

**POST-STORM DAM EVALUATION REPORT
STORM EVENT OF MAY 29-30, 2018
LAKE LURE DAM, APPURTENANCES, & POWERHOUSE
NC DAM ID No. RUTHE-003
LAKE LURE, NORTH CAROLINA
Project No. ME – 18 - 005**

PREPARE FOR:

**TOWN OF LAKE LURE
2948 MEMORIAL HIGHWAY
LAKE LURE, NORTH CAROLINA 28746
Attention: Mr. Shannon Baldwin
Interim Town Manager**

PREPARED BY:

**B. Dan Marks, Ph.D., P.E., Principal
NC Registration No. 09631
Marks Enterprises of NC, PLLC
1 Palatka Street
Arden, North Carolina 28704**

July 23, 2018

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Lake Lure Dam and Hydroelectric Plant

NC Dam Identification No. RUTHE-003

Lake Lure, Rutherford County, North Carolina

Project No. ME – 18 – 005

INTRODUCTION

The first tropical storm of the hurricane season was named Alberto that formed off the coast of the eastern peninsula of Mexico on May 25, 2018. The classified Subtropical Storm traveled almost due north to make landfall on near midnight in the panhandle of Florida before being downgraded to a Subtropical Depression that continued a northward tract to West Tennessee where it was further downgraded to a Tropical Depression that traveled north to the Northern Peninsula of Michigan and into Canada where it disbanded. A map of the Preliminary Track of Alberto from formation through complete disbandment is presented as an Attachment to this report.

Although Alberto was not a strong tropical storm or hurricane the associated low pressure depression was far-reaching and affected the southwestern mountain region of North Carolina. The impact of Alberto was intensified by the presence of a separate low pressure cell that began passing through western North Carolina at the same time as the formation of Alberto that produced a total of about 2.8 inches of rainfall in Lake Lure, North Carolina during the period of May 25 through May 28, 2018 when the outer bands of the Alberto depression began to produce in excess of four (4) inches of rainfall during the 24-hour period of 8:00 am EST on May 29, 2018 through 8:00 am EST on May 30, 2018 at the powerhouse of Lake Lure Dam. Approximately one inch to 1.5 inches of rain fell through the day on May 29, 2018 with the major portion of the rainfall (3.25 to 3.5 inches) occurring during the six-hour period of 8:00 p.m. EST on May 29, 2018 until 2:00 am on May 30, 2018.

Fortunately, the lake level of Lake Lure had been lowered about two (2) feet below normal water surface elevation (NWSE) to about Elevation 988 feet in anticipation of a storm that was forecast to produce as much as five (5) to eight (8) inches of rainfall in some portions of the Lake Lure Watershed. A map of the Lake Lure Watershed and a Vicinity Map of Lake Lure are presented as Attachments to this report. The lake elevation at the time the lake level began to recede at about 2:00 am EST on May 30, 2018 was slightly greater than the NWSE of 990 feet. As such, lowering of the lake elevation by two (2) feet prior to the forecast storm might be considered as excessive by some, the amount of drawdown would have been very close to the amount of storage required for the predicted (forecast) storm event.

FLOOD GATE OPERATION, DISCHARGE, AND STORM EVENT

As a result of a recommendation made at the conclusion of the recently completed extensive two-phase, four-volume Independent Consultant Dam Safety Inspection of Lake Lure Dam; Its Appurtenances; and the Hydroelectric Power Generation Facilities by the author of this report, the No. 1 Flood Control Gate at the left abutment (facing downstream) was not initially utilized to the control the impending flood event. The restricted use of this gate was recommended as a result of the concern about the stability and integrity of the massive reinforced concrete wingwall at the left abutment of the dam.

On the evening of May 29, 2018, Mr. David Arrowood, Public Works Director for the Town of Lake Lure and Dr. Marks exchanged phone calls from about 7:30 p.m. until about 9:00 pm EST about the levels of the lake and the implementation of the use of Gate No. 1. By 7:30 p.m. Gates No. 2 and No. 3 had been opened to a height of five (5) feet, but Gate No.1 had not been opened and the lake level was continuing to rise at a rapid rate, Dr. Marks advised Mr. Arrowood to have the Operator raise Gate No. 1 three (3) feet, monitor the wingwall, and call him back in thirty (30) minutes with a report on the performance of the wall. He told Mr. Arrowood that he was preparing items to leave for Lake Lure Dam. At 8:00 p.m. the Operator called Dr. Marks with a report that the wingwall was performing well but the lake level was still rising. Dr. Marks advised Mr. McCraw to raise Gate No. 1 to Five (5) feet to equalize the forces on the Ogee Spillway structure by having all gates opened to five (5) feet. Mr. Arrowood then got on the phone and advised Dr. Marks **NOT** to attempt to come to Lake Lure or to Lake Lure Dam. All access roads were block by law enforcement agencies because of excessive tree blockage, massive landslides and slope failures, and excessive roadway flooding. At 10:00 p.m. all gates were opened to seven (7) feet and the lake elevation had reached approximately NWSE 990 feet and was continuing to rise about two (2) inches per hour. At 11:00 pm on May 29, 2018 the lake elevation was approaching elevation 990.5 feet and rising at what appeared to be a slower rate than previously observed. Dr. Marks advised the on-site personnel not to raise any of the gates above ten (10) feet unless the lake elevation reached an elevation of 991 feet. During the 11:30 p.m. condition report the Operator advised Dr. Marks that the intensity of the storm appeared to be decreasing slightly and the rise in lake level had almost ceased during the last thirty (30) minutes. Dr. Marks advised to not over-react and continue to monitor conditions (rainfall and lake elevations) before thinking about beginning the gate closing process. At midnight on May 29, 2018 Lake Lure reached the peak elevation in this flood event at an elevation of approximately 990.5 feet. Dr. Marks advised to raise Gate No. 1 to ten (ten) feet but again advised not to raise any of the gates above ten (10) feet unless the lake elevation reached 991.0 feet. By 2:00 a.m. on the morning of May 30, 2018 Lake Lure had past the peak inflow and was at about elevation 989.5 feet. By 4:00 a.m. on the morning of May 30, 2018 the lake

elevation was approximately 989.0 feet and by about 8:00 a.m. on May 30, 2018 the storm associated with remnants of Alberto was deemed to be over and all gates were in closed positions.

The author of this report has always believed that there are always benefits and new levels of understanding associated with all events and/or incidents that occur in our lives no matter how devastating they may seem at the time of occurrence. Some may say that this belief is that of a hopeless optimist, but there you have it. I cannot accept the occurrence of an apparent catastrophe or adverse event without discovering what may be the beneficial affect(s) of the "Happening". Some may say that the storm event that occurred at Lake Lure on the night of May 29, 2018 and early morning of May 30, 2018 was a near catastrophe or disaster; however, I say that it was an opportunity that could have been brought on by a series of unusual natural occurrences or climatological events. This opportunity allowed the author to work with the Dam Operator, Public Works Director, former Town Manager, and unknowingly the Mayor, in making major decisions about flood gate operations at critical times during the storm event to control potential serious flooding and excessive property damage downstream of the dam before these events occurred. This event has provided an invaluable opportunity that could not occurred without the apparent potential disaster. This opportunity allowed the determination of the following performance characteristics of the watershed and flood control gates of Lake Lure and Lake Lure Dam.

- Potential accuracy of the use of approximation methods for runoff determination,
- Potential accuracy of previously estimated stormwater runoff curve numbers,
- Accuracy of lake surface area determination method of stormwater storage, and
- Accuracy of prediction of the return frequency and duration of storm events.

