed. The crushed stone roadway traversing the top of the dam was in reasonably good condition except near the left end of the dam where the road section was rutted and the stone surfacing was missing. Trees, up to 10 inches in diameter, and several areas of dense brush were observed on the downstream face of the dam. The turf cover on the embankment, a combination of fescue, lespedeza and weeds up to 4 feet high, covered the otherwise unprotected areas of the dam. No animal burrows were noticed; however, because of the dense brush and high grass on the downstream slope, it cannot be concluded that none exist. Examination of a soil sample obtained from the downstream side of the embankment near the center of the dam, indicated the surficial material of the dam to be a yellow-brown, slightly sandy, silty lean clay (CL) of low-to-medium plasticity.

According to survey data obtained during the inspection, the top of the dam in the vicinity of the original stream crossing was found to be approximately 0.9 foot lower than the top of the dam at its higest point. It is possible that the dam has experienced some settlment, particularly through the area of the original stream location.

Some seepage, as evidenced by soft ground, standing water, and cattails, was observed at the toe of the dam between stations 3+00 and 5+00 and near the left abutment (see Photo 3) between stations 6+40 and 6+90. The amount of seepage could not be quantified since flow was indistinguishable.

A large marshy area, with standing water, cattails and willow trees, approximately 230 feet wide and several hundred feet long (see Photo 4) in the direction of the valley was observed just downstream of the dam. No provisions for drainage of the area were noticed. The Owner reported that this low area existed prior to construction of the dam. However, judging by the topography adjacent to the original stream, it did appear that the area had been a source of borrow for some unknown purpose.

The upstream and downstream ends of the three 24-inch diameter corrugated metal pipes of the principal spillway (see Photos 5 and 6) were examined and found to be in satisfactory condition. As far as could be determined, the bituminous coating on the interior of the pipes appeared to be intact;

however, some minor rusting of the exterior galvanized surface at the scarfed ends of the pipes was noted. Dense undergrowth consisting of small willow trees and horsetails (see Photo 7) congested the area immediately upstream of the pipes. Just downstream of the pipes, the spillway outlet channel through the paved section, a distance of about 30 feet, was badly eroded. Erosion had undermined the concrete pavement up to a depth of about 3 feet beginning at the ends of the pipes (see Photo 6), and large sections of pavement, on the order of 3 feet wide by 6 feet long, (see Photo 8) were strewn about the channel invert. At an elevation approximately 3 feet below the end of the center pipe, some seepage was observed emerging from the vertical bank. Seepage observed within the spillway channel just downstream of the paved section (see Photo 9) was estimated to be on the order of 0.5 gpm. Downstream of the paved section, the outlet channel was found to be in satisfactory condition, although some minor erosion of the channel banks was noted. The concrete slab that serves to protect the dam and function as the invert of the emergency spillway was also examined and found to be in good condition. No evidence of cracking or spalling of the surface of the concrete slab was noticed.

d. Appurtenant Structures. No appurtenant structures were observed at this dam site.

e. Downstream Channel. Except at road and highway crossings, the channel downstream of the dam within the potential flood damage zone is unimproved. The channel section is irregular, of variable width, and for the most part, lined with trees.

f. Reservoir. For the most part, the hillsides contingent to the reservoir are covered with trees. A small house is located adjacent to the west side of the lake. No significant erosion of the lake banks was observed. At the time of the inspection, the lake was about 0.4 foot below normal pool level and the water within the reservoir was clear. The amount of sediment within the lake could not be determined at the time of the inspection; however, due to the vegetation covering the surrounding area, it is not expected to be significant.

3.2 EVALUATION

The deficiencies observed during the inspection and noted herein are not considered significant to warrant immediate remedial action. However, it is recommended that, as soon as practical, the eroded areas of the outlet channel just downstream of the spillway pipes be restored and some durable form of protection be provided in order to prevent future erosion of the channel banks and invert by spillway releases.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The spillway is uncontrolled. The lake surface level is governed by precipitation runoff, evaporation, seepage, and the capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM

According to the Owner, the dam has not experienced problems with sliding, cracking, burrowing animals, settlement of the dam, or excessive seepage. It was reported that trees were removed from the upstream face of the dam 2 years ago, and that they will again be removed next year. The Owner stated that trees on the downstream face have not been removed and that the grass on the dam crest is cut at least once during the growing season.

As previously indicated, the downstream side of the dam was pressure grouted in 1966. The Owner reported that some seepage was observed within the original stream channel at a point about 50 feet from the toe of the dam prior to grouting. The Owner indicated that grouting of the dam was done more as a precaution than as a necessity.

4.3 MAINTENANCE OF OPERATING FACILITIES

No facilities requiring operation exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection did not reveal the existence of a dam failure warning system.

4.5 EVALUATION

It is recommended that maintenance of the dam include the removal of trees and brush on the downstream face of the dam as well as more frequent cutting of grass during the growing season. Measures should be taken to prevent further erosion of the outlet channel just downstream of the spillway. Clearing of the area just upstream of the spillway is also advised since the vegetation that exists in this area is an obstruction that can impede lake outflow. It is also recommended that a detailed inspection of the dam be instituted on a regular basis by an engineer experienced in the design and construction of dams and that records be kept of all inspections made and remedial measures taken.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data were not available.

b. Experience Data. The drainage area and lake surface area were developed from the 1954 Belew Creek, Missouri, Quadrangle Map, photorevised 1968 and 1974. The proportions and dimensions of the spillway and dam were developed from surveys made during the inspection. Records of rainfall, streamflow or flood data for the watershed were not available.

Due to the fact that the watershed for this reservoir is relatively small, and since there is no history of excessive reservoir leakage, the lake level was assumed to be at normal pool as a result of antecedent storms prior to occurrence of the PMF and the probabilistic storms.

According to the St. Louis District, Corps of Engineers, the estimated flood damage zone, should failure of the dam occur, extends three miles downstream of the dam.

c. Visual Observations.

(1) The principal spillway consists of three 24-inch diameter corrugated metal pipes about 49 feet long. The spillway, a culvert type structure, passes through the abutment at the right end of the dam. The concrete pavement that serves to protect the channel just downstream of the pipes is badly undermined and broken.

(2) The concrete paved section above the spillway pipes will function as an emergency spillway for lake outflow. However, the low point of the dam crest was found to be only 0.4 foot higher than the crest of this spillway, which severely limits its capacity to provide relief for lake surcharge.

(3) A common outlet channel serves both spillways. The outlet channel directs flow away from the embankment. The channel joins a natural draw at a point approximately 350 feet downstream of the center of the dam; the natural draw joins the original stream channel about 400 feet downstream of the dam center. Releases within the capacity of the spillway outlets will not endanger the dam.

d. Overtopping Potential. The spillway is inadequate to pass the probable maximum flood, 1/2 the probable maximum flood, or the 1 percent chance (100-year frequency) flood, without overtopping the dam. The results of the dam overtopping analysis are as follows:

(Note: The data appearing in the following table have been extracted from the computer output data appearing in Appendix B. Decimal values have been rounded to the nearest one-tenth in order to prevent assumption of unwarranted accuracy.)

Ratio of PMF	Q-Peak Inflow (cfs)	Q-Peak Outflow (cfs)	Max. Lake W.S. Elev.	Max. Depth (Ft.) of Flow over Dam (Elev. 588.0)	Duration of Overtopping of Dam (Hrs.)
0.50	2,574	2,315	589.4	1.4	7.6
1.00	5,149	4,909	590.1	2.1	11.2
1% Chance Flood	1,215	159	588.3	0.3	2.0
10% Chance Flood	704	37	587.1	0.0	0.0

Since the crest of the emergency spillway is protected from erosion by lake outflow and since the low point in the embankment was found to be only 0.4 foot higher than the crest of the emergency spillway, the top of the embankment was assumed to be the lowest point, elevation 588.0, in the dam crest. The flow safely passing the spillways just prior to overtopping amounts to approximately 81 cfs, which is the routed outflow corresponding to about 11 percent of the probable maximum flood inflow. This flow is greater than the lake outflow resulting from the 10 percent chance (10-year frequency) flood. During peak flow of the probable maximum flood, the greatest depth of flow over the dam is projected to be 2.1 feet and overtopping will extend across the entire length of the dam.

e. Evaluation. Experience with embankments constructed of similar material (a silty lean clay of low-to-medium plasticity) to that used to construct this dam have shown evidence that the material under certain conditions, such as high velocity flow, can be very erodible. An example of such erosion exists within the spillway outlet channel just downstream of the 24-inch diameter outlet pipes. Such a condition exists during the PMF when large lake outflow, accompanied by high flow velocities, occurs. For the PMF condition where the depth of flow over the dam crest, a maximum of 2.1 feet, and the duration of flow over the dam, 11.2 hours, are substantial, damage by erosion to the crest and downstream face of the dam is expected. The extent of these damages is not predictable within the scope of this investigation; however, there is a possibility that they could result in failure by erosion of the dam. A similar, but not as severe, condition also exists during occurrence of the one-half PMF event.

f. Reference. Procedures and data for determining the probable maximum flood, the 100-year frequency flood, the 10-year frequency flood, and the discharge rating curve for flow passing the spillway and dam crest are presented on pages B-1 through B-3 of Appendix B. Listings of the HEC-1 (Dam Safety Version) input data for the probable maximum flood, the 100-year frequency flood, and the 10-year frequency flood are shown on pages B-4 through B-8. Computer output data, including unit hydrograph ordinates, tabulation of PMF rainfall, loss and inflow data are shown on pages B-9 through B-12; tabulation of lake surface area, elevation and storage volume and tabulation titled "Summary of Dam Safety Analysis" for the PMF is shown on page B-13; "Summary of Dam Safety Analysis" for the 1 percent chance (100-year frequency) flood and the 10 percent chance (10-year frequency) flood are shown on page B-14. Inflow-outflow hydrographs for the PMF and the 1 percent chance flood are presented on page B-15.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

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

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam were available. 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. Operating Records. No appurtenant structures or facilities requiring operation exist at this dam. According to the Owner, no records of the lake level, spillway discharge, dam settlement, or lake seepage are kept.

d. Post Construction Changes. According to the Owner, with the exception of pressure grouting the downstream side of the dam in 1966, no post construction changes have been made or have occurred since completion of the dam which would affect the structural stability of the dam.

e. Seismic Stability. The dam is located within a Zone II seismic probability area. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed earthen dam of this size provided that static stability conditions are satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. A hydraulic analysis indicated that the spillways, principal plus emergency, are capable of passing lake outflow of about 81 cfs without the level of the lake exceeding the low point in the top of the dam. A hydrologic analysis of the lake watershed area, as discussed in Section 5, paragraph 5.1d, indicates that for storm runoff of probable maximum flood magnitude, the lake outflow would be about 4,909 cfs, and that for the 1 percent chance (100-year frequency) flood, the lake outflow would be about 159 cfs. A similar analysis indicated that for the 10 percent chance (10-year frequency) flood, the lake outflow would be approximately 37 cfs. Since the existing spillway is inadequate to pass lake outflow resulting from a storm of PMF magnitude (the recommended spillway design flood for this dam) without overtopping the dam, the possibility exists that overtopping could result in failure by erosion of the dam. A description of the features within the potential flood damage zone should failure of the dam occur is presented in Section 1, paragraph 1.2d.

Seepage and stability analyses of the dam were not available for review, and therefore, no judgment could be made with respect to the structural stability of the dam.

Several items were noticed during the inspection that could adversely affect the safety and future operation of the dam. These items include seepage, erosion of the embankment, trees and dense brush on the dam proper, possible dam settlement, an obstructed spillway approach, a badly eroded spillway outlet channel, and a large marshy area just downstream of the dam that could be detrimental to the stability of the embankment.

b. Adequacy of Information. Due to lack of design and construction data, the assessments reported herein were based on external conditions as determined during the visual inspection. The assessments of the hydrology of the watershed and capacity of the spillways were based on a hydraulic/hydrologic study as indicated in Section 5. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. The remedial measures recommended in paragraph 7.2 for the items concerning the safety of the dam noted in paragraph 7.1a should be accomplished within the near future. The provision of additional spillway capacity should be pursued on a high priority basis since the existing spillways are considered to be seriously inadequate.

d. Necessity for Phase II. Based on the results of the Phase I inspection, a Phase II investigation is not recommended.

e. Seismic Stability. The dam is located within a Zone II seismic probability area. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed earthen dam of this size provided that static stability conditions are satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES

a. Recommendations. The following action is recommended.

(1) Based upon criteria set forth in the recommended guidelines, spillway size and/or height of dam should be increased in order to pass lake outflow resulting from a storm of probable maximum flood magnitude.

(2) Obtain the necessary soil data and perform dam seepage and stability analyses in order to determine the structural stability of the dam for all operational conditions. Seepage and stability analyses should be performed by a qualified professional engineer experienced in the design and construction of earthen dams.

