PERIODIC SAFETY FACTOR ASSESSMENT
PLANT GORGAS ASH POND
ALABAMA POWER COMPANY

EPA's "Disposal of Coal Combustion Residuals from Electric Utilities" Final Rule (40 C.F.R. Part 257 and Part 261) and the State of Alabama's ADEM Admin. Code Chapter 335-13-15, require the owner or operator of an existing CCR surface impoundment to conduct periodic safety factor assessments. Per §257.73(e) and ADEM Admin. Code r. 335-13-15-.04(4)(e), the owner or operator must document that the minimum safety factors outlined in §257.73(e)(1)(i) through (iv) and ADEM Admin. Code r. 335-13-15-.04(4)(e)(1)(i) through (iv) for the critical embankment section are achieved. In addition, §257.73(f)(3) and ADEM Admin. Code r. 335-13-15-.04(4)(f)3. require a subsequent assessment be performed within 5 years of the previous assessment.

The CCR surface impoundment located at Alabama Power Company's Plant Gorgas also referred to as the Plant Gorgas Ash Pond is located on Plant Gorgas property, southeast of Parrish, Alabama. The CCR surface impoundment is formed by an engineered cross-valley embankment. The critical section of this CCR unit had previously been determined to be located, and remains, at the centerline of the embankment, which is the highest section of the embankment. The surface impoundment is currently undergoing closure and some CCR relocation and consolidation within the Ash Pond's footprint has begun per the closure plan. A review of recent changes within the impoundment has determined that the critical section remains at the centerline of the embankment.

The analyses used to determine the minimum safety factor for the critical section resulted in the following minimum safety factors:

Loading Condition	Minimum Calculated Safety Factor	Minimum Required Safety Factor
Long-term Maximum Storage Pool (Static)	1.5	1.5
Maximum Surcharge Pool (Static)	1.5	1.4
Seismic	1.4	1.0

The embankment is constructed of clays, silts, compacted sands and gravel and riprap that are not susceptible to liquefaction. Therefore, a minimum liquefaction safety factor determination was not required.

I hereby certify that the safety factor assessment was conducted in accordance with 40 C.F.R. §257.73 (e)(1) and ADEM Admin. Code r. 335-13-15-.04(4)(e)1.

ALABAMA LICENSED 16516 PROFESSIONAL ENGINEER JAMES C. PEGUES, SR.

10/15/2021

James C. Pegues, P.E.
Licensed State of Alabama, PE No. 16516

Southern Company

Technical and Project Solutions Calculation

Calculation Number: TV-GO-APC962011-001

Project/Plant: Plant Gorgas Ash Pond	**Unit(s):** --	**Discipline/Area:** Env. Solutions
Title/Subject: Periodic Factor of Safety Assessment for CCR Rule		
Purpose/Objective: Determine the Factor of Safety of the Ash Pond Dike		
System or Equipment Tag Numbers: n/a	**Originator:** Jacob A. Jordan, P.E.	

Contents

Revision Record

Rev. No.	Description	Originator Initial / Date	Reviewer Initial / Date	Approver Initial / Date
0	Issued for Information	JAJ/07-12-21	JCP/07-12-21	JCP/07-12-21

Notes:

Purpose of Calculation

Plant Gorgas was a coal-fired electric generating facility, consisting of 10 units over its lifetime. The Plant Gorgas Ash Pond received and stored coal combustion residuals produced during the electric generating process at Plant Gorgas. CCR products were sluiced from the plant to the Ash Pond. The last operating units at the plant, Units 8-10, were shut down in April 2019.

Stability analyses were previously performed in 2016 for the CCR Rule. The purpose of this calculation is to update the 2016 stability analysis of the Ash Pond Dike.

Summary of Conclusions

The following table lists the factors of safety for various slope stability failure conditions. All conditions are steady state except where noted. Construction cases were not considered. The analyses indicate that in all cases the factor of safety is at or above the require minimum.

Load Conditions	Computed Factor of Safety	Required Minimum Factor of Safety
Long-term Maximum Storage (Static)	1.5	1.5
Maximum Surcharge Pool (Static)	1.5	1.4
Seismic	1.4	1.0

Methodology

The calculation was performed using the following methods and software:

- GeoStudio 2021 R2 version 11.1.1.22085 Copyright 1991-2021, GEO-SLOPE International, Ltd.
- Strata (Version 0.8.0), University of Texas, Austin
- Morgenstern-Price analytical method

Criteria and Assumptions

The slope stability models were run using the following assumptions and design criteria:

- Seismic site response was determined using a one-dimensional equivalent linear site response analysis. The analysis was performed using Strata and utilizing random vibration theory. The input motion consisted of the USGS published 2014 Uniform Hazard Response Spectrum (UHRS) for Site Class B/C at a 2% Probability of Exceedance in 50 years. The UHRS was converted to a Fourier Amplitude Spectrum, and propagated through a representative one-dimensional soil column using linear wave propagation with strain-dependent dynamic soil properties. The input soil properties and layer thickness were randomized based on defined statistical distributions to perform Monte Carlo simulations for 100 realizations, which were used to generate a median estimate of the surface ground motions.
- The median surface ground motions were then used to calculate a pseudostatic seismic coefficient for utilization in the stability analysis using the approach suggested by Bray and Tavasarou (2009). The procedure calculates the seismic coefficient for an

allowable seismic displacement and a probability exceedance of the displacement. For this analysis, an allowable displacement of 0.5 ft, and a probability of exceedance of 16% were conservatively selected, providing a seismic coefficient of 0.041g for use as a horizontal acceleration in the stability analysis.

- The current required minimum criteria (factors of safety) were taken from the Structural Integrity Criteria for existing CCR surface impoundment from 40 CFR 257.73, published April 17, 2015.
- The critical section was selected at location having the apparent maximum dam height. The cross-section of the Plant Gorgas Ash Pond dam was modeled using the following sources:
  1) Historical Alabama Power Company (APC) Drawings F-97854, C-189068, and D-586217 depicting typical dam cross sections for original construction, the 1977 dam raise and the 2007 dam raise.
  2) Plant Gorgas CCR Topo and Plan View Mapping Rattlesnake Ash Pond, 2016

Input Data

- Soil Properties: Because the physical properties of the dam construction (materials and configuration) make sampling and testing unfeasible, the selection of soil properties used for the analysis (unit weight, phi angle, and cohesion) relied on historical construction records and historical records of laboratory analyses of borrow material used to construct portions of the dam. The ash properties used for the analysis (unit weight, phi angle, and cohesion) were based on laboratory testing performed on undisturbed and remolded samples of ash from various plants and on engineering judgment.