Lake storage and flood gate discharge calculations and supporting data are presented in Appendix A of this report. These calculations with supporting storm return frequency and duration data produced by the U.S. Weather Bureau indicate that the storm event that occurred during the period of about 8:00 pm May 29, 2018 and 2:00 a.m. May 30, 2018 was a ten (10) year return frequency storm event having a duration of about six (6) hours. The estimated rainfall during this event was approximately 3.25 to 3.75 inches. However, the author is confident that there were locations within the 95 square mile watershed that received rainfall amounts on the order of four (4) to five (5) inches. This opinion is based upon observations of a storm event in the fall of 2016 near the intersection of U.S. 64 Highway with the Eastern Continental Divide east of the town of Edneyville, North Carolina. The erosive action and destruction of stream crossing in this area were attributed to a storm event equal to the fifteen (15) year return frequency rainfall. The stormwater runoff at the peak of the recent storm is estimated to have been about 115,000 cubic feet per second (cfs) with a total of lake storage and flood gate spillway discharge

being about 116,000 cfs. The storm peaked with the lake elevation being about 990.5 feet and the discharge being about 11,734 cfs around midnight of May 29, 2018. Based upon the previously referenced U.S. Weather Bureau data, the recent storm event was an approximate ten (10) to twelve (12) year return frequency storm event having duration of about eight (8) hours.

PERFORMANCE OF LAKE LURE DAM AND POWERHOUSE

The evaluation of the performance of Lake Lure Dam during the storm event of May 29 - 30, 2018 was initiated by Dr. B. Dan Marks on June 7, 2018 with a site visit to visually observe the general condition of the dam especially with regard to stability of the left abutment wingwall and the foundation/bedrock seepage associated with bays No. 9, No.10.and 11. Dr. Marks submitted the former Town Manager a short Email Report indicating that the dam had apparently withstood the activities associated with flood water control without any visual evidence of major structural distress. Attention was then turned to evaluation of the magnitude of the storm event that had occurred and the performance of the flood gate control during the storm event that has previously been reported. The final post-flood dam inspection was conducted on July 7, 2018 after a brief interruption in the work directed toward this report. Notes and illustrations used in descriptions of existing conditions noted during the final inspection are presented in Appendix B of this report. Finding of the final inspection will be presented in accordance with location of observations proceeding from the Left Abutment Wingwall (facing downstream) to the Right Abutment end of the dam. Red number scattered throughout the text of this section of the report indicate conditions or concerns that the author of this report must address with the Operator so that proper attention is directed to these items.

Prior to this storm event, Dr. Marks had advised against routine activation of Flood Gate No. 1 adjacent to the Left Abutment Wingwall to preclude the application of any hydrostatic pressures on the high wall that appeared to exhibit evidence of areas of questionable structural integrity. As such, one of the most significant findings following the recent flood was that the Left Abutment Wingwall did not appear to have undergone any significant additional deterioration as a result of opening Gate No. 1 a full ten (10) feet as were the other two flood gates. There are some additional leaks and/or weeps of water retained behind the wall near the end of the wingwall. These leaks appear to be diminishing in time as one would expect of groundwater trapped in the backfill material of the wall. Flowing weep holes in the higher sections of the wall closer to the dam

continue to flow at about the same rate. However, **vegetation** growing from the holes appears to be flourishing during the summer growing season. **1**The Left Abutment Wingwall shall be continually monitored to determine if there are increases in flows.

The flood gates and operating systems appear to have withstood the multiple adjustments and excess hydrostatic pressure resulting from stored flood water without any sign of distress or malfunction. However, the occasion short-out or contact-failure in **2**the remote activation keypad still remains a problem that must be addressed in the dam maintenance program before the electrical short-out becomes permanent.

Seepage and leakage flows from Bay No. 5 where the existing sewer line passes through components of the dam continue to be significant but not visibly greater than pre-storm conditions. These seeps and leaks will continue to flow at high rates **until** such time that the new sewer line is installed and the existing pass-through of the old sewer line is removed and the opening in the dam properly closed. **3**Attention to this situation shall be monitored continuously so that this detail does not get overlooked in plans to be followed by either the new sewer line contractor or the dam remediation contractor.

There are not indications that the Powerhouse structure underwent any distress during the storm event and the equipment all appears to be operating at the same level as prior to the flood. Thin sections of the penstock that are of concern do not appear to be leaking; however, **4**the plate welding program that was underway and interrupted by sickness of the welder must be continued as soon as possible. Replacement of the smaller turbine and generator appears to be in the latter stages of completion. This project has experienced its share of delays as a result of fabrication problems but appears to be back on track for completion in the near future.

During the most recent site visit to the dam Dr. Marks arrived early in the morning to be sure that he was in position when the larger generator startup procedure began. His purpose was to determine the approximate tailwater head on the outlet manifold of the turbine of the larger generator. Having obtained a water level reference he asked the Hydroelectric Technician to begin the startup procedure. After the turbine was at full speed with the generator engaged Dr. Marks determined that there was a minimum of two (2) feet of head loss at the tailrace outlet. The two (2) feet of head loss is creating a significant loss in power generation efficiency. Although this observation has nothing to do with the flood, Dr. Marks has included this item so that it can be identified as a major concern. **5**The tailrace must be dredged to remove deposited materials, boulders, and gravel. At the same time Dr. Marks will likely **6**develop a plan to backfill a major portion of Bay No.6 to further reduce the potential for excess head in the tail race. **7**A tailwater elevation gage will also be installed in the tailrace to enhance adjustments to generators.

The next most significant area of concern in the order of the inspection tour is the shear crack in Buttress No. 9 on the Bay No. 8 side of the buttress. The shear crack is thought to have been the result of the earthquake shock in December 2007. Remediation of this crack and stabilization of Buttress No. 9 is a portion of Task I of the remediation project for Lake Lure Dam. This item will be numbered as a situation that must remain under continual scrutiny until such time that it is addressed in the remediation construction.

8 Crack monitors capable of monitoring movement in two (2) planes will be installed within a month to begin numerical monitoring of any movement at the crack.

The inspection of post-flood conditions has now reached the area of the dam that has always been of major concern to the author of this report relative to structural stability. This area of the dam is the downstream areas within Bays No. 9, No. 10, and No. 11. Subsurface conditions in this area consist of the presence of massive high-quality Biotite Gneiss interbedded with thick seams of soft, coarse-grained micaceous Schist. Underseepage of the concrete arches at these locations is infiltrating the Schist strata and creating excess hydrostatic pressure in the form of uplift pressures on the foundations of the buttresses. Recent measurements of water levels in the four (4) piezometers installed during the subsurface exploration program reveal that the groundwater level have returned to about fifty (50) percent of the original levels prior to the water pressure used in the rock coring operations flushed large quantities of Iron Oxide sludge from the fractures and Joints in the micaceous Schist formations. Surface level seepage is occurring over a large percentage of the area of these dam bays. The upward flow of seepage water is often referred to as "boils", particularly if they are carrying suspended solids. The flowing surface water at these locations is presently clear and carrying very few suspended particles as a result of the granular nature of the weathered Schist. **9** These areas must be continuously monitored throughout the dam remediation design phase of Task I. Responsibility for monitoring of these areas must be established once the dam remediation design engineering firm is under contract with the Town of Lake Lure.

There is no significant dam stability or structural concern in Bays No. 12 and No. 13 (last bay in the dam); however, there is a drainage "drop-out" in Bay No. 13 that has formed as a result of uncontrolled storm water runoff. Proper drainage will have to be addressed in this area during the dam remediation design to preclude the continued development of this feature.