(3) Restore the dam crest to a uniform elevation and monitor the top of the dam through the area of suspected settlement in order to determine the

extent of possible future settlement and the remedial work required to compensate for such settlement. In any event, the crest of the dam should be uniform throughout without low areas that reduce dam freeboard and penalize spillway capacity. It should be noted that the low point of the top of the dam was found to be only 0.4 foot higher than the crest of the emergency spillway.

b. Operations and Maintenance (O & M) Procedures. The following O & M procedures are recommended:

(1) Provide some means of controlling seepage evident in the areas adjacent to the downstream toe of the dam. Uncontrolled seepage can lead to a piping condition (progressive internal erosion) which could result in failure of the dam. Drainage of the areas affected by seepage including elimination of the large marshy area just downsteam of the dam should be one of the objectives of the seepage control measures since saturation of the soil weakens the foundation which could impair the stability of the dam.

(2) Remove the trees and the undergrowth that can conceal animal burrows from the dam proper. Tree roots and animal burrows can provide passageways for lake seepage that can also develop into a piping condition. Maintain the turf cover on the dam at a height that will not conceal animal burrows or hinder inspection of the dam. Removal of large trees should be under the guidance of an engineer experienced in the design and construction of earthen dams since indiscriminate clearing could jeopardize the safety of the dam.

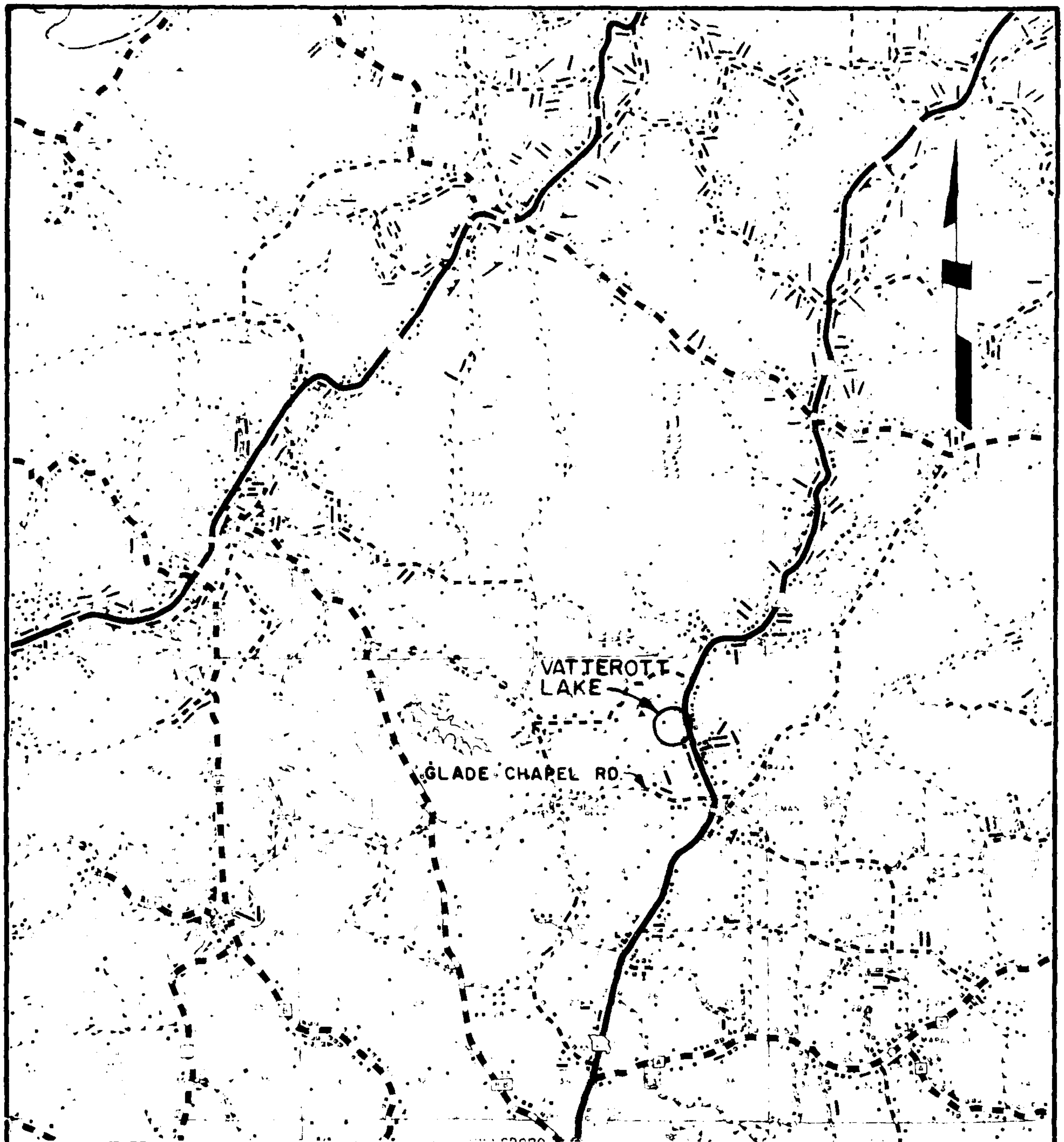
(3) Restore the eroded areas of the dam, including the area within the spillway outlet channel immediately downstream of the spillway pipes. Loss of material due to erosion can be detrimental to the structural stabilty of the dam, or in the case of the outlet channel, to the stability of the section where the spillway pipes are founded. The spillway channel should be protected as necessary to prevent erosion by lake outflow.

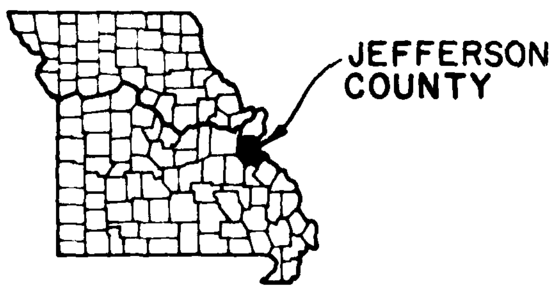
(4) Remove the small trees and undergrowth within the reservoir area just upstream of the spillway pipes that could impede flow to the pipes

resulting in loss of spillway capacity. The existing spillway pipes should be maintained free of trash and debris that could obstruct flow resulting in a loss of capacity of the outlet. If difficulty is anticipated in maintaining the spillway pipes clean, it is recommended that trash racks be installed on their upstream ends.

(5) Provide maintenance of all areas of the dam on a regularly scheduled basis in order to insure features of being in satisfactory operational condition.

(6) A detailed inspection of the dam should be instituted on a regular basis by an engineer experienced in the design and construction of dams. It is also recommended, for future reference, that records be kept of all inspections made and remedial measures taken.



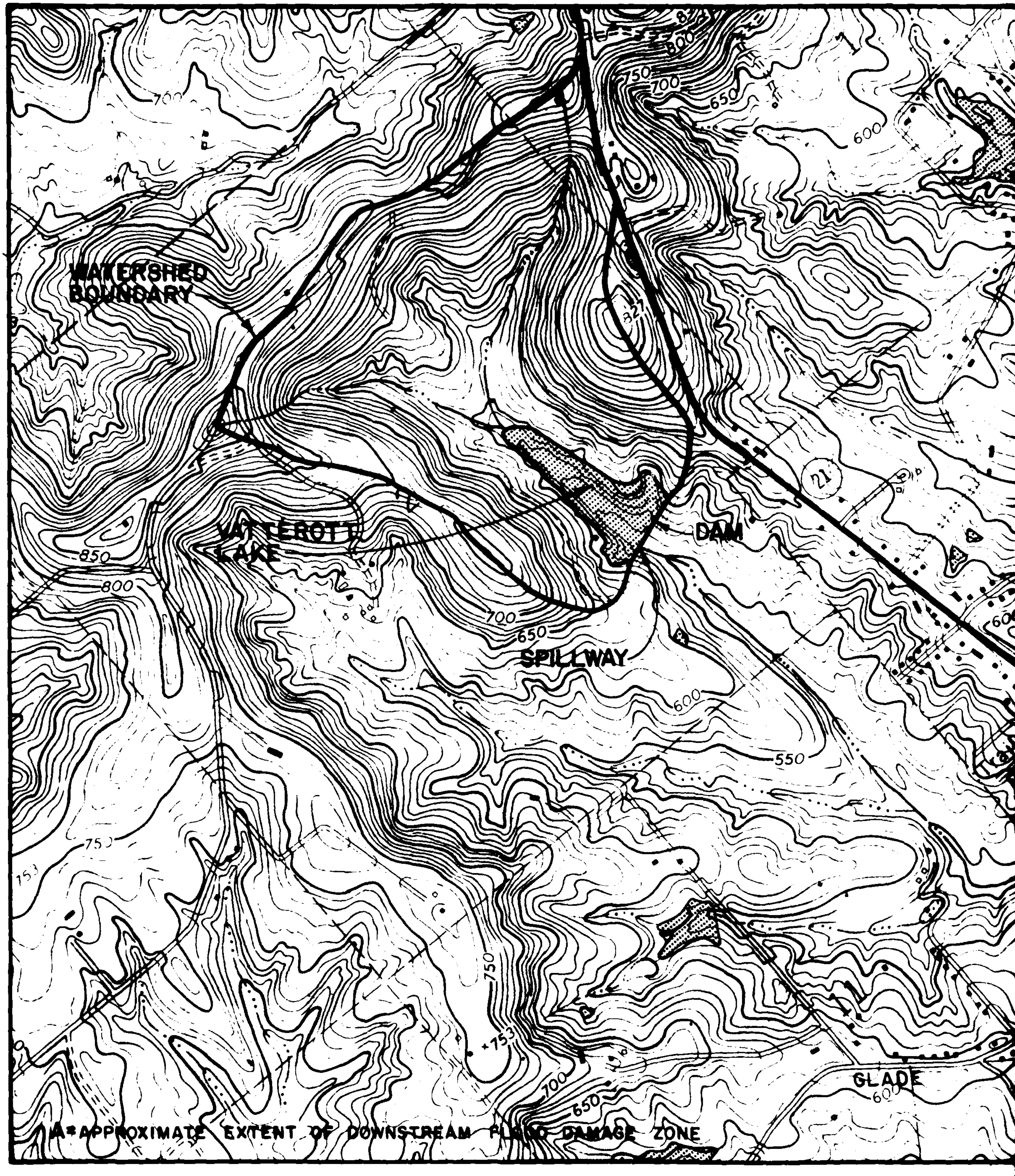


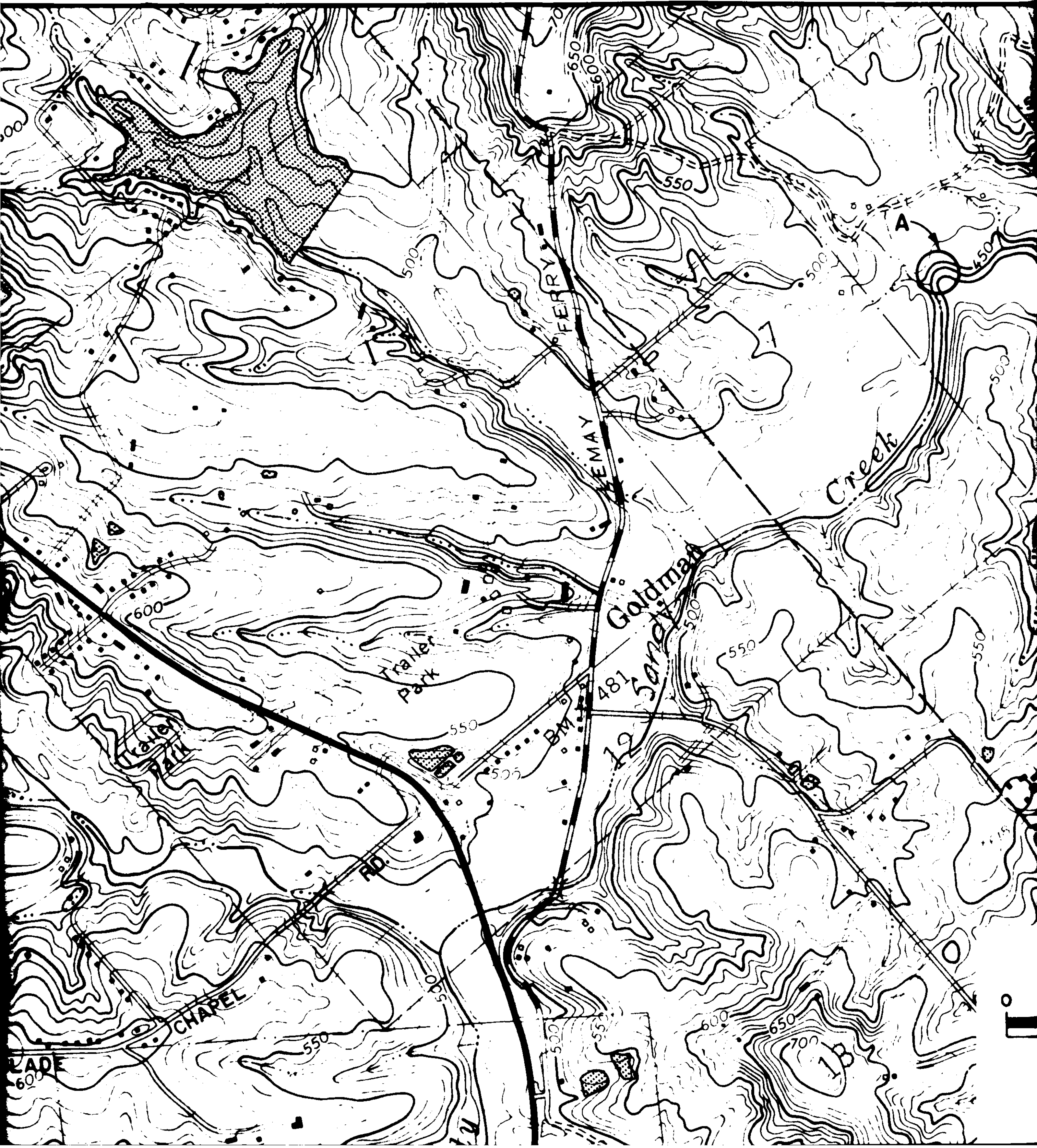
LOCATION MAP

VATTEROTT LAKE

REGIONAL VICINITY MAP

PLATE I


WATERSHED BOUNDARY
VATTEROTT LAKE
DAM
SPILLWAY
GLADE
850
800
750
700
650
600
550
753
21
A=APPROXIMATE EXTENT OF DOWNSTREAM FLOOD DAMAGE ZONE



