B & W Engineering Laboratories, Inc.
P.O. Box 341091 Memphis, Tennessee 38184-1091 (901) 373-7957

SLOPE STABILITY ANALYSIS
WOODLAND LAKE DAM
EUDORA, MISSISSIPPI

B & W Engineering Laboratories, Inc.

P.O. Box 341091 Memphis, Tennessee 38184-1091 (901) 373-7957

03 June 2016
Job No. 8654
Serial No. D-2208

Ms. Shirley Harris, President
Woodland Lake Homeowners Association
(662) 429-4085
cell (870) 995-1715
sbharris20@aol.com

Ref: Slope Stability Analysis
Woodland Lake Dam
Eudora, Mississippi

Dear Shirley:

The purpose of this investigation was to provide slope stability analyses for the referenced earth dam to determine the factors of safety for various anticipated loading conditions, with particular interest in a rapid drawdown condition that could develop should the Lake Delta Crest dam that forms the tailwater of the referenced dam suddenly fail.

The investigation included completion of three test borings at the crest and on the land side slope of the earth dam, completion of physical properties laboratory analyses on the samples obtained, and performance of engineering analyses of the resulting field and laboratory data. The services of Jones-Davis and Associates (JDA) were utilized for determination of the elevations along the section that was analyzed, as represented as Section "C" on Figures 1-C and 1-D, including elevations of the dam embankment and lake bottoms. Groundwater profiles through Sections "A" and "B", illustrated on Figures 1-A and 1-B, were utilized in the analyses, with these sections being on each side of Section "C", as illustrated.

Section Profiles

The subject earth dam has a crest width of about ten feet. The land side (downstream) slope of the earth dam was previously 1 (vertical) to about 3.5 (horizontal), but the crest has since been raised about four feet to provide about seven feet of freeboard under normal pool conditions, effectively steepening the upper portion of the land side slope to 1 (V) to 2 (H). The lower portion of the land side slope remains about 1 (V) to 3.5 H), to the toe, then flattens to about a 5 percent slope to the Lake Delta Crest water line, steepening slightly beneath the pool elevation. Lake Delta Crest is only about seven feet deep at a distance of about 200 feet from the lake's edge at Section "C". The upstream slope of the Woodland Lake dam is not believed to have been significantly effected by the raising of its crest, although historic profiles beneath the pool are not available. Based on the JDA measurements, the upstream slope varies from about 1 (V) to 2 (H) to 1 (V) to 3.5 (H), and Woodland Lake is about thirty feet deep.

Seepage Conditions

As described in the accompanying Seepage/Piezometer report, at this time there is no evidence of excessive seepage through the Woodland Lake earth dam.

Embankment Soil Conditions

Three test borings were completed as a part of this investigation; boring locations are illustrated on Figure Numbers 1-C and 1-D. The borings were drilled using hand augering equipment, and were terminated at depths ranging from twenty to forty feet below the existing ground surface. The boreholes were backfilled with bentonite after completion. Soil samples obtained directly from the hand auger were logged, labeled, and placed in moisture-proof containers in the field. Dynamic Cone Penetration tests were performed at regular intervals in each of the borings. The Dynamic Cone Penetration test consists of driving a conical steel penetrometer 7.25 inches by means of a fifteen pound weight dropping twenty inches. The initial 2.0 inches of this movement properly seats the penetrometer in the undisturbed soil at the bottom of the borehole. The average number of blows required to move the cone the remaining three 1.75 inch increments is recorded as the Dynamic Cone Penetration Test Blow Count. The blow counts are converted to the N-values shown on the boring log which are statistically consistent with N-Values of the Standard Penetration Test. Visual classification and natural water content determinations were performed in the laboratory on all soil samples retrieved from the borings; results are shown on the boring logs presented in Appendix A. Soil classification tests were also performed on representative soil samples; results are presented in Appendix B.

The soils encountered consist of soft to stiff silty clays and clayey silts. As would be expected, the soils encountered beneath the groundwater surface are saturated and subsequently softened. Cohesion values of the soils encountered range from as low as about 250 pounds per square foot to over 1000 pounds per square foot, averaging about 500 pounds per square foot. The saturated clayey silts are on the lower end of this range, however such soils exhibit some strength from friction; the estimated friction angle of the softer clayey silts encountered in the test borings is about 25 to 26 degrees, with that of the firm to stiff being about 32 degrees. These are the values utilized in the slope stability analyses described below.