Soil Description	Unit Weight, pcf	Effective Stress Parameters	
		Cohesion, psf	Phi Angle, degrees
Old Rockfill	140	0	38
New Rockfill	145	0	43
Class H Mine Spoil	129	500	22
Clay Foundation	134	500	31
Ash	98	0	28
Shale	Impenetrable bedrock		

- Phreatic Surface: The phreatic surface used in the analysis was developed from historic geophysical testing and seepage analyses, supplemented by visual observation of dam seepage and engineering judgment.

Design Inputs/References

- SCS Calculation TV-GO-APC389153-001

- USGS Earthquake Hazards website, *earthquake.usgs.gov/hazards/interactive*
- US Corps of Engineers Manual EM 1110-2-1902, October 2003
- Bray, J. D. and Travasarou, T., *Pseudostatic Coefficient for Use in Simplified Seismic Slope Stability Evaluation*, Journal of Geotechnical and Environmental Engineering, American Society of Civil Engineers, September 2009
- APC Drawing F-97854, Gorgas Ash Disposal Pond, Rattlesnake Hollow Site, Rock Fill Dam, 1953
- APC Drawing C-189068, Gorgas Ash Handling, Sloping Core Design (Typical Cross Section), 1973
- APC Drawing D-586217, Crest Raise of Rattlesnake Hollow Ash Pond Sections and Details, 2006
- Crest Raise Feasibility Study, Rattlesnake Hollow Ash Pond Dam, Gorgas Steam Plant, Southern Company Technical Services, 2005

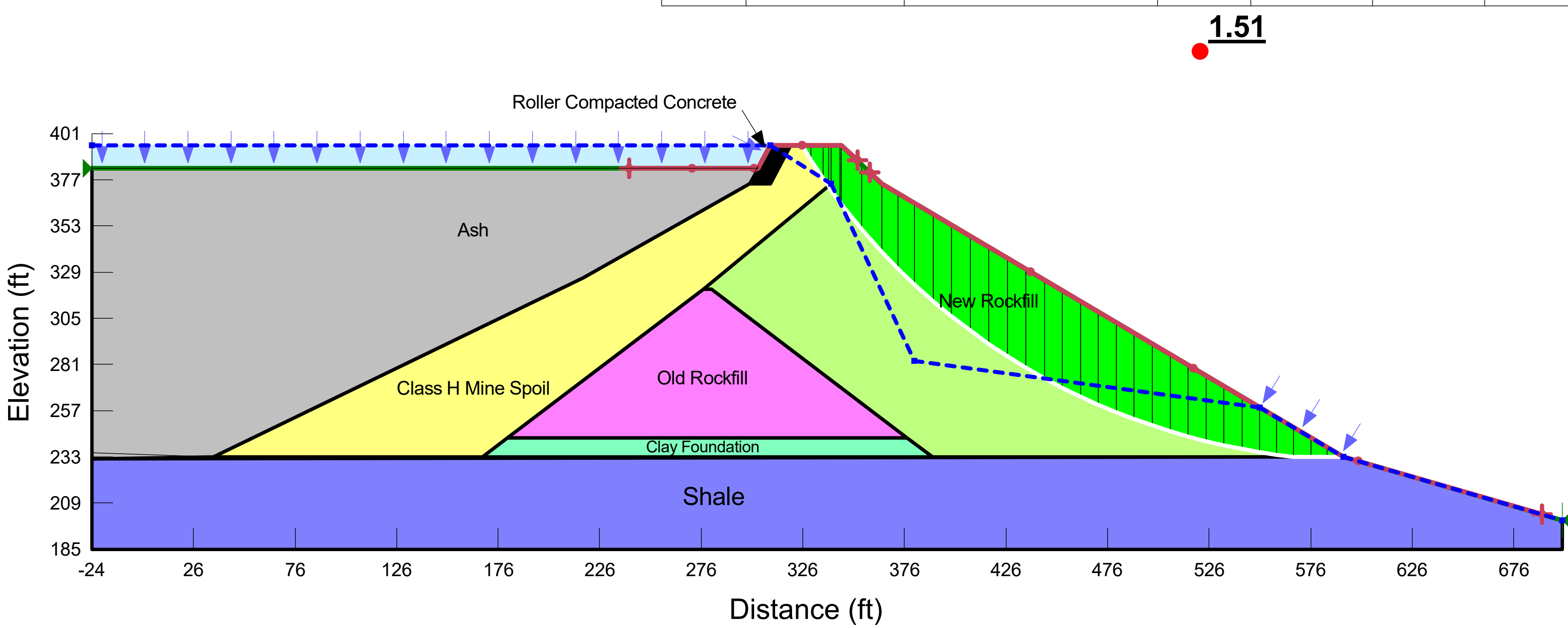
Body of Calculation

SLOPE/W modeling attached.