FERRY
LEMAY
Goldman
Sandy
Creek
Trailer Park
Trailer Park
CHAPEL
RD
BM 481
A
7
12
18
450
500
550
600
650
700

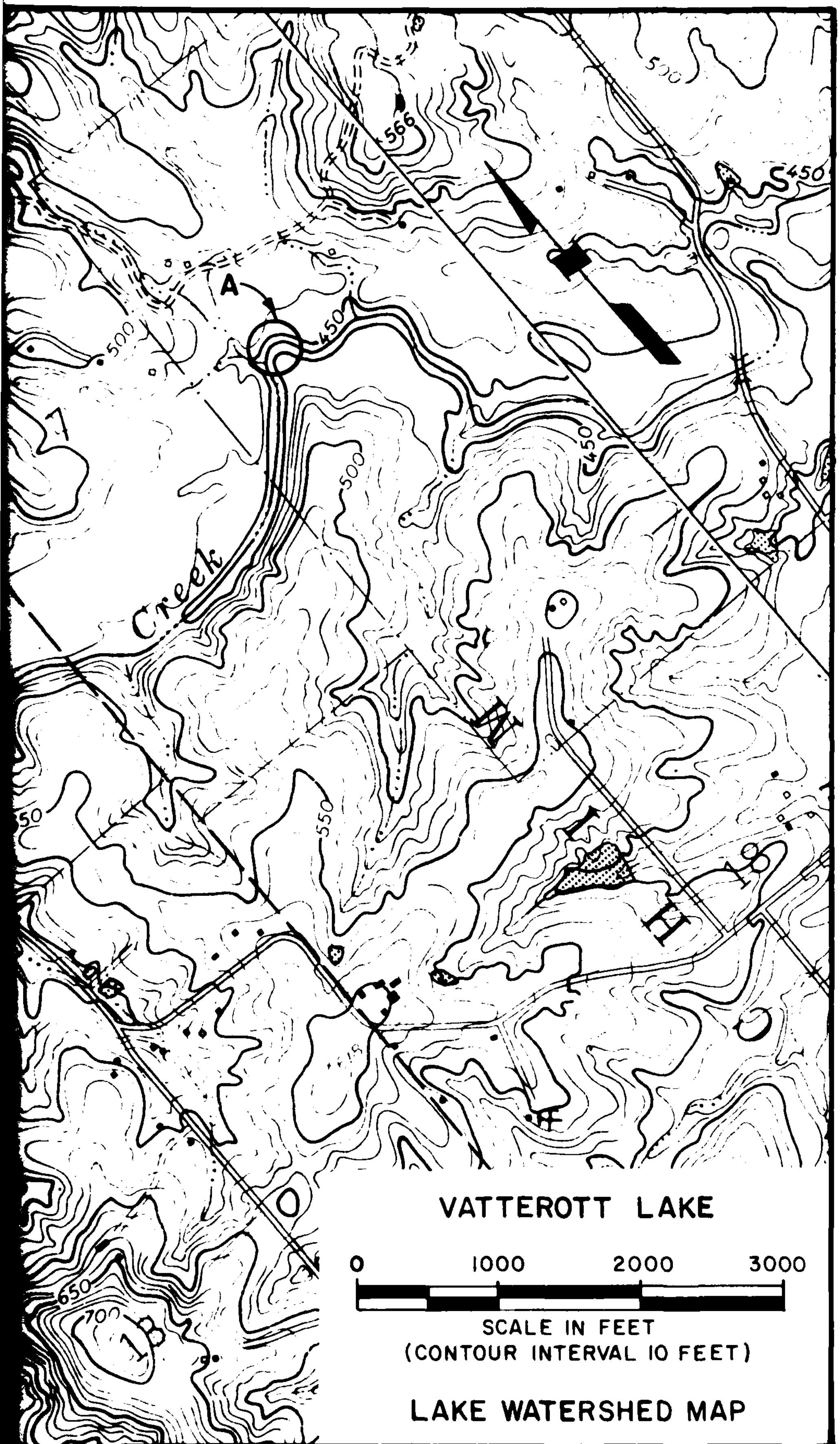
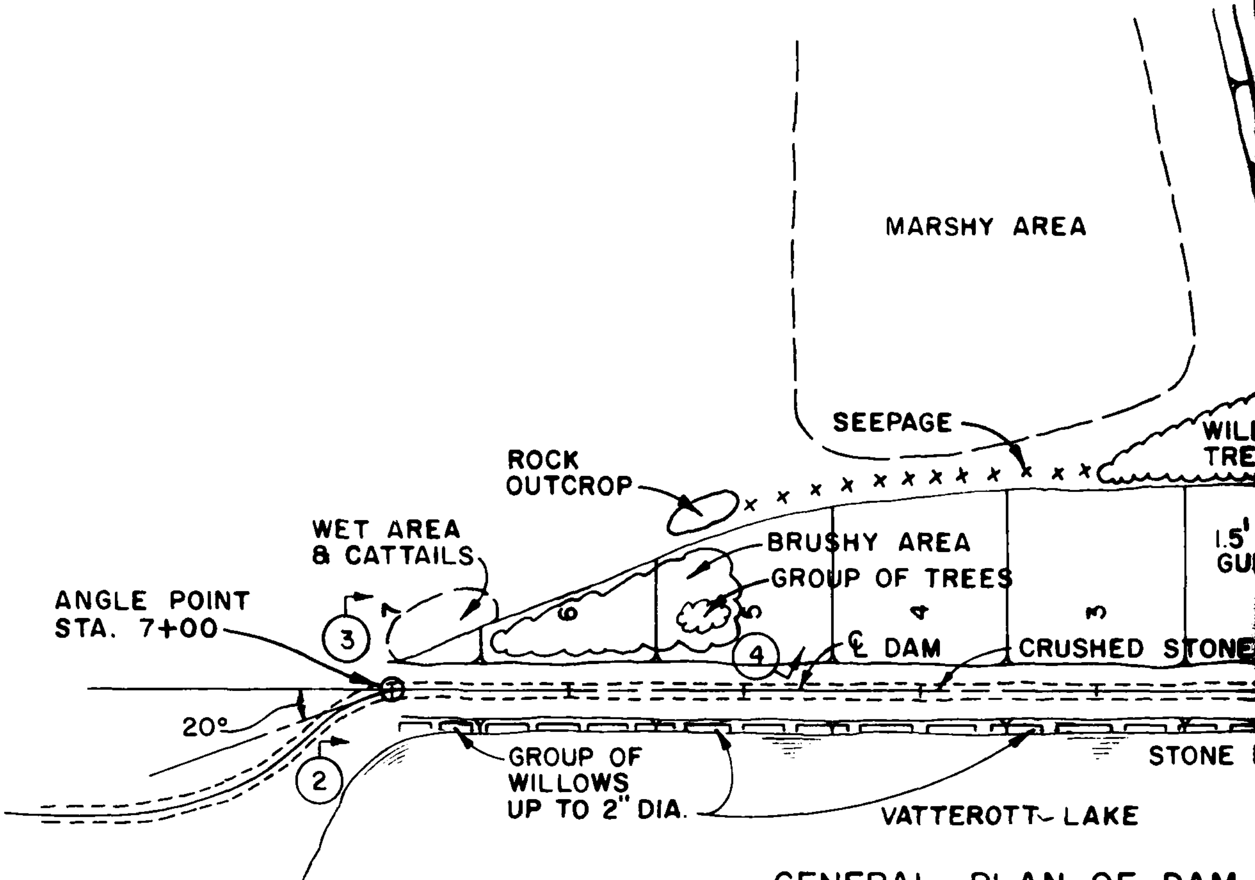
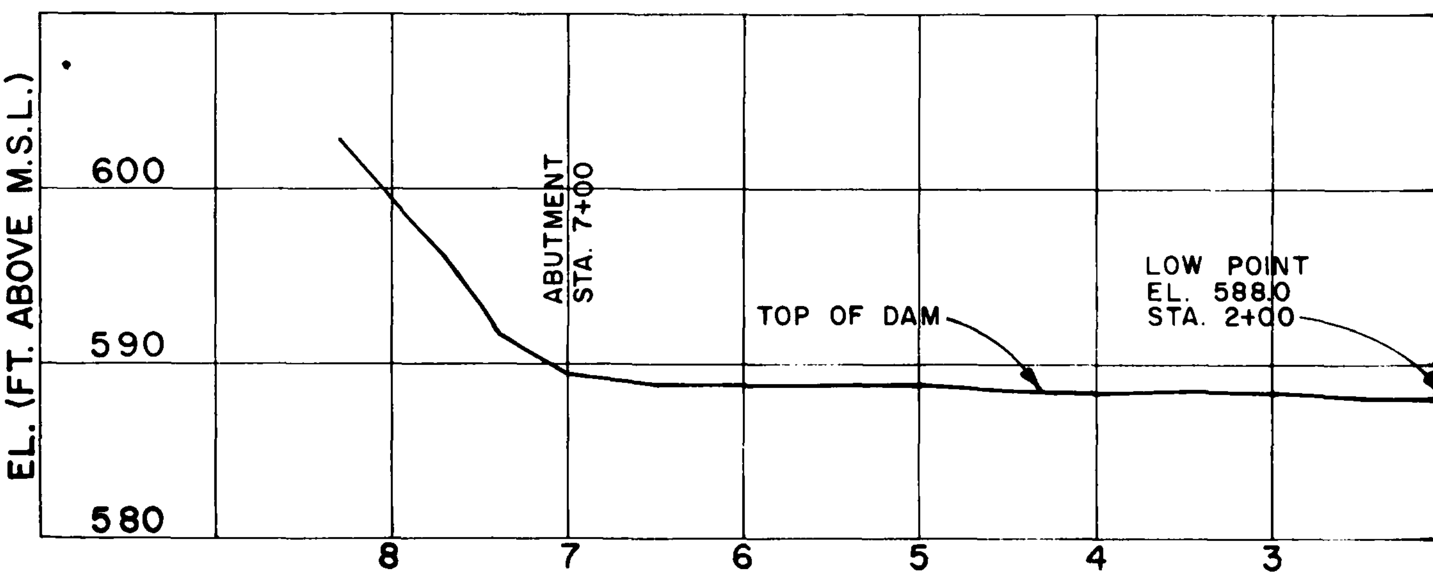

VATTEROTT LAKE
0 1000 2000 3000
SCALE IN FEET
(CONTOUR INTERVAL 10 FEET)
LAKE WATERSHED MAP
A
Creek
450
500
550
566
650
700

PLATE 2



GENERAL PLAN OF DAM

SCALE: 1"=100'