Slope Stability Analyses

Several conditions have been considered in the stability analyses. The first are “normal” conditions, with Woodland Lake and Lake Delta Crest both at their normal pool elevations, with steady, but controlled, seepage through Woodland Lake dam; the calculated factor of safety for these conditions is greater than the generally accepted value of 1.5. The calculated factor of safety of the next condition, being that described above with earthquake loadings included, is greater than the generally accepted value of 1.0. The last condition is similar to the first described above, with a “sudden drawdown” of the tailwaters of Lake Delta Crest, such as that which would occur if the dam that forms that lake were to suddenly breach; the calculated factor of safety for this condition is greater than both

the 1.2 and the 1.3 values commonly utilized for such loading conditions. It was generally found that due to the relative size of the Woodland Lake dam, with its controlled seepage, the gradual slope of the area between the toe of the Woodland Lake dam and the edge of the tailwaters of Lake Delta Crest, and the relatively shallow depth of Lake Delta Crest in the vicinity of the Woodland Lake dam, rapid draining of the lower lake would actually have minimal effect on the stability of the Woodland Lake dam. Under earthquake conditions, however, localized damage to Woodland Lake dam could occur because of the loss of soil strength of some of the already soft saturated soils of the embankment; catastrophic failure would not be expected, however, with the calculated factor of safety exceeding 1.0 under those conditions.

Recommendations

Other than the regularly scheduled dam inspections for signs of potential deficiencies, and the continued measurement of water levels in the recently installed piezometers and analysis of the resulting data, no additional analysis of the overall stability of the subject earth dam is recommended at this time.

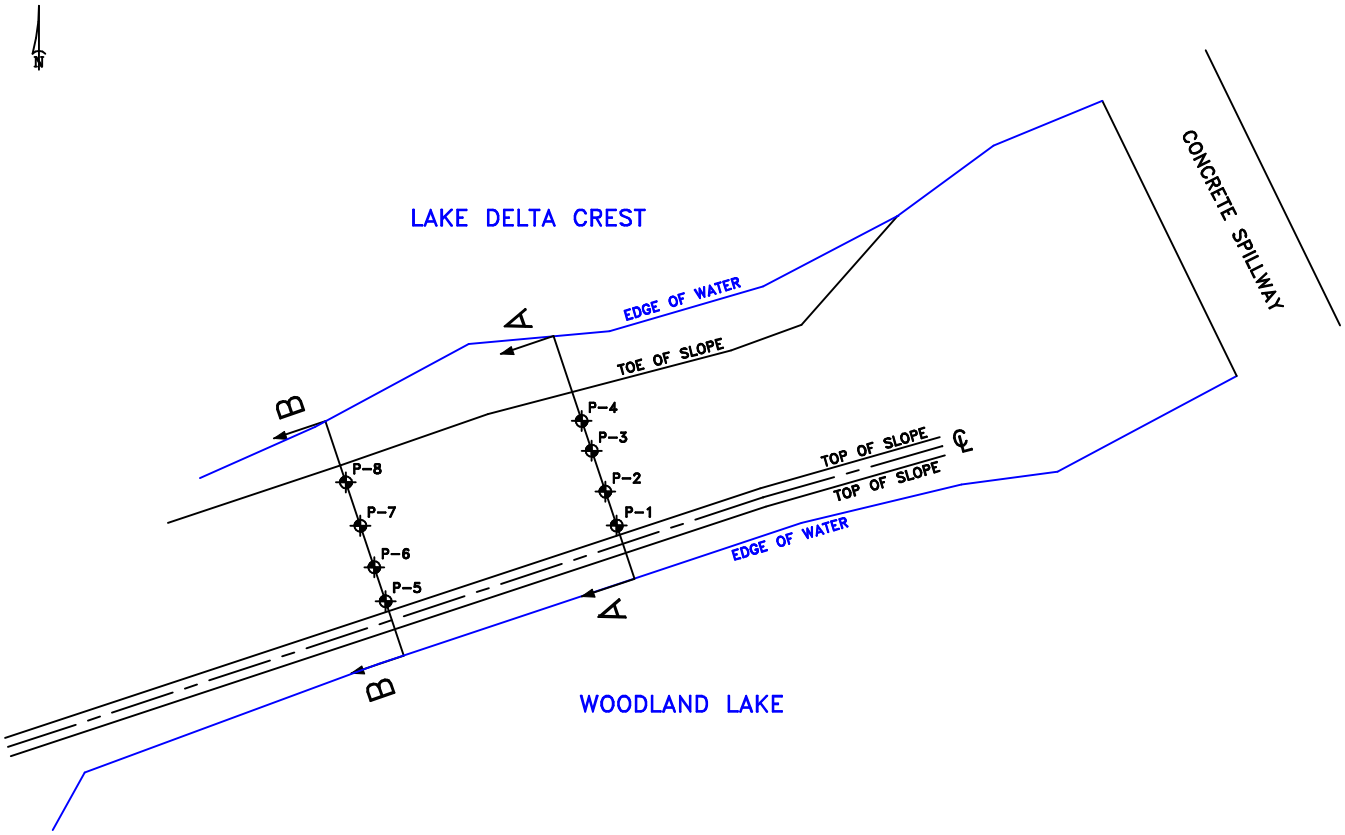
If there are any questions, or if additional information is required, please advise.

