PERIODIC SAFETY FACTOR ASSESSMENT
PLANT BARRY GYPSUM STORAGE FACILITY
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 Barry also referred to as the Plant Barry Gypsum Storage Facility is located on Plant Barry property, near Bucks, Alabama. The lined CCR surface impoundment is formed by an engineered perimeter embankment. The critical section of this CCR unit was previously determined to be, and remains, on the west side of the unit.

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)	1.8	1.5
Maximum Surcharge Pool (Static)	1.7	1.4
Seismic	1.7	1.0

The embankments are constructed of well compacted clayey sands 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).

10/15/2021

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Licensed State of Alabama, PE No. 16516

Southern Company

Technical and Project Solutions Calculation

Calculation Number: TV-BA-APC881952-002

Project/Plant: Plant Barry	**Unit(s):** 1-5	**Discipline/Area:** Env. Solutions
Title/Subject: Periodic Factor of Safety Assessment for CCR Rule		
Purpose/Objective: Determine the Factor of Safety of the Gypsum Pond Dike		
System or Equipment Tag Numbers: n/a	**Originator:** Jacob A. Jordan, P.E.	

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Total # of pages including cover sheet & attachments:	12		

Revision Record

Rev. No.	Description	Originator Initial / Date	Reviewer Initial / Date	Approver Initial / Date
0	Issued for Information	JAJ/06-22-21	JCP/06-22-21	JCP/06-22-21

Notes:

Purpose of Calculation

The purpose of this calculation is to determine the stability of the Gypsum Pond dike under various loading conditions as prescribed by the EPA CCR Rule, updated from the 2016 submittal.

Summary of Conclusions

The analyses determined that the factors of safety of the Gypsum Pond met or exceeded the minimum criteria set forth in the CCR Rule. The results are summarized in the following table.

Factor of Safety Summary Table

Loading Condition	Factor of Safety (FOS)	Minimum FOS
Long-term, Maximum Storage Pool	1.8	1.50
Maximum Surcharge Pool	1.7	1.40
Seismic	1.7	1.00

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. The Morgenstern-Price analytical method used for the analyses.

Strata (Version 0.8.0),University of Texas, Austin

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, 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 0.008g 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 soil properties of unit weight, phi angle, and cohesion were obtained from historical laboratory and in-situ test results.
- Soil stratigraphy and piezometric data was estimated from the historical boring logs.
- The properties of unit weight, phi angle, and cohesion for the gypsum were derived from laboratory test data from Plant Scholz gypsum samples including the following: sedimented – consolidation samples, cast and sedimented triaxial samples, cast gypsum samples, and in-situ tests on sedimented gypsum
- The COE EM 1110-2-1902, October 2003, allows the use of the phreatic surface established for the maximum storage condition (normal pool) in the analysis for the maximum surcharge loading condition. This is based on the short-term duration of the surcharge loading relative to the permeability of the embankment and the foundation materials. This method is used in the analysis for the impoundments at this facility with surcharge loading.

The Cross-Section and materials used in this survey calculation were generally gathered from historical slope stability analyses for the gypsum storage facility. The critical section for the storage facility was identified to be located along the west side of Cell.

Input Data

The following soil properties were used in the analyses.

Soil Properties Table

Soil Type	Unit Weight, pcf	Cohesion, psf	Phi Angle, deg
Gypsum	85	0	30
Dike Fill	122	500	26
Base Soil	110	300	20

Hydrologic Considerations

Since the analysis condition consists of the gypsum stack being at a significantly higher elevation than the perimeter dikes and drainage channels, the gypsum will not receive any runoff from the surrounding areas. For the purpose of the analyses, the hydrologic conditions in the gypsum stack were conservatively assumed to be at the operating pool elevation for the previous level for the long term maximum storage condition, and at the surface of the gypsum top deck for the maximum surcharge condition.

Load Conditions

The stability of the Plant Barry gypsum storage facility was analyzed for maximum storage, maximum surcharge pool, and seismic loading conditions.

Criteria

The current required minimum criteria (factors of safety) were taken from the structural integrity criteria for existing CCR surface impoundments from 40 CFR 257.73, published April 17, 2015.