The final feature of the dam is one that must be dealt with by identifying a liaison between the Town of Lake Lure and the North Carolina Department of Transportation (NCDOT). The reinforced concrete bridge that crosses the dam is owned by the NCDOT and is currently in a state of advanced deterioration as evidenced by excessive spalling of structural concrete. NCDOT does not want to remove the dam since it is an integral part of the dam. However, they must close the bridge to traffic since it is rapidly approaching

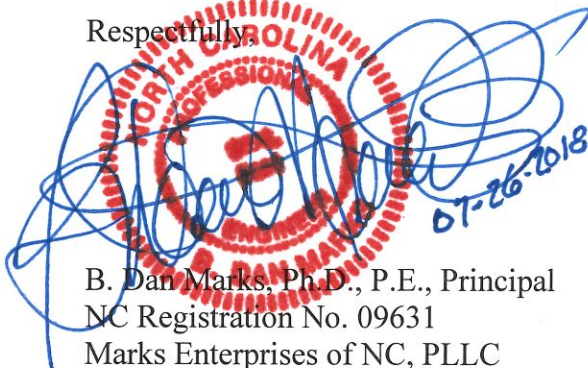
a condition that is structurally unsafe for continued use. **10**The Town of Lake Lure must re-establish contact with the NCDOT and establish a line of communication with a liaison that will report back the Town Council as the Bridge Project progresses. The bridge was not impacted by the recent storm beyond that which it has faced throughout the time of its existence. However, this item was included because it can not be overlooked and will have an impact on the dam and dam safety.

CLOSURE

Marks Enterprises of NC, PLLC (Marks Enterprises) appreciates the opportunity to provide profession service on the evaluation of adverse impact of the storm event of May 29 – 30, 2018. In conclusion, the dam performed well in the face of a storm event that was significant and provided a meaningful test of structural stability and integrity of the dam, its appurtenances, and the hydropower generation facilities. We congratulate Mr. Donnie McCraw, Mr. David Arrowood, and the former Town Manager for proper storm event monitoring and control throughout the duration of the storm. I have reported this storm event as a ten (10) – year return frequency, six (6) – hour duration storm event that exemplified a temporal unit hydrographic distribution. However, I am confident that the storm event was slightly greater than this classification because of known areas within the watershed that received higher rainfall amounts but can not be documented at this time as being greater than 3.25 to 3.5 inches.

If there are questions concerning this report, or if we can provide additional information or assistance please contact us at your convenience. Thank you again, it is always a pleasure to serve you.

Respectfully,



B. Dan Marks, Ph.D., P.E., Principal
NC Registration No. 09631
Marks Enterprises of NC, PLLC

BDM/dm

ATTACHMENTS

U.S. DEPARTMENT OF COMMERCE, NATIONAL WEATHER SERVICE
NORTH ATLANTIC HURRICANE TRACKING CHART

2018

NUMBER	TYPE	NAME	DATE
1	STS	ALBERTO	MAY 25-31

- Major Hurricane
- Hurricane
- Tropical Storm
- Tropical Depression
- Subtropical Storm
- Subtropical Depression
- Wave/Low
- Extratropical Storm
- Position at 0000 UTC
- Position/date at 1200 UTC
- Storm Number