Respectfully submitted,

B & W Engineering Laboratories, Inc.

John L. Walton, Sr., P.E.
President

JLW/jw0616

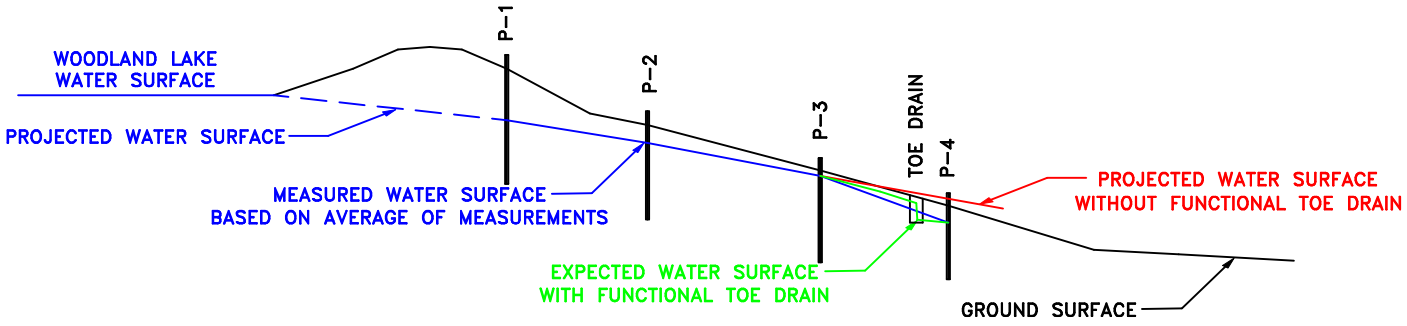


0 120 240

SCALE (FEET)

LEGEND

APPROXIMATE BORING LOCATION



SECTION "A"