Design Inputs/References

- SCS Calculation TV-BA-APC387586-591-002
- USGS Earthquake Hazards - https://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
- SCS Drawing E5C11034 – Cell No. 1 – Sedimentation Pond Detail Plan for Initial Dike Construction
- SCS Drawing E5C11048 – Gypsum Storage Area Cell No. 1 – Operations Plan, Final Stacking Plan

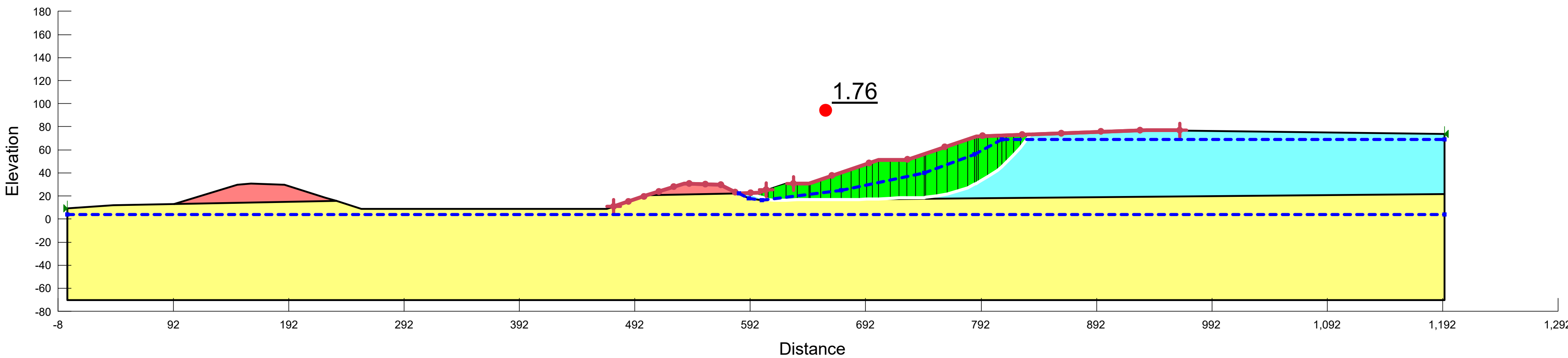
Body of Calculation

Slope/W modeling is attached.

Plant Barry
Gypsum Pond
Slope Stability Analysis

Maximum Storage Conditions

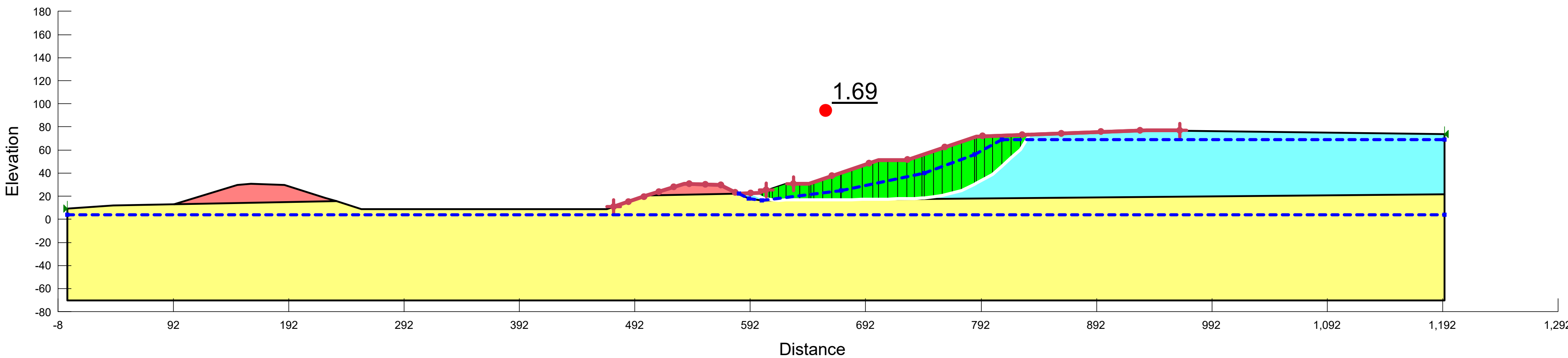
Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Dike Fill	Mohr-Coulomb	122	500	26
	Gypsum	Mohr-Coulomb	85	0	30
	Silty, Clayey Sand	Mohr-Coulomb	110	300	20