LAMBERT CONFORMAL CONIC PROJECTION
STANDARD PARALLELS AT 30° AND 60°
SCALE OF NAUTICAL MILES
0 250 500

Preliminary

1

1

31

30

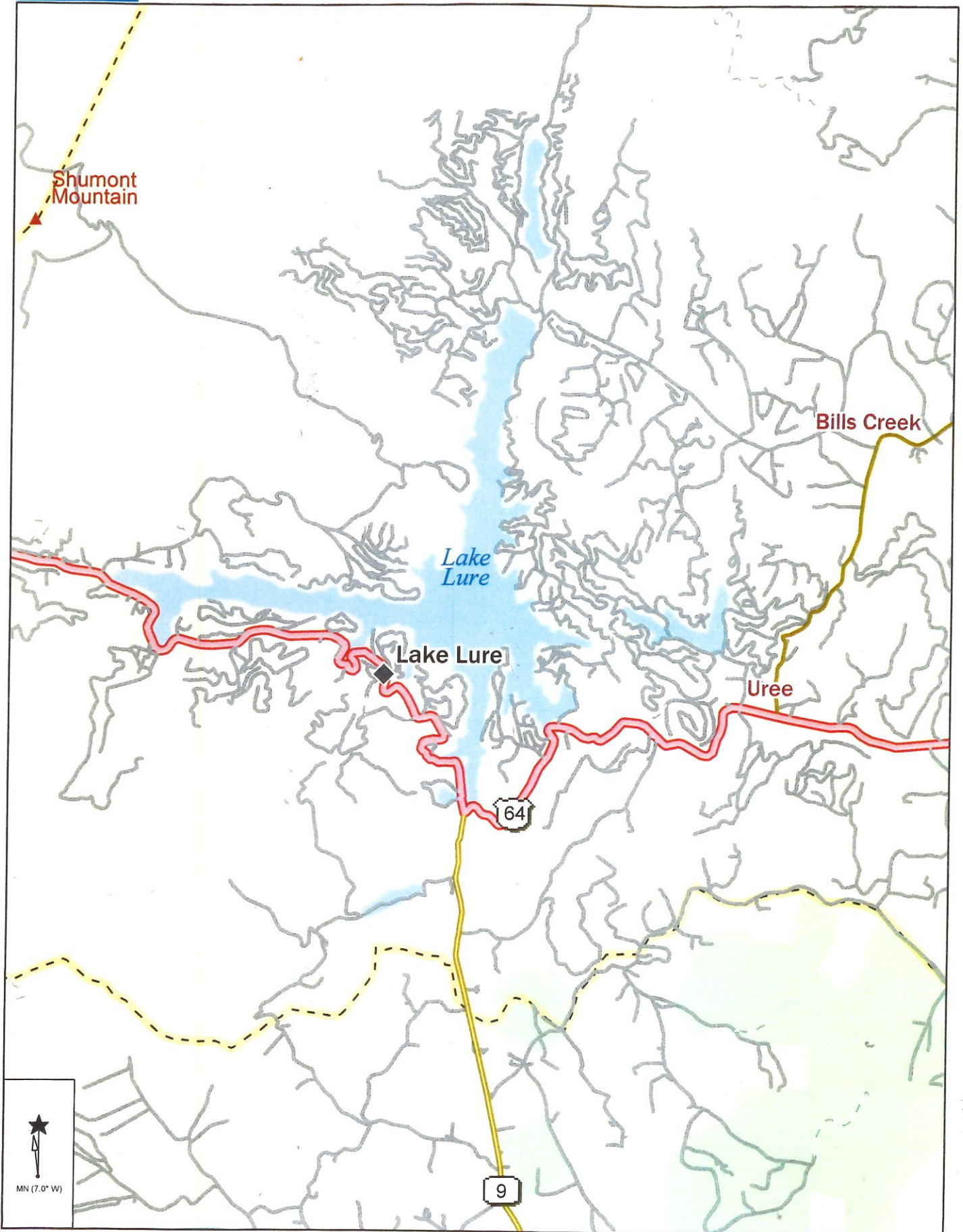
29

28

27

26

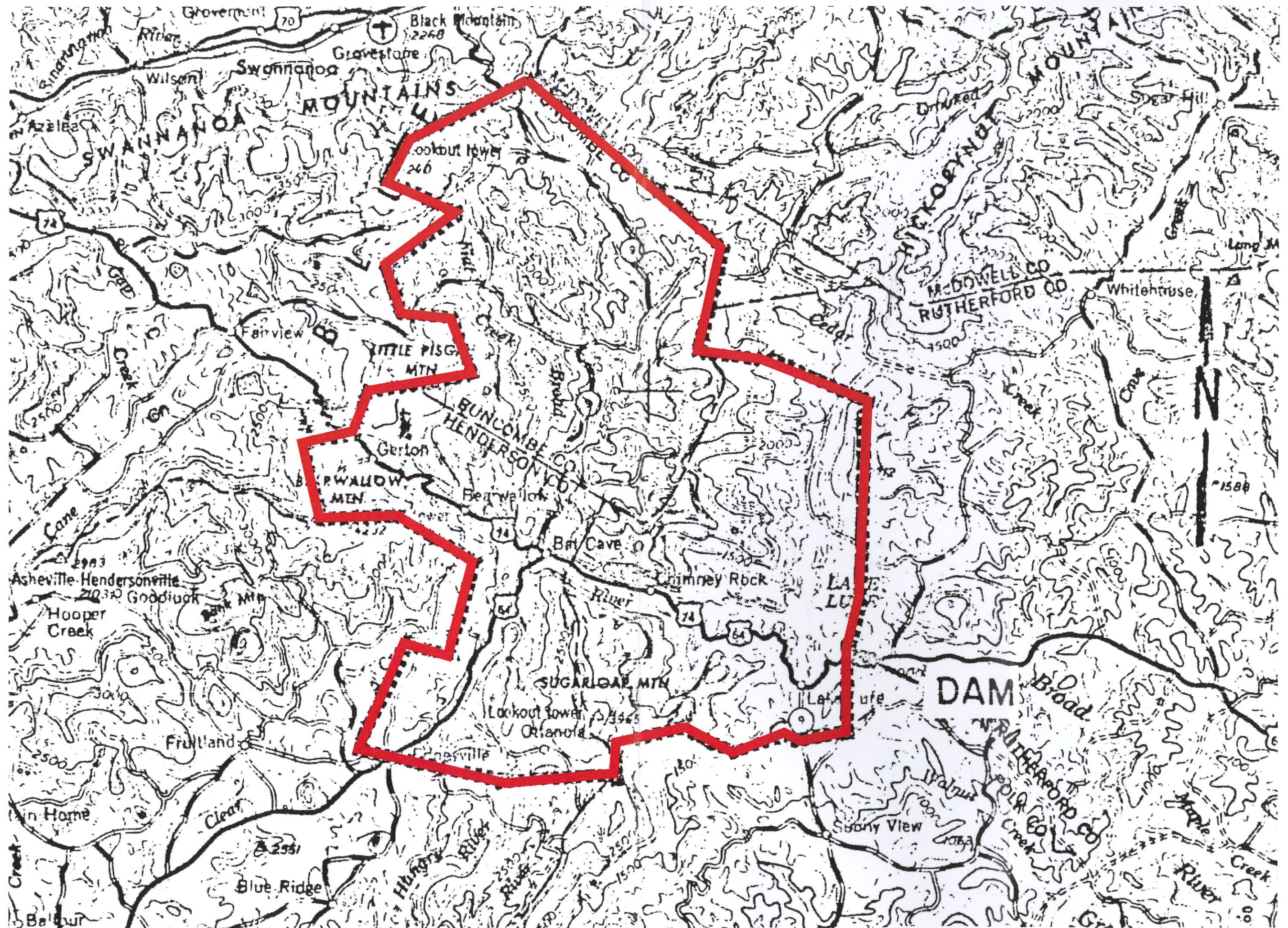
25



Data use subject to license.

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APPENDIX A

LAKE ELEVATIONS:

- ① The Lake Level had been lowered to about 988.0' to provide storage for the oncoming storm
- ② At about 8:00pm the Lake Elevation was being held at about Elevation 988.0' feet by the (2) gates opened about five (5) feet. But the Lake Elevation was beginning to rise gradually & would require more discharge capacity to maintain the Lake Elevation around 990.0' feet to 990.5' feet using 988.0' feet as the base of storage. The storage volumes are as follows:

Time	Elevation, ft	Area, AC	Volume, AC-ft
8:00pm	988.0	749.1	0 BEGINNING ELEV.
10:00pm	990.0	751.2	2.1 ACRE-Feet
6 Hours 12:00 (Midnight)	990.5	752.8	3.2 ACRE-Feet
0200 [05-30-18]	989.5	750.7	1.6 ACRE-Feet
0400 [05-30-18]	989.0	749.9	0.8 ACRE-Feet
0800 [05-30-18]	988.5	749.5	0.4 ACRE-Feet

- GATES CLOSED -

LAKE STABILIZES

CONDITIONS @ Peak of Storm

$$\text{STORAGE} = 3.2 \text{ ACRES-Feet} = 97,097 \text{ cfs}$$

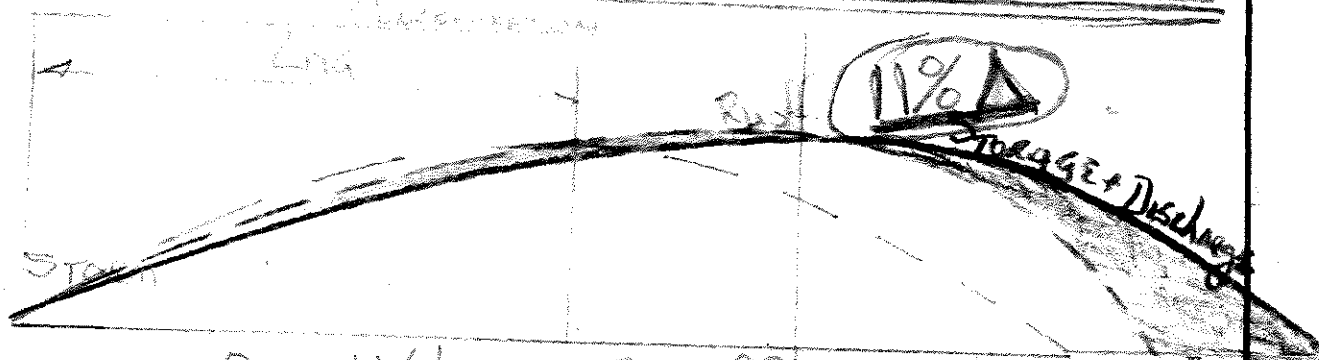
$$\text{FLOOD GATES DISCHARGE} = 11,736 \text{ cfs}$$

$$\text{Total} = 108,833 \text{ cfs}$$

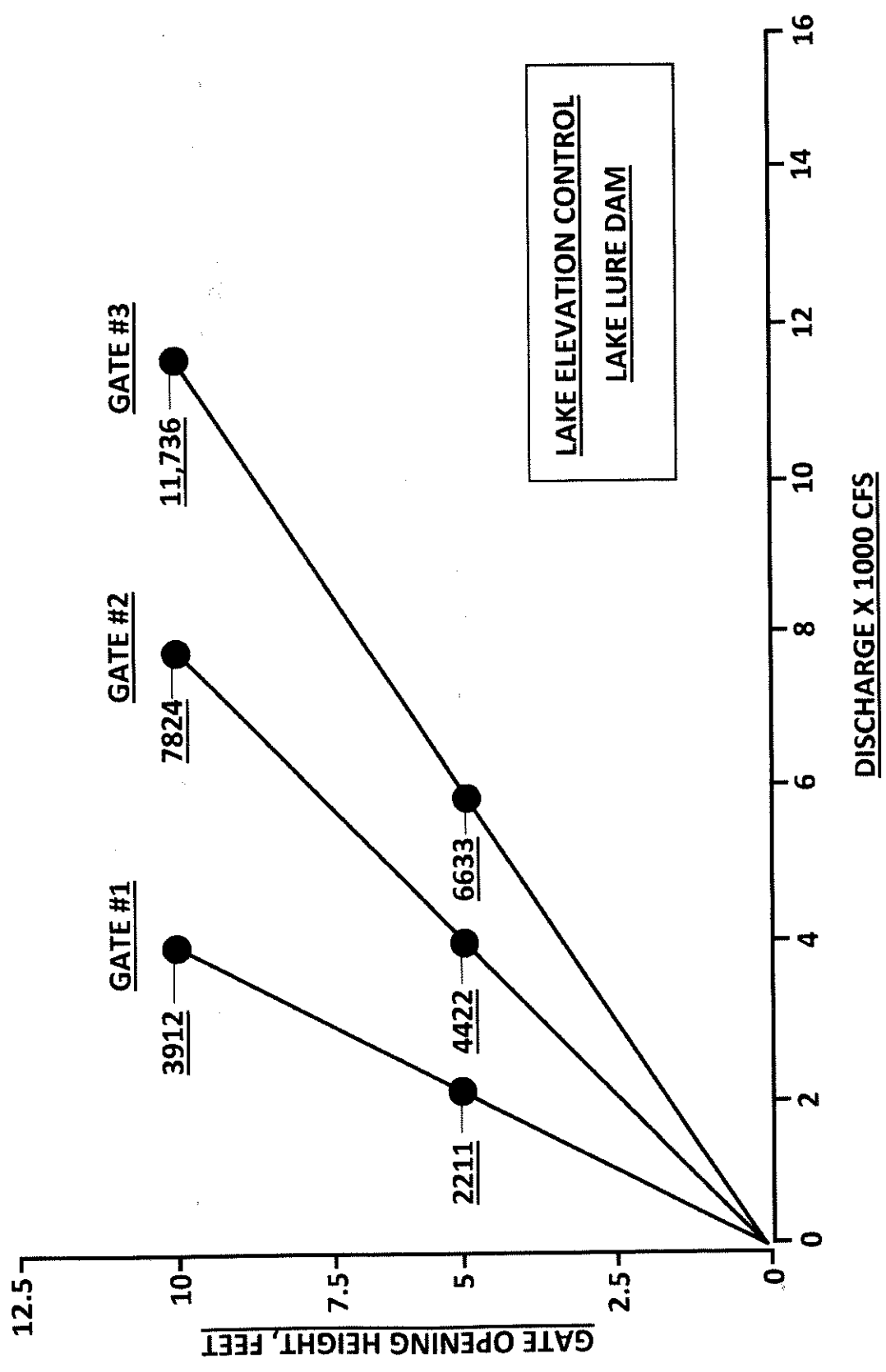
RUNOFF FROM KILLBUCK RIVER AT PEAK 6-Hour Duration