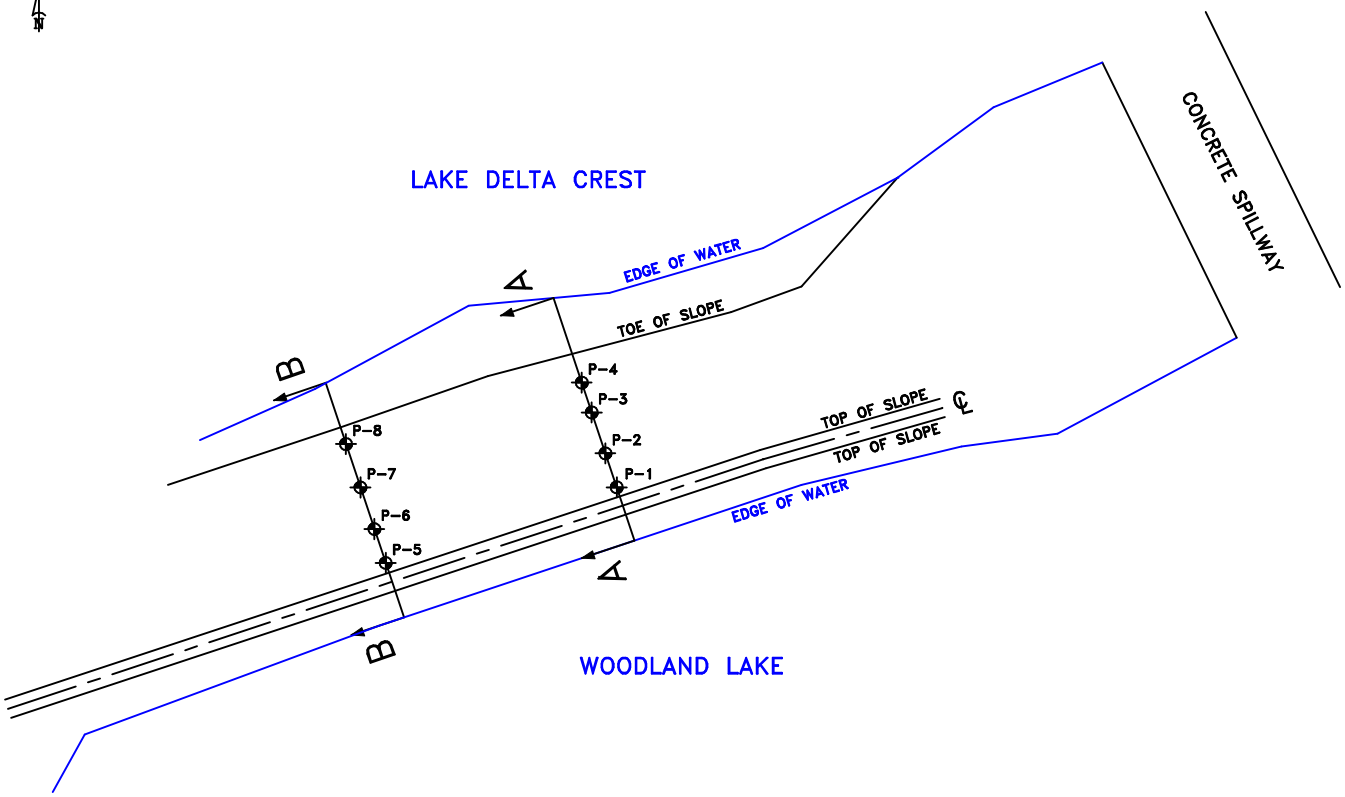
0 30 60

SCALE (FEET)

SEEPAGE STUDY
WOODLAND LAKE DAM
EUDORA, MISSISSIPPI

JOB NUMBER 8654

FIGURE NO. 1–A



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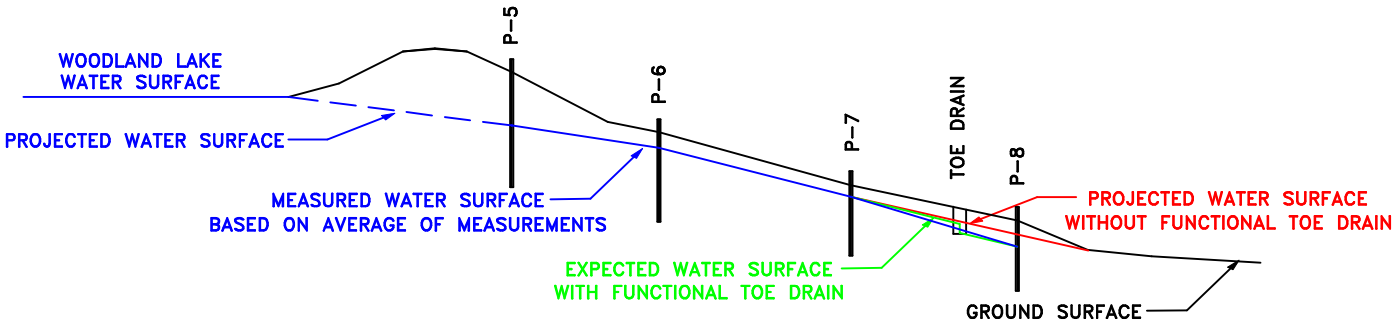
⌖ APPROXIMATE BORING LOCATION

0 120 240

SCALE (FEET)



SECTION "B"

