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NATIONAL DAM SAFETY PROGRAM. NEW LA BELLE LAKE DAM (NO-10372), --ETC(U)

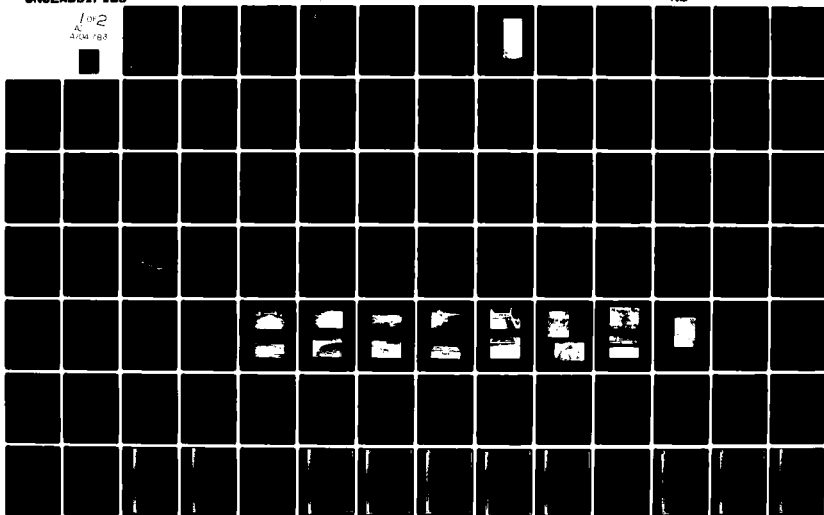
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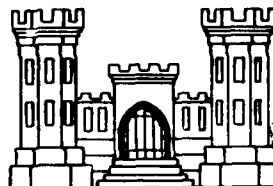
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NEW LA BELLE LAKE DAM
LEWIS COUNTY, MISSOURI
MO 10372



PHASE I INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM

New La Belle Lake Dam (MO-10372), Mississippi -
Salt - Quincy River Basin. Lewis County,
Missouri. Phase I Inspection Report.



Final Report

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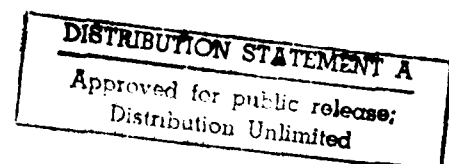
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PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI



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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: New Labelle Lake Dam (Mo. 10372),
Phase I Inspection Report

This report presents the results of field inspection and evaluation of New Labelle Lake Dam (Mo. 10372). It was prepared under the National Program of Inspection of Non-Federal Dams.

SIGNED

SUBMITTED BY:

Chief, Engineering Division

18 JAN 1979

(Date)

SIGNED

APPROVED BY:

Colonel, CE, District Engineer

18 JAN 1979

(Date)

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: New Labelle Lake Dam, Missouri Inv. No. 10372
State Located: Missouri
County Located: Lewis
Stream: Unnamed Tributary of Troublesome Creek
Date of Inspection: September 27 and October 6, 1978

New Labelle Lake Dam No. Mo.10372 was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of Federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. Two houses and a city water treatment plant would be subjected to flooding, with possible damage and/or destruction, and possible loss of life. New Labelle Lake Dam is in the small size classification since it is less than 40 feet high and impounds less than 1,000 acre-feet of water.

Our inspection and evaluation indicates that the spillway of New Labelle Lake Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. New Labelle Lake Dam is a small size dam with a high hazard

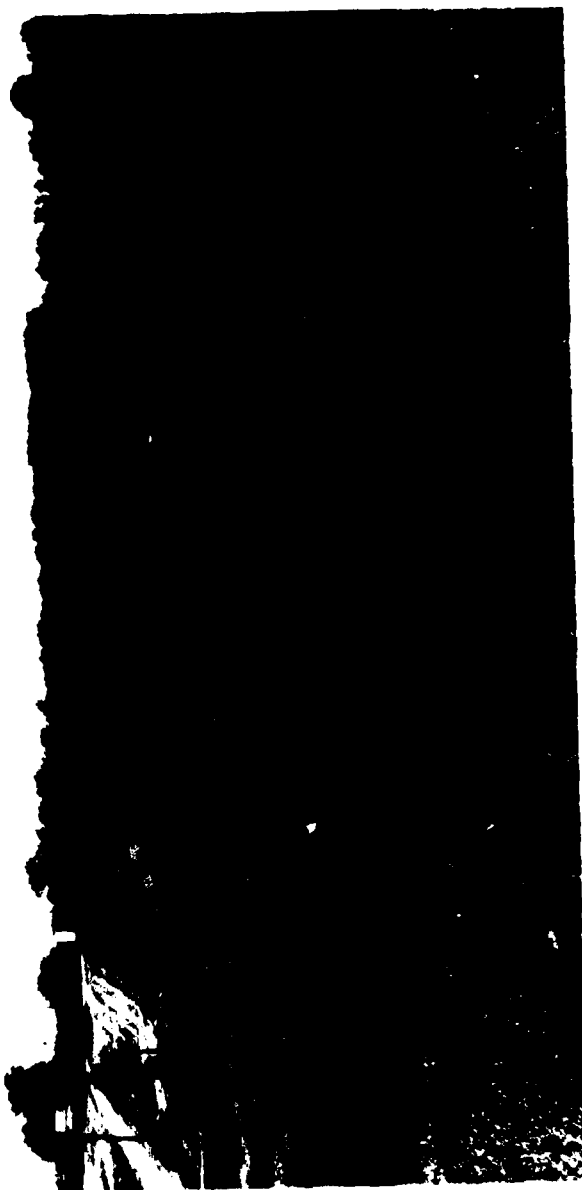
potential required by the guidelines to pass from one-half Probable Maximum Flood to the Probable Maximum Flood without overtopping. Since there is significant hazard potential downstream of the dam, the appropriate spillway design flood for this dam is a flood somewhat greater than one-half of the Probable Maximum Flood. It was determined that the spillway will pass 93 percent of the Probable Maximum Flood without overtopping the dam. ~~Our evaluation indicates 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.

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.

Deficiencies noted by the inspection team were a need for an annual inspection by a qualified professional engineer; lack of a maintenance schedule; required repairs to the service spillway structure, pipe and discharge channel; tree growth on the upstream embankment slope; and the buried discharge end of the reservoir drain line. The lack of stability and seepage analysis on record is also a deficiency that should be corrected.

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

- 12 -



NEW LABELLE LAKE DAI

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

New Labelle Lake Dam, I.D. No. 10372

TABLE OF CONTENTS

<u>Sect. No.</u>	<u>Title</u>	<u>Page</u>
SECTION 1	PROJECT INFORMATION	1
	1.1 General	1
	1.2 Description of Project	2
	1.3 Pertinent Data	7
SECTION 2	ENGINEERING DATA	10
	2.1 Design	10
	2.2 Construction	10
	2.3 Operation	10
	2.4 Evaluation	11
SECTION 3	VISUAL INSPECTION	13
	3.1 Findings	13
	3.2 Evaluation	16
SECTION 4	OPERATION PROCEEDURES	18
	4.1 Procedures	18
	4.2 Maintenance of Dam	18
	4.3 Maintenance of Operating Facilities	19
	4.4 Description of Any Warning System in Effect	19
	4.5 Evaluation	19
SECTION 5	HYDRAULIC/HYDROLOGIC	20
	5.1 Evaluation of Features	20

TABLE OF CONTENTS
(Continued)

<u>Sect. No.</u>	<u>Title</u>	<u>Page</u>
SECTION 6	STRUCTURAL STABILITY	25
	6.1 Evaluation of Structural Stability	25
SECTION 7	ASSESSMENT/REMEDIAL MEASURES	28
	7.1 Dam Assessment	28
	7.2 Remedial Measures	31

LIST OF PLATES

	<u>Plate No.</u>
LOCATION MAP	1
PLAN AND ELEVATION OF DAM	2-13
GENERAL GEOLOGIC MAP	14

APPENDICES

APPENDIX A	-	PHOTOGRAPHS TAKEN DURING INSPECTION
APPENDIX B	-	HYDROLOGIC COMPUTATIONS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

NEW LABELLE LAKE DAM, Missouri Inv. No. 10372

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

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

b. Purpose of Inspection

The visual inspection of the New Labelle Lake Dam was made on September 27, and October 6, 1978. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

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

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

d. Evaluation Criteria

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

1.2 Description of the Project

a. Description of Dam and Appurtenances

The dam is a zoned embankment earthfill structure. The crest of the embankment has a width of 15 feet, and a length of 950 feet. The crest elevation is set at 696.0 feet above MSL, with the maximum height of the embankment 37 feet

above the minimum streambed elevation. The crest of the dam from station 4+27.8 to station 7+54.72 is in a curved shape, with a radius of curvature equal to 220.38 feet.

The upstream slope of the typical embankment section is constructed with a 1V to 3H side slope to elevation 685.5, a 5-foot wide berm at elevation 685.5, and a 1V to 3H slope to the ground surface.

An 18-inch layer of dumped rock riprap underlain by a 6-inch layer of pit run gravel was placed on the upstream slope for protection between elevation 685.5 and 691.0. The rocks used for the riprap were angular blocks of limestone up to 1 foot in diameter, with the typical size 4 to 10 inches in diameter. The crest and downstream slope of the embankment section is protected with vegetative cover.

The embankment section contains a central core of "Class 1" fill, and outside shells of "Class 2" fill. No information concerning the properties of the materials used for the embankment is available. The central core starts at crest elevation 694.0, with a width of 10 feet, and has side slopes of 1V to 1H.

Bedrock within the vicinity is composed of Mississippian age limestones. No rock crops out over the site. The soil in the vicinity of the dam is likely a Lindley silt loam, which is glacial in origin.

A cut-off trench, with side slopes of 1V to 1-1/2H, and a base width of 10 feet, was excavated into the foundation for a depth of 5 feet through abutments and up to 15 feet in the channel section.

There are two spillways for the New Labelle Lake reservoir. The service spillway is located near the mid-section of the dam embankment. This spillway consists of an uncontrolled concrete drop box inlet structure, currently at elevation 690.0 feet, which connects to a 30 inch C.M.P. discharge pipe at elevation 685.5. The discharge pipe extends from the inlet structure for about 64'-6" at a slope of approximately 3 percent, then slopes at 1V to 2-1/2H for 61'-6". The pipe then returns to a horizontal gradient for 39'-0" at an exit elevation of 660.0 into a trapezoidal grass-lined channel.

The emergency spillway is a grass-lined open channel located at the left abutment of the dam. The spillway crest has a bottom width of about 20 feet and side slopes of 1V to 3H. The spillway crest is at elevation 691.0 MSL. The spillway discharge channel is also grass-lined, which runs almost parallel to the embankment toe until it joins the service spillway discharge channel. There is a 24-inch C.M.P. under the county road at the junction of the service spillway discharge channel and the emergency spillway channel.

A municipal water treatment plant for the town of Labelle is situated approximately 200 feet below the downstream toe of the dam. The treatment plant provides for chemical treatment, settling, and filtering of the water supply. Pumps in the plant deliver the water through a pipeline to storage facilities at Labelle. Raw water from the reservoir is fed into the plant by gravity flow.

The raw water line consists of an 8-inch diameter cast iron pipe which connects at its upstream end with and 8-inch diameter flexible hose fitted with an intake strainer. The strainer is suspended by a galvanized wire rope connected

to a hand hoist which is mounted on the service spillway intake structure on the dam crest. The degree of submergence of the intake strainer can be adjusted by the hoist. The wire rope is carried over and suspended from a rope sheave attached to the end of a structural steel strut which projects out from the dam to a point above the strainer.

The design drawings indicate that the reach of the waterline under the dam embankment is encased in a 15 inch by 14 gage corrugated metal pipe.

Immediately downstream of the dam toe, an 8-inch drain line with a gate valve branches from the raw water line and leads to the watercourse draining from the downstream area of the dam.

The reservoir surface area is about 20 acres at the service spillway crest. A sediment channel exists at the upper end of the reservoir.

b. Location

The New Labelle Lake Dam is located on an unnamed tributary of Troublesome Creek, Lewis County, Missouri. The nearest downstream community is Steffenville, Missouri, approximately 11 miles downstream from the dam. The dam and reservoir are shown on Labelle Quadrangle Sheet (7.5 minute series) in Section 16, Township 61 North, Range 9 West.

c. Size Classification

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

d. Hazard Classification

The dam has been classified as having "High" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. Our findings concur with the classification. The estimated damage zone extends three miles downstream of the dam. Within the damage zone are two houses and a city water treatment plant. Also within the damage zone are one state highway and one county road. The floodplann is farmed.

e. Ownership

New Labelle Lake Dam is owned by the City of Labelle, located in Lewis County, Missouri.

f. Purpose of Dam

The purpose of the dam is to impound water for water supply system operated by the City of Labelle. The impounded water is released by means of the bottom outlet for subsequent use in the city by way of a pumping station immedi-

ately downstream from the dam. The reservoir is also for recreational use.

g. Design and Construction History

The dam was designed in 1959 by Wm. Klingner Engineers of Quincy, Illinois. Construction was completed in 1961 by Hardy and Sons Construction of Shelbyville, Missouri.

The only post construction work on the dam and appurtenant structures has been the addition of 2 feet to the top of the drop box inlet structure for the service spillway.

h. Normal Operational Procedures

The dam is used to impound water for use as water supply for the City of Labelle, Missouri. The reservoir level is controlled by rainfall, runoff, evaporation, and the water supply requirements of the city. The reservoir is likely close to full at all times.

1.3 Pertinent Data

a. Drainage Area	176 acres
b. Discharge at Damsite	All discharge at the dam-site is through two uncontrolled spillways and a water supply outlet
Estimated experienced maximum flood:	600 cfs
Estimated ungated spillway capacity at maximum pool elevation:	1,200 cfs (W.S. at 696.0)

c. Elevation (Feet above MSL)

Top of dam:	696.0
Spillway crest: (Service spillway)	690.0
(Emergency spillway)	691.0
Minimum streambed elevation at centerline of dam:	659.0
Maximum tailwater:	Unknown

d. Reservoir

Length of maximum pool:	1,800 feet <u>±</u>
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e. Storage (Acre-Feet)

Top of dam:	339
Spillway crest (Service Spillway):	194

f. Reservoir Surface (Acres)

Top of dam:	30
Spillway crest: (Service spillway)	17

g. Dam

Type:	Zoned earthfill embankment
Length:	950 feet
Height (maximum):	37 feet
Top width:	15 feet
Side slopes:	
Downstream	1V to 3H
Upstream	1V to 2-1/2H
Zoning:	Central core and outer shells
Impervious core:	Central core has a crest width at elevation 694.0 and 1V to 1H side slopes
Cutoff:	Core trench with 10-foot bottom width and 1V to 1-1/2H side slopes
Grout curtain:	None

h. Diversion and Regulating Tunnel

None

i. Spillway

Type: (Service spillway)	Uncontrolled, 30-inch diameter C.M.P.
(Emergency spillway)	Uncontrolled
Length of weir: (Service spillway)	16 feet
(Emerg. spillway)	20 feet
Crest Elevation: (Service spillway)	690 feet MSL
(Emergency spillway)	691 feet MSL

j. Regulating Outlets

Type:	8-inch diameter cast iron pipe
Length:	350 feet
Closure:	8-inch diameter gate valve
Maximum Capacity:	5.2 cfs

SECTION 2: ENGINEERING DATA

2.1 Design

Original design drawings are available for the dam and appurtenant structures. These drawings were made in 1959, and some are given as plates in this report. The design drawings are available from Klingner Engineering, 310 Broadway Street, Quincy, Illinois.

2.2 Construction

The dam was constructed in 1959 and 1960. In 1971, 2 feet was added to the drop box inlet structure for the service spillway to increase the storage to elevation 690.0. An 8-inch thick wall has also been constructed inside of the drop box structure. No additional construction data is available.

2.3 Operation

No operation records for New Labelle Lake Dam are available.

A seep has been detected 1 to 2 vertical feet below the berm on the line of the corrugated metal pipe for the service spillway. This seep was originally detected about 8 years ago, but corrective measures have not been taken.

2.4 Evaluation

a. Availability

The only available data for this project is the original design drawings. No construction data or operation data is available.

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

b. Adequacy

The design drawings are adequate to aid in evaluating the adequacy of the hydraulic and hydrologic capabilities and stability of the dam for Phase I investigations.

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

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

c. Validity

The dam and appurtenant structures appear to have been constructed in accordance with the available design drawings. However, the modification to the drop box inlet structure is not shown on the design drawings.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of New Labelle Lake Dam was made on September 27, and October 6, 1978. The following persons were present during the inspection:

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

Specific observations are discussed below.

b. Dam

The crest of the dam has a heavy vegetative cover which adequately protects the embankment material. The crest of the dam near the section of the service spillway pipe appears to have settled several feet. This could be observed best from across the paved road to the right of the dam, but the high grass on the embankment crest makes observing the condition very difficult. The local dam superintendent stated that the settlement could be easily observed following cutting of the grass on the crest.