10-YEAR RETURN FREQUENCY
STORM EVENT RAINFALL = 3.5 in

* Based Upon Hydrographical Method
 Not Composite Runoff of Model
 $R_{\text{Runoff @ Peak}} = 722,613 \text{ cfs} = \text{STORAGE}$
 $+ \text{Discharge} = 108,833 \text{ cfs}$



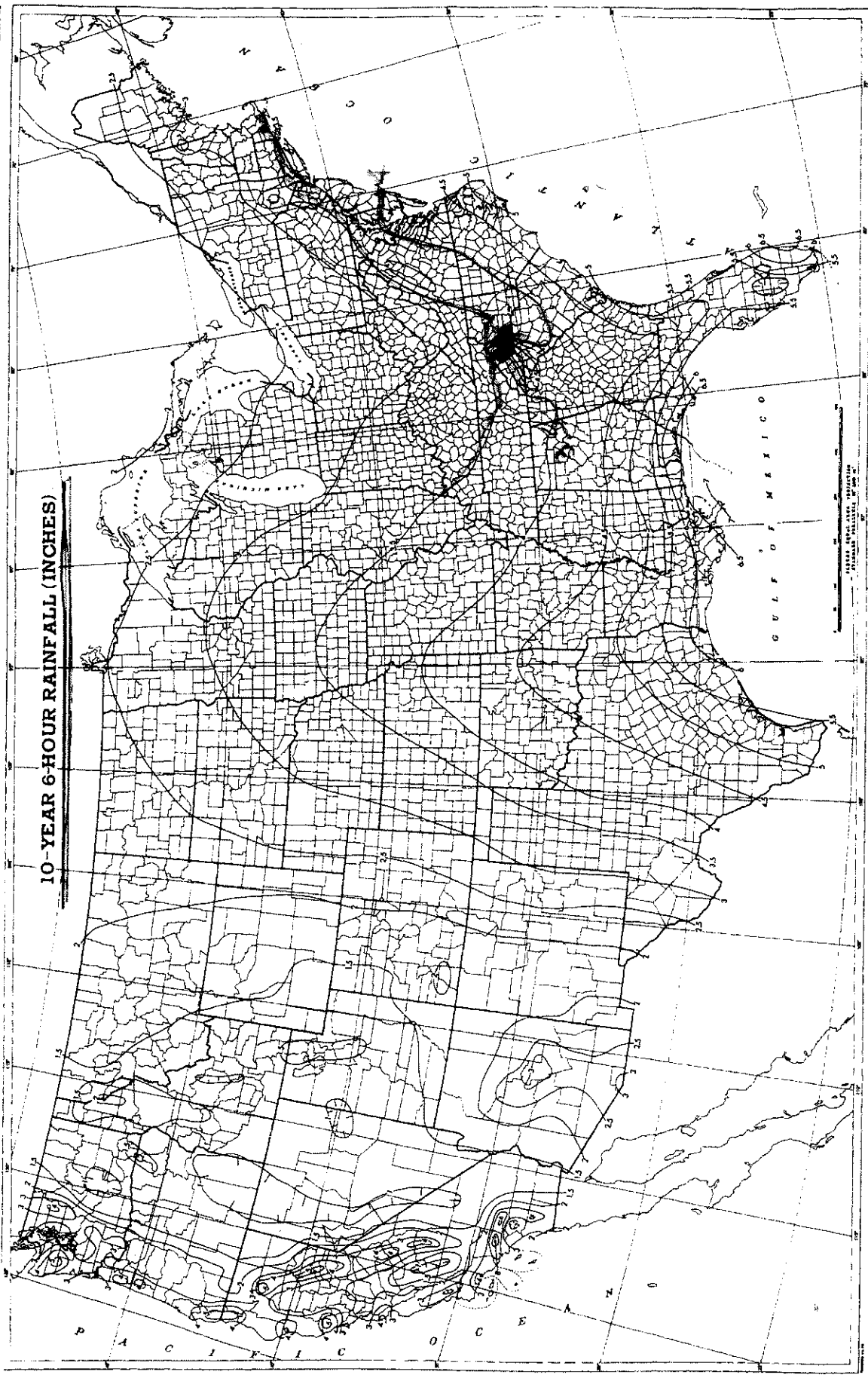
ACTUAL VALUES: $R_{\text{Runoff}} \approx 115,000 \text{ cfs}$
 @ PEAK of STORM $\text{STORAGE} + \text{Discharge} \approx 116,500 \text{ cfs}$



LAKE ELEVATION CONTROL
LAKE LURE DAM

Chart 32

33



10-YEAR 6-HOUR RAINFALL (INCHES)

GULF OF MEXICO

RAINFALL = 3.25 TO 3.75 INCHES

APPENDIX B

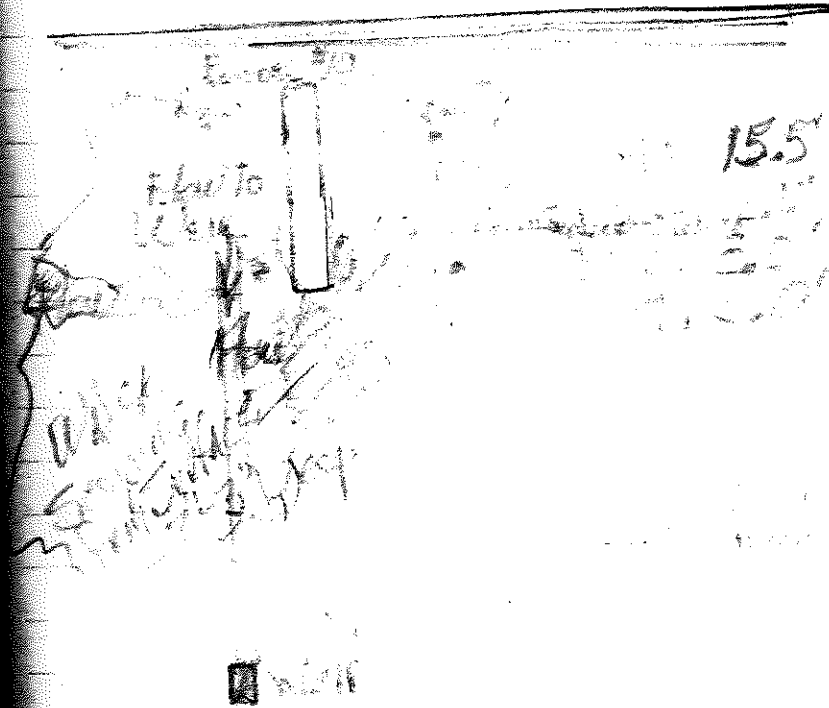
①

Post-Flood Inspection of 2-1-5

Creek Flowing in 1918
from 1st to 2nd Rd 1-30
1-1-06-2015 then on

Evolution of the 1st Rd
Lanes, and the 2nd Rd
1-1-06-2015 then on

Lake FENA +
San Emigdio River
Flow rate 1-1-06-2015
Check in the river



One's philosophy is not best expressed in words;
it is expressed in the choices one makes.
—Eleanor Roosevelt