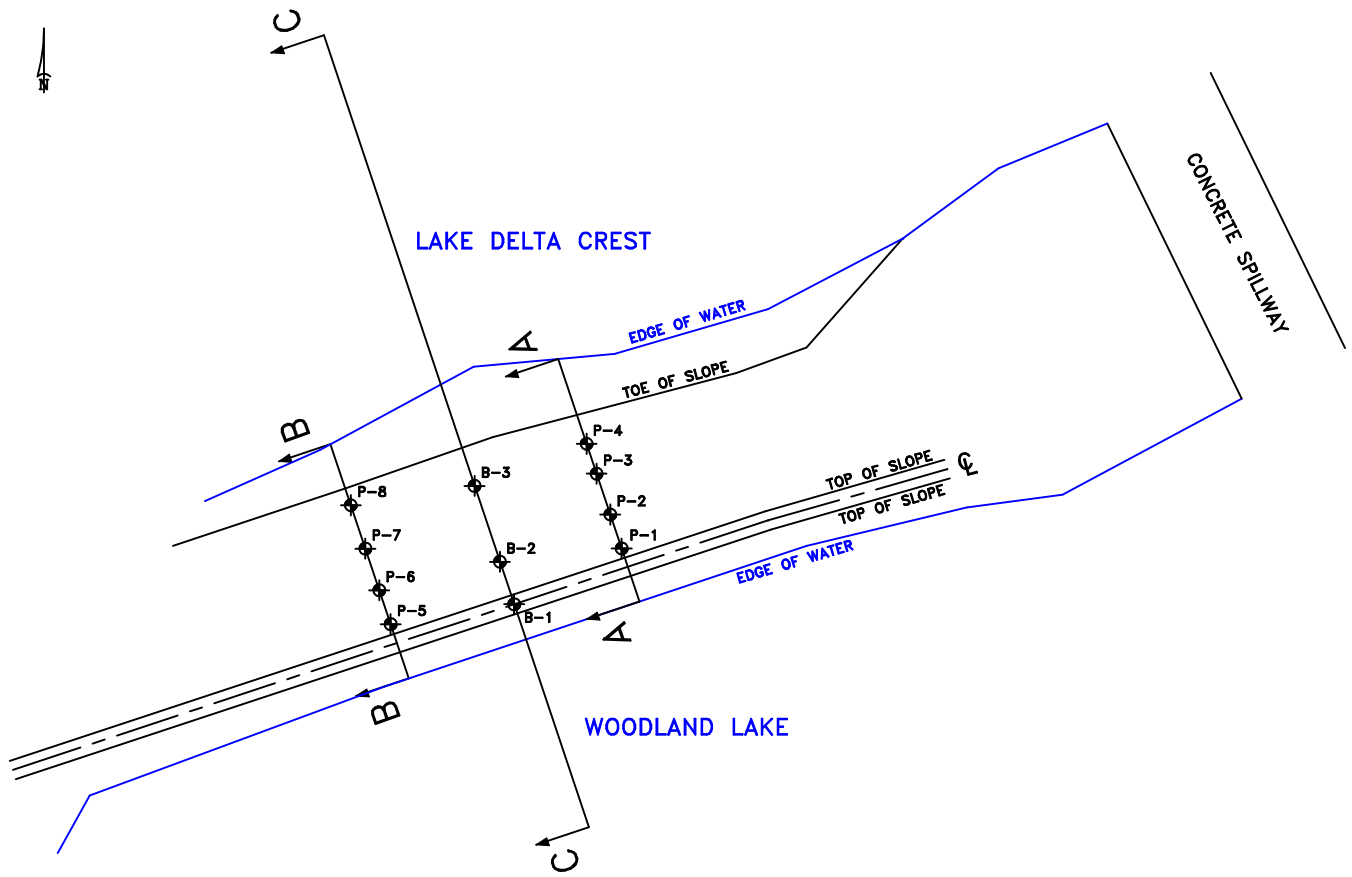
0 30 60

SCALE (FEET)