Plant Gorgas Ash Pond
Factor of Safety Assessment

Maximum Surcharge Pool

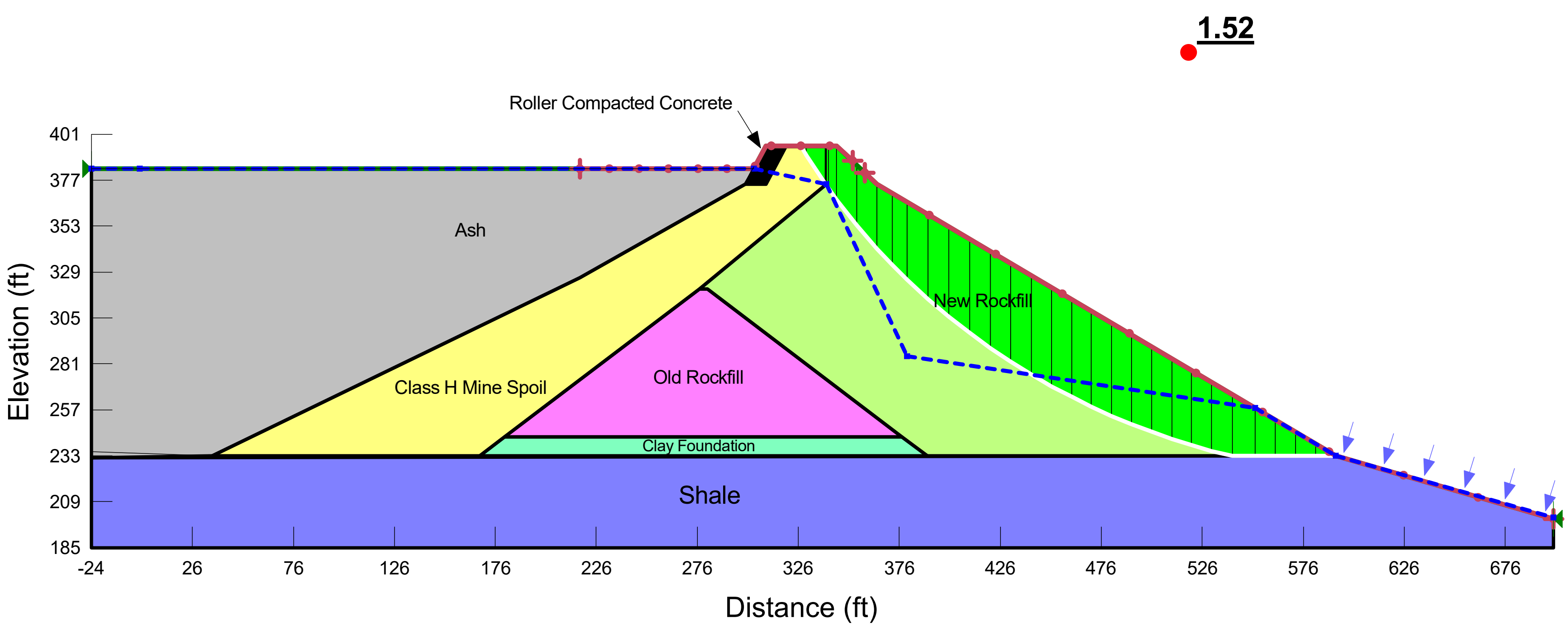
Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Constant Unit Wt. Above Water Table (pcf)
	Ash	Mohr-Coulomb	98	0	28	
	Class H Mine Spoil	Mohr-Coulomb	129	500	22	
	Clay Foundation	Mohr-Coulomb	134	500	31	
	New Rockfill	Mohr-Coulomb	145	0	43	145
	Old Rockfill	Mohr-Coulomb	140	0	38	
	Roller Compacted Concrete	Mohr-Coulomb	140	144,000	40	
	Shale Foundation	Bedrock (Impenetrable)				



Plant Gorgas Ash Pond
Factor of Safety Assessment

Maximum Storage

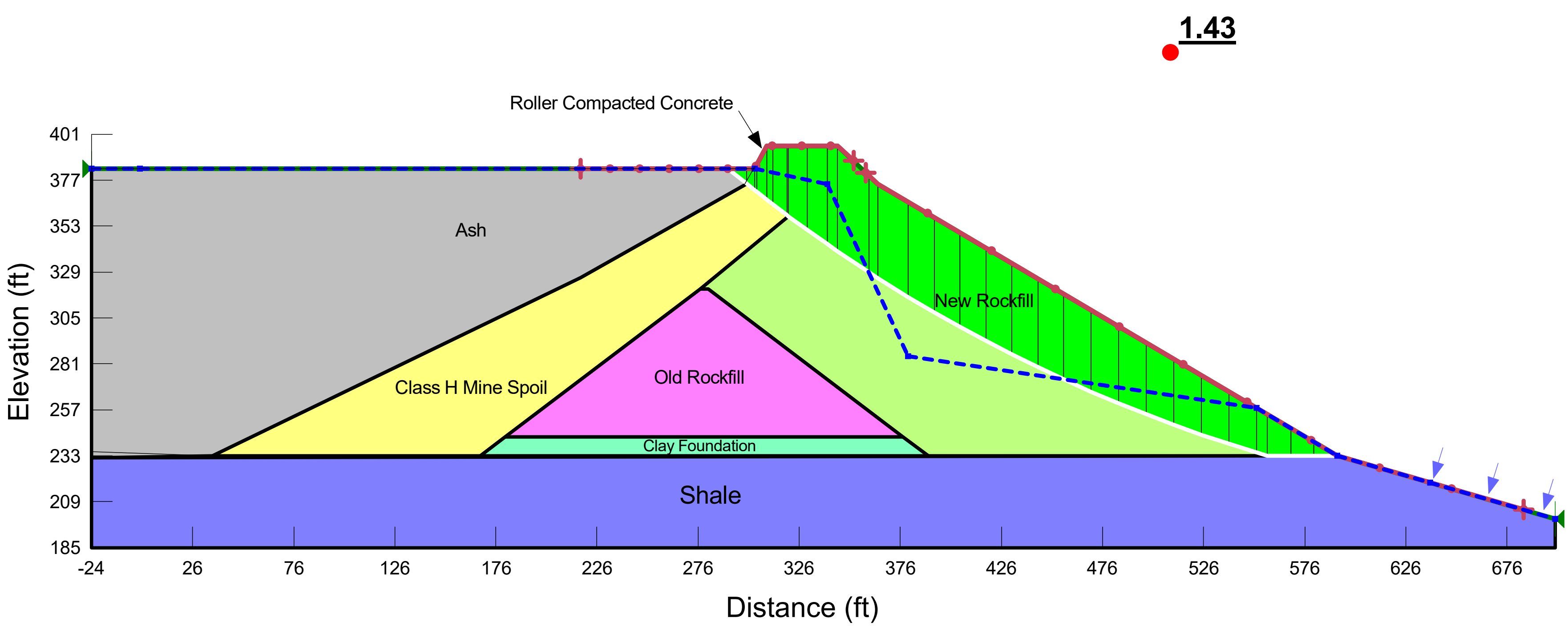
Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Constant Unit Wt. Above Water Table (pcf)
	Ash	Mohr-Coulomb	98	0	28	
	Class H Mine Spoil	Mohr-Coulomb	129	500	22	
	Clay Foundation	Mohr-Coulomb	134	500	31	
	New Rockfill	Mohr-Coulomb	145	0	43	145
	Old Rockfill	Mohr-Coulomb	140	0	38	
	Roller Compacted Concrete	Mohr-Coulomb	140	144,000	40	
	Shale Foundation	Bedrock (Impenetrable)				