Friday
July 2018

Daily Notes

187th Day 178 Left Week 27

Post-Flare Inspection & Report

Collected 1800 psi & 5 flares

Inspected & measuring
the contents

Visual Observations:

① Excessive Seepage 1 hour later
Sample 10 Pressure 2 3/4"

E. Valve 100 psi in 10 min
Pressure 2 1/2" in 10 min
Sample 10 Pressure 100 psi
Sample 10 Pressure 100 psi

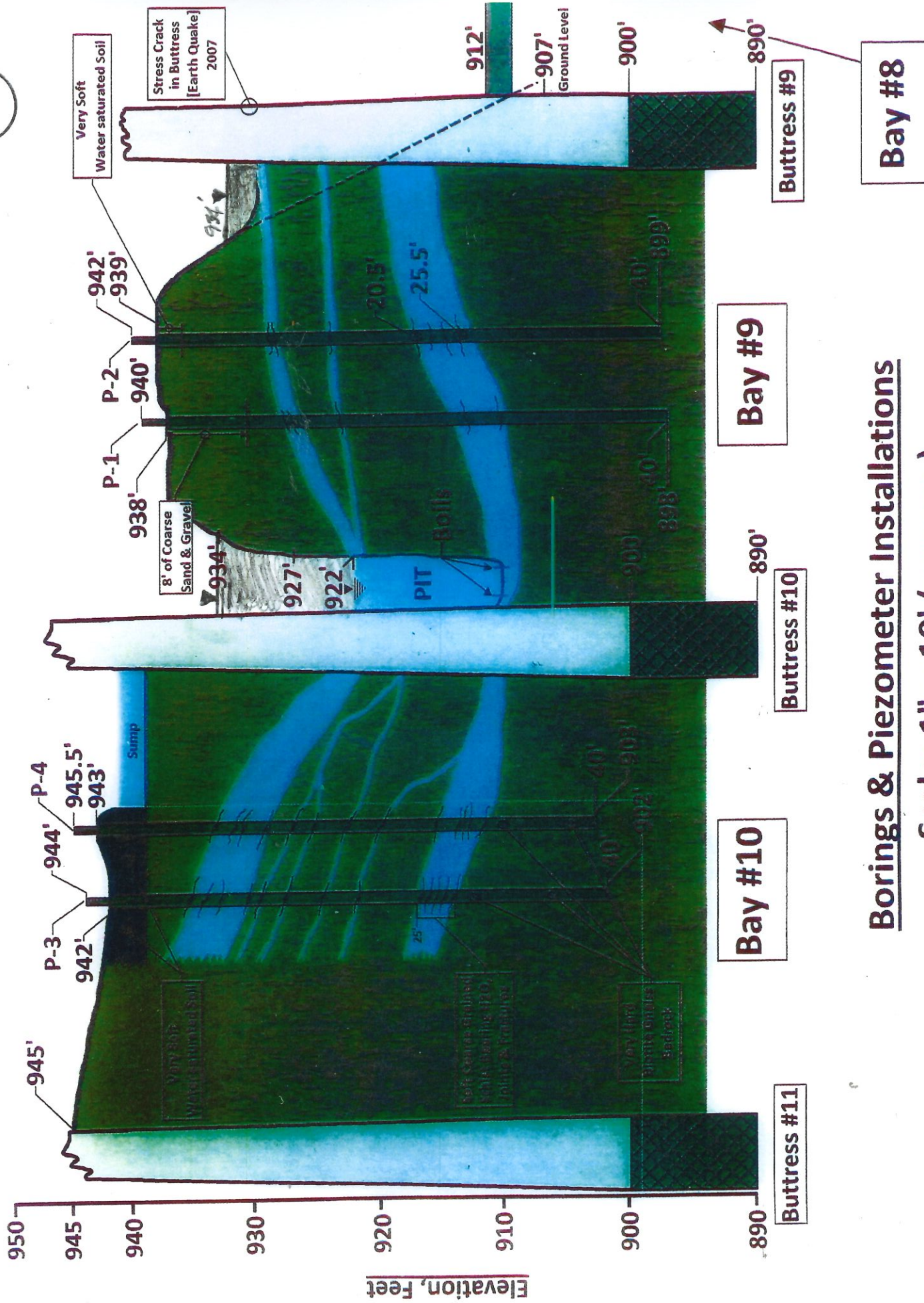
② Air Abundant Pressure 2.48 [2.75" / 12" / in] 2.45
Washed 100 psi in 10 min
Sample 10 Pressure 100 psi

③ Pressure 0.097 cfs
= 43.6 gpm

③ Piezometer Readings

Pressure 15.0 psi
Pressure 15.0 psi
Pressure 15.0 psi
Pressure 15.0 psi
Pressure 15.0 psi
Pressure 15.0 psi
Pressure 15.0 psi
Pressure 15.0 psi
Pressure 15.0 psi
Pressure 15.0 psi