The upstream embankment slope did not exhibit significant sloughing of the embankment material. The riprap, which was placed originally to elevation 691.0, is only 1 foot above the maximum water surface elevation following the reconstruction of the drop inlet structure. However, the heavy grass on the upstream slope is adequately protecting the embankment. Some small trees were observed growing on the upstream embankment slope during the inspection.

The downstream slope is generally well-protected by the vegetative cover. An area was observed on the downstream embankment slope where water appears to flow through the embankment material. The location of this area is approximately 2 vertical feet below the berm on the alignment of the corrugated metal pipe service spillway. A conversation with the dam superintendent indicated that the leak originated approximately 8 years ago. Five years ago a high chlorine solution was injected into the C.M.P. at the upstream end, and a chlorine detector was used to test the water flowing from the embankment. It was found that the seepage flow showed a high chlorine concentration almost immediately, indicating that the water flow from the embankment was the same water injected into the C.M.P. It can, therefore, be concluded that the water flow from the embankment is caused by leakage in the C.M.P. This conclusion is substantiated by the fact that the flow only occurs if water is flowing in the C.M.P. No flow was seen during the day of inspection.

c. Appurtenant Structures

(1) Spillways

The concrete drop inlet structure is in a deteriorated condition. Several major vertical cracks, minor erosion and moderate spalling on the concrete were observed.

There are small trees growing on the upstream slope of the dam near the spillway intake entrance.

The emergency spillway is well-defined, adequately maintained and in a good condition.

Capacity of the 24-inch C.M.P. culvert under the unpaved county road is inadequate for passing the discharge from the spillways without overtopping the road.

The downstream channel leading to the 24-inch C.M.P. is covered with thick grass.

(2) Outlet Works

A cursory inspection was made of the water treatment plant. The plant was clean and in good operating condition. Except for routine maintenance tasks, it is designed to operate unattended.

The sizes, material, and condition of the raw water outlet and drain line under the dam could not be confirmed since they are buried and not accessible for inspection. This includes the discharge end of the

8-inch drain line which is shown to discharge in the spillway discharge channel, and the gate valve controlling this drain line.

d. Reservoir Area

The water level in the reservoir was 688.5 on the day of the inspection. No indication of instability or severe erosion along the rim was apparent. At present, no development has occurred along the shoreline.

e. Downstream Channel

Spillway discharge from the service spillway flows into an unlined trapezoidal channel which was covered with thick grass at the time of inspection. The discharge channel is connected with a 24-inch C.M.P. culvert, approximately 150 feet downstream from the 30-inch C.M.P. exit. Spillway discharge from the emergency spillway also joins at this point. Due to the smaller capacity of the 24-inch culvert, as compared to the spillways capacities, overtopping of the unpaved county road is unavoidable whenever the spillway discharge exceeds the capacity of the 24-inch culvert pipe.

3.2 Evaluation

The visual inspection revealed several items which should be repaired within a reasonable time. However, the location on the downstream embankment slope exhibiting water flow, coupled with the apparent settlement of the embankment in this section, is a condition which indicates a potential serious problem, and should be investigated as soon as possible.

Other items which indicated the need for remedial measures within a reasonable period of time include:

1. The deteriorated concrete drop inlet structure.
2. The small trees growing on the upstream embankment slope.
3. The downstream discharge channel of the service spillway exhibiting heavy vegetative growth, preventing proper flow away from the dam.
4. The inability of the downstream discharge channel and the 24-inch C.M.P. to take the capacity of both spillways without submerging the toe of the dam.
5. The buried valve and discharge end of the reservoir drain line.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

New Labelle Lake Dam is used to impound water from an unnamed tributary of Troublesome Creek for use as water supply for the City of Labelle, Missouri. The water superintendent lives in close proximity to the dam and reservoir, and monitors the lake and treatment plant daily.

The only operating facility the the damsite is the raw water supply intake and appurtenant piping. The intake for the water supply is a flexible hose fitted with a strainer. Downstream of the dam an 8-inch drain line branches from the raw water line.

The valve for controlling the flow through the branch drain line is manually operated, and should normally be kept closed. The drain valve would be opened to drain the reservoir for dam or spillway maintenance, or in event of an emergency situation.

4.2 Maintenance of Dam

The dam is maintained by the Labelle Water Superintendent. Maintenance for the dam appears to be adequate. The small trees beginning to grow on the upstream slope should be cut before they become a hazard.

4.3 Maintenance of Operating Facilities

The discharge end of the reservoir drain line is apparently buried, and should be uncovered. A cursory inspection of the water treatment plant showed the plant to be clean and in good operating condition.

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

The operation procedures and maintenance program at the dam and appurtenant structures appears to be satisfactory. Necessary maintenance includes uncovering the discharge end of the drain line and cutting of trees on the upstream embankment slope.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

New Labelle Lake is located near the western edge of Lewis County, Missouri, in the northeast corner of the state. The main access to the Labelle Lake from the city of Labelle, Missouri is south on State Road D for 1.3 miles. The reservoir is on the east side of Route D next to the Labelle pumping station.

The watershed area for the New Labelle Lake encompasses approximately 176 acres with a minimal amount of forest and wooded area. The reservoir is located on a tributary of Troublesome Creek. Land gradient for the watershed area average about 3 to 4 percent.

Elevations within the watershed range from approximately 685 feet above MSL at the damsite to over 725 feet above MSL in the upper portion of the watershed.

A drainage map showing the watershed area is included in Appendix B.

Evaluation of the hydraulic and hydrologic features of New Labelle Lake Dam was based on criteria set forth in the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum

Precipitation (PMP) using the methods outlined in the U.S. Weather Bureau Publication, Hydrometeorological Report No. 33. The probable maximum storm duration was set at 24 hours, and storm rainfall distribution was based on criteria given in EM 1110-2-1411 (Standard Project Storm). The SCS triangular hydrograph, transformed to a curvilinear hydrograph, was adopted for developing the unit hydrograph. The derived unit hydrograph is presented in Appendix B.

Initial and infiltration loss rates were applied to the PMP to obtain rainfall excesses. The rainfall excesses were then applied to the unit hydrograph to obtain the PMF hydrograph, utilizing the Corps of Engineers' computer program HEC-1, (Dam Safety Version), which was prepared specifically for dam safety analysis. The computed peak discharge of the PMF and one-half of the PMF are 3,615 cfs and 1,807 cfs, respectively.

Both the PMF and one-half of the PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method, also utilizing the HEC-1 (Dam Safety Version) computer program. The peak outflow discharges for the PMF and one-half of the PMF are 1,571 cfs and 532 cfs, respectively. Only the PMF, when routed through the reservoir, resulted in overtopping of the dam. The capacity of the emergency spillway is 1,070 cfs, with the water surface at the dam crest.

The stage-outflow relation for the spillways were prepared from field notes, sketches and limited construction drawings. The reservoir stage-capacity data were based on the U.S.G.S. Labelle Quadrangle (7.5 minute series) topographic maps (dated 1975) in combination with data given in the National Dam Safety Inventory Table. Reservoir storage capacity included surcharge levels exceeding the top of the

dam, and the spillways and overtop rating curve assumed that the dam remains intact during routing. In the routing computations, the discharge through the outlet facilities was excluded due to its insignificant magnitude as compared to the spillways discharge and the PMF. The combined spillways and overtop rating curve and the reservoir capacity curve are also presented in Appendix B.

From the standpoint of dam safety, the hydrologic design of a dam aims at avoiding overtopping. Overtopping is especially dangerous for an earth dam because the downrush of waters over the crest will erode the dam face and, if continued long enough, will breach the dam embankment and release all the stored water suddenly into the downstream floodplain. The safe hydrologic design of a dam calls for a spillway discharge capability, in combination with an embankment crest height that can handle a very large and exceedingly rare flood without overtopping.

b. Experience Data

No records of reservoir stage or spillway discharge are maintained for this site. However, according to the owner, the maximum reservoir level was never higher than the crest of the embankment, and only once did the water flow over the emergency spillway.

c. Visual Observations

The service spillway intake structure is deteriorating. Vertical cracks, minor erosion and moderate spalling on the concrete were apparent. There are no energy dissipators of any kind downstream from the spillway pipe exit. The downstream channel, particularly the 24-inch C.M.P. culvert

under the county road, is not capable of passing the spillway discharge without overtopping the road. The channel is well-defined, but with no riprap protection. Grass growth in the channel is thick and tall. The emergency spillway is in good condition. However, this spillway merges with the service spillway discharge channel 175 feet downstream from the maximum section of the dam. In case the total spillway release is larger than the 24-inch culvert, water would probably submerge the embankment toe, thus, adversely affecting the structural integrity of the dam.

A sedimentation channel was observed several hundred feet north of the right abutment.

The original design called for a pumping system to bring water from Troublesome Creek up to the sedimentation channel and, eventually, to the lake. The pumps at Troublesome Creek were never installed, but the sedimentation channel was constructed, regardless.

d. Overtopping Potential

As indicated in Section 5.1-a., only the Probable Maximum Flood, when routed through the reservoir, results in overtopping of the dam. The PMF overtopped the dam crest by 0.18 feet. The total duration of embankment overflow is 0.33 hours. The settlement of the embankment was not great enough to be considered in the overtopping calculation. The spillways of New Labelle Lake Dam are capable of passing a flood equal to approximately 93 percent of the PMF just before overtopping the dam. The 100-year flood is equal to approximately 10 percent of the PMF, therefore, the spillway will pass the 100-year flood without overtopping of the dam.

The effect from rupture of the dam could extend approximately three miles downstream of the dam. Immediately downstream there are two houses and a city water treatment plant. Also within this zone are one state highway and one county road. The floodplain is farmed.

SECTION 6: STRUCTURAL STABILITY

6.1 Structural Stability

a. Visual Observations

The apparent settlement of the maximum section of the dam embankment along the alignment of the C.M.P. spillway indicates a potentially hazardous condition. Possibly related to this settlement is the water breaking out on the downstream slope from leakage of the C.M.P. It is highly possible that these two observations are related, with the embankment settlement either the cause or the result of the leakage through the C.M.P.

The service spillway drop inlet structure should be repaired to prevent continuous flow through the pipe. This condition is especially critical due to the likely leakage in the C.M.P. pipe and the poor condition of the service spillway discharge channel.

The route of spillways discharges is incapable of carrying potential flows without submerging the toe of the dam. This is a condition which should be corrected. Such submergence may seriously influence the stability of the structure.

The buried discharge end of the reservoir drain is a condition which should be repaired.

b. Design and Construction Data

No design or construction data relating to the structural stability of the dam were found. No design data relating to seepage and stability analysis are known to exist.

c. Operating Records

No operating records are available relating to the stability of the dam. The water level on the day of the inspection was 1.5 feet below the service spillway crest, which is .5 feet above the high water level shown on the design drawings. It is not certain whether the additional 2 feet of water now allowed in the reservoir was accounted for in the original design, but the dam has apparently functioned satisfactorily with the additional water in the reservoir.

d. Post Construction Changes

The original plans show an elevation of 688.0 for the crest of the service spillway. Two feet has been added to the top of the drop box inlet structure to increase the storage of the reservoir. The elevation of the top of the spillway is now 690.0. The elevation of the emergency spillway remains at 691.0 as on the original plans. No other post construction changes were apparent.

e. Seismic Stability

In general, projects which are located in Seismic Zones 0, 1 and 2 may be assumed to present no hazard from earthquake, provided the static stability conditions are satisfactory and conventional safety margins exist.

New Labelle Lake Dam is located in Seismic Zone 1. A detailed seismic analysis is not felt to be necessary for this embankment.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

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

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

It is also important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that an unsafe condition could be detected.

a. Safety

The spillway capacity was found to be satisfactory to pass 93 percent of the Probable Maximum Flood.

The apparent settlement of the dam embankment along the alignment of the corrugated metal pipe utilized for the service spillway, coupled with the apparent leakage of the pipe, is a potentially hazardous condition which should be investigated. It is possible that either embankment settle-

ment caused misalignment of the corrugated metal pipe, resulting in a leak, or that the leak developed first and the embankment settlement was caused by saturation of the embankment materials.

The poor condition of the service spillway upstream and downstream ends magnifies the problem. The drop inlet structure is in a deteriorated condition, with the joints between the drop box and headwall allowing flow into the C.M.P. pipe, and since the C.M.P. leaks, water is continuously allowed into the embankment materials. The downstream discharge channel of the service spillway is full of vegetative growth, not allowing even small discharges to adequately drain from the downstream toe of the embankment. Large discharges would be constrained by the 24-inch C.M.P. culvert under the road as well. Discharges from the emergency spillway would flow along the toe of the dam and into this discharge channel, which will compound the drainage problem. Due to the number and relationships of the various problems associated with the service spillway, it is recommended that a complete engineering study be performed to find the most satisfactory and economical solution.

Other items observed during the visual inspection which should be repaired within a reasonable period of time are the trees beginning to grow on the upstream embankment slope, and the buried discharge end of the reservoir drain line.

b. Adequacy of Information

Information concerning operation and maintenance of the dam and appurtenant structures is somewhat lacking. It is recommended that the following programs be initiated to help alleviate this problem:

1. Annual inspection of the dam by a professional engineer experienced in the design and construction of earthen dams should be made and this inspection report made a matter of record.
2. Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.
3. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams".

The design drawings, together with performance history and visual inspection findings is felt to be adequate information to support the conclusions presented in this report.

c. Urgency

The engineering study suggested in the previous section should be accomplished as soon as soon as possible. Other remedial measures should be accomplished during routine maintenance.

d. Necessity for Phase II Inspection

Based on results of the Phase I inspection, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

The engineering study previously recommended should address various alternatives to find the best solution to the problem.

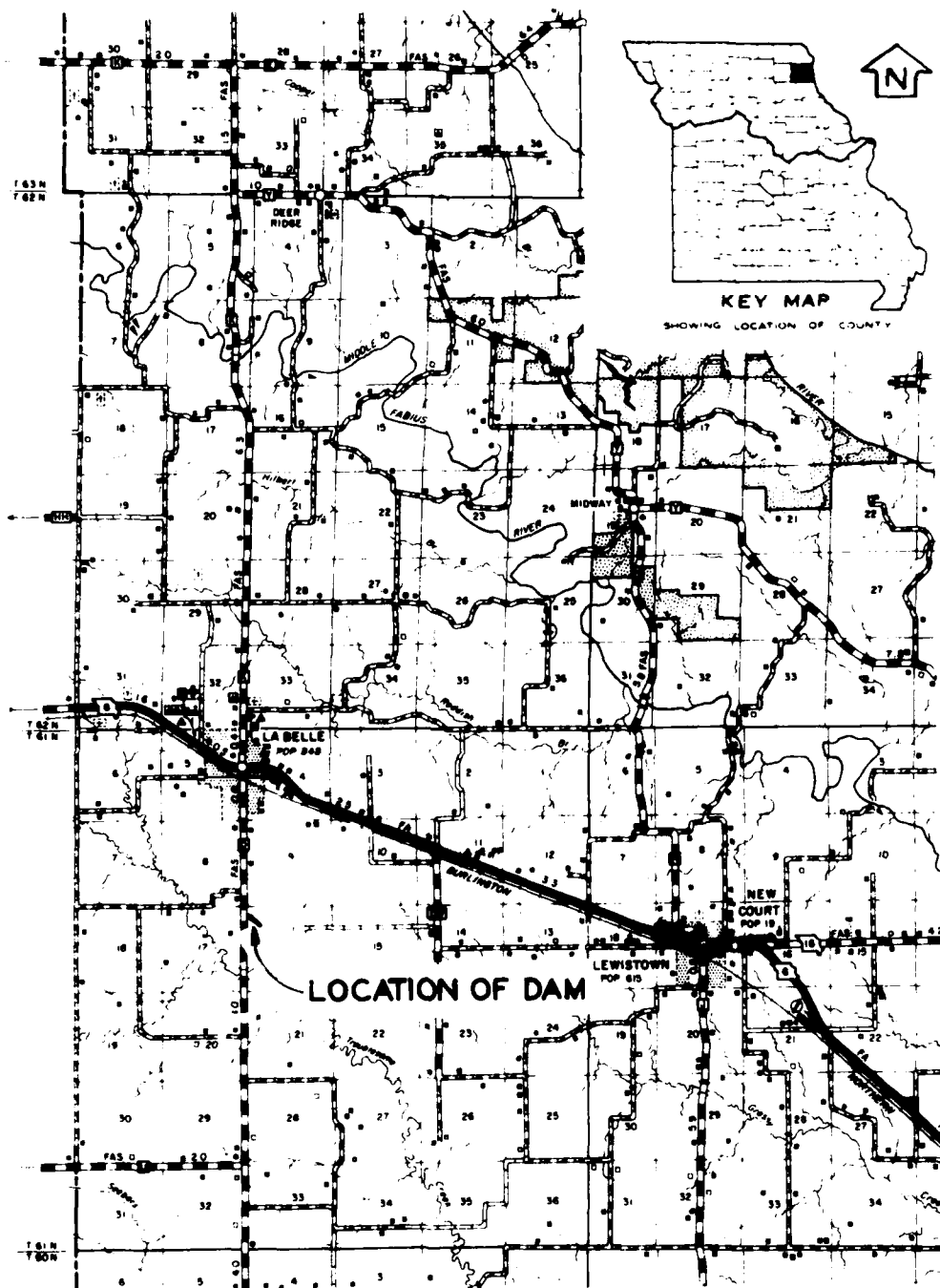
b. O & M Maintenance Procedures

The owner should initiate the following programs:

1. Annual inspection of the dam by a professional engineer experienced in the design and construction of earth dams.
2. Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.
3. Cut all trees on the upstream embankment slope and prevent future growth.
4. Uncover the valve operator and discharge end of the reservoir drain line.

5. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of dams.

PLATES



LOCATION MAP
NEW LABELLE LAKE DAM
LEWIS COUNTY, MISSOURI

1. The first step is to identify the problem. This involves understanding the symptoms and the context in which they are occurring.

STRENGTH

1. The first step in the process is to identify the problem. This involves gathering information about the situation and the people involved. It is important to understand the context and the stakes of the situation.

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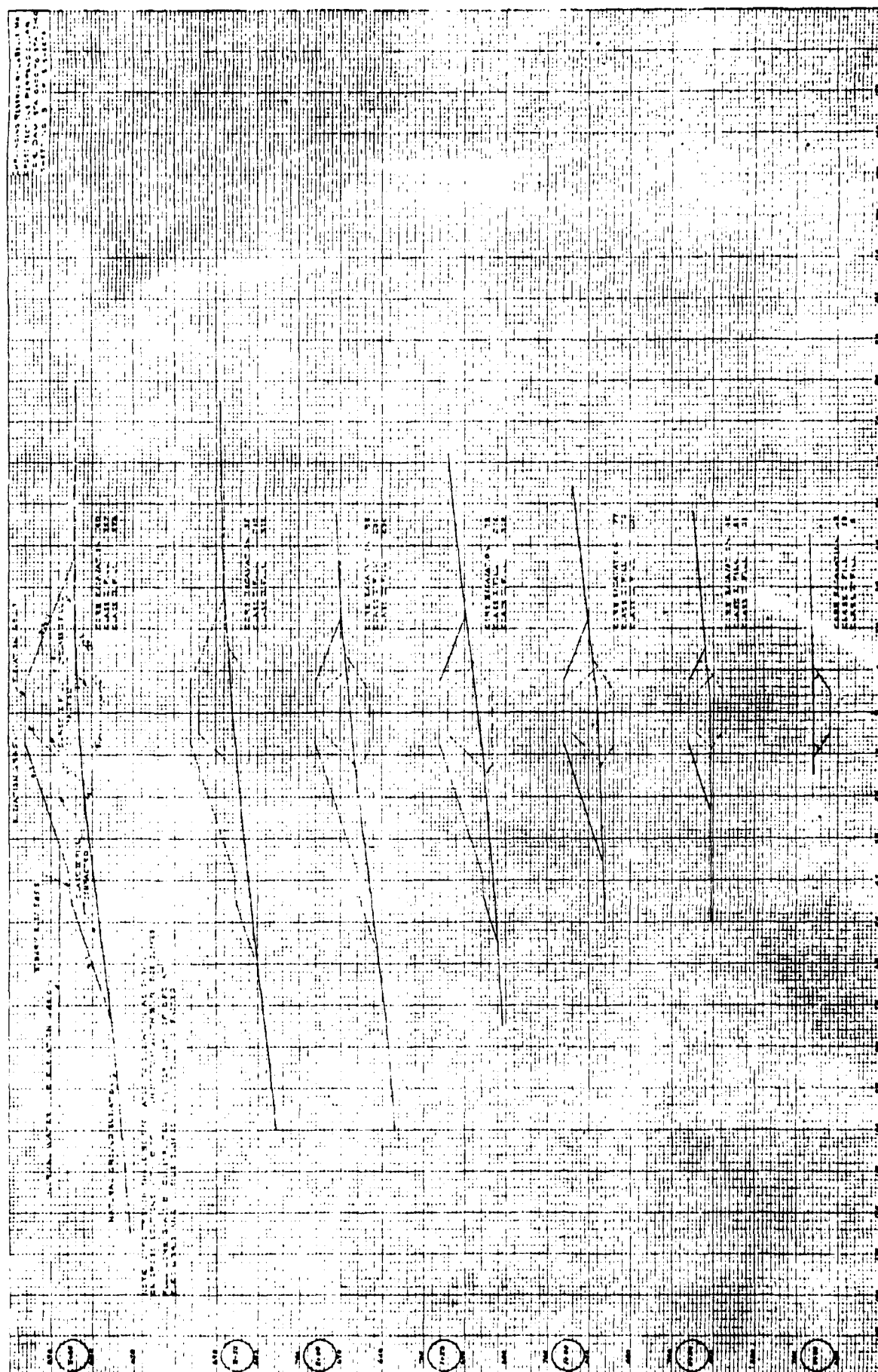
CITY OF LABELLE, MISSOURI
GENERAL PLAN

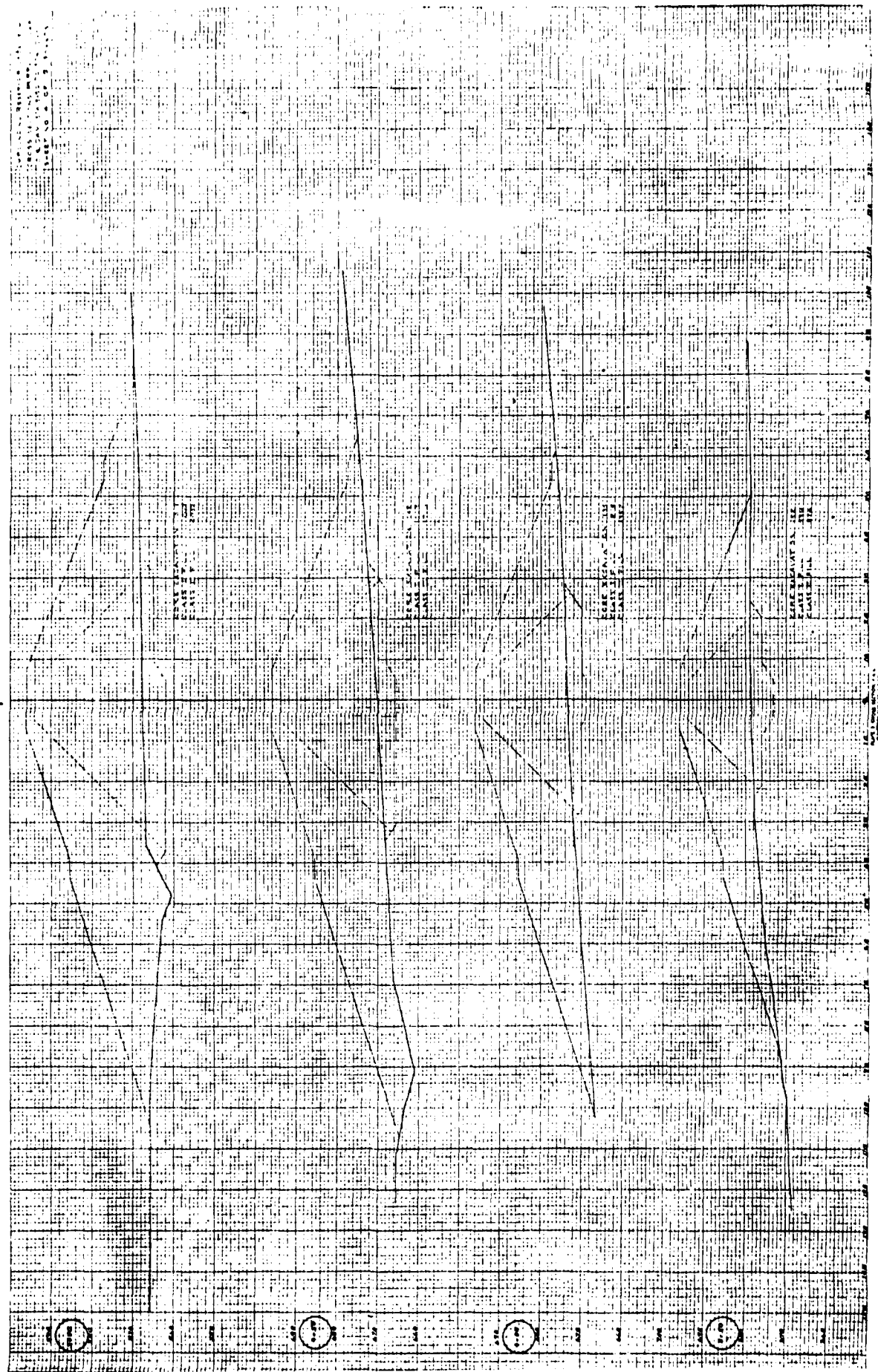
IMPOUNDING RESERVOIR & APPURTENANCES

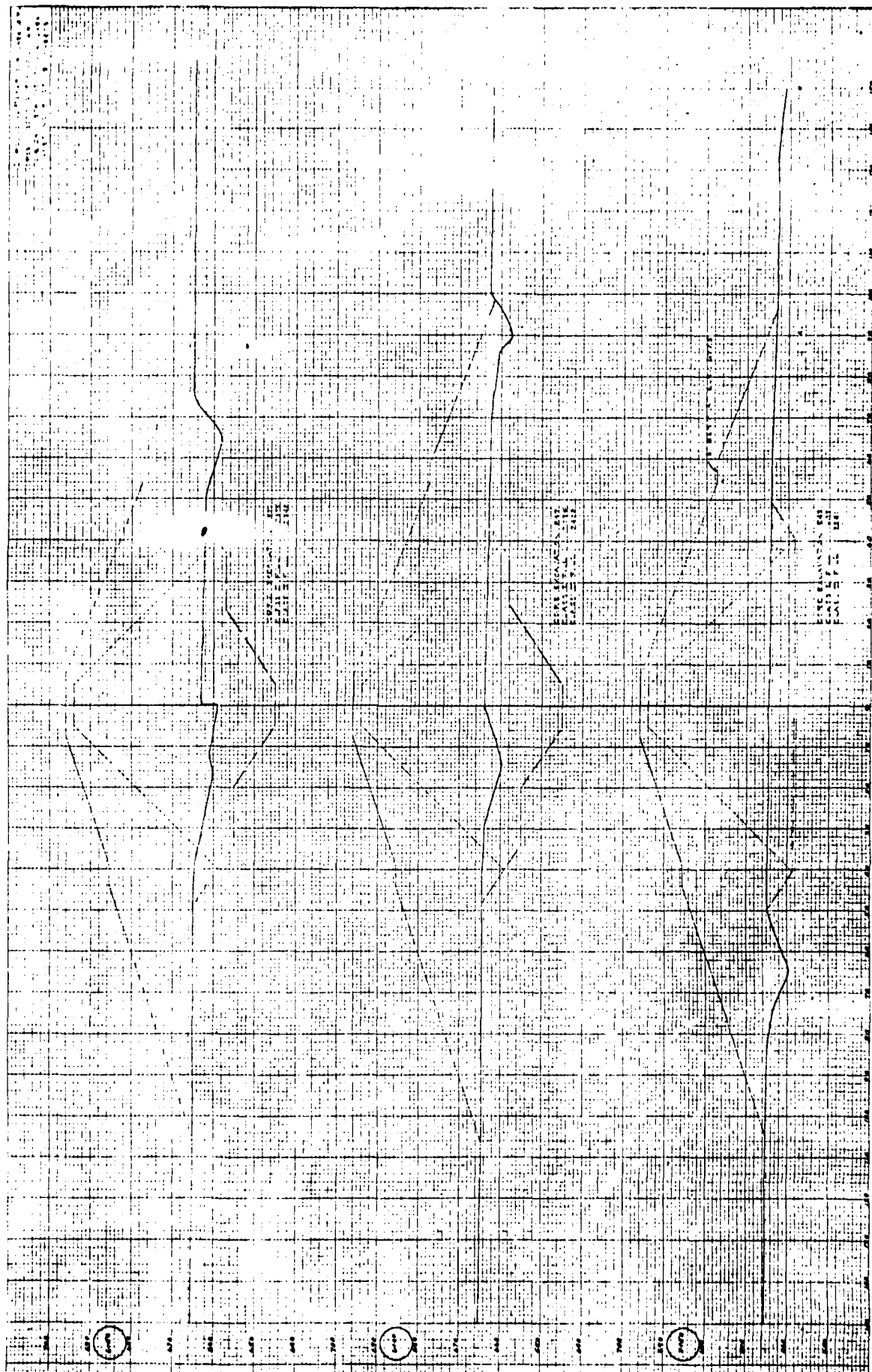
WM. CLINGER & ASSOC., CONSULT'G ENGINEERS
220 W. C. W. BUILDING
CHICAGO, ILLINOIS

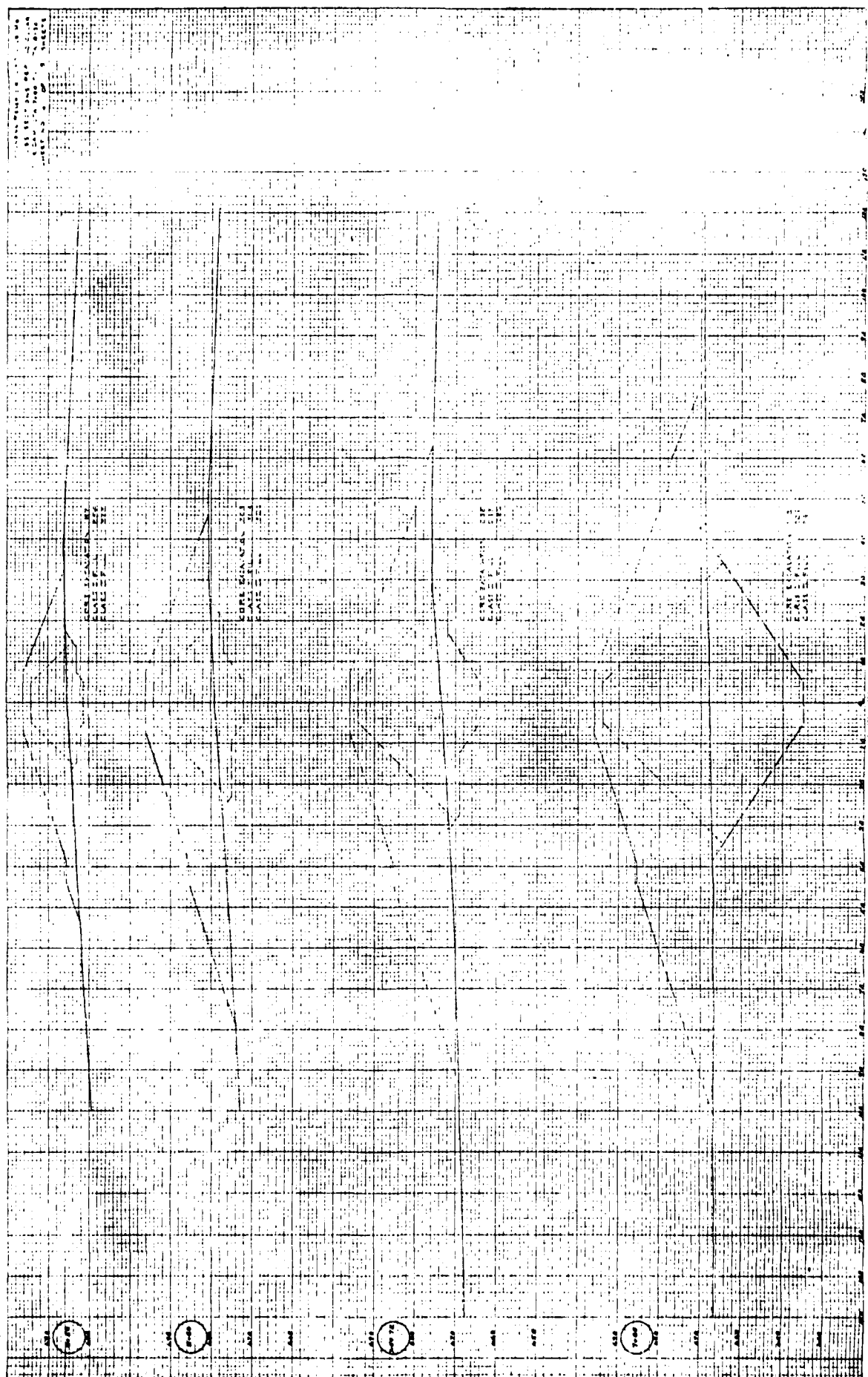
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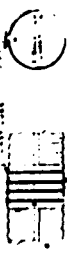