Plant Barry
Gypsum Pond
Slope Stability Analysis

Seismic Loading
Horzontal Coefficient = 0.008g

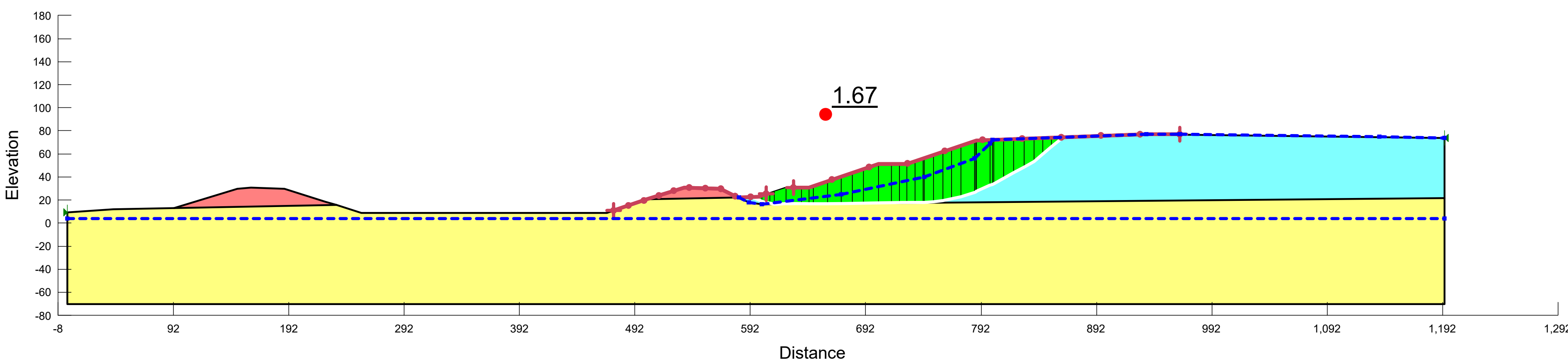
Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Dike Fill	Mohr-Coulomb	122	500	26
	Gypsum	Mohr-Coulomb	85	0	30
	Silty, Clayey Sand	Mohr-Coulomb	110	300	20