Plant Gorgas Ash Pond
Factor of Safety Assessment

Seisimc Loading
Horizontal Coefficient: 0.041g

Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Cohesion R (psf)	Phi R (°)	Constant Unit Wt. Above Water Table (pcf)
	Ash	Mohr-Coulomb	98	0	28	0	0	
	Class H Mine Spoil	Mohr-Coulomb	129	500	22	0	0	
	Clay Foundation	Mohr-Coulomb	134	500	31	0	0	
	New Rockfill	Mohr-Coulomb	145	0	43	0	0	145
	Old Rockfill	Mohr-Coulomb	140	0	38	0	0	
	Roller Compacted Concrete	Mohr-Coulomb	140	144,000	40	0	0	
	Shale Foundation	Bedrock (Impenetrable)						



Attachment A

Laboratory Analysis

3.1.3 Dike Material Engineering Properties

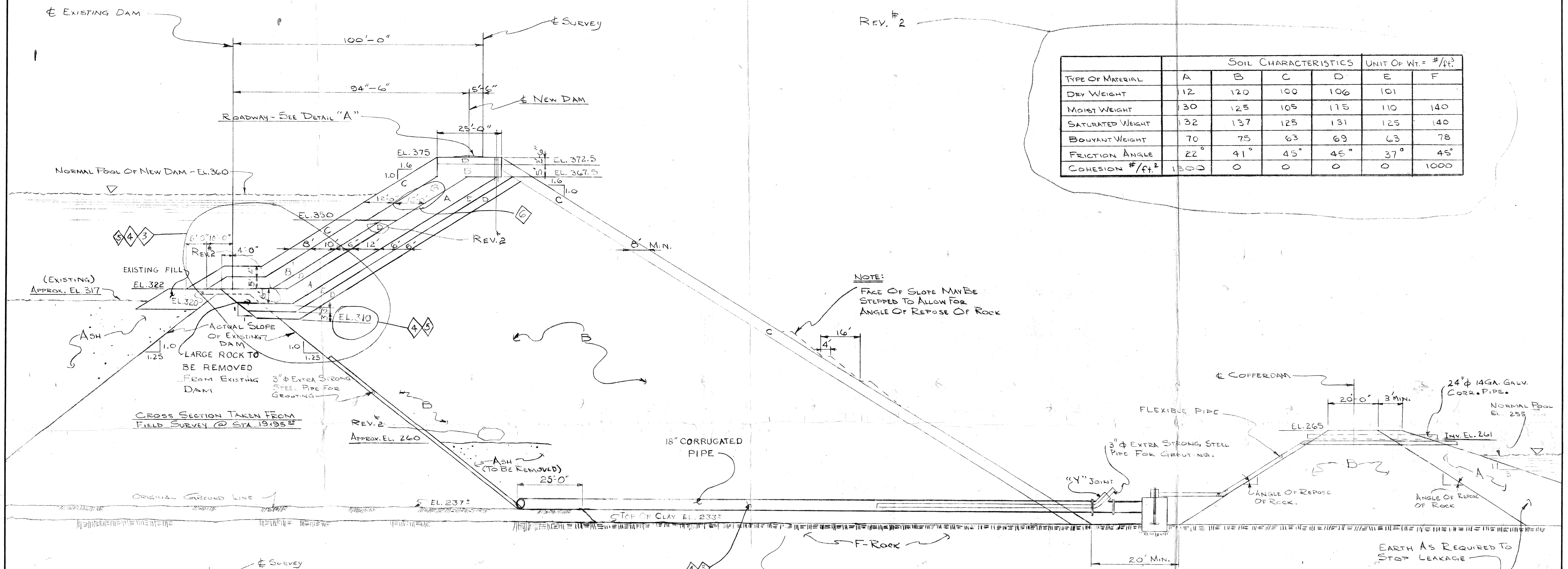
In considering the possible increase in seepage from a proposed raise in hydrostatic head, it was necessary to research previous files for information regarding soil types and properties used in design/construction of the core and filter materials of the last dike raise. During March and April of 1979, samples from potential borrow sources and mine spoil stockpiles in the immediate area were transported to APCo's Central Soils Testing Laboratory in Varnons, Alabama. Most of this material was mine waste with sufficient fines to be considered for use as the upstream "impervious" blanket, or Class H material. These were samples #332 and #333. Two other samples from local sources selected by plant personnel were also tested, taken from areas near the abutments and thought to have greater fines contents. These were designated samples #334 and #335. All samples were tested for shear strength and permeability at both 85% and 92% of their Standard Proctor (SP) maximum dry density for compaction. Table 1 below presents a summary of those test results.

Table 1: Properties of Class H Material

	Lab #332	Lab #333	Lab #334	Lab #335
Description:	Mine Spoil (E)	Mine Spoil (S)	Clayey Silt Borrow 57% passing LL=31, PI=4	NW Abutment 60% passing (25% cl) LL=31, PI=7
Density:	γ_m=122.7 OMC=13.6%	γ_m=118.9 OMC=13.2%	γ_m=107.5 OMC=18.2%	γ_m=111.0 OMC=16.5%
Permeability, κ (cm/sec):				
85% SP	7.4×10^{-4}	5.1×10^{-4}	1.9×10^{-4}	2.0×10^{-4}
92% SP	8.1×10^{-6}	1.0×10^{-5}	2.2×10^{-5}	7.3×10^{-6}
Strength (C=cohesion, ϕ=angle of internal friction. Prime values are effective stress):				
85% SP	C=2.2 ksf ϕ=5° C'=0 ksf ϕ'=32.9°	C=1.4 ksf ϕ=23° C'=0 ksf ϕ'=35°	C=0.4 ksf ϕ=21.5° C'=0 ksf ϕ'=33.7°	
92% SP	C=2.1 ksf ϕ=6.5° C'=0 ksf ϕ'=36.1°	C=1.5 ksf ϕ=28° C'=0 ksf ϕ'=36.1°	C=1.0 ksf ϕ=23° C'=0 ksf ϕ'=36°	C=2.2 ksf ϕ=9°