SEEPAGE STUDY
WOODLAND LAKE DAM
EUDORA, MISSISSIPPI

JOB NUMBER 8654

FIGURE NO. 1–B

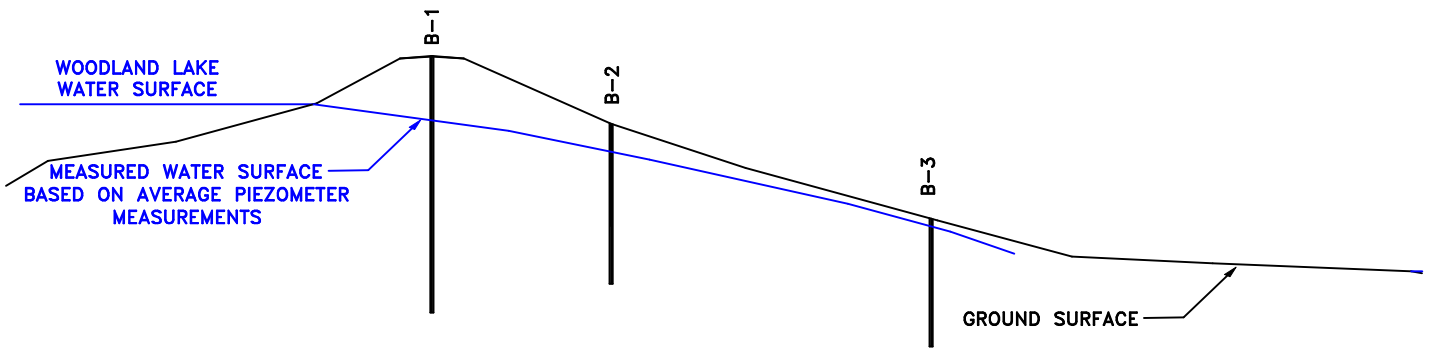


0 120 240

SCALE (FEET)

LEGEND

⌖ APPROXIMATE BORING LOCATION



SECTION "C"