Plant Barry
Gypsum Pond
Slope Stability Analysis

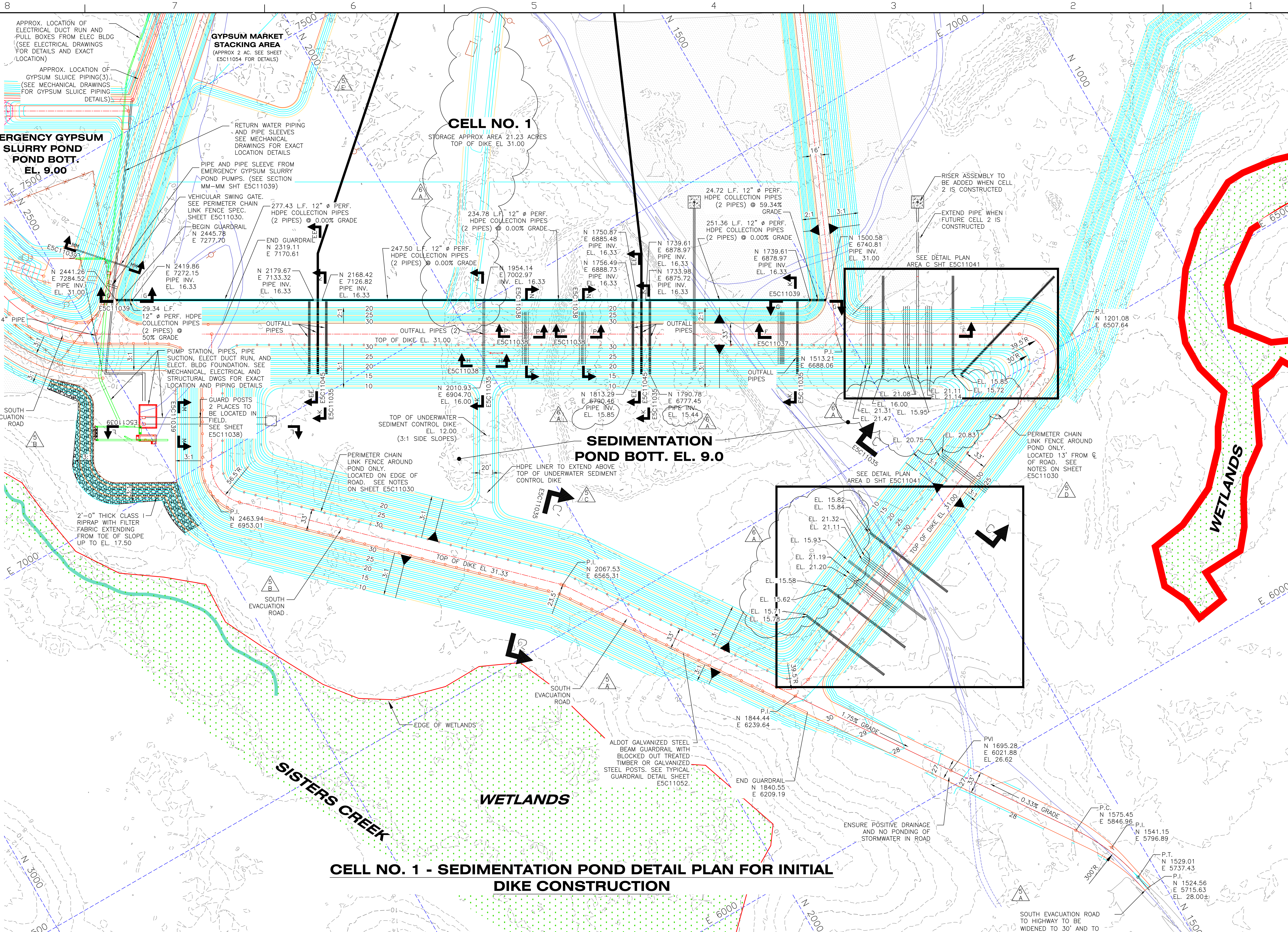
Maximum Surcharge Pool

Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Dike Fill	Mohr-Coulomb	122	500	26
	Gypsum	Mohr-Coulomb	85	0	30
	Silty, Clayey Sand	Mohr-Coulomb	110	300	20



Attachment A

Cell 1 Construction Drawings



CELL NO. 1 - SEDIMENTATION POND DETAIL PLAN FOR INITIAL DIKE CONSTRUCTION

GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

NOTES:

1. GRIDLINES AND COORDINATES SHOWN ARE IN PLANT GRID.

REVISION	DATE	DESCRIPTION	EWO	BY	CHK'D	CIVIL APPR	ELECT APPR	I/C APPR	MECH APPR	DISC MGR
6	12-19-11	A. ADDED AS-BUILT CONDITIONS	ECS5517	CSM	DPK	JBS				
5	08-14-09	A. B-2 CHANGED GAB TO 12" B. C-3, E-6, F-8, ADDED SOUTH EVACUATION NOTE. C. D-5, CHANGED SECTION C-C TO C'-C' D. E-2, REVISED DISTANCE TO CL E. H-7, ADDED GYPSUM MARKET STACKING AREA	EWO 2161DE	EEJ	PMG	BRH	JTM	KAH	TDJ	CKT
4	07-02-09	A. C-4, F-7 ADDED GUARDRAIL AND SWING GATE	EWO 2161DE	JWM	PMG	BRH	JTM	KAH	TDJ	CKT
3	03-05-09	A. G-7 ADDED PIPE SLEEVES AND PIPING B. H-7 ADDED ELECT DUCT RUN C. B-6 ADDED ELECT DUCT RUN D. F-7 ADDED ELECT DUCT RUN AND EDITED NOTE E. F-8 ADDED PIPE SLEEVE AND PIPING	EWO 2161DE	JWM	PMG	BRH	JTM	KAH	TDJ	CKT
2	11-14-08	ISSUED FOR CONSTRUCTION GENERAL REVISION	EWO 2161DE	JWM	PMG	BRH	JTM	KAH	TDJ	CKT
1	04-11-08	ISSUED FOR CONSTRUCTION GENERAL REVISION	EWO 2161DE	JWM	PMG	BRH	JTM	KAH	RAM	CKT
0	12-03-07	ISSUED FOR CONSTRUCTION	EWO 2161DE	JWM	PMG	BRH	JTM	KAH	RAM	CKT

Southern Company Generation Engineering and Construction Services
FOR
Alabama Power Company

PLANT BARRY UNIT 5
FGD PROJECT
GYPSUM STORAGE AREA
CELL NO. 1-SEDIMENTATION POND DETAIL PLAN FOR INITIAL DIKE CONSTRUCTION