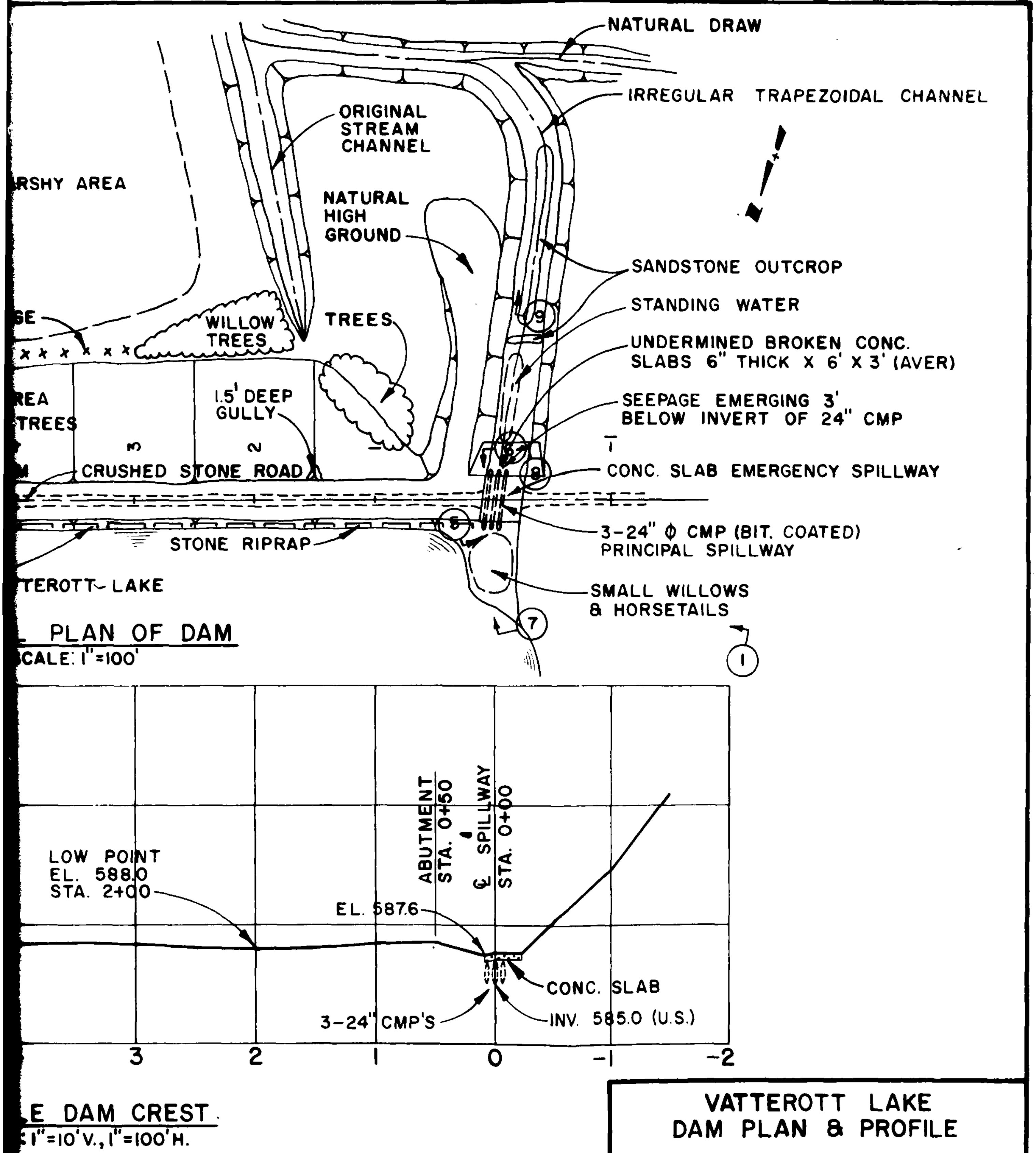


PROFILE DAM CREST

SCALES: 1"=10'V., 1"=100'H.

(6) ↑

PHOTO LOCATION & KEY
(SEE APPENDIX A)



VATTEROTT LAKE
DAM PLAN & PROFILE

Horner & Shifrin, Inc. Dec. 1980

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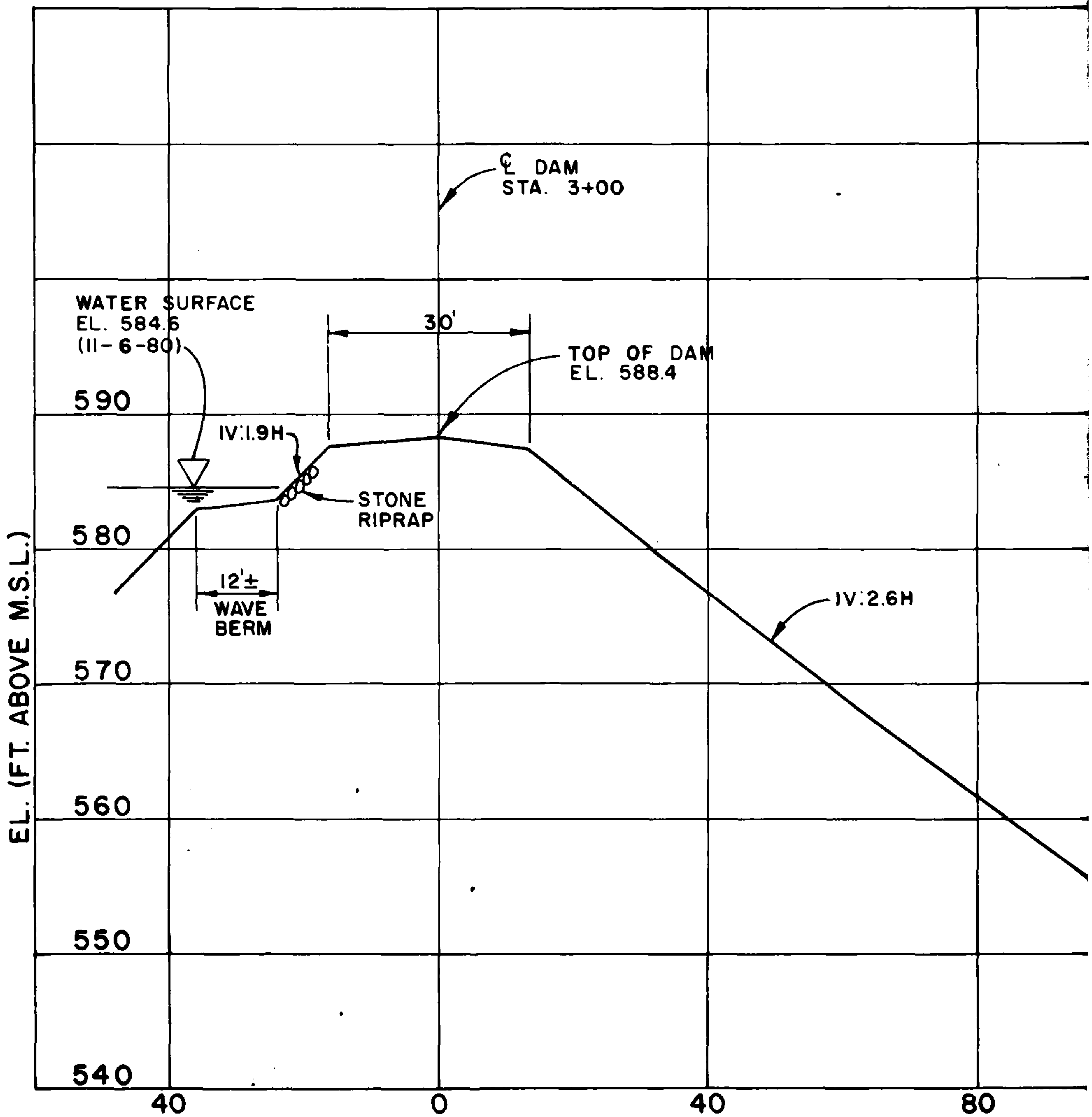
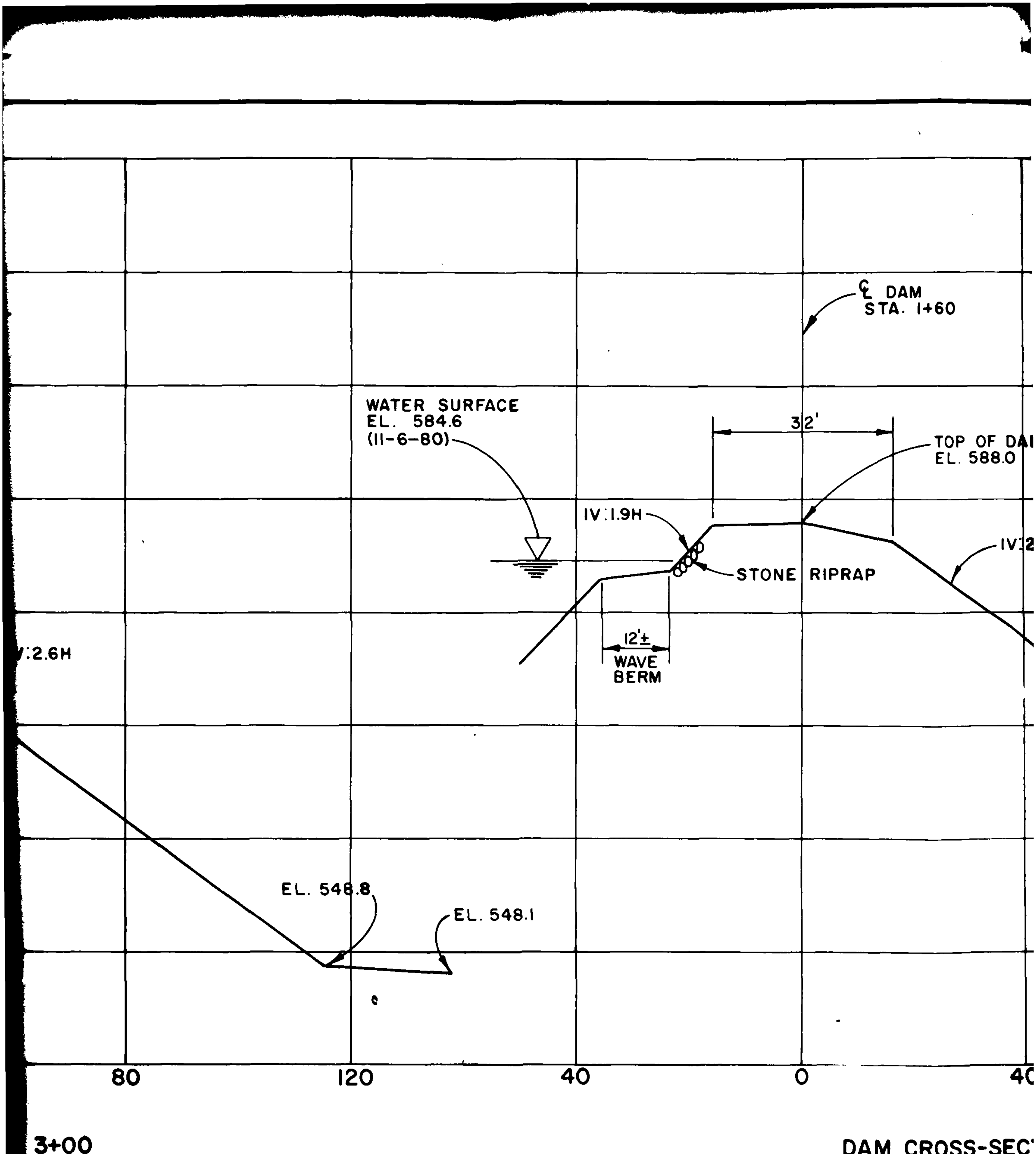
PLATE 3



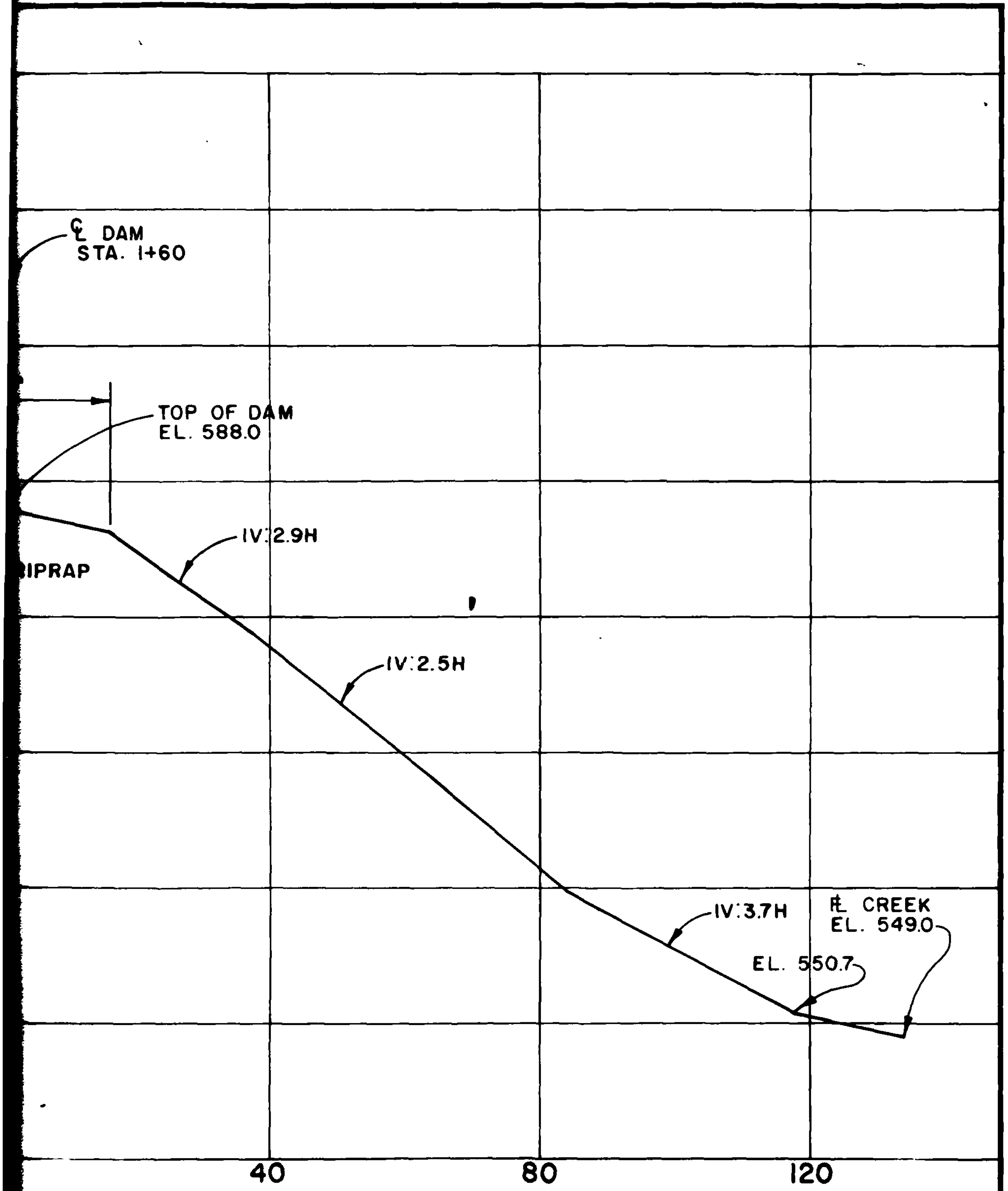
DAM CROSS-SECTION STA. 3+00

SCALE: 1"=10'V., 1"=20'H.