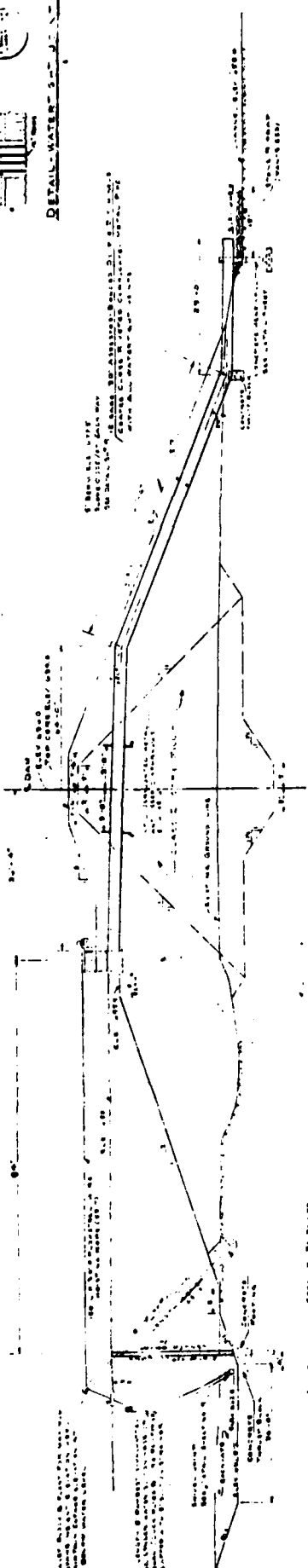


Scale 1/4" = 1'-0"

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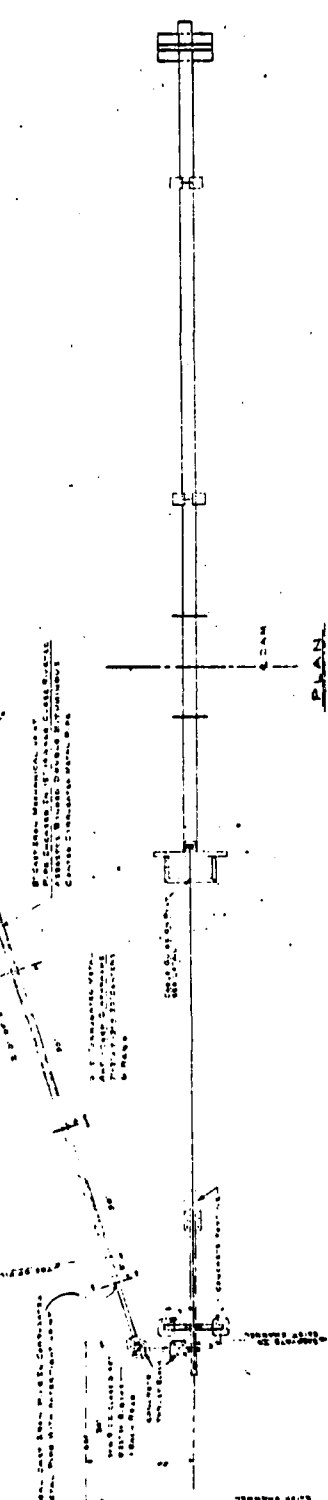


DETAIL - WATER TANK

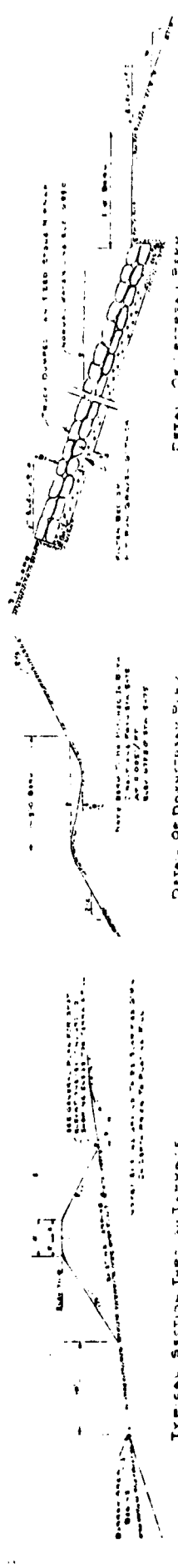


LONGITUDINAL SECTION OF STRUCTURE

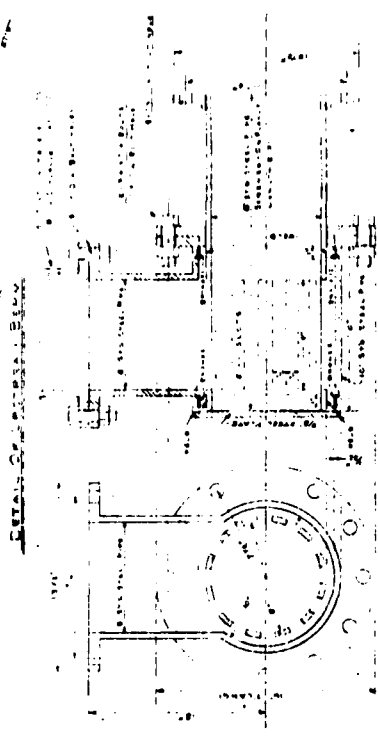
SECTIONAL ELEVATION OF STRUCTURE
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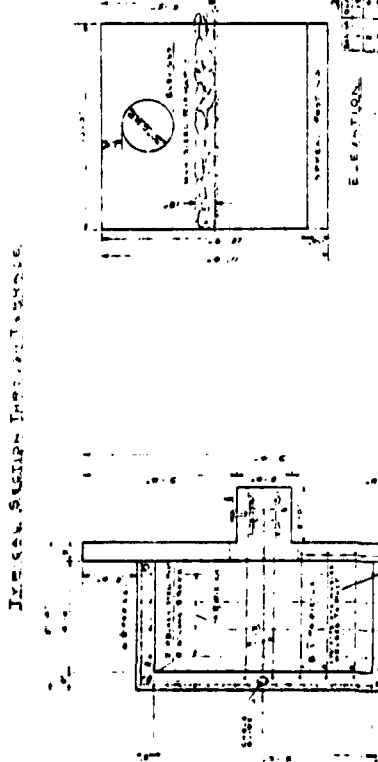
MECHANICAL SPILLWAY INTAKE LAYOUT	
IMPOUNDING RESERVOIR	
FOR	
LABELLE, MISSOURI	
W. H. L. & SONS ASSOCIATES, INC. ENGINEERS	DESIGNED BY
CHICAGO, ILL.	DATE
BY	DATE
CHECKED BY	DATE
APPROVED BY	DATE



PLAN



ELEVATION

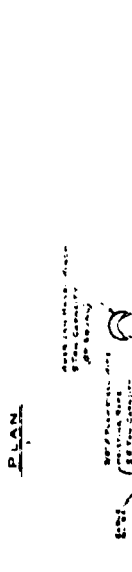


SECTION

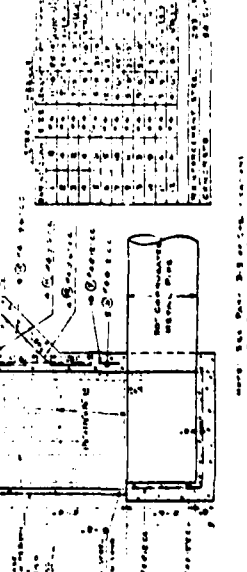
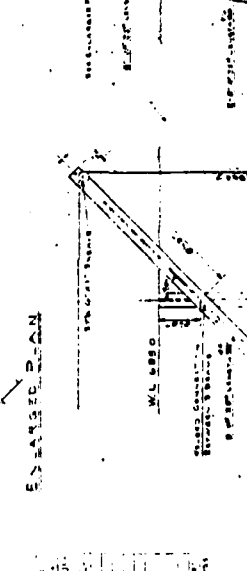
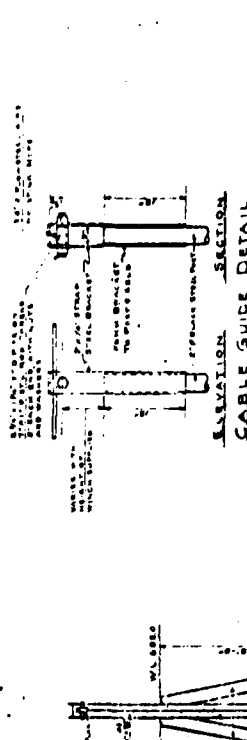
SWIVEL JOINT DETAIL

AS SHOWN IN THE DRAWING, THE SWIVEL JOINT SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE FOLLOWING DETAILS:

DETAIL OF CONCRETE SPILLWAY HEADWALL



TYPICAL SECTION THROUGH SEGMENTATION SPILLWAY



DETAIL SHEET
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FOR
LABELLE, MISSOURI
BY ENGINEER AND ARCHITECT
ROOM 300 W. 10th ST. QUINCY, ILL.
DESIGNED BY: [Name]
APPROVED BY: [Name]

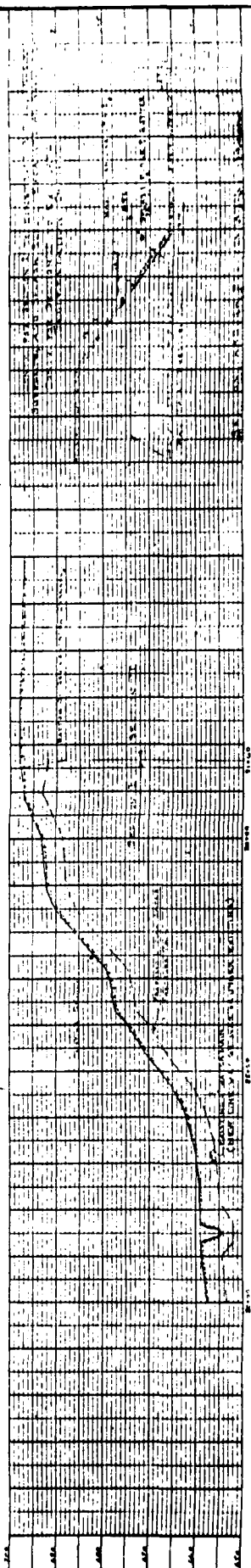
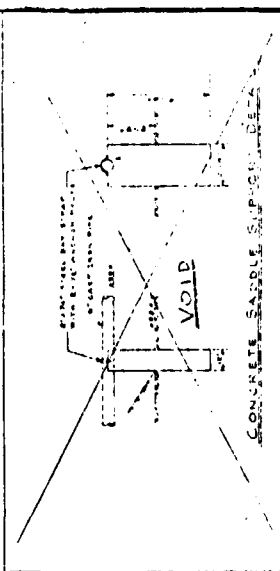
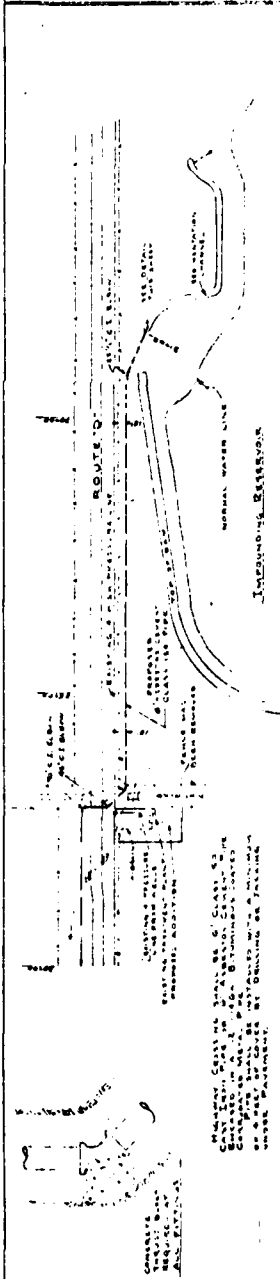
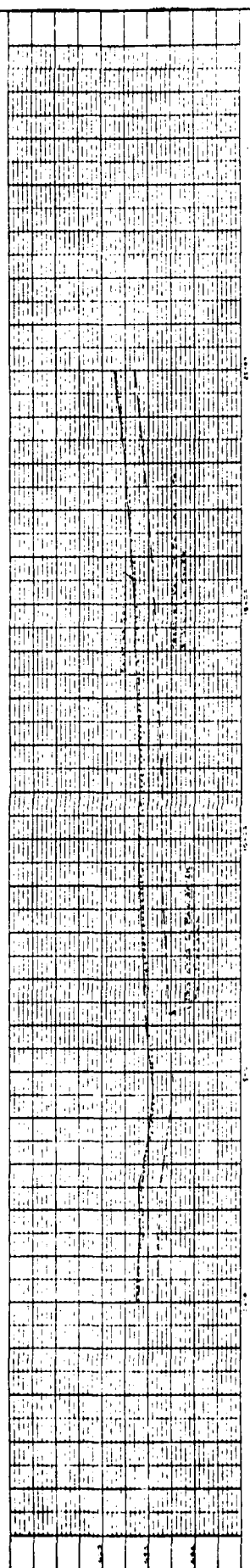
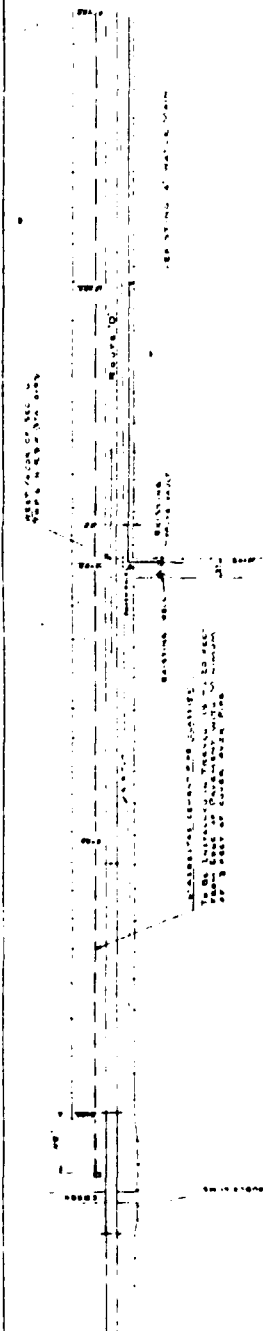
NOTE: SEE THE DRAWING FOR THE
PARTIAL SECTION THROUGH SPILLWAY

SECTION
ELEVATION
INTAKE HOUSE DETAIL

SECTION
ELEVATION
INTAKE HOUSE DETAIL

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ESTIMATED TOTAL QUANTITY OF PIPE
REQUIRED FROM OUTSIDE EDGE OF VALVE
VALVE TO DISCHARGE POINT - 3300 LBS



ENGINEERING CONSULTANTS, INC.

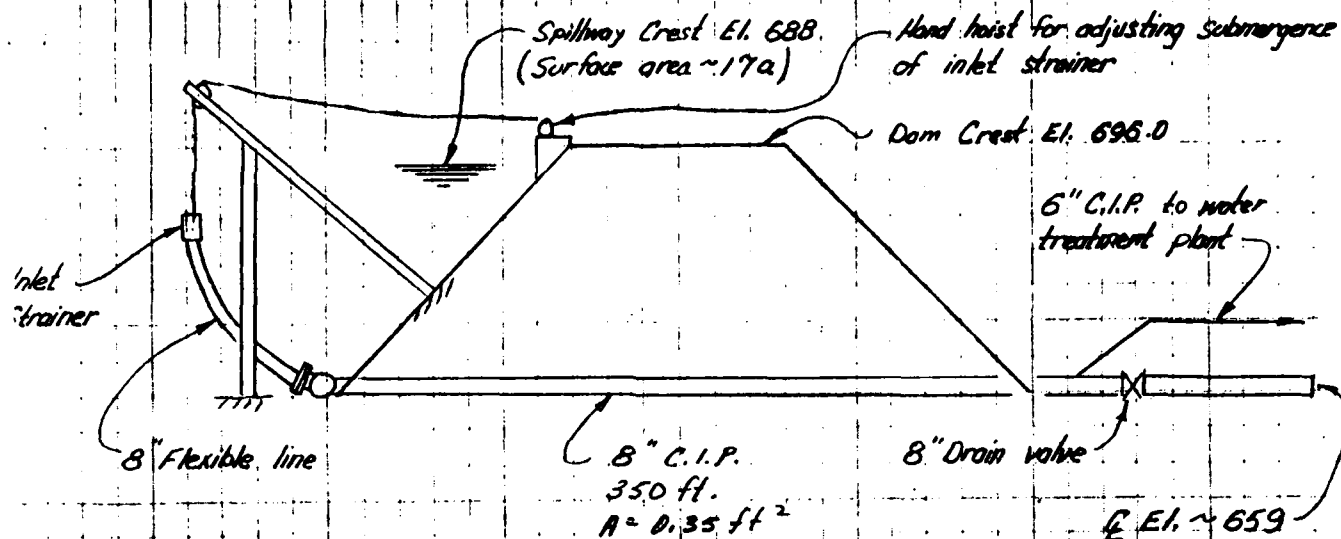
LABELLE DAM - MISSOURI

SHEET NO. 1 OF

JOB NO. 1223

ROUTING CURVE FOR DRAIN OUTLET

BY J.C.I. DATE 10/17/28



Only significant losses are entrance loss, pipe friction, plus exit velocity head.