PARTIAL, SEE FIGURE 1–D FOR COMPLETE SECTION

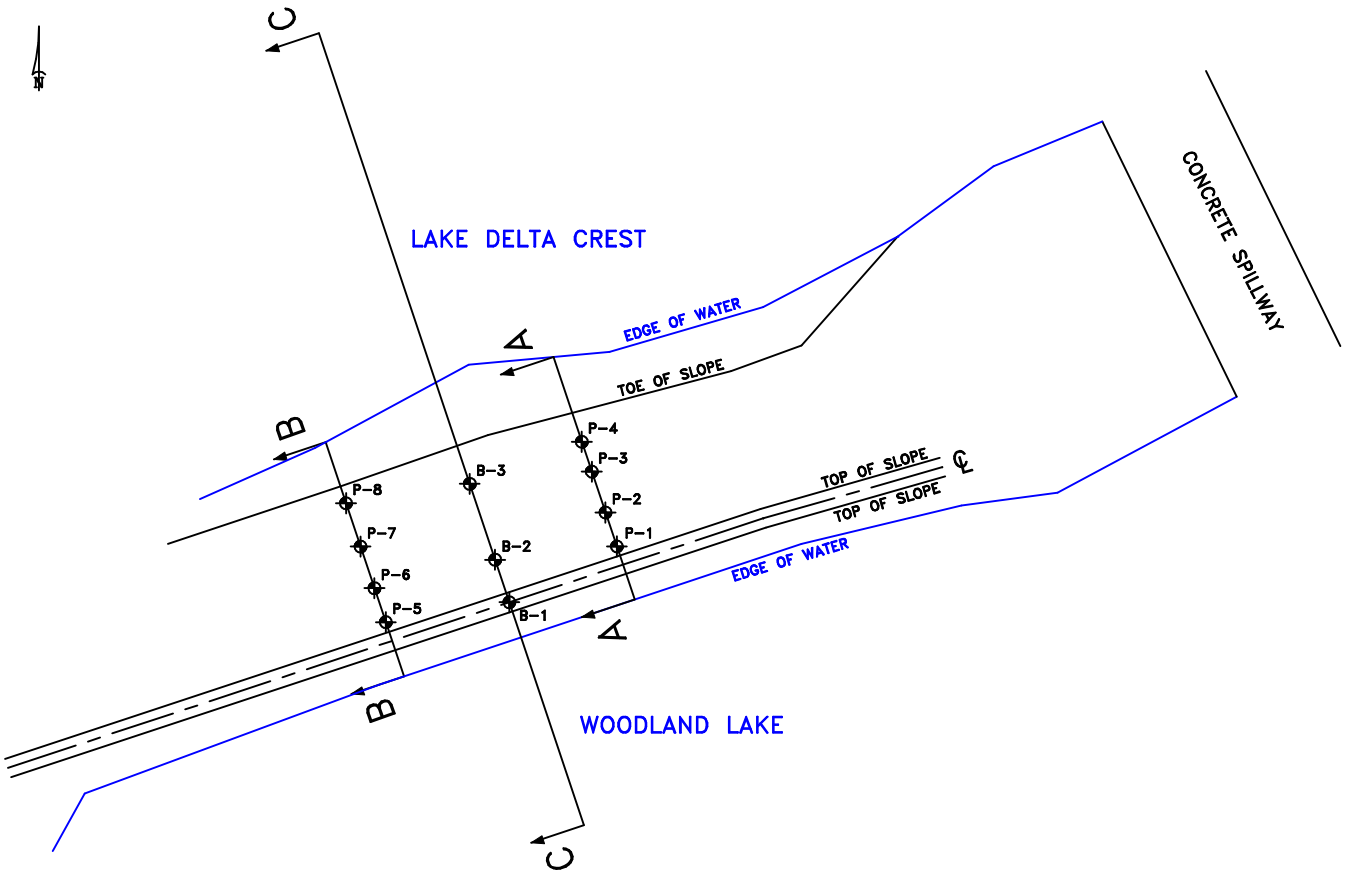
0 30 60

SCALE (FEET)

STABILITY ANALYSIS
WOODLAND LAKE DAM
EUDORA, MISSISSIPPI

JOB NUMBER 8654

FIGURE NO. 1–C

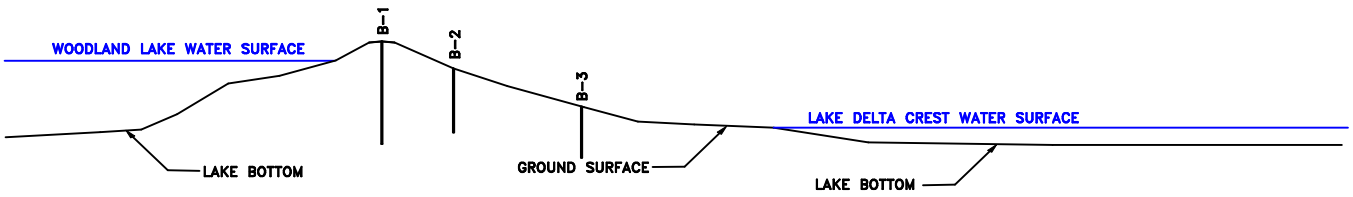


LEGEND

⌖ APPROXIMATE BORING LOCATION

0 120 240

SCALE (FEET)



SECTION "C"

0 75 150

SCALE (FEET)

STABILITY ANALYSIS
WOODLAND LAKE DAM
EUDORA, MISSISSIPPI

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FIGURE NO.
1–D

APPENDIX A

BORING LOGS

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LOG OF BORING

Woodland Lake Dam Stability Analysis
Woodland Lake
Eudora, Mississippi

Job No.: 8654
Boring: B-1
Sheet 1 of 1

Boring Location: See Figure Number 1
Boring Depth: 40 feet
Groundwater Depth: 14 feet at drilling
Boring Type: Hand Auger/Dynamic Cone Penetration

Ground El: 243.3 feet
Date: 09 May 2016
Weather: Clear/Warm
Insp: S. Ikner

Sample Number	Sample Interval (feet)	N - Value	Water Content	Sample Description
1	1.0-1.5	12+	23%	Stiff Tan Clayey SILT
2	2.0-2.5	12+	24%	Stiff Tan Clayey SILT
3	3.0-3.5	12+	23%	Stiff Tan Clayey SILT
4	4.5-5.0	12+	26%	Stiff Gray Silty CLAY
5	7.0-7.5	3	33%	Soft Brown and Tan Clayey SILT
6	9.5-10.0	3	33%	Soft Brown and Tan Clayey SILT to 12.0 feet
7	13.0-13.5	12+	27%	Stiff Brown Silty CLAY to 14.0 feet
8	14.5-15.0	3	35%	Soft Brown Silty CLAY to 16.5 feet
9	19.5-20.0	12+	29%	Stiff Brown Silty CLAY
10	24.5-25.0	8	32%	Firm Brown and Gray Silty CLAY
11	27.0-27.5	10	31%	Stiff Gray Silty CLAY
12	29.5-30.0	12+	28%	Stiff Gray Clayey SILT
13	34.5-35.0	12+	26%	Stiff Gray Clayey SILT
14	39.5-40.0	12+	27%	Stiff Gray Clayey SILT