DAM CROSS-SEC

SCALE: 1"=1



DAM CROSS-SECTION STA. 1+60

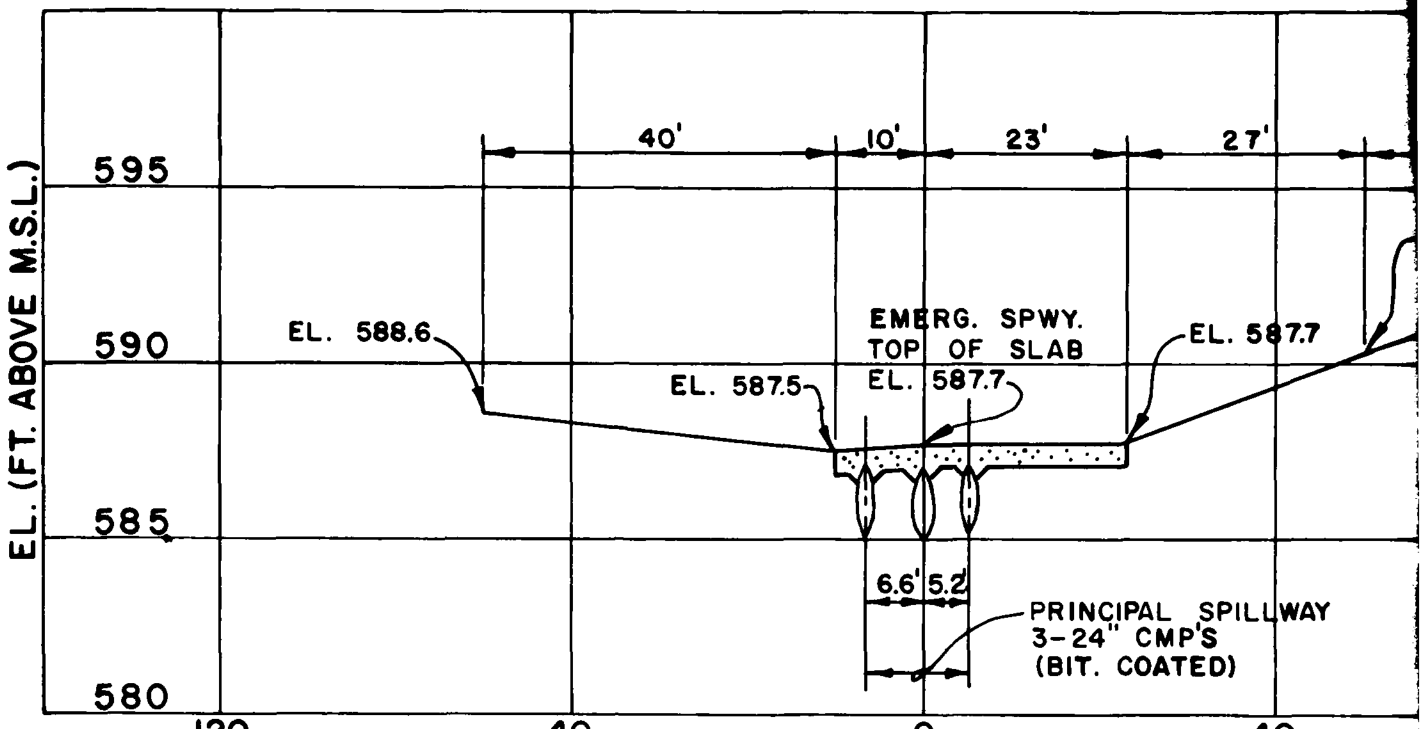
SCALE: 1"=10' V., 1"=20' H.

VATTEROTT LAKE
DAM CROSS-SECTIONS

Horner & Shifrin, Inc. Dec. 1980

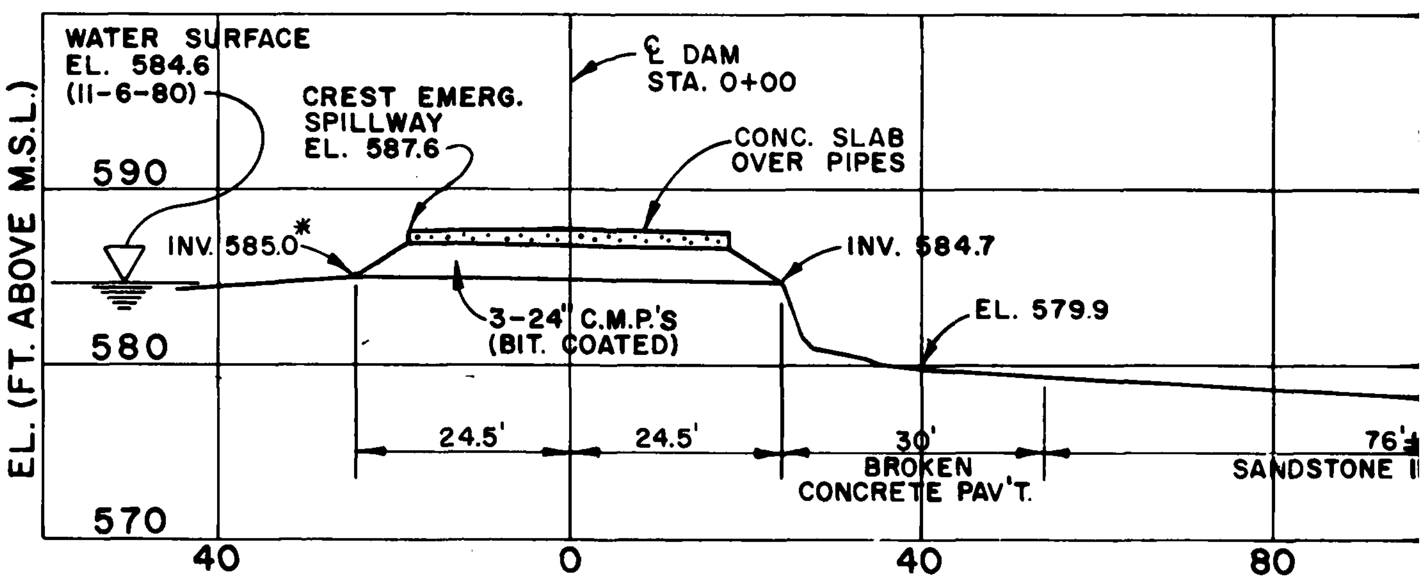
3

PLATE 4



SPILLWAY CROSS-SECTION

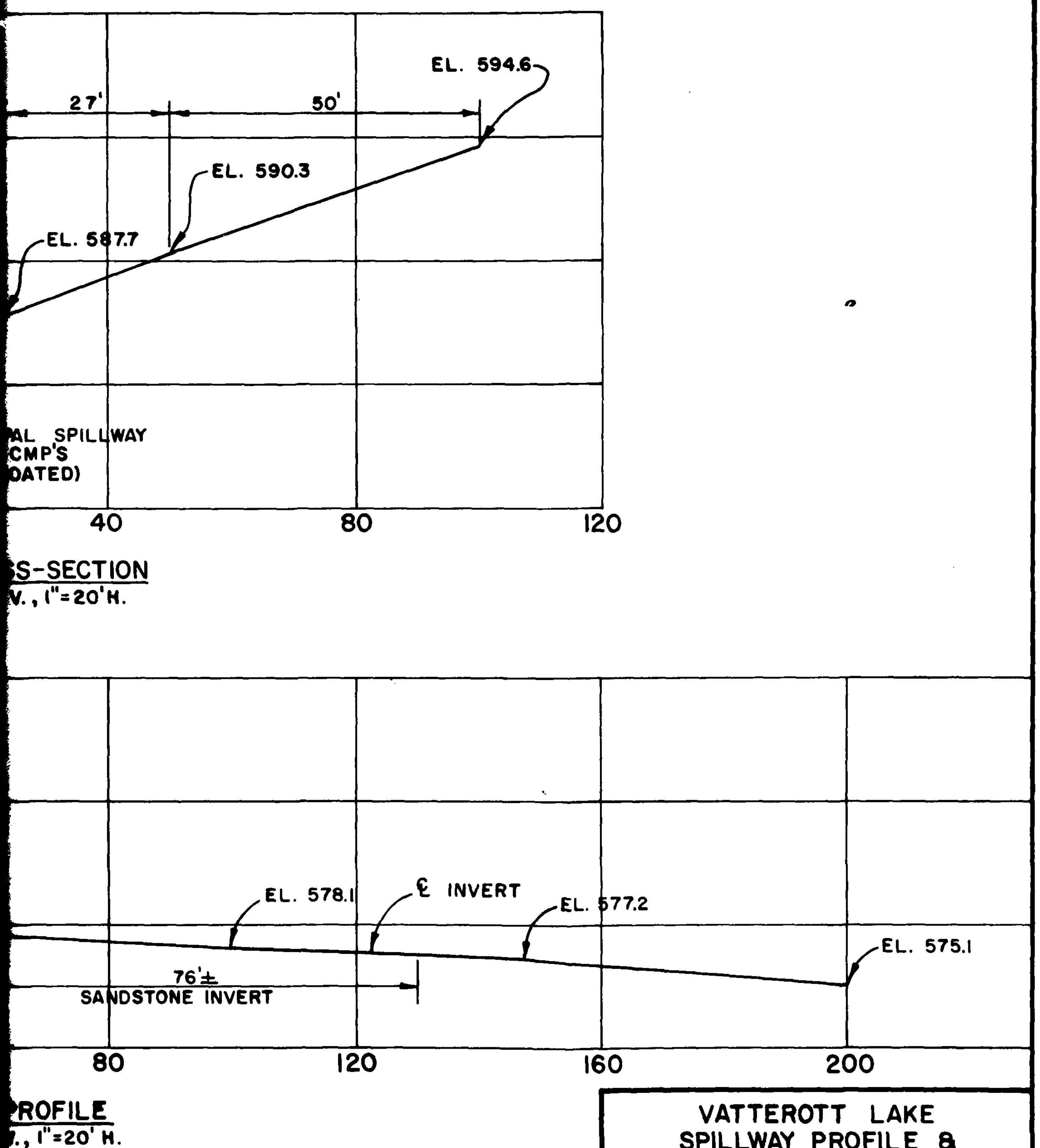
SCALES: 1"= 5' V., 1"=20' H.



SPILLWAY PROFILE

SCALES: 1"=10'V., 1"=20' H.