Pipe friction

From Hyd. Institute Tables $F \cong 2.75$ where $h_f = F \frac{v^2}{2g}$ per 100'

Increase about 15% for ageing $F = 1.15 \times 2.75 \times \frac{350}{100} = 11.1$

$$h_f = 11.1 \frac{v^2}{2g}$$

Entrance Loss:

Assume $K = 1.$

$$h_e = 1.0 \frac{v^2}{2g}$$

$$\text{Exit Vel. Head} = 1.0 \frac{v^2}{2g}$$

Total

11.1 $\frac{v^2}{2g}$	- Friction
1.0	- Entrance
1.0	- Outlet
<u>13.1 $\frac{v^2}{2g}$</u>	

ENGINEERING CONSULTANTS, INC.

LABELLE DAM - MISSOURI

SHEET NO. 2 OF

JOB NO. 1223

BY JCI DATE 10/17/28

$$H_{TOTAL} = 13.1 \text{ ft}^2/29 = \frac{11.1 Q^2}{A^2 (29)} = \frac{11.1 Q^2}{(0.35)^2 (29)}$$

$$Q = 0.35 \sqrt{\frac{29 H}{11.1}} = 0.84 \sqrt{H} \text{ CFS}$$

EL. FT	H - FT	Q - CFS
663	4	1.7
665	6	2.1
670	11	2.8
675	16	3.4
680	21	3.8
685	26	4.3
688	29	4.5

Drawdown rate at design pool elevation

Surface area = 17 acres

Time to drawdown one foot

$$= \frac{17 \times 43,560 \text{ ft}^2}{4.7 \text{ ft}^3/s \times 60 \times 60 \times 24} = 1.8 \text{ days}$$

ENGINEERING CONSULTANTS, INC.

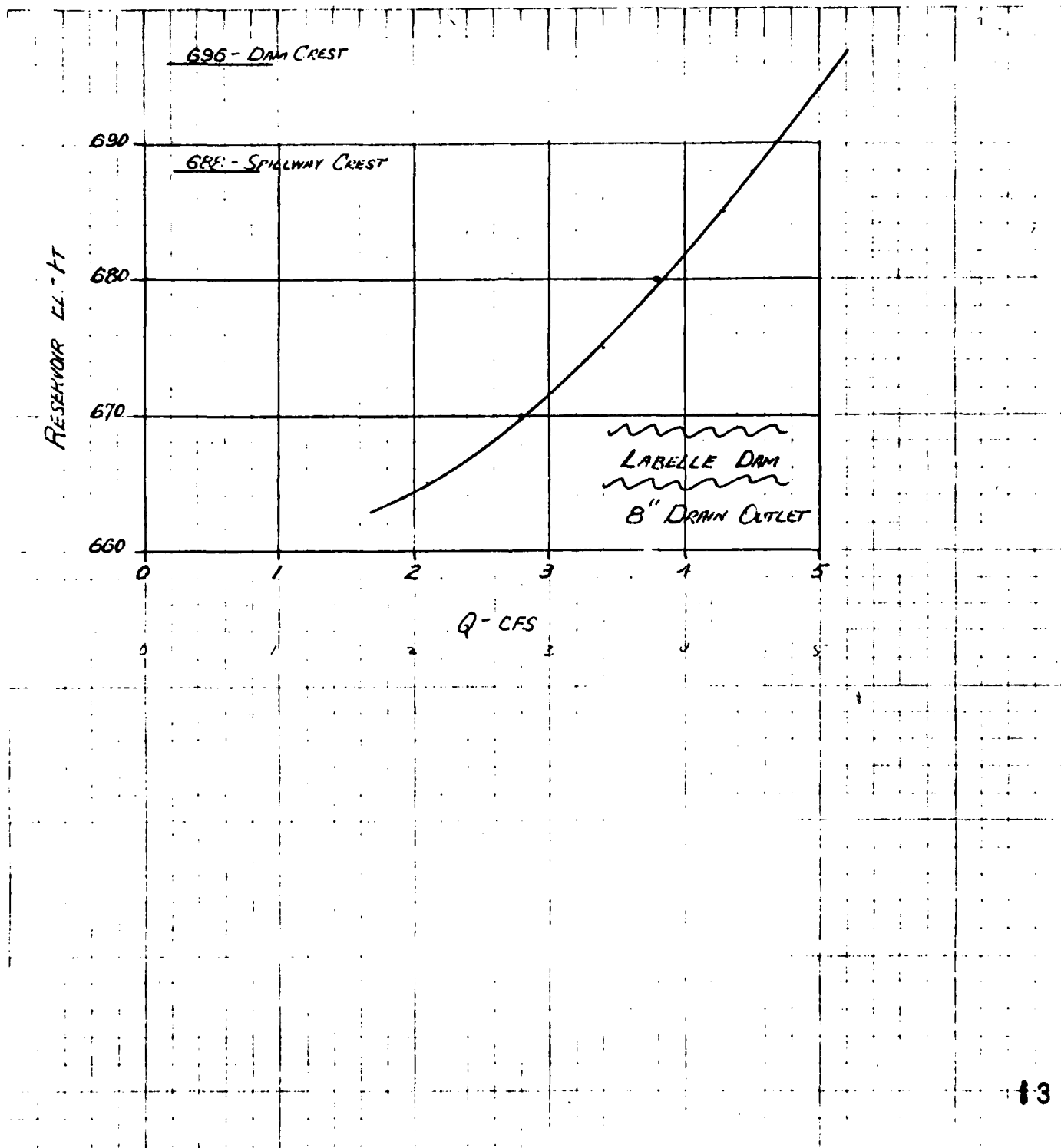
LABELLE DAM - MISSOURI

SHEET NO. 3 OF

JOB NO. 1223

RATING CURVE FOR DRAIN OUTLET

BY JCI DATE 10/17/78





Explanation

Pennsylvanian System

- P_{kc} - Kansas City group: cyclic deposits with numerous limestones.
- P_{pwm} - Pleasanton group: sandstone channel member.
- P_m - Marmaton group: cyclic deposits with limestones.
- P_{cc} - Cherokee group: cyclic deposits, predominately shale, sandstone and coal beds.

Mississippian System

- M_m - sandy, oolitic, fossiliferous, lithographic, or cherty limestones.
- M_o - cherty, crinoidal limestone, with some shale.
- M_k - intercalated limestones and shales.

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

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

NEW LABELLE LAKE DAM

- Photo 1 - View along crest of dam taken at right abutment.
- Photo 2 - View of downstream slope of dam taken across road downstream of dam.
- Photo 3 - Picture of downstream slope of dam at section with outlet works and spillway pipes.
- Photo 4 - Picture of upstream slope to right of drop inlet spillway taken at crest near spillway.
- Photo 5 - Picture of grass-lined spillway at left abutment taken from spillway channel.
- Photo 6 - Picture of water supply pumping house. Note downstream slope of dam in background.
- Photo 7 - Picture of drop inlet for service spillway along with hoist arrangement for water supply piping.
- Photo 8 - Picture of hoist arrangement for water supply piping.
- Photo 9 - Close-up of inlet structure for service spillway. Note cracked concrete on outside concrete wall.
- Photo 10 - Close-up of cracked concrete on outside wall of inlet structure.
- Photo 11 - Close-up of crack on concrete wall above entrance to corrugated metal pipe in drop inlet structure.
- Photo 12 - Picture of entrance to corrugated metal pipe in drop inlet structure.
- Photo 13 - Picture of discharge and of corrugated metal pipe used for service spillway.
- Photo 14 - Picture of inlet to corrugated metal pipe culvert under gravel road downstream of dam.
- Photo 15 - Close-up of location of seep through downstream embankment slope above discharge end of corrugated metal pipe service spillway.

New Labelle Lake Dam



Photo 1 - View along crest of dam taken at right abutment.



Photo 2 - View of downstream slope of dam taken across road downstream of dam.

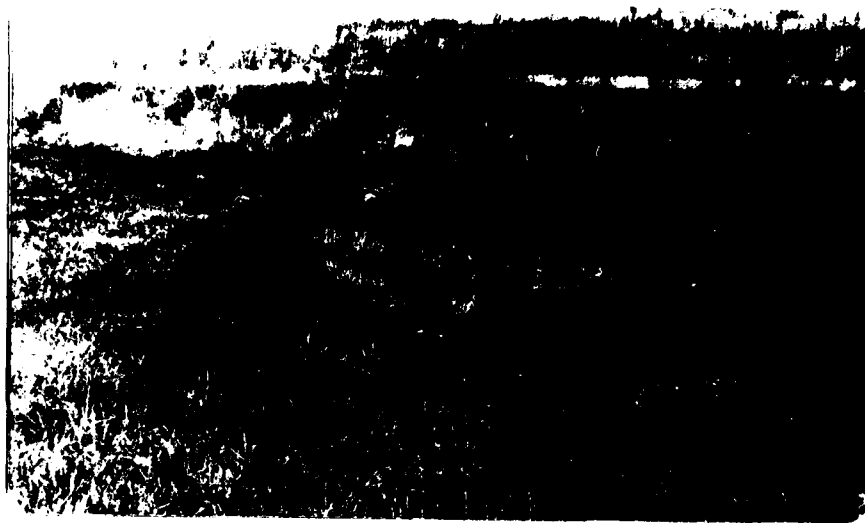


Photo 3 - Picture of downstream slope of dam at section with outlet works and spillway pipes.



Photo 4 - Picture of upstream slope to right of drop inlet spillway taken at crest near spillway.



Photo 5 - Picture of grass-lined spillway at left abutment taken from spillway channel.



Photo 6 - Picture of water supply pumping house. Note downstream slope of dam in background.



Photo 7 - Picture of drop inlet for service spillway along with hoist arrangement for water supply piping.

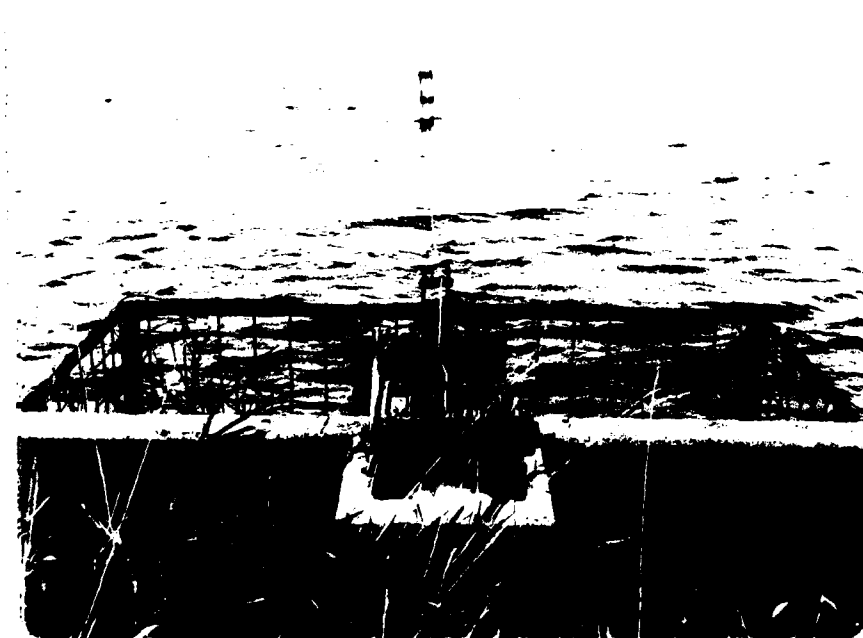


Photo 8 - Picture of hoist arrangement for water supply piping.



Photo 9 - Close-up of inlet structure for service spillway.
Note cracked concrete on outside concrete wall.



Photo 10 - Close-up of cracked concrete on outside wall of
inlet structure.



Photo 11 - Close-up of crack on concrete wall above entrance to corrugated metal pipe in drop inlet structure.



Photo 12 - Picture of entrance to corrugated metal pipe in drop inlet structure.



Photo 13 - Picture of discharge and of corrugated metal pipe used for service spillway.



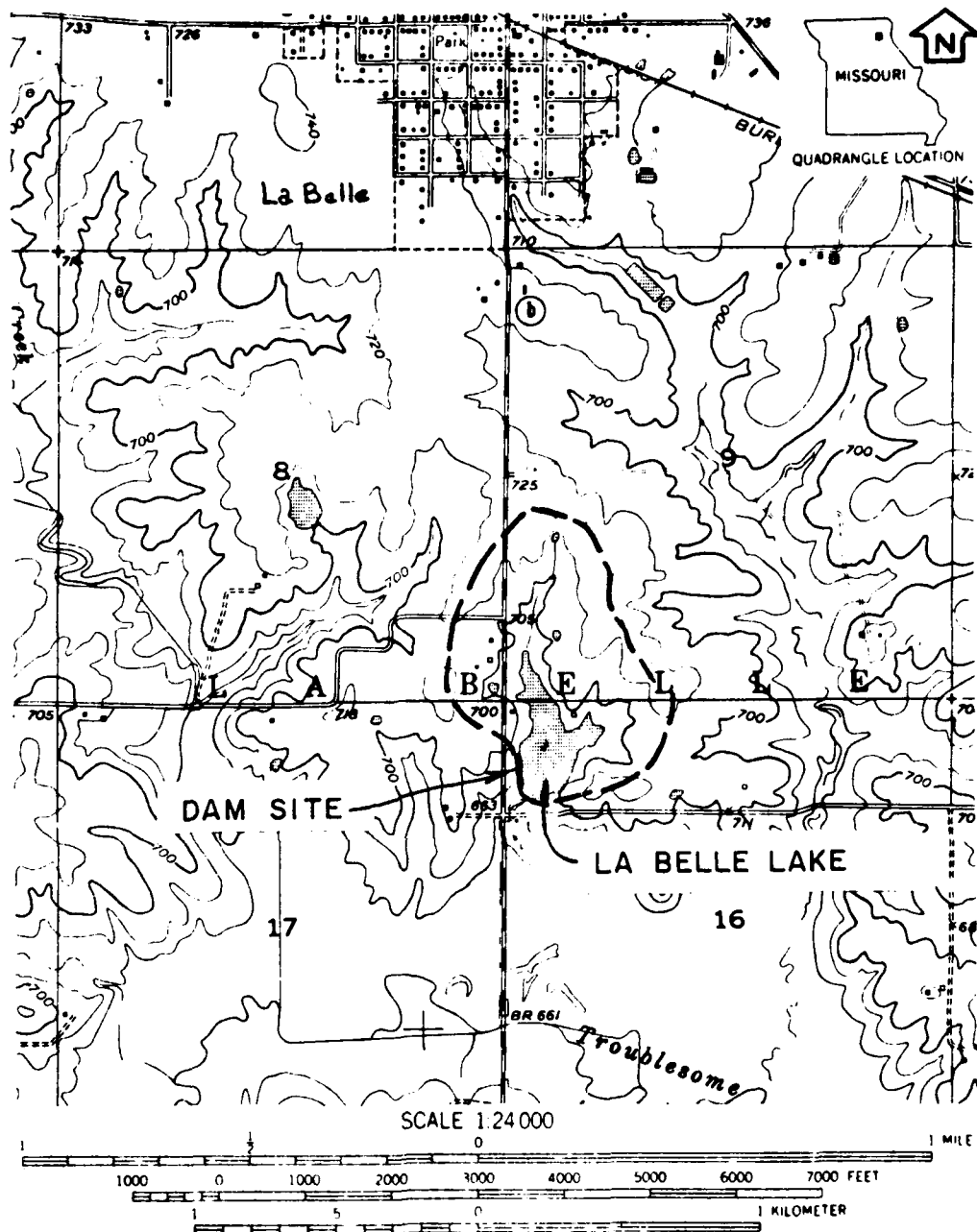
Photo 14 - Picture of inlet to corrugated metal pipe culvert under gravel road downstream of dam.