5

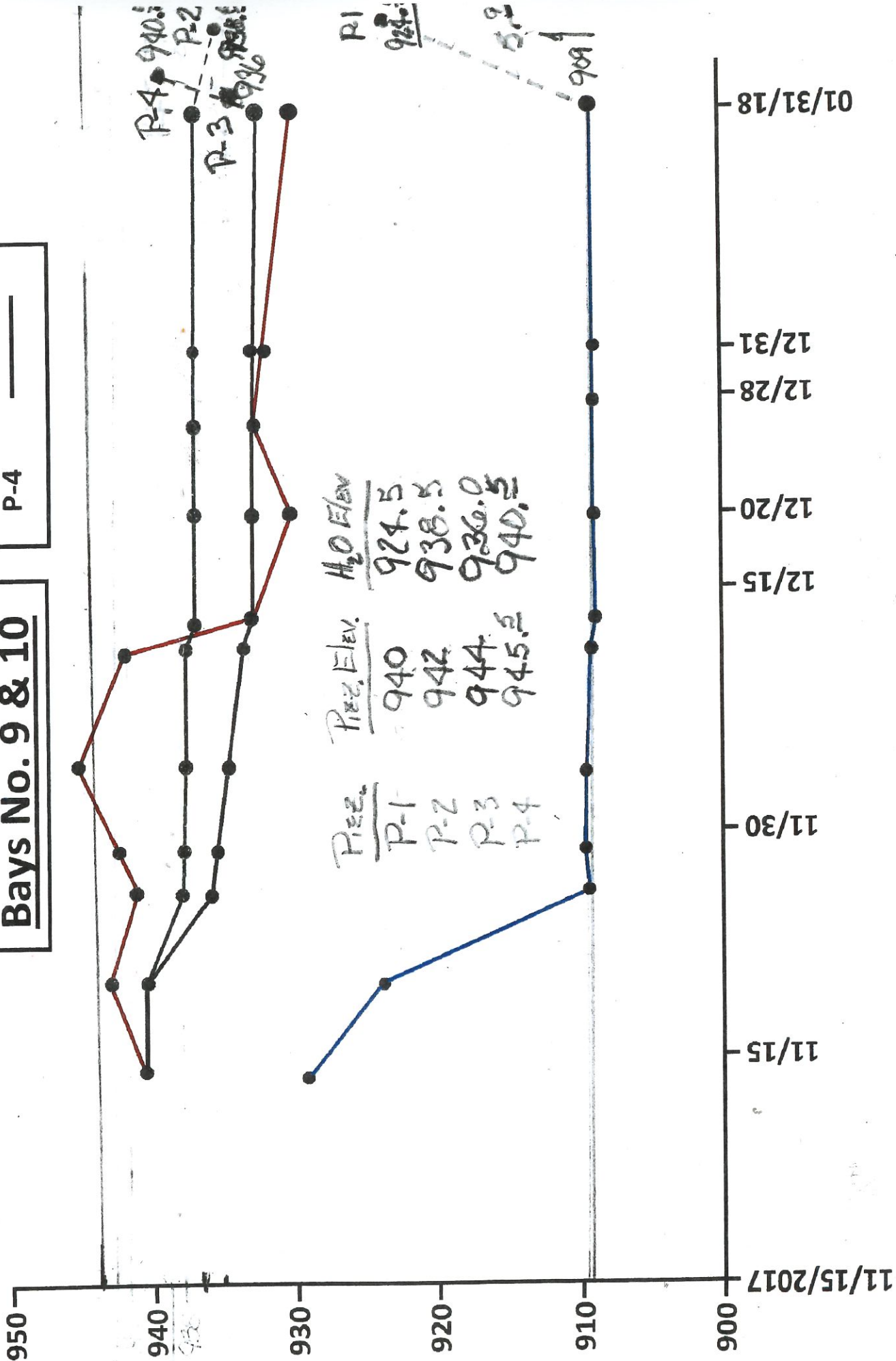


Borings & Piezometer Installations
Scale: 1" = 10' (approx.)

6

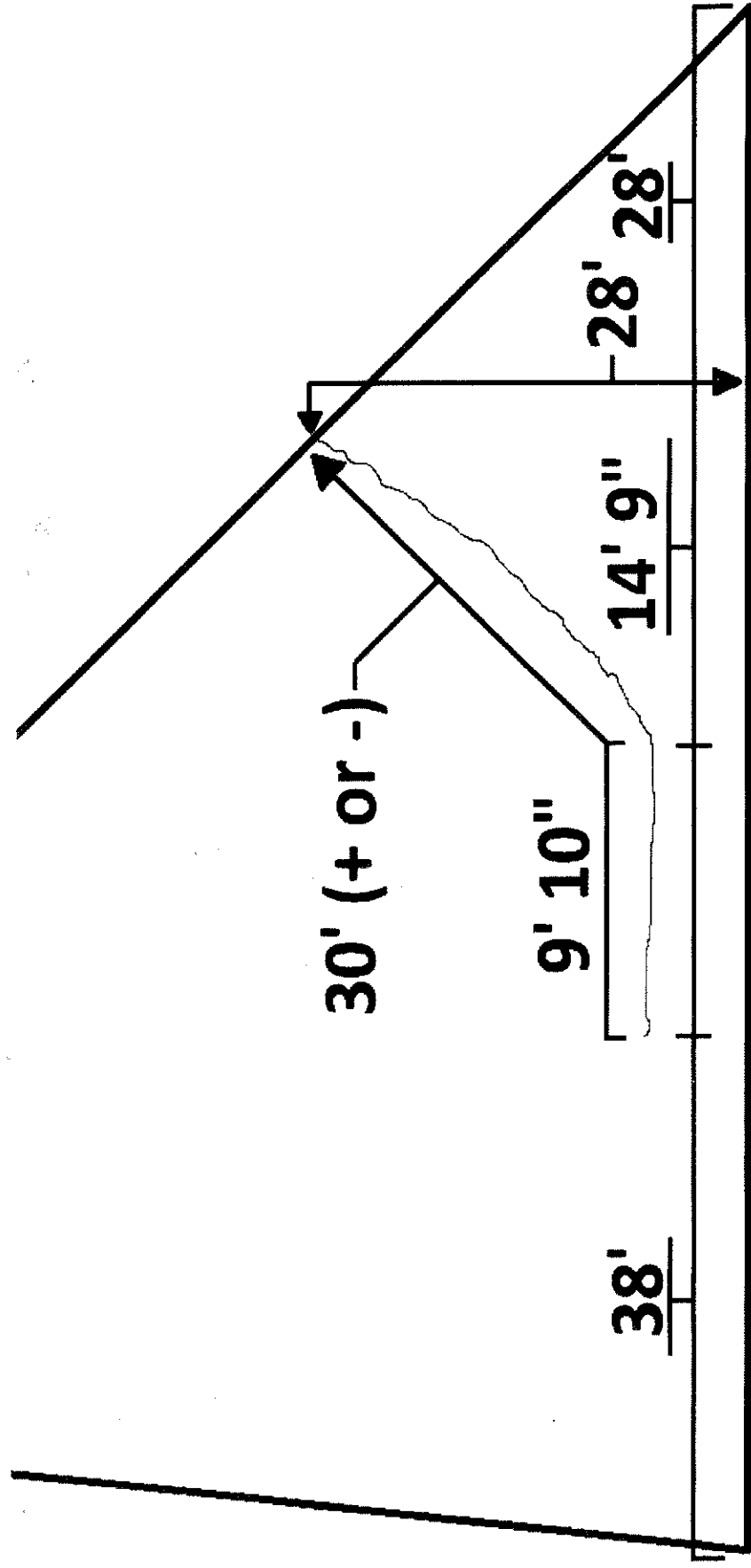
Piezometer Data Lake Lure Dam Bays No. 9 & 10

P-1
P-2
P-3
P-4



Buttress #9 in Bay #8

Image Showing a large Stress Fracture



APPENDIX C

DAM INSPECTION CHECKLIST

Date 07-06-18
Time ARRIVED 7:00AM

NAME OF DAM LAKE LURE Dam & Hydroelectric
COUNTY RUTHERFORD CLASS VERY LARGE - HIGH RISK
WEATHER & SITE CONDITIONS DR. B. DAVIS MARKS RE: POST FLOOD INSPECTION
INSPECTORS OPERATOR DONNIE McCRAW ON-SITE AFTER 8:00AM
OTHERS

CHECK AREA AS INSPECTED	CONCRETE DAM	TYPE <u>Multi-Arch Slab & Buttress</u>	ACTION		
			REPAIR	MONITOR	INVESTIGATE
☒	CHECK/CIRCLE CONDITION NOTED	OBSERVATIONS			
		COMPARATIVE OBSERVATIONS PRE & POST FLOODING			
☒	deteriorated joints	NO VISUAL EVIDENCE OF ADDITIONAL			
☒	cracking/spalling	SAME - AS - ABOVE			
☒	Newly Visible Cracks	NONE			
☒	deteriorated joints				
☒	cracking/spalling	N/A			
☒	poor alignment				
☒	deteriorated joints	No Evidence of Additional Deterioration			
☒	cracking/spalling	SAME - AS - ABOVE			
☒	seepage	NO VISUAL EVIDENCE OF ADDITIONAL LEAKAGE ON D/S FACE			
☒	vegetation/erosion	EXCESSIVE VEGETATIVE GROWTH IN BAYS			
☒	sloughs/slides/cracks	SLOUGH OR SLOPE FAILURE ON ACCESS ROAD			
☒	seepage/wetness	EXCESSIVE SEEPAGE FROM BAYS 9 & 10			
☒		EXCESSIVE SEEPAGE = EXCESSIVE UPLIFT			
☒	erosion/undermining	NONE VISIBLE			
☒	seepage/wetness	SEE COMMENT ABOVE			
☒	foundation drains	NONE PRESENT			
☒	deteriorated joints				
☒	cracking/spalling	N/A			
☒	seepage				

GENERAL COMMENTS, SKETCHES & FIELD MEASUREMENTS

[Signature]

DAM INSPECTION CHECKLIST

Date 07-06-18
Time 5:00 AM

NAME OF DAM
INSPECTORS

LAKE LURE LANE HYDROELECTRIC DAM
DR. B. DAN WALKER, P.E., PE - Flood Insp.