Attachment B

Drawings Used to Develop Critical Section Profile

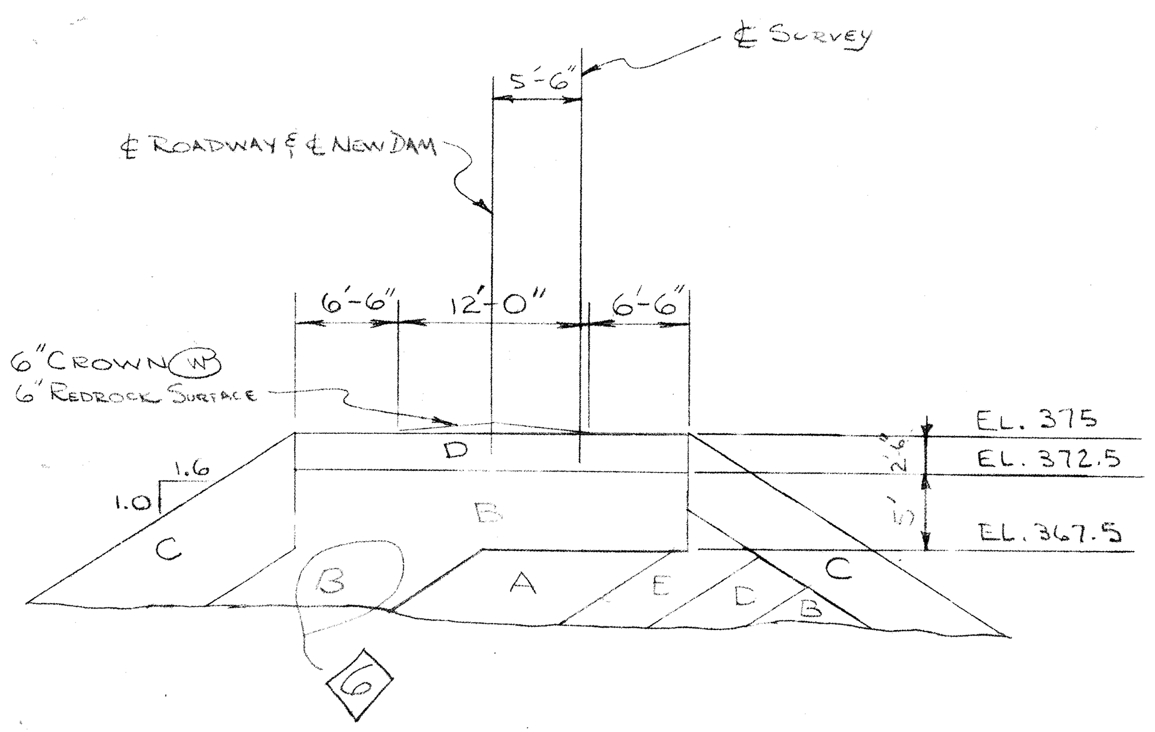


Note:
Location Of Sumps, Pumps And Unwatering Pipe Lines To Be Determined After Overburden Is Removed And Amount Of Leakage Is Determined. Pipe Lines To Be Cement Grouted After They Are No Longer Needed.

Rev. #2

	Soil Characteristics				Unit Of Wt. = #/ft.³	
Type Of Material	A	B	C	D	E	F
Dry Weight	112	120	100	106	101	
Moist Weight	130	125	105	115	110	140
Saturated Weight	132	137	125	131	125	140
Bouyant Weight	70	75	63	69	63	78
Friction Angle	22°	41°	45°	45°	37°	45°
Cohesion #/ft.²	1300	0	0	0	0	1000

Notes:
1. Material Designation (All Material To Be Compacted).
   "A" Impervious Fill.
   "B" Rock, 12" Max. Size.
   "C" Rock, 12" And Larger.
   "D" Coarse Filter.
   "E" Fine Filter.
   "F" Rock.
2. Top Of Dam To Be Furnished With A 12 Foot Wide Redrock Surfaced Roadway - See Detail "A".



Detail - "A"

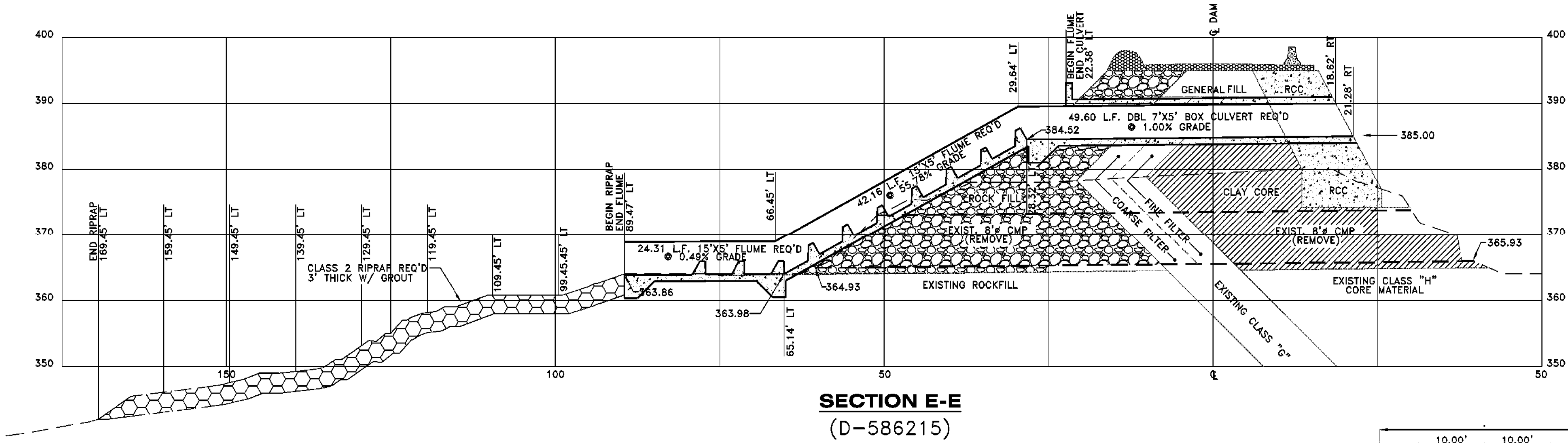
Reference:
D-189178 - General Layout Of Dam.