*NORMAL POOL = SPILLWAY CREST EL. 585.0



VATTEROTT LAKE
SPILLWAY PROFILE &
CROSS-SECTION

Horner & Shifrin, Inc. Dec. 1980

PLATE 5

APPENDIX A

INSPECTION PHOTOGRAPHS

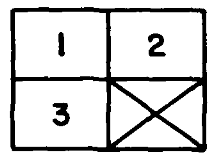


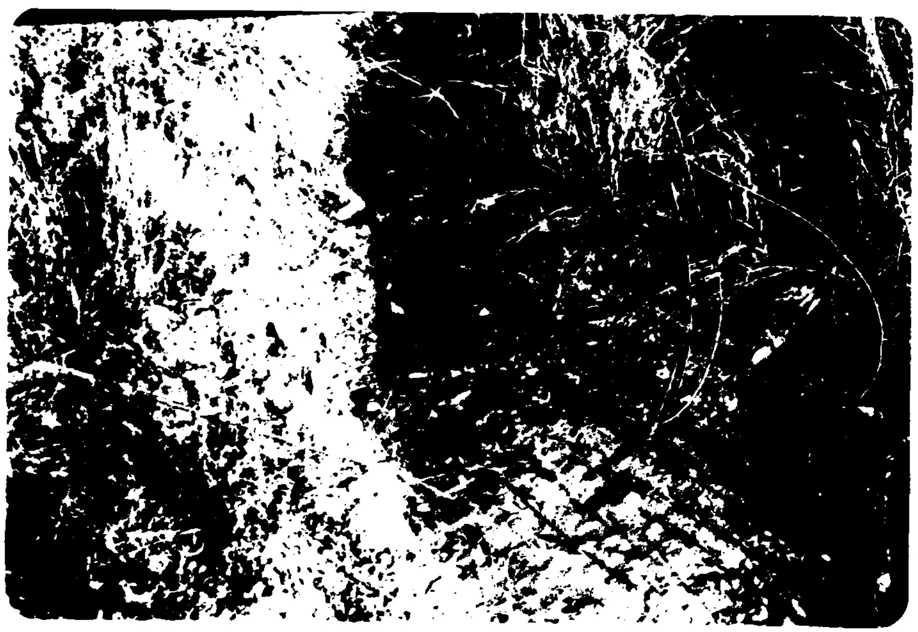
PHOTO KEY

NO.	DESCRIPTION
1	DAM OVERVIEW
2	UPSTREAM FACE OF DAM
3	DOWNSTREAM FACE OF DAM (NOTE CATTAILS AT TOE OF SLOPE)

4	5
6	X

PHOTO KEY

NO.	DESCRIPTION
4	MARSHY AREA DOWNSTREAM OF DAM
5	UPSTREAM END 24" SPILLWAY PIPES
6	DOWNSTREAM END 24" SPILLWAY PIPES



7	8
9	☒

PHOTO KEY

NO.	DESCRIPTION
7	UNDERGROWTH UPSTREAM OF SPILLWAY
8	BROKEN PAVEMENT WITHIN SPILLWAY CHANNEL
9	SEEPAGE WITHIN SPILLWAY OUTLET CHANNEL

APPENDIX B

HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

1. The HEC-1 Dam Safety Version (July 1978, Modified 26 February 1979) program was used to develop inflow and outflow hydrographs and dam overtopping analyses, with hydrologic inputs as follows:

a. Probable maximum precipitation (200 sq. mile, 24-hour value equals 25.5 inches) from Hydrometeorological Report No. 33. The precipitation data used in the analysis of the 1 percent (100-year frequency) and 10 percent chance (10-year frequency) flood was provided by the St. Louis District, Corps of Engineers.

b. Drainage area = 0.361 square miles = 231 acres.

c. SCS parameters:

Time of Concentration $(T_C) = \left(\frac{11.9L^3}{H}\right)^{0.385}$ = 0.162 hours

Where: T_c = Travel time of water from hydraulically most distant point to point of interest, hours
L = Length of longest watercourse = 0.597 miles
H = Elevation difference = 286 feet

The time of concentration (T_c) was obtained using Method C as described in Figure 30, "Design of Small Dams", by the United States Department of the Interior, Bureau of Reclamation, and was verified using average channel velocity estimates and watercourse lengths.

Lag Time = 0.097 hours (0.60 Tc)
Hydrologic soil group = 100% D (Gasconade series, mostly wooded, per Mo. General Soil Map and field investigation)
Soil type CN = 77 (AMC II, 100-yr and 10-yr flood conditions)
= 89 (AMC III, PMF condition)

2. Determination of spillway capacity:

a. Flow through the three 24-inch diameter corrugated metal spillway pipes was computed using Bernoulli's equation for pressure flow in pipes. A pipe friction factor (n) of 0.021 was used. Losses, including entrance, pipe and exit losses totaled 4.1 velocity heads. Reference "Handoook of Hydraulics", Fifth Edition, by King and Brater, pages 8-5 and 8-6.

b. The trapezoidal concrete emergency spillway section consists of a broad-crested section, for which conventional weir formulas do not apply.

Spillway release rates were determined as follows:

(1) Spillway crest section properties (areas, "a", and top width, "t") were computed for various depths, "d".

(2) It was assumed that flow over the spillway crest would occur at critical depth. Flow at critical depth Q_c was computed as

$Q_c = \left(\frac{a^3 g}{t}\right)^{0.5}$ for the various depths, "d". Corresponding velocities (v_c) and velocity heads (H_{vc}) were determined using conventional formulas.* Reference "Handbook of Hydraulics", Fifth Edition, by King & Brater, page 8-7.

(3) Static lake levels corresponding to the various flow values passing the spillway were computed as critical depths plus critical velocity heads ($d_c + H_{vc}$), and the relationship between lake level and spillway discharge was thus obtained. The procedure neglects the minor insignificant friction losses across the length of the spillway.

* $v_c = \frac{Qc}{a}$; $Hvc = \frac{v_c^2}{2g}$

c. Discharge quantities for equal elevations determined as described herein were summated for the principal and emergency spillways for entry on the Y4 and Y5 cards.

3. The profile of the dam crest is irregular and flow over the dam cannot be determined by application of conventional weir formulas. Crest length and elevation data for the dam crest proper were entered into the HEC-1 Program on the $L and the $V cards. The program assumes that flow over the dam crest section occurs at critical depth and computes internally the flow over the dam crest and adds this flow to the flow over the spillway as entered on the Y4 and Y5 cards.

```
A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF VATTEROTT LAKE DAM
A3       RATIOS OF PMF ROUTED THROUGH RESERVOIR
B      288       0       5       0       0       0       0       0       0       0
B1       5
J        1       4       1
J1    0.11    0.12    0.50    1.00
K        0  INFLOW                                       1
K1       INFLOW HYDROGRAPH
M        1       2   0.361                     1.0                       1
P        0    25.5     102     1[illegible]     1[illegible]
T                                                       -1     -89
W2            0.0[illegible]
X     -1.0    -.10     2.0
K        1     DAM                                       1
Y1       RESERVOIR ROUTING BY MODIFIED PULS
Y1       1                                      15[illegible]     -1
Y4   585.0   586.3   587.6  588.13  588.54  5[illegible]  58[illegible].8[illegible]  590.65  5[illegible]1.35  5[illegible]2.0[illegible]
Y4  592.71  593.39  594.05  594.[illegible]  595.[illegible]  5[illegible].04  5[illegible].70  597.0[illegible]
Y5       0      26      45      [illegible]     1[illegible]1     [illegible]     7[illegible]    12[illegible]1    17[illegible]    24[illegible]
Y5    3094    3856    4694    56[illegible]    [illegible]    7[illegible]    [illegible]    [illegible]570
$A       0    14.[illegible]    15.2    17.[illegible]    [illegible]
$E     552     585     590     600     [illegible]
$$   585.0
$D   588.0
$L       0     100     225     375     412     [illegible]08     650     [illegible]90     720     750
$V   588.0   588.1   588.4   58[illegible].5   588.[illegible]   588.[illegible]   589.4   591.6   596.0   599.3
K       99
```

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1A1       ANALYSIS OF DAM OVERTOPPING USING 1 PERCENT CHANCE FLOOD
A2        HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF VATTEROTT LAKE DAM
A3        1 PERCENT CHANCE FLOOD ROUTED THROUGH RESERVOIR
B      288        0        5                                                       4
B1       5
J        1        1        1
J1    1.00                                              1
K        0   INFLOW                                                          1
K1         INFLOW HYDROGRAPH                 1.0
M        0        2    0.341
O      288  [illegible].274                .007     .007     .007     .007     .007     .007
01    .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
01    .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
01    .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
01    .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
01    .007     .007     .007     .007     .007  [illegible] [illegible] .007   .007  [illegible]
01 [illegible] .007 [illegible] [illegible] [illegible] [illegible] [illegible] .007 .007 .007
01    .007     .007  [illegible] [illegible] .012  .012     .012     .012     .012     .012
01    .007     .007     .012     .012     .012     .012     .012     .012     .012     .012
01    .012     .012     .012     .012     .012     .012     .012     .012     .012     .012
01    .012     .012     .012     .012     .012     .012     .012     .012     .023     .023
01    .012     .012     .012     .012     .012     .012     .012  [illegible] [illegible] [illegible]
01    .023     .023  [illegible] [illegible] .023  .023  [illegible]  .030     .030     .030
01    .023     .023     .023     .023     .023     .023     .030     .048     .134     .134
01    .030     .030     .048     .048     .048     .048     .041     .134     .134     .134
01    .134     .255     .255     .542     .017     .300     .255     .030     .030     .030
01    .049     .049     .049     .048     .041     .048     .030     .023     .023     .023
01    .030     .030     .030     .023     .023     .023     .023     .023     .023     .023
01    .023     .023     .023     .023     .023     .023     .023
```

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1 PERCENT CHANCE FLOOD (Cont'd)

```
01  .012   .012   .012   .012   .012   .012   .012   .012   .012   .012
01  .012   .012   .012   .012   .012   .012   .012   .012   .012   .012
01  .012   .012   .012   .012   .012   .012   .012   .012   .012   .012
01  .012   .012   .012   .012   .012   .012   .007   .007   .007   .007
01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
01  .007   .007   .007   .007   .007   .007   .007   .007
T                                             -1     [illegible]
WI         0.097
X   -1.0   -.10   2.0
K    1     DAM                                1
KI    RESERVOIR ROUTING BY MODIFIED PULS
Y                               1      1
Y1   1                                        1[illegible].[illegible]0     1
Y4  585.0  586.3  587.6  588.13  588.54  5[illegible]  5[illegible].00  590.65  591.[illegible]5  592.0[illegible]
Y4  592.71  593.[illegible]  594.05  594.72  595.38  59[illegible].04  5[illegible]6.70  5[illegible]7.0[illegible]
Y5     0     26     45     93    181    310    722   1261   1798   2408
Y5  3094   3856   4694   5612   6608   7688   8808   9570
$A     0   14.2   15.2   17.9   25.7
$E   552    585    590    600    610
$$ 585.0
$D 588.0
$L     0    100    225    375    412   [illegible]   [illegible]   690    720    750
$V 588.0  588.1  588.4  588.5  588.6  588.[illegible]  5[illegible].4  591.6  59[illegible].0  5[illegible].3
K    99
```

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1A1        ANALYSIS OF DAM OVERTOPPING USING 10 PERCENT CHANCE FLOOD
A2        HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF VATTEROTT LAKE DAM
A3        10 PERCENT CHANCE FLOOD ROUTED THROUGH RESERVOIR
B     288       0       5
B1      5                                                                      4
J       1       1       1
J1   1.00
K       0   INFLOW
K1      INFLOW HYDROGRAPH                                        1
M       0       2   0.381                      1.0                             1
O     288   4.906
O1   .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
O1   .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
O1   .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
O1   .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
O1   .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
O1   .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
O1   .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
O1   .005    .005    .009    .009    .009    .009    .009    .009    .009    .009
O1   .009    .009    .009    .009    .009    .009    .009    .009    .009    .009
O1   .009    .009    .009    .009    .009    .009    .009    .009    .009    .009
O1   .009    .009    .009    .009    .009    .009    .009    .009    .015    .015
O1   .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
O1   .015    .015    .015    .015    .015    .015    .028    .028    .028    .028
O1   .028    .028    .041    .041    .041    .041    .041    .041    .086    .086
O1   [illegible] [illegible] .165 .374   .583 [illegible] .165    .087    .086    .086
O1   .041    .041    .041    .041    .041    .041    .028    .028    .028    .028
O1   .028    .028    .015    .015    .015    .015    .015    .015    .015    .015
O1   .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
```

10 PERCENT CHANCE FLOOD (Cont'd)

01	.009	.009	.009	.009	.009	.009	.009	.009	.009	.009
01	.009	.009	.009	.009	.009	.009	.009	.009	.009	.009
01	.009	.009	.009	.009	.009	.009	.009	.009	.009	.009
01	.009	.009	.009	.009	.009	.009	.005	.005	.005	.005
01	.005	.005	.005	.005	.005	.005	.005	.005	.005	.005
01	.005	.005	.005	.005	.005	.005	.005	.005	.005	.005
01	.005	.005	.005	.005	.005	.005	.005	.005	.005	.005
01	.005	.005	.005	.005	.005	.005	.005	.005	.005	.005
01	.005	.005	.005	.005	.005	.005	.005	.005	.005	.005
01	.005	.005	.005	.005	.005	.005	.005	.005	.005	.005
01	.005	.005	.005	.005	.005	.005	.005	.005		
T							-1	-77		
W2		0.097								
X	-1.0	-.10	2.0							
K	1	DAM					1			
H1	RESERVOIR ROUTING U. MODIFIED PULS									
V				1	1					
Y1	1						154.20	1		
Y4	585.0	586.3	587.6	588.13	588.54	588.93	589.80	590.65	591.65	592.03
Y4	592.71	593.39	594.05	594.72	595.38	596.04	596.70	597.09		
Y5	0	25	45	95	131	310	712	1261	1798	2400
Y5	3074	3856	4594	5612	6468	7083	8000	8570		
$A	0	14.2	15.2	17.9	25.7					
$E	552	585	590	600	610					
$$	585.0									
$D	588.0									
$L	0	100	225	375	412	608	650	690	720	750
$V	588.0	588.1	588.4	588.5	588.6	588.9	589.4	591.6	596.0	599.3
K	99									

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF VATTEROTT LAKE DAM
RATIOS OF PMF ROUTED THROUGH RESERVOIR

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1
RTIOS= .11 .12 .50 1.00

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

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

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

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.36	0.00	.36	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.50	102.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-89.00	0.00	0.00

CURVE NO = -89.00 WETNESS = -1.00 EFFECT CN = 89.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .10

RECESSION DATA
STRTQ= -1.00 ORCSN= -.10 RTIOR= 2.00

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

UNIT HYDROGRAPH 8 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .10 VOL= 1.00
836. 1174. 471. 185. 69. 26. 11. 2.