SCALE	PROJ I.D.	DRAWING NUMBER	SHEET	CONT'D	REV
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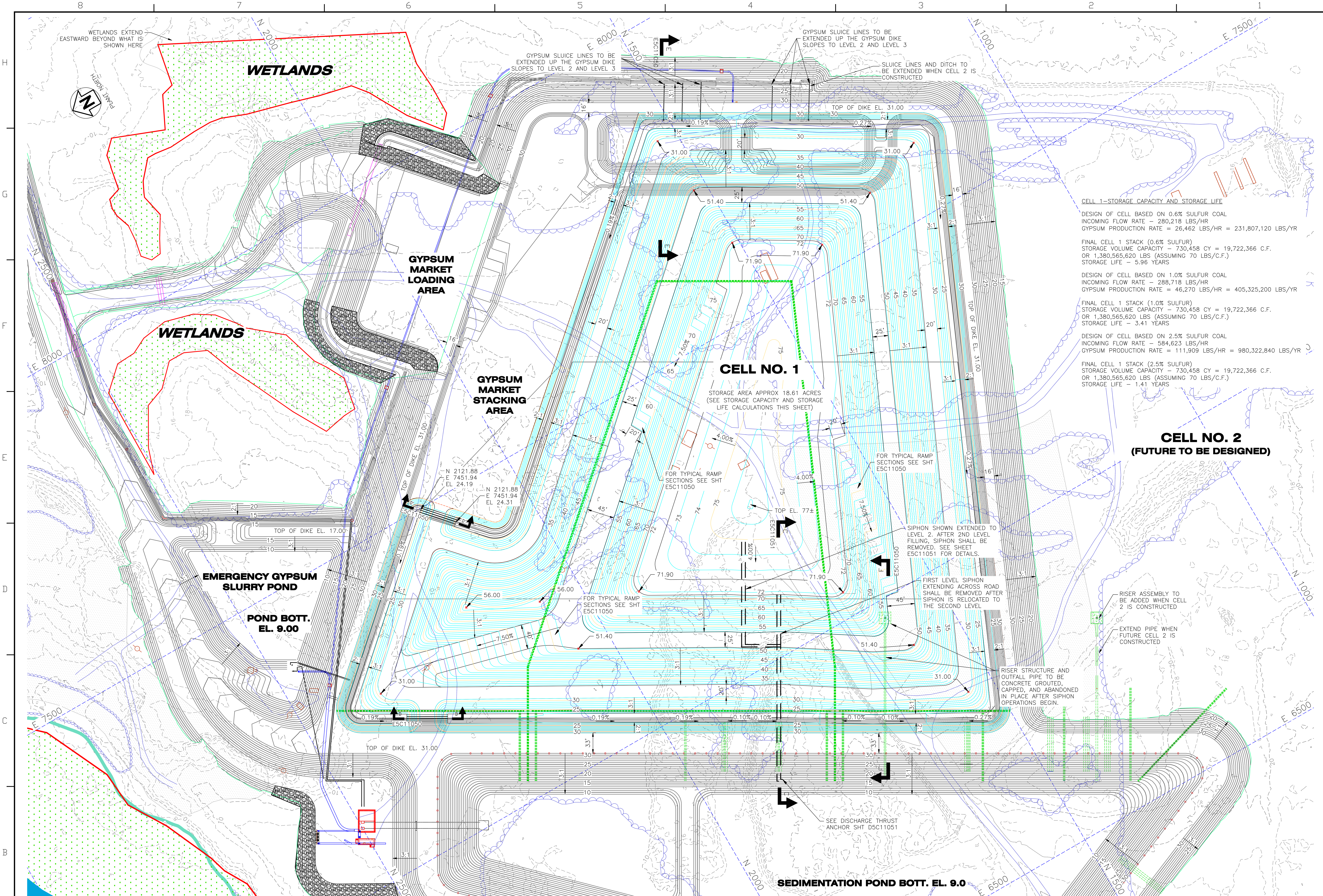
ANSI E: 44x34 Acad2004



CELL NO. 1 - OPERATIONS AND CONSTRUCTION FINAL STACKING PLAN

NOTES:

1. GRIDLINES AND COORDINATES SHOWN ARE IN PLANT GRID.

GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

Southern Company Generation Engineering and Construction Services FOR

Alabama Power Company

PLANT BARRY UNIT 5
FGD PROJECT
GYPSUM STORAGE AREA
CELL NO. 1–OPERATIONS PLAN
FINAL STACKING PLAN

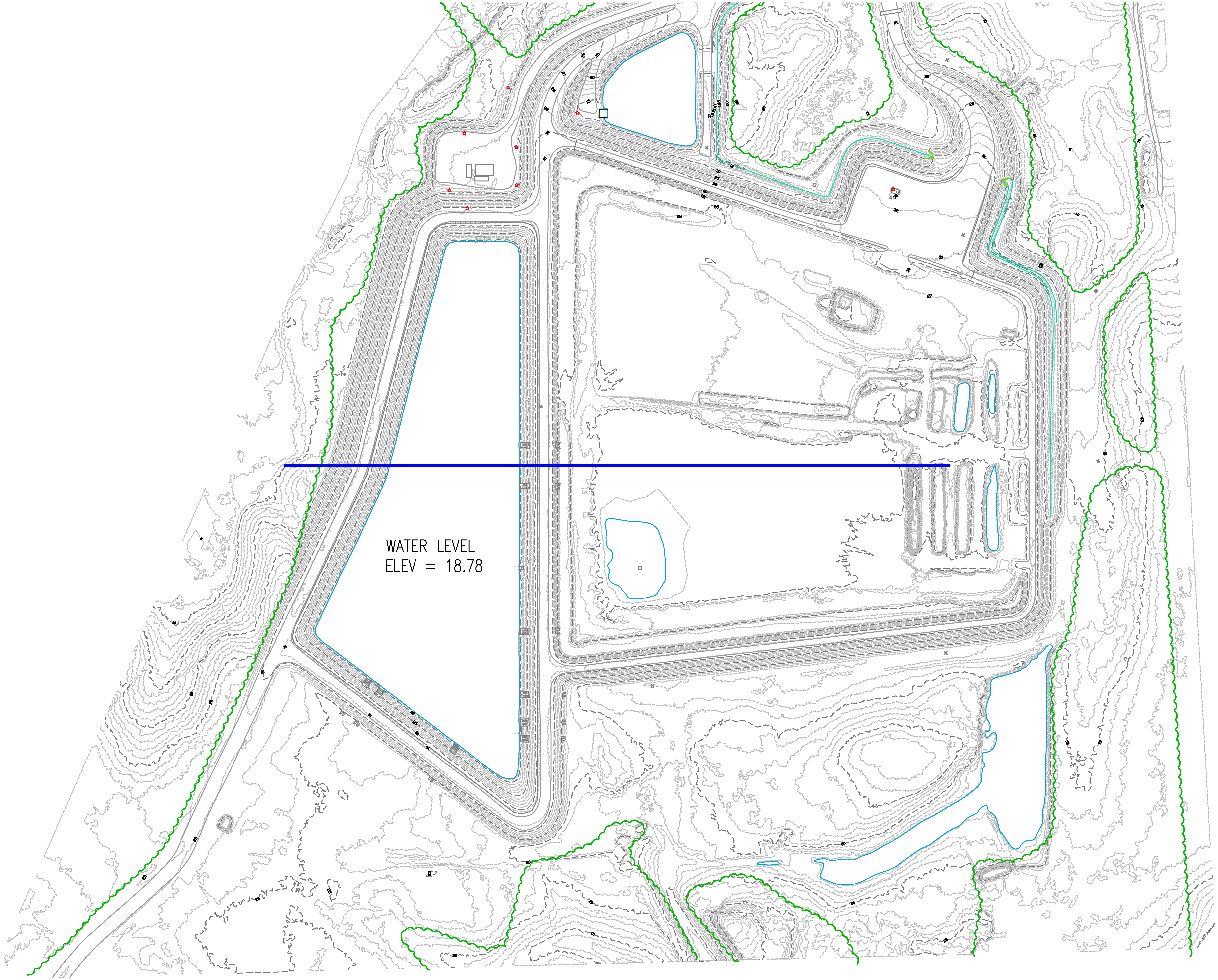
REVISION	DATE	DESCRIPTION	EWO	BY	CHK'D	CIVIL APPR	ELECT APPR	I/C APPR	MECH APPR	DISC MGR
1	09-04-09	GENERAL REVISION	2161DE	EEJ	PMG	BRH	JTM	KAH	TDJ	CKT
0	12-31-08	ISSUED FOR CONSTRUCTION	2161DE	JWM	PMG	BRH	JTM	KAH	TDJ	CKT

SCALE	PROJ I.D.	DRAWING NUMBER	SHEET	CONT'D	REV
1"=50'	210800	**E5C11048**	1	FINAL	1

ANSI E: 44x34 Acad2004

Attachment B

Analysis Section Location


WATER LEVEL
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