Rev. #6 G.L.H 3-5-75	Rev. #5 D.C. 10-11-74	Rev 4 N.W. Hyde 10-9-74	Rev. #3 D.C. 9-30-74	Rev. #2 4-27-73	Rev. #2 (Cont'd) 4-27-73	Rev. #1 3-13-73
Chg'd 6' Layer Of "E" & "D" Filter Mtl. To 12' Layer Of "B" Mat'l Above Elev. 350' On U.S. Side Of Core.	Changed EL. 308 To EL. 310 Revised Soil Layers In Core	Changed EL. 310 To EL. 308 Change Rev On Dwg. Had Rev 3 Marked As Rev 4	Revised Soil Layers In Core & Changed Elevation Of Drain Pipe.	Added "D" Filter Material To Upstream Face Of "A" Filter Material. R.D.C.	Changed Assumed Soil Characteristics To Actual Results From Lab Tests. R.D.C.	General Revision. R.D.C

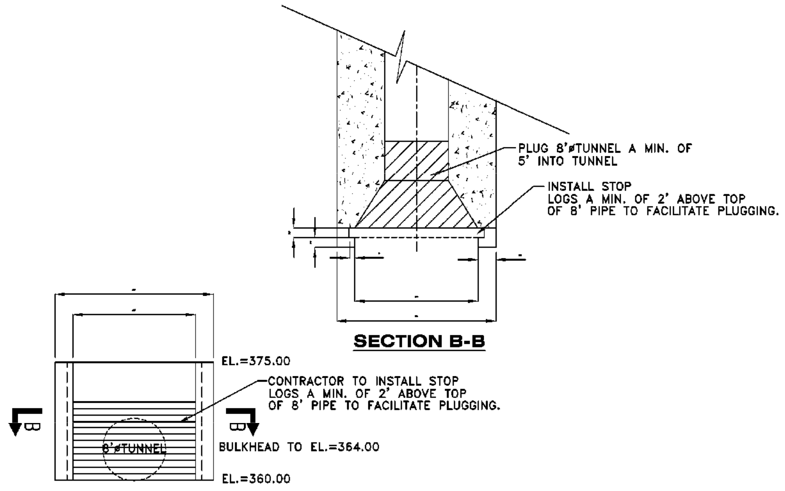
Drawn R. Crowson 3-13-73 Checked GDB 3-26-73 Traced
Approved [signature] Date 3-26-73
Approved [signature] Date 3/26/73

ALABAMA POWER COMPANY
Job: Gorgas Ash Handling
Detail: Sloping Core Design - (Typical Cross Section).
Scale: 1" = 20' Vertical & Horizontal B/M
Sheet 1 Of 1 Sheets
Supersedes
C-189068

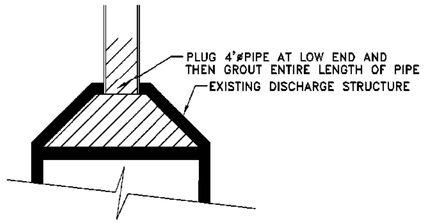
K&E 17 0253 2-72 2300+



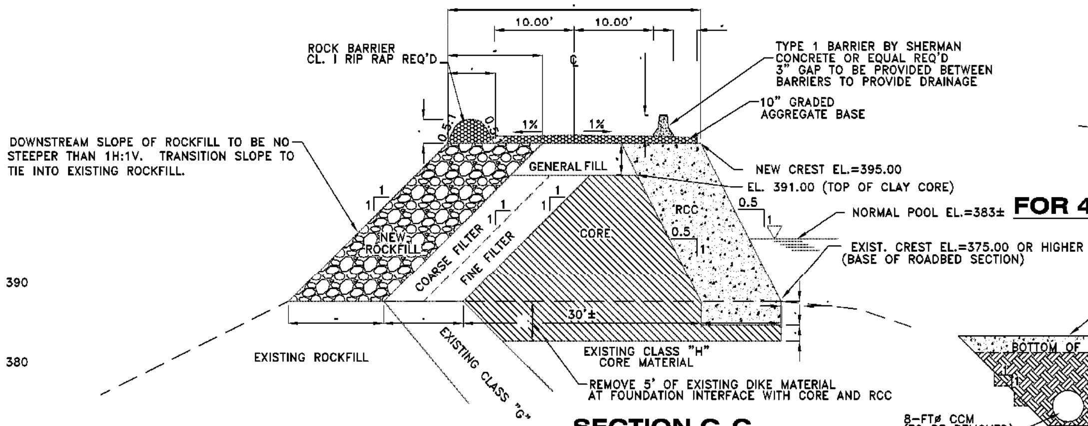
SECTION E-E
(D-586215)



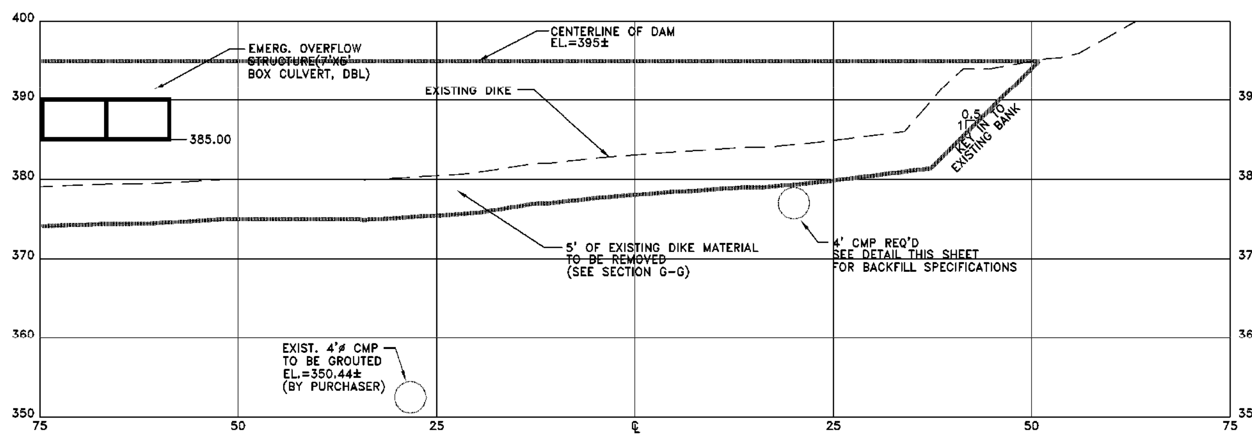
PLUGGING DETAIL FOR 8'Ø PIPE AT PRESCOTT CREEK (BY CONTRACTOR)