Photo 15 - Close-up of location of seep through downstream embankment slope above discharge end of corrugated metal pipe service spillway.

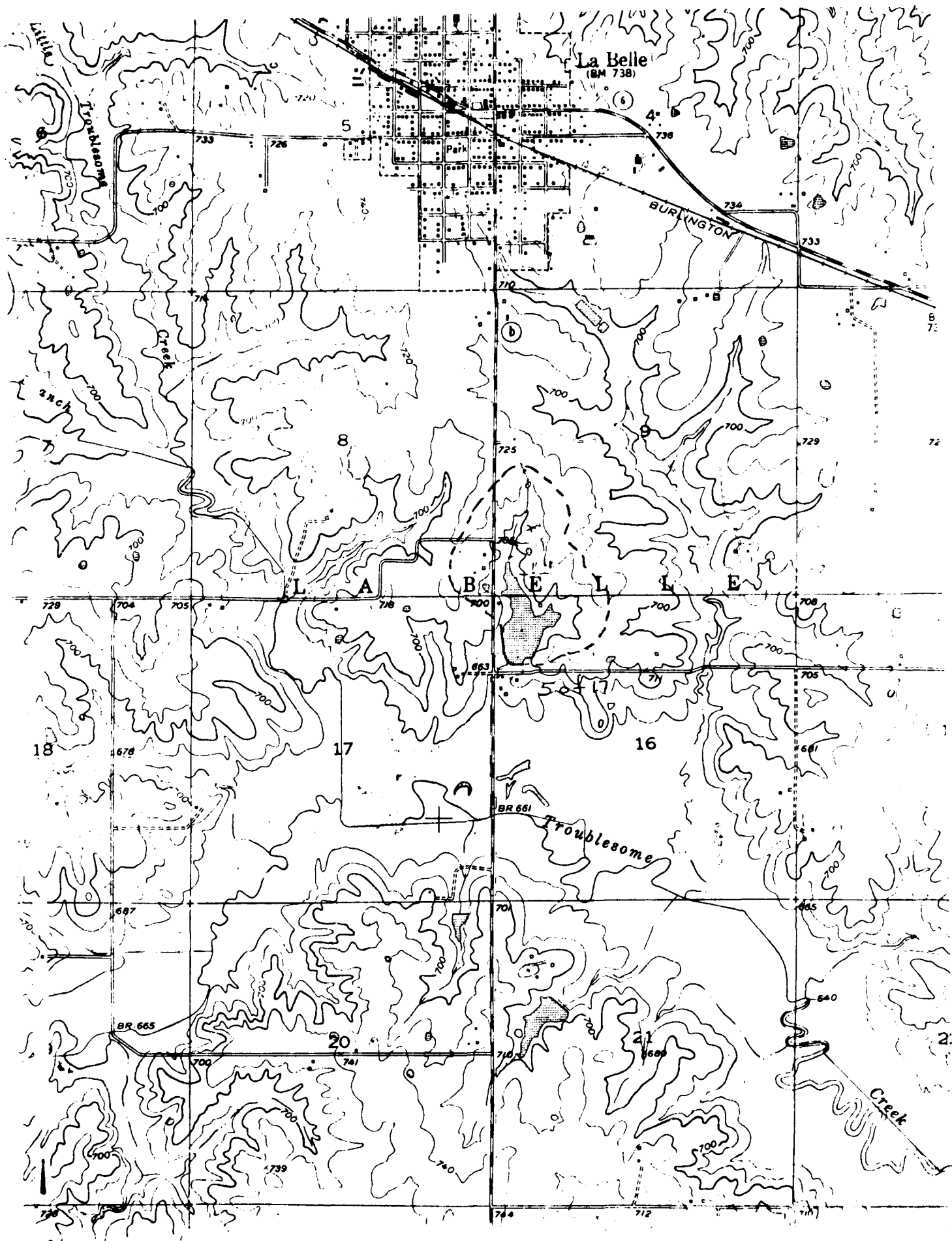
APPENDIX B

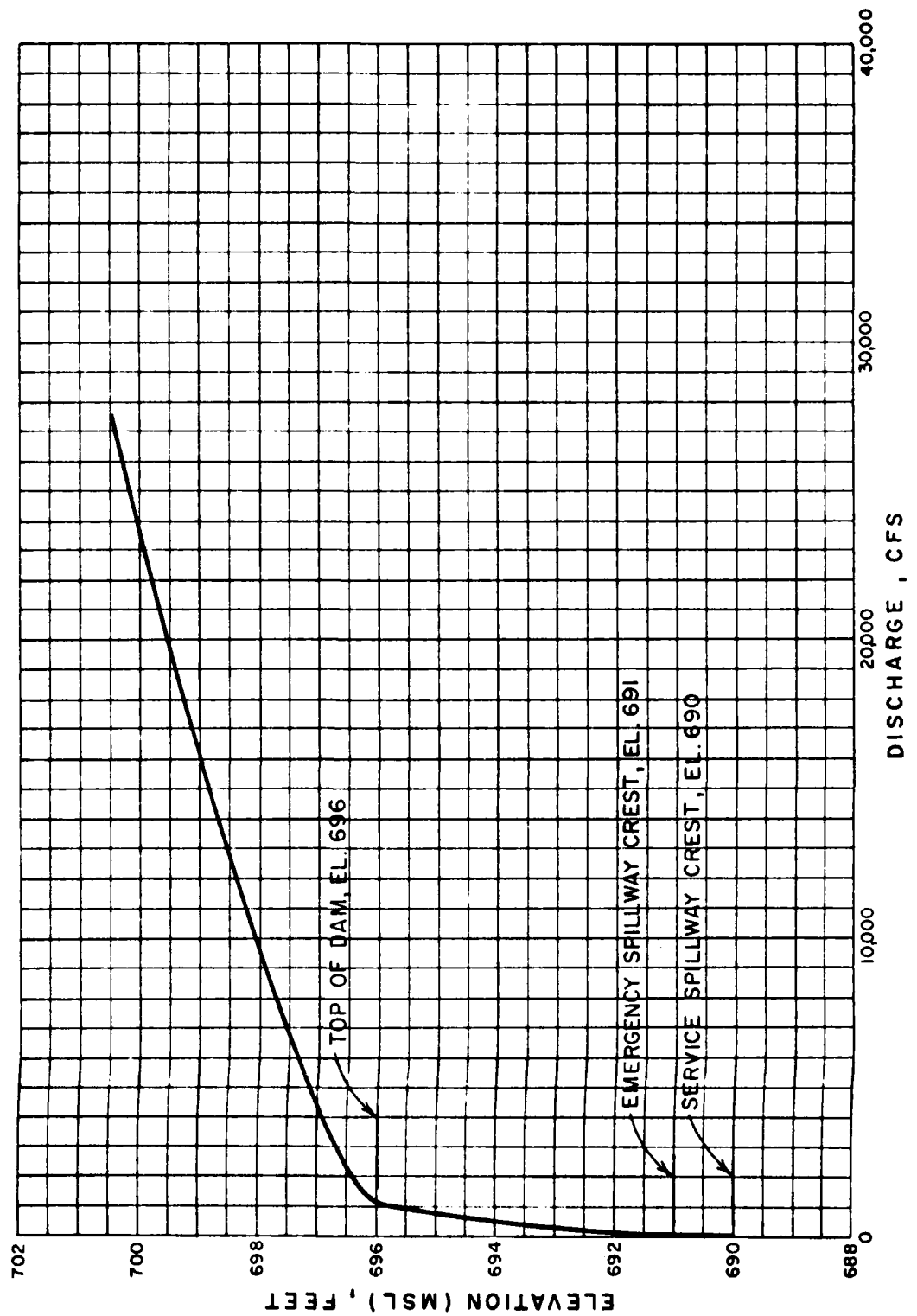
HYDROLOGIC COMPUTATIONS



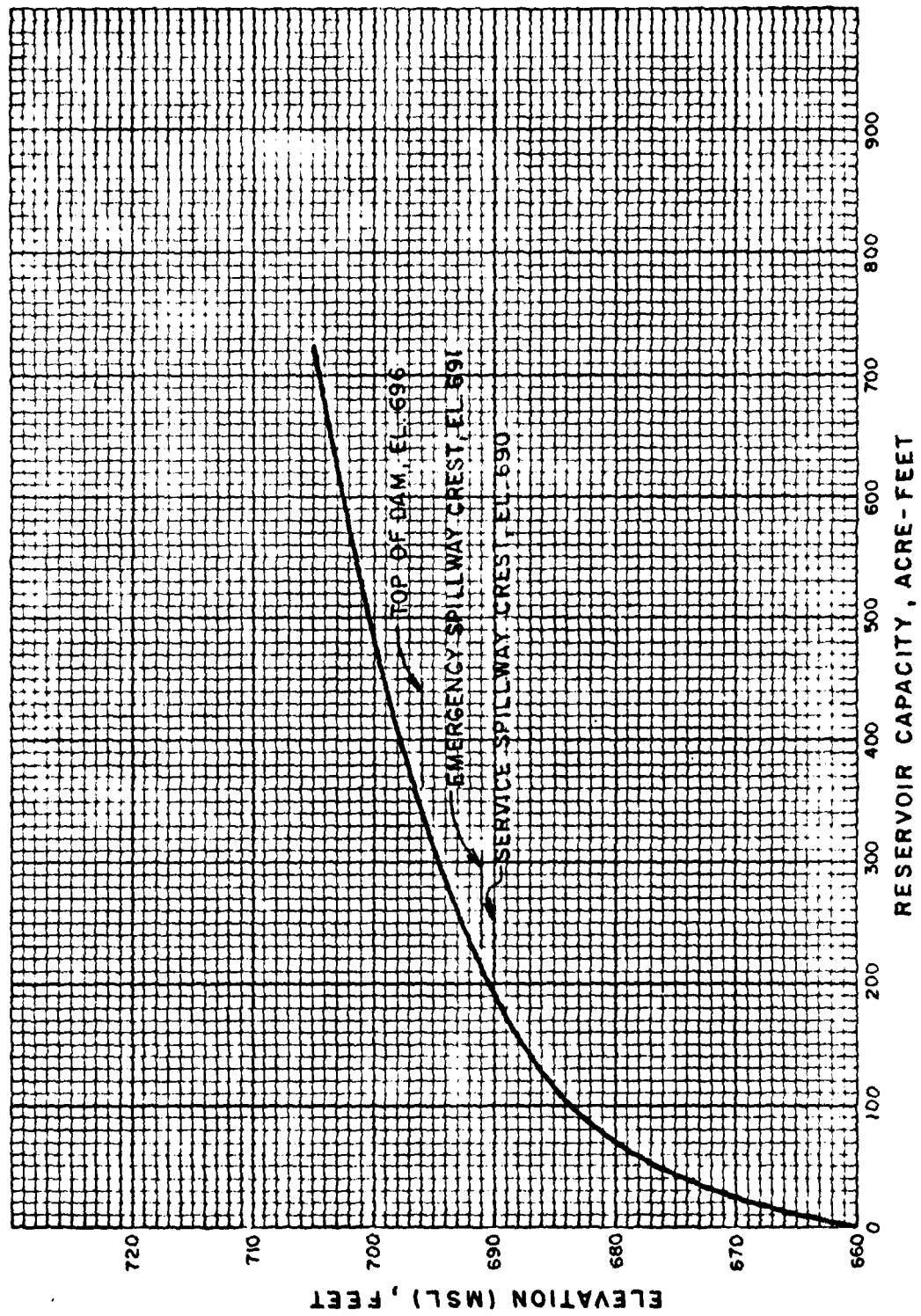
SCALE 1:24 000
 1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
 1 KILOMETER
 CONTOUR INTERVAL 20 FEET
 NATIONAL GEODETIC VERTICAL DATUM OF 1929
 DRAINAGE BOUNDARY - - - -

NEW LA BELLE LAKE DAM DRAINAGE AREA





NEW LA BELLE LAKE DAM
COMBINED SPILLWAYS & OVERTOP RATING CURVE



NEW LA BELLE LAKE DAM
RESERVOIR CAPACITY CURVE

DAM SAFETY INSPECTION - MISSOURI

SHEET NO. 1 OF

NEW LABEILLE LAKE DAM

JOB NO. 1223-001-1

RESERVOIR AREA CAPACITY DATA

BY KLB DATE

Lym

NEW LABEILLE DAMRESERVOIR AREA CAPACITY DATA

Data was obtained on USGS

ELEV. FT.	SURFACE AREA (ACRES)	INCREMENTAL VOLUME (AC-FT)	TOTAL VOLUME (AC-FT)	REMARKS
660.0	0	-	0	STREAM BED AT CENTER OF DAM
688.0	17	152	152	
690	19.9*	42	194	SERVICE SPIWAY CREST
691	21.5*	16	210	EMERGENCY SPIWAY CREST
696	30.0*	129	339	TOP OF DAM
700	40.	140	479	
705	58*	245	724	

* INTERPOLATED DATA

DAM SAFETY INSPECTION - MISSOURI

SHEET NO. 1 OF

NEW LABENE LAKE DAM

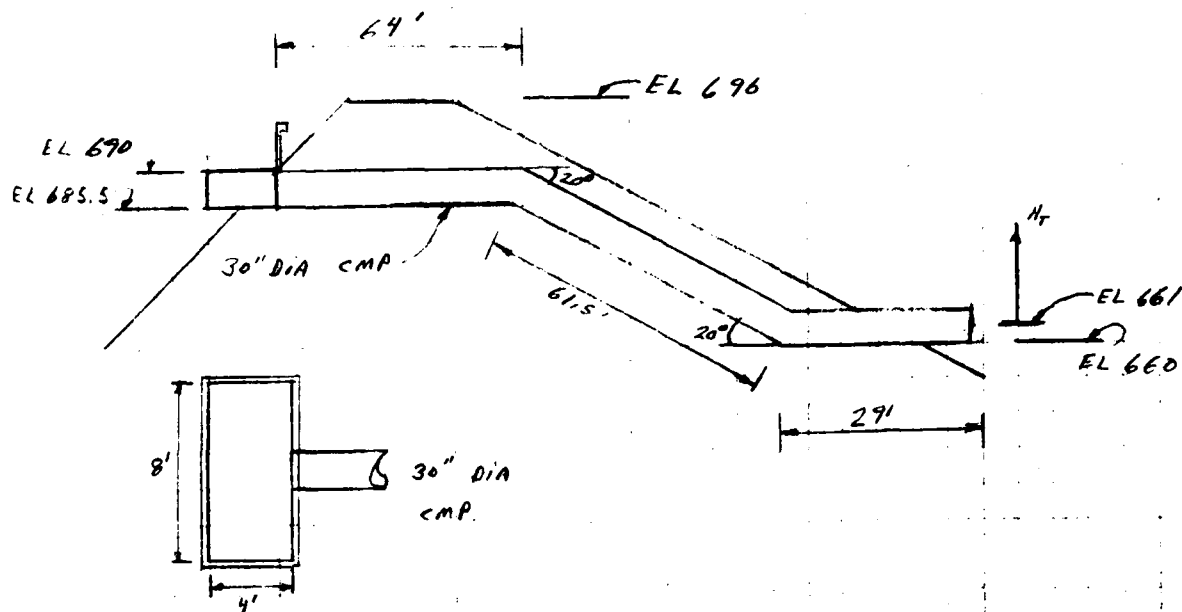
JOB NO. 1223-001-1

SERVICE SPILLWAY CAPACITY

BY KLB DATE 10-18-78

Yim

NEW LABENE LAKE



UPSTREAM W.S. ELEV AT 690.5

a) WEIR FLOW

ASSUME $C = 3.1$

$$Q_w = C L H^{3/2} = 3.1 \times 16 \times 0.5^{1.5} = 18 \text{ CFS}$$

b) PIPE FLOW

ASSUME $m = 0.025$, $K_e = 0.5$, $K_b = 0.16$ (FOR 20° BENDS)

$$H_f = \left(1 + K_e + K_b + K_b + \frac{29 m^2 L}{R^{1.33}} \right) \frac{V^2}{2g}$$

$$H_f = \left(1 + 0.5 + 0.16 + 0.16 + \frac{29 (0.025^2 \times 154.5)}{0.625^{1.33}} \right) \frac{V^2}{2g}$$

ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION -- MISSOURI
NEW LABEIE DAM
SERVICE SPILLWAY CAPACITY

SHEET NO. 2 OF
JOB NO. 1223-001-1
BY KLB DATE 11-2-78

Umm

$$H_T = 7.06 \frac{V^2}{2g}$$

$$V = \frac{1}{\sqrt{7.06}} \sqrt{2g H_T} = 0.376 \sqrt{2g H_T}$$

$$Q = V \cdot A = 0.376 A \sqrt{2g H_T}$$

$$Q = 0.376 \times 4.91 \times \sqrt{64.4 \times 29.5} = 80.1 \text{ CFS}$$

ACTUAL Q = 18 CFS

UPSTREAM W.S. AT ELEV. 691

a) WEIR FLOW

$$Q = CLH^{3/2} = 3.1 \times 16 \times 1^{3/2} = 50 \text{ CFS}$$

b) PIPE FLOW

$$Q = 0.376 \times A \times \sqrt{2g H_T}$$

$$= 0.376 \times 4.91 \times \sqrt{64.4 \times 30}$$

$$Q = 81 \text{ CFS}$$

ACTUAL Q = 50 CFS.