CHECK AREA AS INSPECTED	SPILLWAYS • DRAINS • OUTLETS		ACTION		
	CHECK/CIRCLE CONDITION NOTED	OBSERVATIONS	REPAIR	MONITOR	INVESTIGATE
☒ INLET- RISER	Principal Spillway	Type: <u>Ogee S/H Controlled By Flood Gates</u>			
	trashrack/debris	<u>None</u>			
	gates/flashboards	<u>None</u>			
	cracks/deterioration	<u>PEDESTAL RISER CLEAR & NO DAMAGE</u>			
☒ FLOW- WAY	improper alignment	<u>N/A</u>			
	cracks/deterioration	<u>No Structural Intake</u>			
	joint deterioration	<u>N/A</u>			
☒ STILLING BASIN/OUTLET WAY	type	<u>UNLINED TAIL RACE</u>			
	cracks/deterioration	<u>N/A</u>			
	seepage/piping	<u>N/A</u>			
	undercutting	<u>No Erosion or Undercutting</u>			
	erosion	<u>NONE</u>			
	debris	<u>Siltation & Erosion Depos</u>			
		<u>NATURAL BACKFILLING & PROPOSED HEADGATES</u>			
☒ ALL AREAS	Emergency Spillway	Type: <u>Tainter Gate Flood Gates</u>			
	vegetation/cover	<u>N/A</u>			
	erosion	<u>N/A</u>			
	obstructions	<u>NONE PRESENT</u>			
☒ DRAINS, DRAIN OUTLETS	Lake Drains/Other Outlets	Type: <u>NONE</u>			
	gates/valves	<u>N/A</u>			
	joints/flow surface	<u>N/A</u>			
	inlet tower	<u>N/A</u>			
	outlet area	<u>N/A</u>			
	operability	<u>N/A</u>			
☒ TOE DRAIN OUTLETS	flow amounts				
	flow clear/muddy				

GENERAL COMMENTS, SKETCHES & FIELD MEASUREMENTS

[Signature]

DAM INSPECTION CHECKLIST

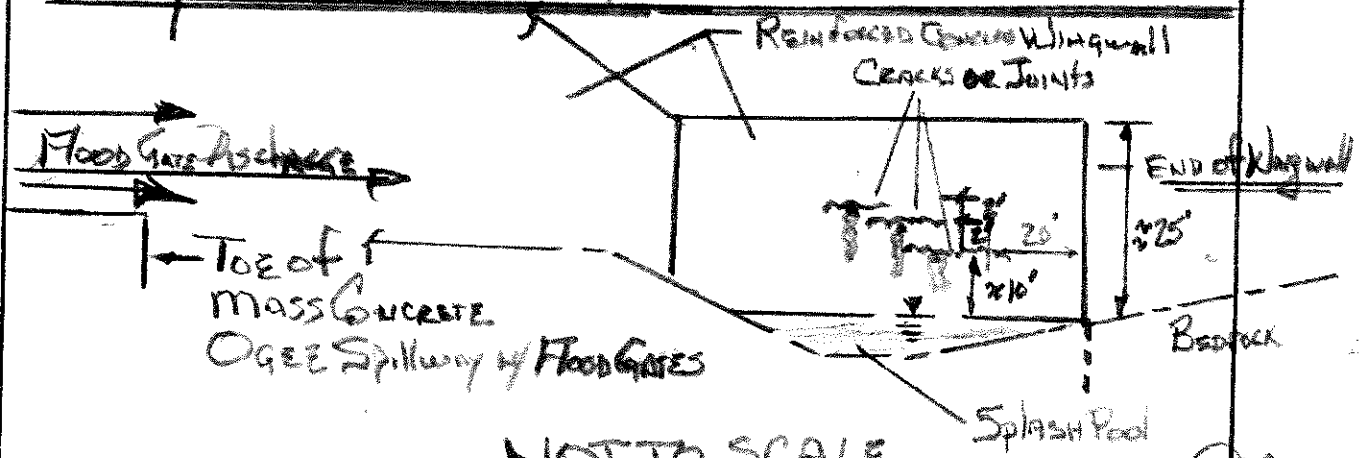
Date 07-06-18
Time 9:00 AM

NAME OF DAM Dr. P. Dan Marks P.E. Post-Flood Inspection
INSPECTORS Lakeview Dam & Hydroelectric River

CHECK AREA	CHECK/CIRCLE CONDITION NOTED	OBSERVATIONS	ACTION		
			REPAIR	MONITOR	INVESTIGATE
NON-TOURING AS INSPECTED	piezometers	SEE ATTACHED SHEET			
	weirs				
	monuments				
	crack monitors	TO BE INSTALLED			
	rainfall	READ & RECORDED BY OPERATOR - 9:00 AM			
GAGES	pool level	989.8 FT - GENERATED ALL NIGHT			
	stream	GENERATING ALL DAY			
		NO OVERNIGHT RAINFALL			
	erosion/ground cover	MOST OF THE RIM OF LAKE LURE IS OCCUPIED BY PRIVATE RESIDENCES HAVING LANDSCAPED YARDS AND/OR BOAT DOCKS - MINOR EROSION			
	development				
POOL AND SHORELINE	reservoir crossings				
	sedimentation				
	water quality				
	slopes	STEEP			
	land use	PREDOMINANTLY FORESTED			
WATER-SHED	other impoundments	TOWN OF LAKE LURE CHURCHVILLE VILLAGE			
	stream channel	UNDULATED EXCEPT LEFT ABUTMENT			
	channel crossings	NONE			
	flood plain	MINIMUM FLOODPLAIN OUTSIDE RIVER CHANNEL			
	development	NO DEVELOPMENT IN FLOODPLAIN			
D/S AREA	notification list	IN PROCESS OF MAJOR REVISION			
	evacuation plan				
	materials/equipment				
	access road to dam				
EMERG. PLAN					

GENERAL COMMENTS, SKETCHES & FIELD MEASUREMENTS

NEWLY IDENTIFIED LEAKAGE IN LEFT ABUTMENT WINGWALL



07-06-18/30M

DAM

OBSERVATION WELL AND PIEZOMETER DATA COLLECTION FORM

Date: 07-06-18 Time: 10:00am Personnel: Dr. B. Dan Micks P.E.

Weather: CLEAR & WARMING RAPIDLY - 83°F

Recent rainfall: Post-Flood Inspection (3.0" to 3.5" 6 Hour Duration) ~25 Year RFSF

Headwater Elevation: 989.8 feet Tailwater Elevation: 895 feet (ESTIMATED)

Visual Observations (unusual or abnormal conditions):
 BOF ~ 890 feet Uplift ~ 99.8 feet (100' x 62.4 pft = 6240 pft)
 EXCESSIVE AMOUNT OF UPWARD SEEPAGE (PIPING) - 44' 62.4 pft
 IN BAYS NO. 9, 10 & 11. EXCESS FLOW IS FLOODING CHANNEL TO WEIR & NOT BEING MEASURED (2746)
 = 3494

READINGS

INSTRUCTIONS: Measure depth to water from top of standpipe with water level meter. Record depth to nearest 0.1 foot. Note under "COMMENTS" any difficulties in taking the measurements, need for repair, maintenance, etc. Compare readings with threshold limits and previous readings. If readings exceed threshold limits or are more than 3 feet different than previous readings, retake the readings to confirm them.

PIEZOMETER/ OBSERVATION WELL	THRESHOLD READINGS, FEET (MIN/MAX)	DEPTH TO WATER, FEET	COMMENTS	
P-1	—	15.5	Top Elev. 940.0'	14.0 Elev. 924.5'
			942.0	938.5
P-2	—	3.5	0.5' Below Ground Surface	
P-3	—	8.0	944.0'	936.0'
P-4	—	5.0	945.5	940.5'
WEIR	—	2.75 (3.25 to 3.50)	→ Overflow Rdg.	

Surface Elev.
 938.0 ft
 939.0 ft
 942.0 ft
 943.0 ft

07-06-18
 75