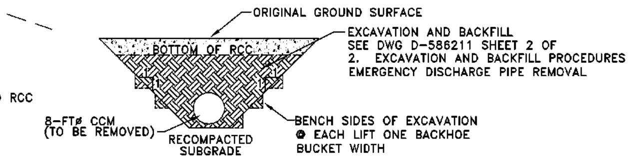
PLUGGING DETAIL FOR 4' Ø CMP AT EXISTING WEIR (BY PURCHASER)



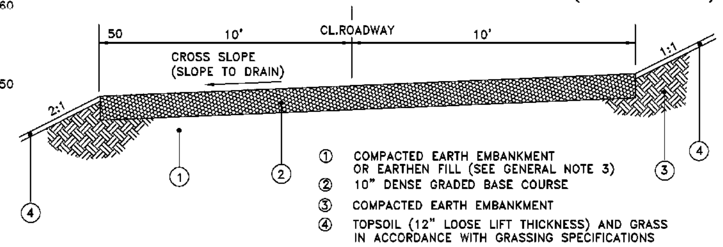
SECTION G-G DAM TYPICAL SECTION
(N.T.S.)
(D-586216)



SECTION F-F
(D-586215)



EXISTING EMERGENCY DISCHARGE PIPE EXCAVATION & BACKFILL
(N.T.S.)
(D-586215)



SECTION H-H WEST DOWNSTREAM ACCESS ROAD
(N.T.S.)
(D-586216)

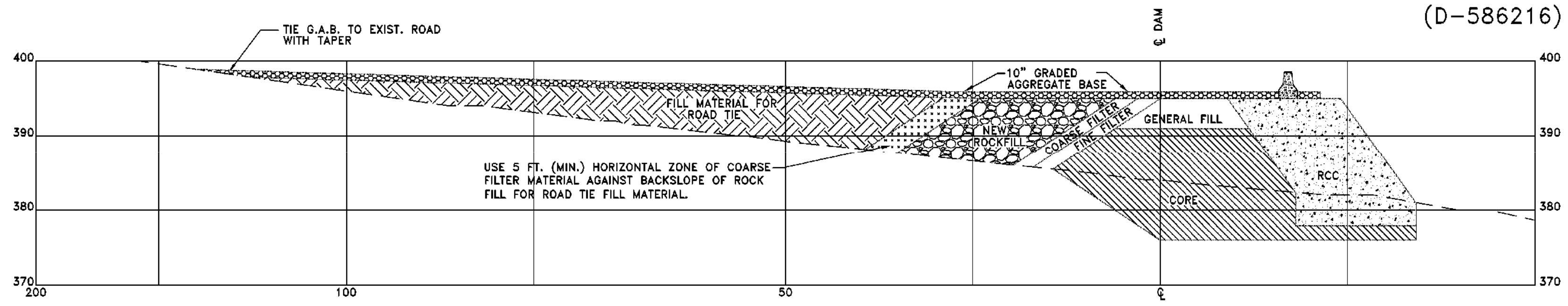
NOTES:

1. FOR DRAWING INDEX, NOTES, AND SPECIFICATIONS SEE DWG. NO. D-586211, SHEETS 1 & 2.
2. CURVE DATA SHOWN ON D-586214.
2. WORK THIS DRAWING WITH DRAWINGS:
   D-586214
   D-586215
   D-586216
   D-586220

REFERENCES:

SEE DRAWING D-586211

SEE TECHNICAL SPECIFICATIONS FOR EARTHWORK AND ROLLER COMPACTED CONCRETE CREST RAISE CONSTRUCTION



SECTION D-D
(D-586215)

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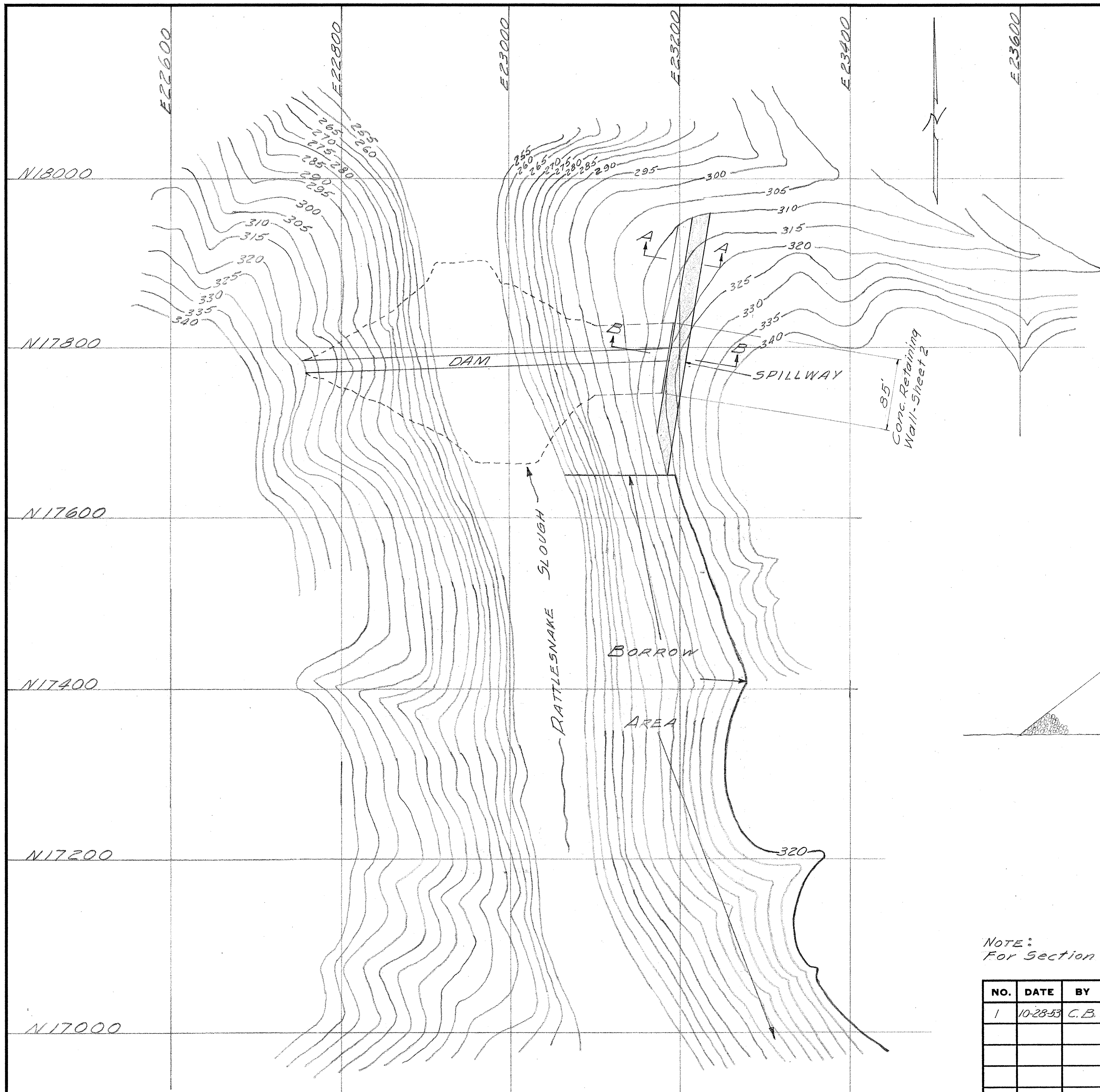
Southern Company Services, Inc.
FOR
Alabama Power Company