UPSTREAM W.S. AT 691.73

a) WEIR FLOW

$$Q = CLH^{3/2} = 3.1 \times 16 \times 1.73^{3/2} = 113 \text{ CFS.}$$

ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI

SHEET NO. 3

OF

NEW LABELLE LAKE DAM

JOB NO. 1223-001-1

SERVICE SPILLWAY CAPACITY

BY KLB

DATE 10-18-78

CL

UPSTREAM W.S. AT EL 691.73

PIPE FLOW CONTROLS

$$Q = 0.376 \times A \times \sqrt{2g H_T} = 0.376 \times 4.91 \times \sqrt{64.4 \times 30.73}$$

$$Q = 82 \text{ CFS}$$

UPSTREAM W.S. AT EL 692.44

PIPE FLOW CONTROLS

$$Q = 0.376 \times A \times \sqrt{2g H_T} = 0.376 \times 4.91 \times \sqrt{64.4 \times 31.44}$$

$$Q = 83 \text{ CFS}$$

UPSTREAM W.S. AT EL 695.14

PIPE FLOW CONTROLS

$$Q = 0.376 \times A \times \sqrt{2g H_T} = 0.376 \times 4.91 \times \sqrt{64.4 \times 34.14}$$

$$Q = 87 \text{ CFS}$$

UPSTREAM W.S. AT ELEV 696.45

PIPE FLOW CONTROLS

$$Q = 0.376 \times A \times \sqrt{2g H_T} = 0.376 \times 4.91 \times \sqrt{64.4 \times 35.45}$$

$$Q = 88 \text{ CFS}$$

UPSTREAM W.S. AT ELEV 697.45

PIPE FLOW CONTROLS

$$Q = 0.376 \times A \times \sqrt{2g H_T} = 0.376 \times 4.91 \times \sqrt{64.4 \times 36.45}$$

$$Q = 89 \text{ CFS}$$

DAM SAFETY INSPECTION - MISSOURI

SHEET NO. 4 OF

NEW LABELLE LAKE DAM

JOB NO. 1223-001-1

SERVICE SPILLWAY CAPACITY

BY KLB DATE 10-18-78

LHM

UPSTREAM W.S. AT ELEV. 699.13

PIPE FLOW CONTROLS

$$Q = 0.376 \times A \times \sqrt{2g H_T} = 0.376 \times 4.91 \times \sqrt{64.4 \times 38.13}$$

$$Q = \underline{91 \text{ CFS}}$$

UPSTREAM W.S. AT ELEV. 700.45

PIPE FLOW CONTROLS

$$Q = 0.376 \times A \times \sqrt{2g H_T} = 0.376 \times 4.91 \times \sqrt{64.4 \times 39.45}$$

$$Q = \underline{93 \text{ CFS}}$$

DRAIN SAFETY INSPECTION - MISSOURI

NEW LABELLE LAKE DAM

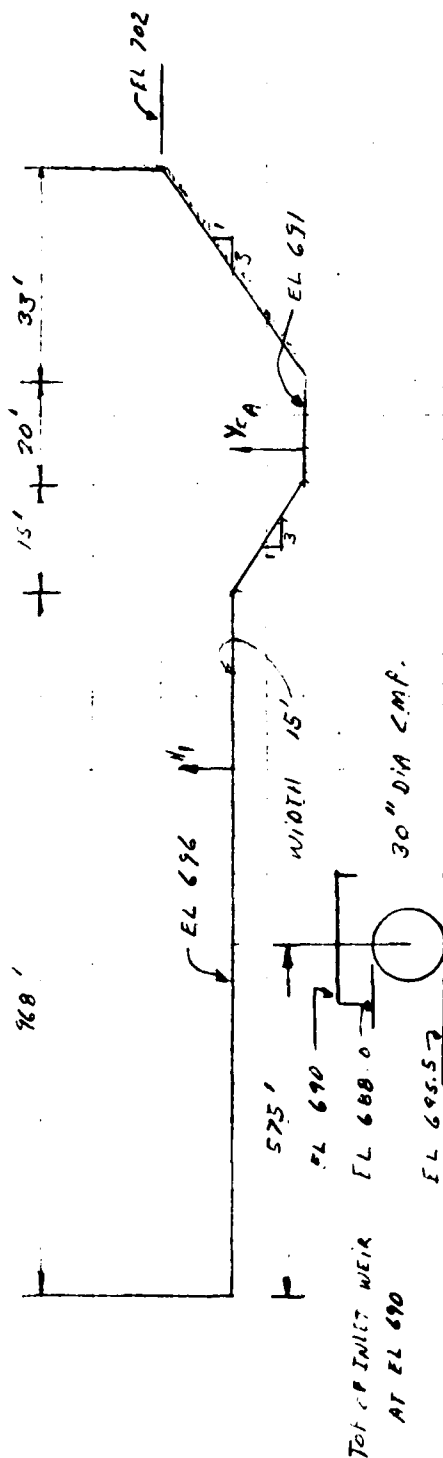
EMERGENCY RAILWAY AND OVERTOP DISCHARGE CAPACITY

SHEET NO. 1 OF

JOB NO. 1223-001-1

BY HLB

DATE 10-14-16



$\frac{1}{2}CA$ (FT.)	TCA	ACA	$VCA = 5.67 \sqrt{\frac{ACA}{TCA}}$	$\frac{U/S \text{ W.S.}}{W.A.T.}$ $CHANNEL \text{ BOT.} = VCA + \frac{VCA^2}{2g}$	$QCA = VCA \times ACA$	H_1	L_1	C_1	$Q_T = QCA + C_1 H_1^{3/2}$
0.5	23	10.75	3.88	691.73	42	-	-	-	42
1.0	26	23	5.33	692.49	123	-	-	-	123
3.0	38	87	8.58	695.14	746	-	-	-	746
4.0	44	128	9.67	696.45	1238	0.45	968	2.70	2027
5.0	50	175	10.61	697.75	1856	1.75	968	2.63	6591
6.0	53	226.5	11.72	699.13	2655	3.13	968	2.63	16753
7.0	56	281	12.57	700.45	3531	4.45	968	2.63	27430

ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI

NEW LABELLE LAKE DAM

COMBINED SERVICE SPILLWAY, EMERGENCY SPILLWAY AND
OVERTOP DISCHARGE CAPACITY

SHEET NO. 1 OF

JOB NO. 1223-001-1

BY HLB DATE 11-2-78

lim

ELEV. (FT) M.S.L.	SERVICE SPILLWAY DISCHARGE (CFS)	EMERGENCY SPILLWAY DISCHARGE (CFS)	OVERTOP DISCHARGE (CFS)	TOTAL DISCHARGE (CFS)
690.00	0	-	-	0
690.50	18	-	-	18
691.00	50	-	-	50
691.73	82	42	-	124
692.44	83	123	-	206
695.14	87	746	-	833
696.45	88	1238	789	2115
697.45	89	1856	4735	6680
699.13	91	2655	14098	16844
700.45	93	3531	23899	27523

DAM SAFETY INSPECTION - MISSOURI

SHEET NO. 1 OF

NEW LA REBE LAKE

JOB NO. 1223-001-1

UNIT HYDROGRAPH PARAMETERS

BY HLB

DATE 10-4-78

1. DRAINAGE AREA = 176 ACRES = 0.28 SQ. MI.

2. LENGTH OF STREAM = $L = (0.9" \times 2000') / 5280 = 0.34$ MI.

3. DIFFERENCE IN ELEVATION: ΔH

$$\Delta H = 723 - 690 = 33'$$

4. TIME OF CONCENTRATION

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

$$T_c = \left(\frac{11.9 \times 0.34^3}{33} \right)^{0.385} = \underline{0.19 \text{ HR}}$$

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

$$L_t = 0.6 \times 0.19 = 0.11 \text{ HR}$$

6. RAINFALL UNIT DURATION = D

$$D \leq \frac{L_t}{3} = \frac{0.11}{3} = 0.04 \text{ HR}$$

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

(MINIMUM VALUE ACCORDING TO SLD CRITERIA)

7. TIME TO PEAK

$$T_p = \frac{D}{2} + 0.6 \times T_c = \frac{0.083}{2} + 0.6 \times 0.19$$

$$T_p = 0.156 \text{ HR}$$

8. $q_p = \frac{484 \times A}{T_p} = \frac{484 \times 0.28}{0.156} = 868.72 \text{ CFS.}$

DAM SAFETY INSPECTION - MISSOURI

SHEET NO. 2 OF

NEW LA BELLE LAKE DAM

JOB NO. 1223-001.1

UNIT HYDROGRAPH DERIVATION

BY HLB DATE 10-4-78

9.) CURVILINEAR UNIT HYDROGRAPH

TIME T/T_p	DISCHARGE q/q_p	UNIT HYDROGRAPH	
		TIME, T (HR)	DISCHARGE (CFS)
0.0	0.000	0.00	0.000
0.1	0.015	0.02	13.03
0.2	0.075	0.03	65.15
0.3	0.16	0.05	139.00
0.4	0.28	0.06	243.24
0.5	0.45	0.08	390.92
0.6	0.60	0.09	521.23
0.7	0.77	0.11	668.91
0.8	0.89	0.12	773.16
0.9	0.97	0.14	842.66
1.0	1.00	0.16	868.72
1.1	0.98	0.17	851.35
1.2	0.92	0.19	799.22
1.3	0.84	0.20	729.72
1.4	0.75	0.22	651.54
1.5	0.66	0.23	573.36
1.6	0.56	0.25	486.48
1.8	0.42	0.28	364.86
2.0	0.32	0.31	277.99
2.2	0.24	0.34	208.49
2.4	0.18	0.37	156.37
2.6	0.13	0.41	112.93
2.8	0.098	0.44	85.13
3.0	0.075	0.47	65.15
3.5	0.036	0.55	31.27
4.0	0.018	0.62	15.64
4.5	0.009	0.70	7.82
5.0	0.004	0.78	3.47

183.76

DAM SAFETY INSPECTION/MISSOURI

SHEET NO. 1 OF

NEW LABELLE LAKE DAM

JOB NO. 122.3-001

(1) PROBABLE MAXIMUM STORM (PMS)

BY MAS DATE

NEW LABELLE LAKE DAMDETERMINATION OF PMS

1. Determine drainage area of the basin

$$D.A. = 0.25 \text{ sq. mi.}$$

2. Determine PMP Index rainfall:

Location of centroid of basin:

$$\text{Long. } 91.91^{\circ}; \text{ Lat. } 40.09^{\circ}$$

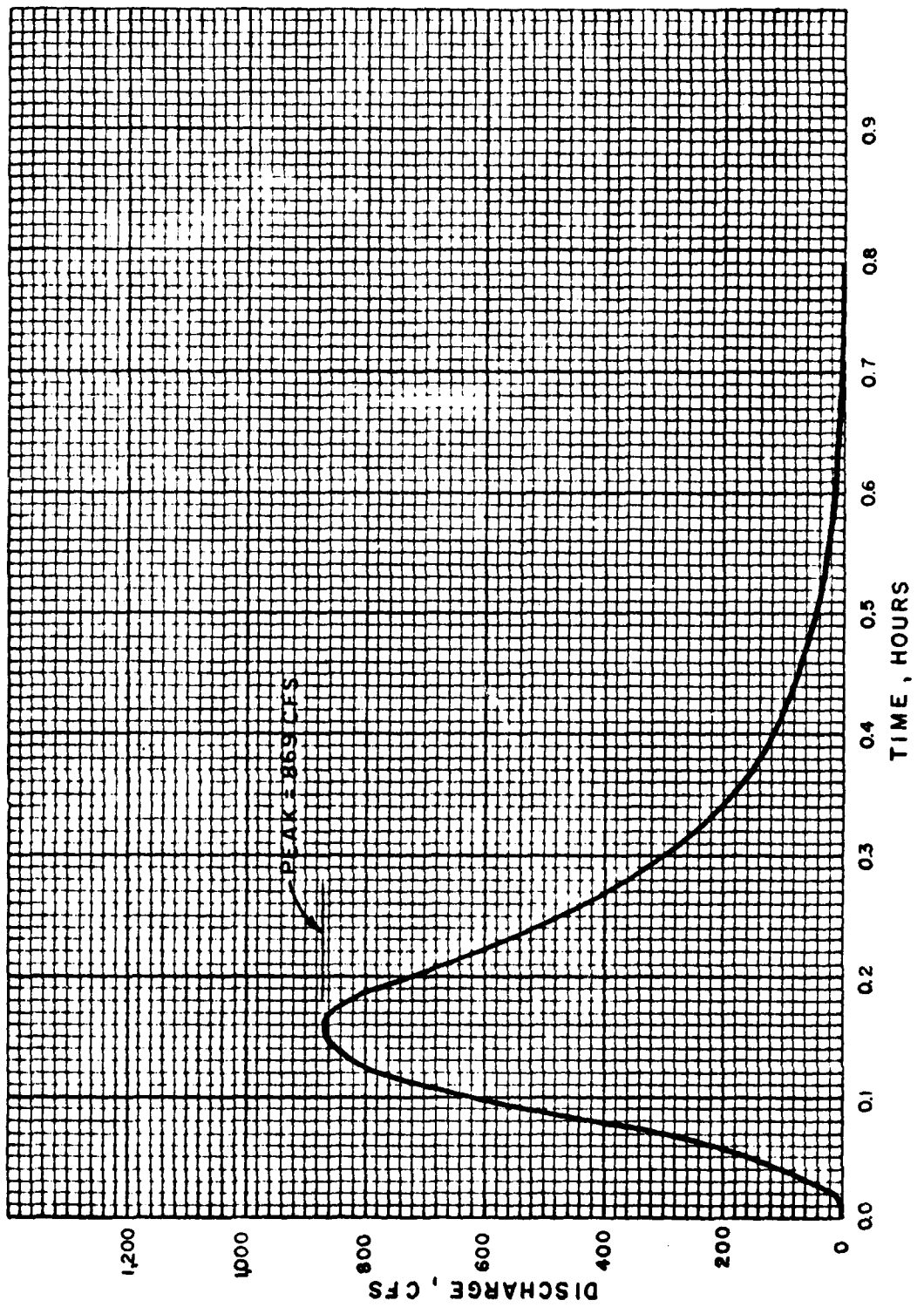
$$\rightarrow \text{PMP for } 200 \text{ sq. mi. \& 24 hrs duration} \\ = 24" \text{ (from Fig 1, HMR NO 33)}$$

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

$$\text{Location: Long. } 91.91^{\circ}; \text{ Lat. } 40.09^{\circ}$$

$$\Rightarrow \text{Zone 7}$$

Duration (Hrs.)	Percent of Index rainfall (%)	Total rainfall (Inches)	Rainfall increments (Inches)	Duration of incre- ment (Hrs.)
6	100	24	24	6
12	120	28.8	4.8	6
24	130	31.2	2.4	12



NEW LA BELLE LAKE DAM
5 MINUTE UNIT HYDROGRAPH

DAM SAFETY INSPECTION / MISSOURI

SHEET NO. 1 OF 1

NEW LABELLE LAKE DAM

JOB NO. 1223-001

100-YEAR FLOOD BY REGRESSION EQUATION

BY MAS DATE 10-24-78

NEW LABELLE LAKE DAM100-YR FLOOD BY REGRESSION EQ.

Regression equation for 100-year flood for

Missouri:

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

where A = drainage area in sq. mi.

S = main channel slope, ft/mi.