0

END OF PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.05	145	.22	.21	.01	295.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.10	146	.22	.21	.01	469.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.15	147	.22	.21	.01	547.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.20	148	.22	.21	.01	571.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.25	149	.22	.21	.01	583.
1.01	.30	6	.01	0.00	.01	0.	1.01	12.30	150	.22	.21	.01	587.
1.01	.35	7	.01	0.00	.01	0.	1.01	12.35	151	.22	.21	.01	590.
1.01	.40	8	.01	0.00	.01	0.	1.01	12.40	152	.22	.21	.00	591.
1.01	.45	9	.01	0.00	.01	0.	1.01	12.45	153	.22	.21	.00	592.
1.01	.50	10	.01	0.00	.01	0.	1.01	12.50	154	.22	.21	.00	593.
1.01	.55	11	.01	0.00	.01	0.	1.01	12.55	155	.22	.21	.00	593.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.00	156	.22	.21	.00	594.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.05	157	.26	.26	.00	630.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.10	158	.26	.26	.00	681.
1.01	1.15	15	.01	0.00	.01	0.	1.01	13.15	159	.26	.26	.00	702.
1.01	1.20	16	.01	0.00	.01	0.	1.01	13.20	160	.26	.26	.00	711.
1.01	1.25	17	.01	0.00	.01	0.	1.01	13.25	161	.26	.26	.00	714.
1.01	1.30	18	.01	.00	.01	0.	1.01	13.30	162	.26	.26	.00	716.
1.01	1.35	19	.01	.00	.01	0.	1.01	13.35	163	.26	.26	.00	717.
1.01	1.40	20	.01	.00	.01	1.	1.01	13.40	164	.26	.26	.00	717.
1.01	1.45	21	.01	.00	.01	2.	1.01	13.45	165	.26	.26	.00	718.
1.01	1.50	22	.01	.00	.01	3.	1.01	13.50	166	.26	.26	.00	718.
1.01	1.55	23	.01	.00	.01	3.	1.01	13.55	167	.26	.26	.00	719.
1.01	2.00	24	.01	.00	.01	4.	1.01	14.00	168	.26	.26	.00	719.
1.01	2.05	25	.01	.00	.01	5.	1.01	14.05	169	.33	.32	.00	773.
1.01	2.10	26	.01	.00	.01	6.	1.01	14.10	170	.33	.32	.00	849.
1.01	2.15	27	.01	.00	.01	6.	1.01	14.15	171	.33	.32	.00	881.
1.01	2.20	28	.01	.00	.01	7.	1.01	14.20	172	.33	.32	.00	893.
1.01	2.25	29	.01	.00	.01	8.	1.01	14.25	173	.33	.32	.00	898.
1.01	2.30	30	.01	.00	.01	8.	1.01	14.30	174	.33	.32	.00	900.
1.01	2.35	31	.01	.00	.01	9.	1.01	14.35	175	.33	.32	.00	901.
1.01	2.40	32	.01	.00	.01	10.	1.01	14.40	176	.33	.32	.00	902.
1.01	2.45	33	.01	.00	.01	10.	1.01	14.45	177	.33	.32	.00	902.
1.01	2.50	34	.01	.00	.01	11.	1.01	14.50	178	.33	.32	.00	902.
1.01	2.55	35	.01	.00	.01	11.	1.01	14.55	179	.33	.32	.00	903.
1.01	3.00	36	.01	.00	.01	12.	1.01	15.00	180	.33	.32	.00	903.
1.01	3.05	37	.01	.00	.01	12.	1.01	15.05	181	.20	.20	.00	797.
1.01	3.10	38	.01	.00	.01	13.	1.01	15.10	182	.40	.39	.00	816.
1.01	3.15	39	.01	.00	.01	13.	1.01	15.15	183	.40	.39	.00	937.
1.01	3.20	40	.01	.01	.01	14.	1.01	15.20	184	.59	.59	.00	1219.
1.01	3.25	41	.01	.01	.01	14.	1.01	15.25	185	.69	.69	.00	1560.
1.01	3.30	42	.01	.01	.01	15.	1.01	15.30	186	1.68	1.67	.01	2606.
1.01	3.35	43	.01	.01	.01	15.	1.01	15.35	187	2.77	2.76	.01	4758.
1.01	3.40	44	.01	.01	.01	16.	1.01	15.40	188	1.09	1.08	.00	5149.
1.01	3.45	45	.01	.01	.01	16.	1.01	15.45	189	.69	.69	.00	3581.
1.01	3.50	46	.01	.01	.01	16.	1.01	15.50	190	.59	.59	.00	2488.
1.01	3.55	47	.01	.01	.01	17.	1.01	15.55	191	.40	.39	.00	1807.
1.01	4.00	48	.01	.01	.01	17.	1.01	16.00	192	.40	.39	.00	1378.
1.01	4.05	49	.01	.01	.01	18.	1.01	16.05	193	.30	.30	.00	1129.
1.01	4.10	50	.01	.01	.01	18.	1.01	16.10	194	.30	.30	.00	952.

END-OF-PERIOD FLOW (Cont'd)

1.01	4.15	51	.01	.01	.01	18.
1.01	4.20	52	.01	.01	.01	19.
1.01	4.25	53	.01	.01	.01	19.
1.01	4.30	54	.01	.01	.01	19.
1.01	4.35	55	.01	.01	.01	20.
1.01	4.40	56	.01	.01	.01	20.
1.01	4.45	57	.01	.01	.01	20.
1.01	4.50	58	.01	.01	.01	21.
1.01	4.55	59	.01	.01	.01	21.
1.01	5.00	60	.01	.01	.01	21.
1.01	5.05	61	.01	.01	.01	22.
1.01	5.10	62	.01	.01	.01	22.
1.01	5.15	63	.01	.01	.01	22.
1.01	5.20	64	.01	.01	.01	22.
1.01	5.25	65	.01	.01	.01	23.
1.01	5.30	66	.01	.01	.01	23.
1.01	5.35	67	.01	.01	.01	23.
1.01	5.40	68	.01	.01	.01	23.
1.01	5.45	69	.01	.01	.01	24.
1.01	5.50	70	.01	.01	.01	24.
1.01	5.55	71	.01	.01	.01	24.
1.01	6.00	72	.01	.01	.01	24.
1.01	6.05	73	.06	.04	.02	51.
1.01	6.10	74	.06	.04	.02	89.
1.01	6.15	75	.06	.04	.02	107.
1.01	6.20	76	.06	.04	.02	116.
1.01	6.25	77	.06	.05	.02	122.
1.01	6.30	78	.06	.05	.02	126.
1.01	6.35	79	.06	.05	.02	129.
1.01	6.40	80	.06	.05	.02	131.
1.01	6.45	81	.06	.05	.01	134.
1.01	6.50	82	.06	.05	.01	136.
1.01	6.55	83	.06	.05	.01	138.
1.01	7.00	84	.06	.05	.01	140.
1.01	7.05	85	.06	.05	.01	142.
1.01	7.10	86	.06	.05	.01	143.
1.01	7.15	87	.06	.05	.01	145.
1.01	7.20	88	.06	.05	.01	146.
1.01	7.25	89	.06	.05	.01	148.
1.01	7.30	90	.06	.05	.01	149.
1.01	7.35	91	.06	.05	.01	150.
1.01	7.40	92	.06	.05	.01	151.
1.01	7.45	93	.06	.05	.01	152.
1.01	7.50	94	.06	.06	.01	153.
1.01	7.55	95	.06	.06	.01	154.
1.01	8.00	96	.06	.06	.01	155.
1.01	8.05	97	.06	.06	.01	156.
1.01	8.10	98	.06	.06	.01	157.
1.01	8.15	99	.06	.06	.01	157.
1.01	8.20	100	.06	.06	.01	158.
1.01	8.25	101	.06	.06	.01	159.
1.01	8.30	102	.06	.06	.01	159.
1.01	8.35	103	.06	.06	.01	160.
1.01	16.15	195	.30	.30	.00	833.
1.01	16.20	196	.30	.30	.00	859.
1.01	16.25	197	.30	.30	.00	850.
1.01	16.30	198	.30	.30	.00	847.
1.01	16.35	199	.30	.30	.00	846.
1.01	16.40	200	.30	.30	.00	846.
1.01	16.45	201	.30	.30	.00	846.
1.01	16.50	202	.30	.30	.00	846.
1.01	16.55	203	.30	.30	.00	846.
1.01	17.00	204	.30	.30	.00	846.
1.01	17.05	205	.24	.24	.00	792.
1.01	17.10	206	.24	.24	.00	716.
1.01	17.15	207	.24	.24	.00	684.
1.01	17.20	208	.24	.24	.00	672.
1.01	17.25	209	.24	.24	.00	668.
1.01	17.30	210	.24	.24	.00	666.
1.01	17.35	211	.24	.24	.00	665.
1.01	17.40	212	.24	.24	.00	665.
1.01	17.45	213	.24	.24	.00	665.
1.01	17.50	214	.24	.24	.00	665.
1.01	17.55	215	.24	.24	.00	665.
1.01	18.00	216	.24	.24	.00	665.
1.01	18.05	217	.02	.02	.00	509.
1.01	18.10	218	.02	.02	.00	475.
1.01	18.15	219	.02	.02	.00	443.
1.01	18.20	220	.02	.02	.00	413.
1.01	18.25	221	.02	.02	.00	386.
1.01	18.30	222	.02	.02	.00	360.
1.01	18.35	223	.02	.02	.00	336.
1.01	18.40	224	.02	.02	.00	313.
1.01	18.45	225	.02	.02	.00	292.
1.01	18.50	226	.02	.02	.00	273.
1.01	18.55	227	.02	.02	.00	254.
1.01	19.00	228	.02	.02	.00	237.
1.01	19.05	229	.02	.02	.00	222.
1.01	19.10	230	.02	.02	.00	207.
1.01	19.15	231	.02	.02	.00	193.
1.01	19.20	232	.02	.02	.00	180.
1.01	19.25	233	.02	.02	.00	168.
1.01	19.30	234	.02	.02	.00	157.
1.01	19.35	235	.02	.02	.00	146.
1.01	19.40	236	.02	.02	.00	136.
1.01	19.45	237	.02	.02	.00	127.
1.01	19.50	238	.02	.02	.00	119.
1.01	19.55	239	.02	.02	.00	111.
1.01	20.00	240	.02	.02	.00	103.
1.01	20.05	241	.02	.02	.00	96.
1.01	20.10	242	.02	.02	.00	90.
1.01	20.15	243	.02	.02	.00	84.
1.01	20.20	244	.02	.02	.00	78.
1.01	20.25	245	.02	.02	.00	73.
1.01	20.30	246	.02	.02	.00	68.
1.01	20.35	247	.02	.02	.00	64.