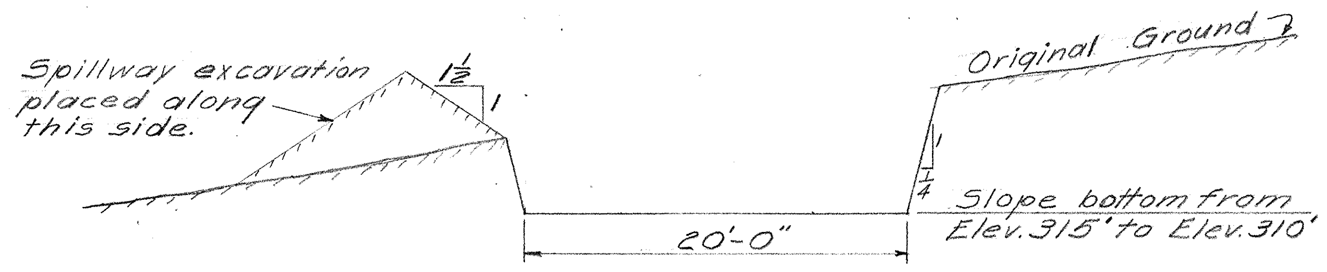
PLANT GORGAS
CREST RAISE OF RATTLESNAKE HOLLOW ASH POND
SECTIONS AND DETAILS

REVISION	DATE	REVISION A	DATE 7-21-06
		ISSUED FOR INQUIRY	JOB NO. 2101FS

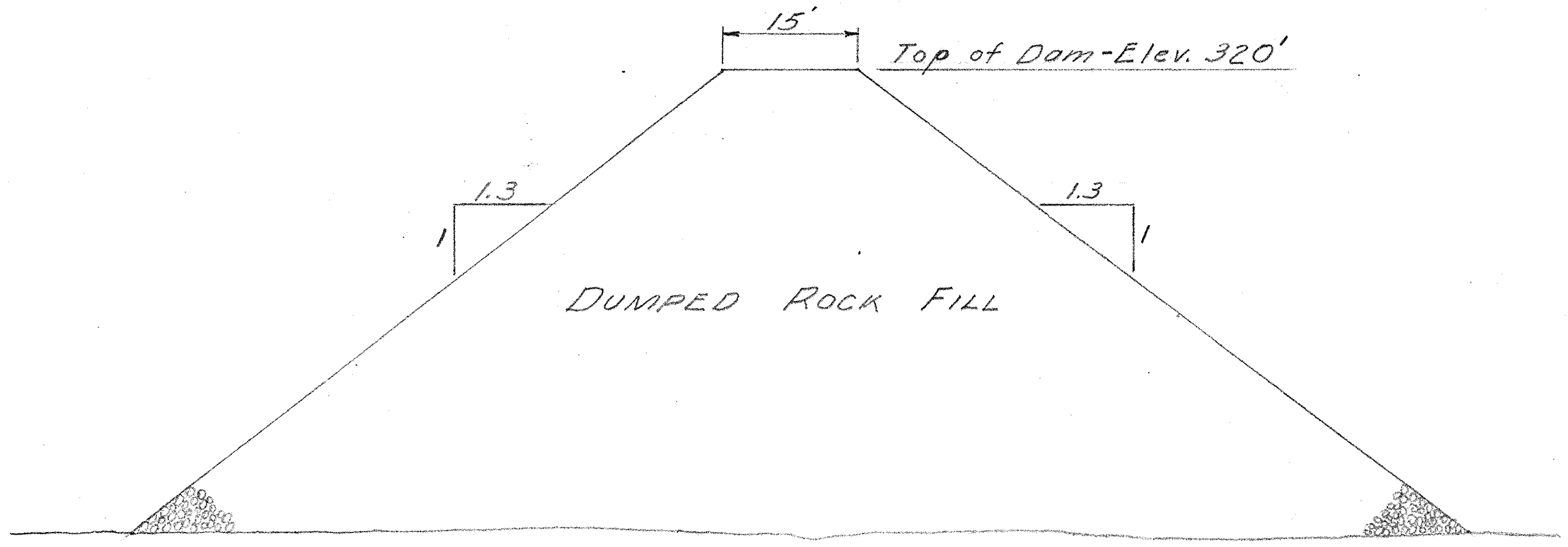
BY	CHK'D	CIVIL APPR	ELECT APPR	I/C APPR	MECH APPR	MGR APPR	SCALE	PROJ I.D.	DRAWING NUMBER	SH	CONT'D	REV
JWM	PMG JCP	JBS				CKT	1"=10'		D-586217	1	FINAL	A

ANSI F: 28x40 Acad2000





Section A-A
Spillway Details
Scale: 1"=10'



Typical Fill Section
Scale: 1"=20'

Note:
For Section B-B see sheet 2.

NO.	DATE	BY	REVISION
1	10-28-53	C.B.	Relocate spillway.

ALABAMA POWER COMPANY

SUBJECT Gorgas Ash Disposal Pond
DETAIL Rattlesnake Hollow Site
Rock Fill Dam
DRAWN C.B. TRACED
CHECKED DATE August 19, 1953
APPROVED DATE
APPROVED DATE
SCALE As Shown
SHEET 1 OF 2 SHEETS
SUPERSEDES
B/M

F-97854

K+E ALBANENE 195M TRACING PAPER