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LOG OF BORING

Woodland Lake Dam Stability Analysis
Woodland Lake
Eudora, Mississippi

Job No.: 8654
Boring: B-2
Sheet 1 of 1

Boring Location: See Figure Number 1
Boring Depth: 25 feet
Groundwater Depth: 10 feet at drilling
Boring Type: Hand Auger/Dynamic Cone Penetration

Ground El: 232.8 feet
Date: 04-05 May 2016
Weather: Clear/Warm
Insp: D. Lively

Sample Number	Sample Interval (feet)	N - Value	Water Content	Sample Description
1	1.0-1.5	12+	26%	Stiff Tan Clayey SILT
2	2.0-2.5	8	30%	Firm Brown Silty CLAY
3	3.0-3.5	3	30%	Soft Brown Silty CLAY
4	4.5-5.0	3	34%	Soft Brown Silty CLAY
5	7.0-7.5	3	33%	Soft Brown and Tan Silty CLAY
6	9.5-10.0	3	30%	Soft Brown and Tan Silty CLAY to 12.0 feet
7	13.0-13.5	8	27%	Firm Brown and Gray Silty CLAY
8	14.5-15.0	7	27%	Firm Brown Silty CLAY
9	19.5-20.0	10	25%	Stiff Gray Clayey SILT
10	24.5-25.0	10	25%	Stiff Brown and Gray Silty CLAY

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LOG OF BORING

Woodland Lake Dam Stability Analysis
Woodland Lake
Eudora, Mississippi

Job No.: 8654
Boring: B-3
Sheet 1 of 1

Boring Location: See Figure Number 1
Boring Depth: 20 feet
Groundwater Depth: 11.5 feet at drilling
Boring Type: Hand Auger/Dynamic Cone Penetration

Ground El: 217.7 feet
Date: 05 May 2016
Weather: Clear/Warm
Insp: D. Lively

Sample Number	Sample Interval (feet)	N - Value	Water Content	Sample Description
1	1.0-1.5	3	29%	Soft Brown and Gray Silty CLAY
2	2.0-2.5	6	33%	Firm Brown Silty CLAY
3	3.0-3.5	6	29%	Firm Brown and Gray Silty CLAY
4	4.5-5.0	12+	25%	Stiff Gray Clayey SILT
5	7.0-7.5	12+	27%	Stiff Gray Clayey SILT
6	9.5-10.0	12+	27%	Stiff Gray Clayey SILT
7	13.0-13.5	7	26%	Firm Gray Clayey SILT
8	14.5-15.0	7	28%	Firm Gray Clayey SILT to 16.5 feet
9	19.5-20.0	12+	29%	Stiff Gray Silty CLAY w/trace of Sand

APPENDIX B

LABORATORY TEST RESULTS

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LABORATORY TEST REPORT

Slope Stability Analysis
Woodland Lake Dam
Eudora, Mississippi

Job No.: 8654

ATTERBERG LIMITS

Boring No.	Sample No.	Sample Interval	Moisture Content	LL	PL	PI	Soil Classification
B-1	2	2.0-2.5	24%	28	25	3	Clayey SILT, ML
B-1	4	4.5-5.0	26%	35	12	12	Silty CLAY, CL
B-1	6	9.5-10.0	33%	34	24	10	Silty CLAY, CL
B-1	8	14.5-15.0	35%	38	23	15	Silty CLAY, CL
B-1	10	24.5-25.0	32%	35	23	12	Silty CLAY, CL
B-1	13	34.5-35.0	26%	35	27	17	Clayey SILT, ML
B-2	1	1.0-1.5	26%	28	25	3	Clayey SILT, ML
B-2	4	4.5-5.0	34%	37	22	15	Silty CLAY, CL
B-2	7	13.0-13.5	27%	32	20	12	Silty CLAY, CL
B-3	4	4.5-5.0	25%	32	26	6	Clayey SILT, ML
B-3	6	9.5-10.0	27%	33	26	7	Clayey SILT, ML