END-OF-PERIOD FLOW (Cont'd)

1.01	8.40	104	.06	.06	.01	161.	1.01	20.40	248	.02	.02	.00	59.
1.01	8.45	105	.06	.06	.01	161.	1.01	20.45	249	.02	.02	.00	59.
1.01	8.50	106	.06	.06	.01	162.	1.01	20.50	250	.02	.02	.00	59.
1.01	8.55	107	.06	.06	.01	162.	1.01	20.55	251	.02	.02	.00	59.
1.01	9.00	108	.06	.06	.01	163.	1.01	21.00	252	.02	.02	.00	59.
1.01	9.05	109	.06	.06	.01	163.	1.01	21.05	253	.02	.02	.00	59.
1.01	9.10	110	.06	.06	.01	164.	1.01	21.10	254	.02	.02	.00	59.
1.01	9.15	111	.06	.06	.00	164.	1.01	21.15	255	.02	.02	.00	59.
1.01	9.20	112	.06	.06	.00	164.	1.01	21.20	256	.02	.02	.00	59.
1.01	9.25	113	.06	.06	.00	165.	1.01	21.25	257	.02	.02	.00	59.
1.01	9.30	114	.06	.06	.00	165.	1.01	21.30	258	.02	.02	.00	59.
1.01	9.35	115	.06	.06	.00	166.	1.01	21.35	259	.02	.02	.00	59.
1.01	9.40	116	.06	.06	.00	166.	1.01	21.40	260	.02	.02	.00	59.
1.01	9.45	117	.06	.06	.00	166.	1.01	21.45	261	.02	.02	.00	59.
1.01	9.50	118	.06	.06	.00	166.	1.01	21.50	262	.02	.02	.00	59.
1.01	9.55	119	.06	.06	.00	167.	1.01	21.55	263	.02	.02	.00	59.
1.01	10.00	120	.06	.06	.00	167.	1.01	22.00	264	.02	.02	.00	59.
1.01	10.05	121	.06	.06	.00	167.	1.01	22.05	265	.02	.02	.00	59.
1.01	10.10	122	.06	.06	.00	168.	1.01	22.10	266	.02	.02	.00	59.
1.01	10.15	123	.06	.06	.00	168.	1.01	22.15	267	.02	.02	.00	59.
1.01	10.20	124	.06	.06	.00	168.	1.01	22.20	268	.02	.02	.00	59.
1.01	10.25	125	.06	.06	.00	168.	1.01	22.25	269	.02	.02	.00	59.
1.01	10.30	126	.06	.06	.00	169.	1.01	22.30	270	.02	.02	.00	59.
1.01	10.35	127	.06	.06	.00	169.	1.01	22.35	271	.02	.02	.00	59.
1.01	10.40	128	.06	.06	.00	169.	1.01	22.40	272	.02	.02	.00	59.
1.01	10.45	129	.06	.06	.00	169.	1.01	22.45	273	.02	.02	.00	59.
1.01	10.50	130	.06	.06	.00	169.	1.01	22.50	274	.02	.02	.00	59.
1.01	10.55	131	.06	.06	.00	170.	1.01	22.55	275	.02	.02	.00	59.
1.01	11.00	132	.06	.06	.00	170.	1.01	23.00	276	.02	.02	.00	59.
1.01	11.05	133	.06	.06	.00	170.	1.01	23.05	277	.02	.02	.00	59.
1.01	11.10	134	.06	.06	.00	170.	1.01	23.10	278	.02	.02	.00	59.
1.01	11.15	135	.06	.06	.00	170.	1.01	23.15	279	.02	.02	.00	59.
1.01	11.20	136	.06	.06	.00	171.	1.01	23.20	280	.02	.02	.00	59.
1.01	11.25	137	.06	.06	.00	171.	1.01	23.25	281	.02	.02	.00	59.
1.01	11.30	138	.06	.06	.00	171.	1.01	23.30	282	.02	.02	.00	59.
1.01	11.35	139	.06	.06	.00	171.	1.01	23.35	283	.02	.02	.00	59.
1.01	11.40	140	.06	.06	.00	171.	1.01	23.40	284	.02	.02	.00	59.
1.01	11.45	141	.06	.06	.00	171.	1.01	23.45	285	.02	.02	.00	59.
1.01	11.50	142	.06	.06	.00	171.	1.01	23.50	286	.02	.02	.00	59.
1.01	11.55	143	.06	.06	.00	172.	1.01	23.55	287	.02	.02	.00	59.
1.01	12.00	144	.06	.06	.00	172.	1.02	0.00	288	.02	.02	.00	59.

SUM	33.15	31.71	1.44	92708.
	(842.)	(805.)	(37.)	(2625.20)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5149.	997.	372.	372.	92694.
CMS	146.	28.	9.	9.	2625.
INCHES		25.70	33.18	33.18	33.18
MM		652.79	842.65	842.65	842.65
AC-FT		495.	638.	638.	638.
THOUS CU M		610.	787.	787.	787.

SURFACE AREA=	0.	14.	15.	18.	26.
CAPACITY=	0.	156.	230.	395.	612.
ELEVATION=	552.	585.	590.	600.	610.

SUMMARY OF DAM SAFETY ANALYSIS

PMF

....		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	585.00	585.00	588.00
	STORAGE	156.	156.	[illegible]
	OUTFLOW	0.	0.	[illegible]

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.11	587.90	0.00	[illegible]	72.	0.00	[illegible]	0.00
.12	588.05	.05	200.	[illegible]	1.75	17.17	0.00
.50	589.39	1.39	[illegible]	[illegible]	7.50	[illegible]	0.00
1.00	590.06	2.06	231.	[illegible]	11.25	[illegible]	0.00

SUMMARY OF DAM SAFETY ANALYSIS

1 PERCENT CHANCE FLOOD

....		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	585.00	585.00	588.00
	STORAGE	156.	156.	200.
	OUTFLOW	0.	0.	81.

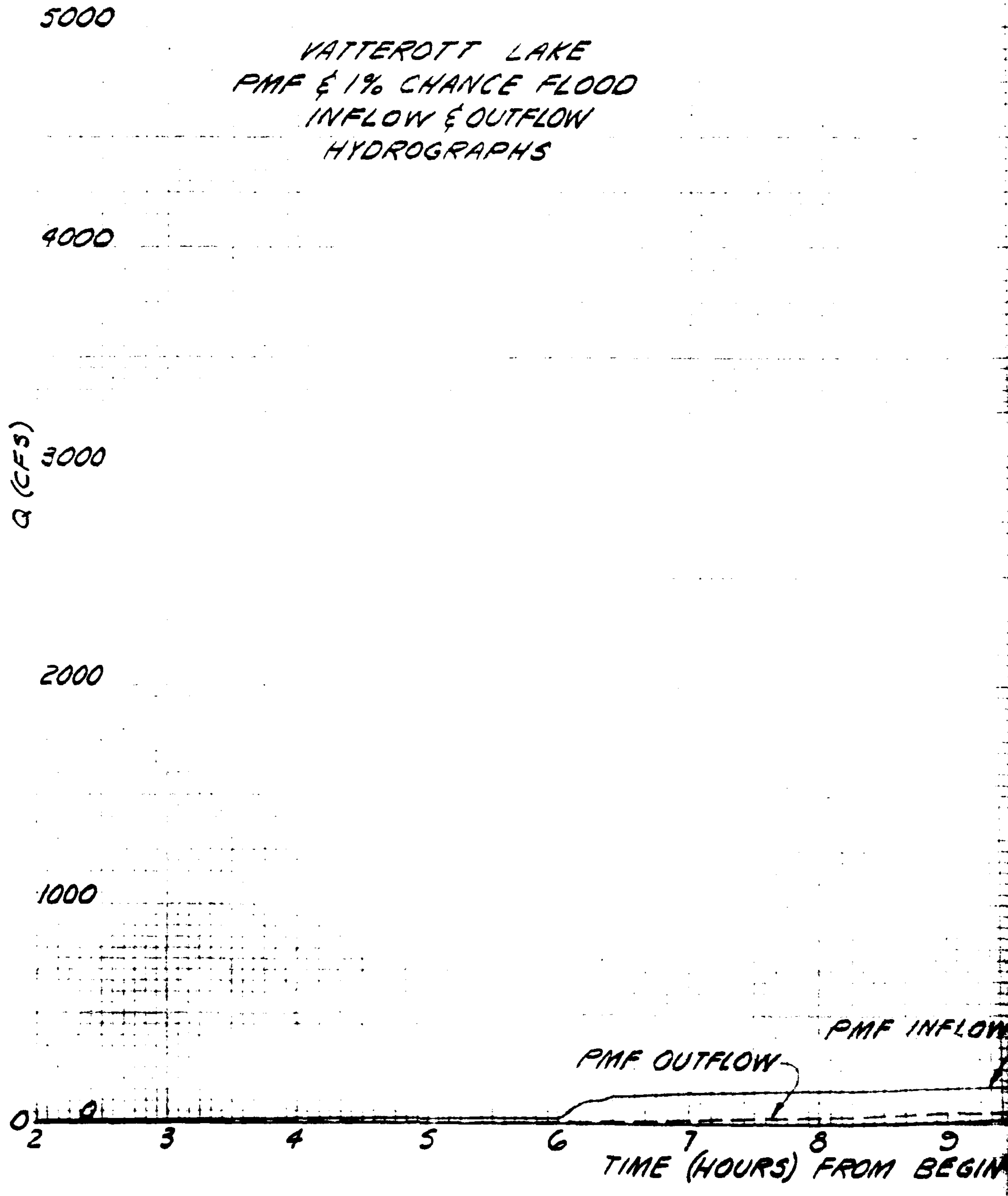
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	588.27	.27	204.	159.	2.00	12.67	0.00

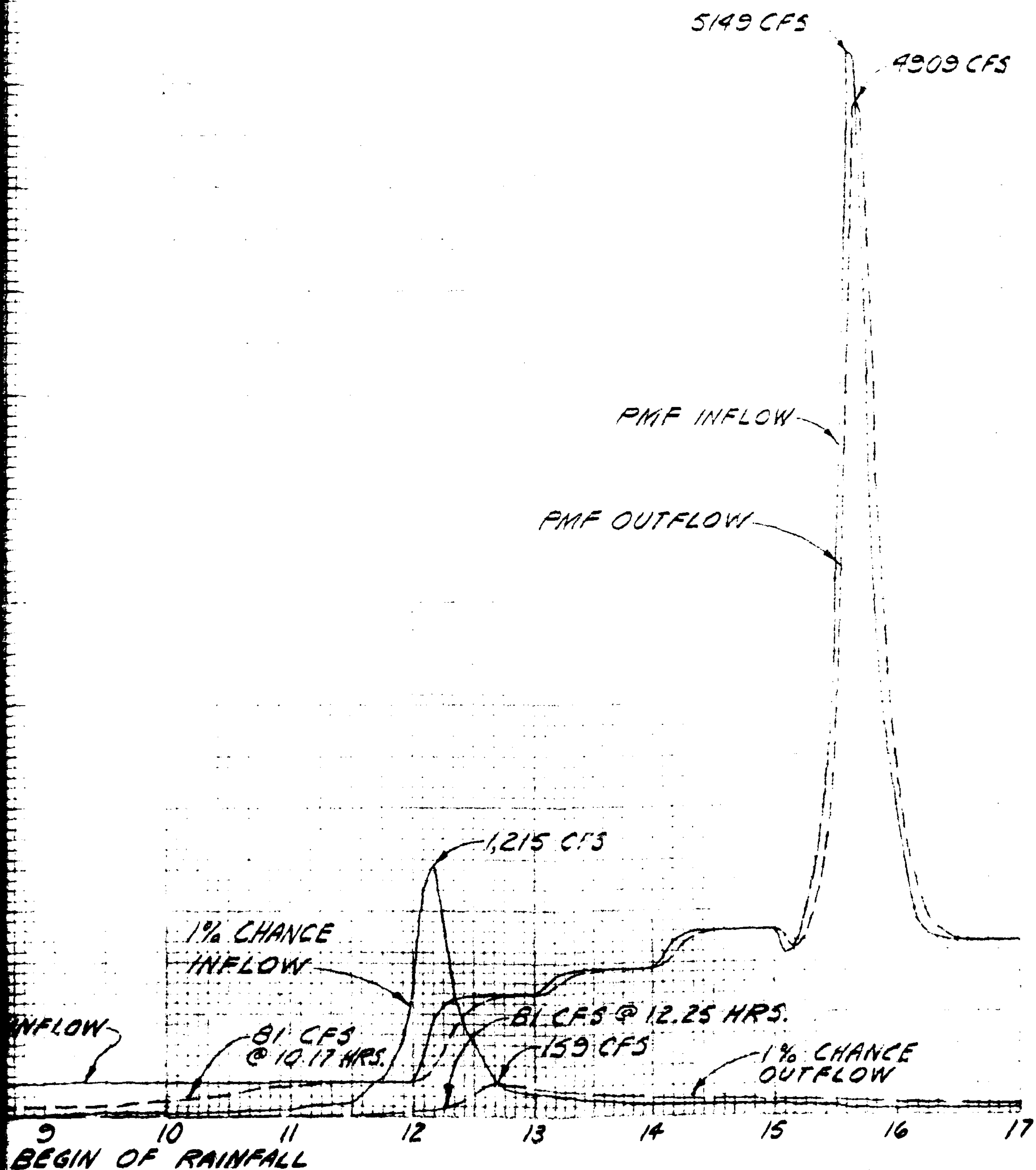
SUMMARY OF DAM SAFETY ANALYSIS

10 PERCENT CHANCE FLOOD

....		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	585.00	585.00	588.00
	STORAGE	156.	156.	200.
	OUTFLOW	0.	0.	81.

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
1.00	587.07	0.00	186.	37.	0.00	14.08	0.00


VATTEROTT LAKE
PMF & 1% CHANCE FLOOD
INFLOW & OUTFLOW
HYDROGRAPHS
5000
4000
3000
2000
1000
0
Q (CFS)
PMF INFLOW
PMF OUTFLOW
2
3
4
5
6
7
8
9
TIME (HOURS) FROM BEGIN


5149 CFS
4909 CFS
PMF INFLOW
PMF OUTFLOW
1,215 CFS
1% CHANCE INFLOW
INFLOW
81 CFS @ 10.17 HRS.
81 CFS @ 12.25 HRS.
159 CFS
1% CHANCE OUTFLOW
9
10
11
12
13
14
15
16
17
BEGIN OF RAINFALL

DATE
ILME