(Avg slope between 0.14 & 0.85)

For New Labelle Lake Dam:

$$A = 158 \text{ acres} = 0.25 \text{ sq. mi.}$$

$$S = 34 \text{ ft} / 0.26 \text{ mi} = 130.77 \text{ ft/mi}$$

$$Q_{100} = 85.1 (0.25)^{0.934 (0.25)^{-0.02}} (130.77)^{0.576}$$

$$= \underline{\underline{372 \text{ cfs}}}$$

HEC1DB INPUT DATA

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

DAM SAFETY INSPECTION - MISSOURI		NEW LABELLE LAKE DAM		PMF AND 50 PERCENT PMF DETERMINATION AND ROUTING	
1	A			0	0
2	A			0	0
3	A			0	0
4	A	300		0	0
5	H1	5		0	0
6	J	1	1		
7	J1	1.0	0.5		
8	K	0			
9	K1				
10	M	1	0.28	0.28	1.0
11	M1	24.00	100	120	130
12	T				0.85 0.07
13	J	11			
14	M1	0.0	420	860	400
15	M1	0			225
16	K		0		100
17	K1		0		45
18	K1		0		25
19	V				15
20	V1				2
21	V4680.00	690.50	691.00	691.73	692.44
22	V4700.45				695.14
23	V5	0.0	10	50	124
24	V527523				206
25	V5	3	152	194	210
26	V5	60	690	691	696
27	V5	60			700
28	V5	60			705
29	V5	60			
30	V5	60			

PREVIEW OF SOURCE OF SIFSA-NT-DNA CALCULATIONS

ROUTE HYDROGRAPH AT
ROUTE HYDROGRAPH TO
END OF ROUTE

4

4

INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS

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

RUN DATE= 7/11/82
 TIME= 13.51.04.

DAM SAFETY INSPECTION - MISSOURI
 NEW TALLEULLE LAKE DAM
 PMF AND 50 PERCENT PMF DETERMINATION AND ROUTING

NG	NPR	NMTH	INBY	IMIN	WETMC	IPIT	IPRT	ASTAN
300	0	5	0	0	0	0	0	0
			UPPER	5	0	0	0	0
				LMPT	TRACE			

MULTI-PHASE ANALYSES TO BE PERFORMED
 RELEASE 1 PRICE 2.0000E 1

PTIUS= 1.00 .50

SUB-AREA RUNOFF COMPUTATION

INPUT PMF INDEX PRECIPITATION AND RATIOS, INPUT SCS UN
 ISTAT ICOMP ITCOM ISTATE JPLT JPRM ISTATE IASTG IASTG

IMDC	IUNG	TAPEA	SNAP	TSDA	TSPC	RATIO	ISNM	ISAME	LOCAL
1	1	1	1	1	1	1.00	0	0	0

PRECIP DATA
 SPCF R6 R12 R24 R48 R72 R96
 0.00 20.00 100.00 120.00 130.00 0.00 0.00 0.00

LOSS DATA
 LRPT STARR OLTKR RTIOL EPAIN STPKS RTIOL STMTL CMTSL ALSMX RTIMP
 0 0.00 0.00 1.00 0.00 0.00 1.00 0.00 0.00 0.00 0.00

GIVEN UNIT GRAPH, NUMGOS 11
 490. 225. 100. 45. 25. 19. 20.

UNIT GRAPH TOTALS 2191. CFS OR 1.01 INCHES OVER THE AREA

RECESSION DATA
 STATION 0.00 RECSNS 0.00 RTIOL 1.00
 PMF-OF-PERIOD FLOW
 MO.0A HR.00 PERIOD RAIN PKCS LOSS 4 COMP 0
 1 0.01 9.00 0.01 0. 1.01 12.32 151 0.20 0.19 0.01 0.20

1.01	5.10	62	.01	.00	.01	0.	1.01	17.40	212	.22	.21	.01	470.
1.01	5.15	63	.01	.00	.01	0.	1.01	17.45	213	.22	.21	.01	469.
1.01	5.20	64	.01	.00	.01	0.	1.01	17.50	214	.22	.21	.01	469.
1.01	5.25	65	.01	.01	.01	1.	1.01	17.55	215	.22	.21	.01	469.
1.01	5.30	66	.01	.01	.01	5.	1.01	18.00	216	.22	.21	.01	469.
1.01	5.35	67	.01	.01	.01	11.	1.01	18.05	217	.22	.21	.01	469.
1.01	5.40	68	.01	.01	.01	14.	1.01	18.10	218	.22	.21	.01	469.
1.01	5.45	69	.01	.01	.01	15.	1.01	18.15	219	.22	.21	.01	469.
1.01	5.50	70	.01	.01	.01	16.	1.01	18.20	220	.22	.21	.01	469.
1.01	5.55	71	.01	.01	.01	16.	1.01	18.25	221	.22	.21	.01	469.
1.01	6.00	72	.01	.01	.01	16.	1.01	18.30	222	.22	.21	.01	469.
1.01	6.05	73	.01	.01	.01	16.	1.01	18.35	223	.22	.21	.01	469.
1.01	6.10	74	.01	.01	.01	16.	1.01	18.40	224	.22	.21	.01	469.
1.01	6.15	75	.01	.01	.01	16.	1.01	18.45	225	.22	.21	.01	469.
1.01	6.20	76	.01	.01	.01	16.	1.01	18.50	226	.22	.21	.01	469.
1.01	6.25	77	.01	.01	.01	16.	1.01	18.55	227	.22	.21	.01	469.
1.01	6.30	78	.01	.01	.01	16.	1.01	19.00	228	.22	.21	.01	469.
1.01	6.35	79	.01	.01	.01	16.	1.01	19.05	229	.22	.21	.01	469.
1.01	6.40	80	.01	.01	.01	16.	1.01	19.10	230	.22	.21	.01	469.
1.01	6.45	81	.01	.01	.01	16.	1.01	19.15	231	.22	.21	.01	469.
1.01	6.50	82	.01	.01	.01	16.	1.01	19.20	232	.22	.21	.01	469.
1.01	6.55	83	.01	.01	.01	16.	1.01	19.25	233	.22	.21	.01	469.
1.01	7.00	84	.01	.01	.01	16.	1.01	19.30	234	.22	.21	.01	469.
1.01	7.05	85	.01	.01	.01	16.	1.01	19.35	235	.22	.21	.01	469.
1.01	7.10	86	.01	.01	.01	16.	1.01	19.40	236	.22	.21	.01	469.
1.01	7.15	87	.01	.01	.01	16.	1.01	19.45	237	.22	.21	.01	469.
1.01	7.20	88	.01	.01	.01	16.	1.01	19.50	238	.22	.21	.01	469.
1.01	7.25	89	.01	.01	.01	16.	1.01	19.55	239	.22	.21	.01	469.
1.01	7.30	90	.01	.01	.01	16.	1.01	20.00	240	.22	.21	.01	469.
1.01	7.35	91	.01	.01	.01	16.	1.01	20.05	241	.22	.21	.01	469.
1.01	7.40	92	.01	.01	.01	16.	1.01	20.10	242	.22	.21	.01	469.
1.01	7.45	93	.01	.01	.01	16.	1.01	20.15	243	.22	.21	.01	469.
1.01	7.50	94	.01	.01	.01	16.	1.01	20.20	244	.22	.21	.01	469.
1.01	7.55	95	.01	.01	.01	16.	1.01	20.25	245	.22	.21	.01	469.
1.01	8.00	96	.01	.01	.01	16.	1.01	20.30	246	.22	.21	.01	469.
1.01	8.05	97	.01	.01	.01	16.	1.01	20.35	247	.22	.21	.01	469.
1.01	8.10	98	.01	.01	.01	16.	1.01	20.40	248	.22	.21	.01	469.
1.01	8.15	99	.01	.01	.01	16.	1.01	20.45	249	.22	.21	.01	469.
1.01	8.20	100	.01	.01	.01	16.	1.01	20.50	250	.22	.21	.01	469.
1.01	8.25	101	.01	.01	.01	16.	1.01	20.55	251	.22	.21	.01	469.
1.01	8.30	102	.01	.01	.01	16.	1.01	21.00	252	.22	.21	.01	469.
1.01	8.35	103	.01	.01	.01	16.	1.01	21.05	253	.22	.21	.01	469.
1.01	8.40	104	.01	.01	.01	16.	1.01	21.10	254	.22	.21	.01	469.
1.01	8.45	105	.01	.01	.01	16.	1.01	21.15	255	.22	.21	.01	469.
1.01	8.50	106	.01	.01	.01	16.	1.01	21.20	256	.22	.21	.01	469.
1.01	8.55	107	.01	.01	.01	16.	1.01	21.25	257	.22	.21	.01	469.
1.01	9.00	108	.01	.01	.01	16.	1.01	21.30	258	.22	.21	.01	469.
1.01	9.05	109	.01	.01	.01	16.	1.01	21.35	259	.22	.21	.01	469.
1.01	9.10	110	.01	.01	.01	16.	1.01	21.40	260	.22	.21	.01	469.
1.01	9.15	111	.01	.01	.01	16.	1.01	21.45	261	.22	.21	.01	469.
1.01	9.20	112	.01	.01	.01	16.	1.01	21.50	262	.22	.21	.01	469.
1.01	9.25	113	.01	.01	.01	16.	1.01	21.55	263	.22	.21	.01	469.
1.01	9.30	114	.01	.01	.01	16.	1.01	22.00	264	.22	.21	.01	469.
1.01	9.35	115	.01	.01	.01	16.	1.01	22.05	265	.22	.21	.01	469.
1.01	9.40	116	.01	.01	.01	16.	1.01	22.10	266	.22	.21	.01	469.
1.01	9.45	117	.01	.01	.01	16.	1.01	22.15	267	.22	.21	.01	469.
1.01	9.50	118	.01	.01	.01	16.	1.01	22.20	268	.22	.21	.01	469.
1.01	9.55	119	.01	.01	.01	16.	1.01	22.25	269	.22	.21	.01	469.
1.01	10.00	120	.01	.01	.01	16.	1.01	22.30	270	.22	.21	.01	469.
1.01	10.05	121	.01	.01	.01	16.	1.01	22.35	271	.22	.21	.01	469.

PMF FLOOD ROUTING

INCHES 31.43 14.48 18.68 14.48
 MM 304.56 372.86 372.86 372.86
 FT 17.7 219. 219. 219.
 THOUS CU M 219. 270. 270. 270.

HYDROGRAPH MODEL

ROUTE HYDROGRAPH THROUGH NEW LABELLE LAKE DAM

INSTAD ICOMP IFCM ITRC JRT JNAME ISTAGE IAUJO

4 1 0 0 0 0 0 0

ROUTING DATA

AVG 185 185 185 185

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DAW DATA

TUNEL COND EXPD DAMK10

690.0 0.0 0.0 0.0

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0.0 0.0 0.0 0.0

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END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.0 0.0 0.0 0.0

0.0 0.0 0.0 0.0

0.0 0.0 0.0 0.0

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0.0 0.0 0.0 0.0

	PEAK	COMP	2-MINUTE	72-MINUTE	TOTAL	WEIGHT
LEF 9	1571.6	31.0	21.0	20.4	6117.0	
FW 9	44.0	18.0	6.0	6.0	1781.0	
1-CHE 9	5037.0	50.0	28.0	28.0	26120.0	
FW	33.0	716.50	716.50	716.50	716.50	
AC-F 1	421.0	421.0	421.0	421.0	421.0	
FW	510.0	510.0	510.0	510.0	510.0	

maximal 51.25% = 144.

AD-A104 783

PRC CONSOER TOWNSEND INC ST LOUIS MO
NATIONAL DAM SAFETY PROGRAM. NEW LA BELLE LAKE DAM (MO-10372), --ETC(U)
DEC 78
DACW43-78-C-0160
NL

UNCLASSIFIED

2nd
4th 78x



END

DATE

FILMED

10-81

DTIC

ONE-HALF PMF FLOOD ROUTING

END-OF-PERIOD HYDROGRAPH COORDINATES

[illegible][illegible]

SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING

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

RATIOS APPLIED TO FLOWS

OPERATION STATION AREA PLAN RATIO 1 RATIO 2

HYDROGRAPH AT 4 28 1 3615 1807
 (73) (102.35) (51.18)

ROUTED TO 4 28 1 1571 582
 (73) (49.20) (15.06)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 INITIAL VALUE SPILLWAY CREST TOP OF DAM
 690.00 690.00 690.00
 145. 145. 339.
 0. 0. 1200.

RATIO OF LIFE	MAXIMUM RESERVOIR % S.ELEV	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF	
					MAX. DUTY HOURS	FAILURE HOURS
1.00	690.18	344.	1571.	.53	16.00	0.00
.50	693.40	285.	532.	0.90	16.04	0.00

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

PERCENT OF PMF FLOOD ROUTING
EQUAL TO SPILLWAY CAPACITY

RUN DATE 79/11/2.
TIME 15.49.14.

DAW SAFETY INSPECTION - MISSOURI
NE - LA BELLE LAKE DAM
DEFECTS OF DME DETERMINATION AND ROUTING

[illegible]

MULTI-DATA ANALYSIS TO DETERMINE
PLANE NUMBER 9 (PI02)

[illegible]

SIMPLE AREA RUNOFF COMPUTATION

INPUT PMP	INDEX	PRECIPITATION	AND	HATTUS,	INPUT	SES	IN
ISTAC	ICCN	ISAP	JPLT	JMPT	INAME	ISTAGE	ISOUTH

INTDC	KJUNG	TAREA	SFAP	TRSDA	IRSDC	RATIN	ISRDZ	ISRMF	LOCAL
			9.00	28		1.00	0.008	0	0
HYDROGRAPH DATA									

[illegible]

	STANK	DLTRP	RTIOL	ERAIN	STRAS	RZYOK	SPTPL	CNSTL	ALSNX	MIMP
LPROT								.07	/0.00	06.00

RECESSION DATA	STATIONS
0.00	1.00
END OF PERIOD	

END-OF-PERIOD FLOW				END-OF-PERIOD FLOW			
MO.DA	HR.MM	PERIOD	EXCS	LOSS	MO.DA	HR.MM	PERIOD
		COMP 0	RAIN	EXCS			COMP 0
0	0	0	0	0	0	0	0

	31120	29.08	P.10	B3600
1.50M				

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH NEW LARELLE LAKE DAM

ISTAU 4 ICOMP 1 ILCN 0 IIFE 0 JPLT 0 JPR1 0 JNAME 1 ISTAGE 0 JAUTO 0

ROUTING DATA

GLUSS 0.0 CLOSS 0.000 AVG 0.000 IRES 1 ISAME 1 IOPI 0 IPMP 0 LOPR 0

NSIPS NSIDL LAG ANSKK X TSK STORA ISBRAT

0 0 0 0.000 0.000 0.000 -690.0

STAGE 690.0 690.5 691.0 691.7 692.4 693.1 694.0 694.5 694.8 694.8

FLOW 10. 50. 124. 206. 339. 449. 724.

CAPACITY 0. 152. 194. 219. 339. 449. 724.

ELEVATIONS 690. 690. 690. 691. 696. 700. 705.

CREL 690.0 SHWID 0.0 COOP 0.0 EXPN 0.0 ELEV 0.0 CAREA 0.0 EXPL 0.0

DAM DATA

TOPEL 696.0 COOD 0.0 EXPD 0.0 DAMWID 0.0

PEAK OUTFLOW IS 1153. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1171. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1190. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1206. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1224. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1242. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1260. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1278. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1296. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1314. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1332. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1350. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1368. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1386. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1404. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1422. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1440. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1458. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1476. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1494. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1512. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1530. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1548. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1566. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1584. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1602. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1620. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1638. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1656. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1674. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1692. AT TIME 16.08 HOURS

PEAK OUTFLOW IS 1710. AT TIME 16.08 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLANT ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE FEET (SQUARE METERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
HYDROGRAPH AT	4	.28 (.73)	1	3209.	3325.	5362.	1108.	3434.	3470.	3504.	35424	3590.
				(95.14)	(94.16)	(95.19)	(96.21)	(97.24)	(98.26)	(99.28)	(100.31)	(101.33)
DISTRIBUTED TO	4	.28 (.73)	1	1153.	1171.	1190.	1208.	1226.	1366.	1425.	1474.	1523.
				(32.65)	(33.17)	(33.69)	(34.21)	(34.73)	(35.25)	(35.77)	(36.29)	(36.81)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1..... INITIAL VALUE SPILLWAY CREST TOP OF DAM
 ELEVATION 690.00 690.00 696.70
 STORAGE 194. 194. 339.
 OUTFLOW 0. 0. 1200.

RATIO OF PHF	MAXIMUM RESPONDER H.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE ACFT	MAXIMUM OUTFLOW CES	DURATION OVER TOP HOURS	TIME OF MAY FLOW HOURS	TIME OF FAILURE HOURS
.91	695.89	0.00	336.	1153.	0.00	16.08	0.00
.92	695.93	0.00	337.	1171.	0.00	16.56	0.00
.93	695.94	0.00	338.	1190.	0.00	16.08	0.00
.94	696.01	.01	339.	1228.	.17	16.08	0.00
.95	696.04	.04	340.	1269.	.17	16.00	0.00
.96	696.08	.08	341.	1360.	.17	16.00	0.00
.97	696.11	.11	342.	1425.	.33	16.00	0.00
.98	696.13	.13	343.	1474.	.33	16.00	0.00
.99	696.16	.16	345.	1523.	.33	16.00	0.00

