Prepared for

Lower Colorado River Authority (LCRA)
P.O. Box 220
Austin, Texas 78767

LOCATION RESTRICTIONS CERTIFICATION REPORT FOR EXISTING COMBUSTION BYPRODUCT LANDFILL REGISTRATION NO. 31575

LCRA FAYETTE POWER PROJECT
FAYETTE COUNTY, TEXAS

Prepared by

Geosyntec consultants
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June 2017

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1. INTRODUCTION

1.1 Purpose

This report presents an evaluation of the Combustion Byproduct Landfill (CBL) at LCRA's Fayette Power Project (FPP) with respect to compliance with the United States Environmental Protection Agency's (USEPA's) location restrictions regulations for existing coal combustion residuals (CCR) landfills. Of the location restrictions listed in 40 CFR §257.60 to §257.64, the only one applicable to existing CCR landfills is the one related to unstable areas (40 CFR §257.64). The report was prepared by Geosyntec Consultants (Geosyntec) under the direction of Dr. Beth A. Gross, P.E., a qualified professional engineer.

1.2 Background

The FPP is a coal-fired power plant located east of La Grange in Fayette County, Texas. CCR generated at the facility are disposed in the CBL, a CCR landfill located south of the power plant and north of the railroad that borders the FPP site (Drawing 1). The existing CBL consists of Cell 1 and Subcell 2D (Drawing 2). At final buildout, the CBL may consist of up to three cells, Cells 1 to 3 (Drawing 2); however, future development phases may not be needed and are not addressed herein.

Cell 1 was constructed in 1988 with a recompacted clay liner installed over natural clay subgrade. The northern slope of Cell 1 was closed with a final cover system in 1992 (Drawing 2). From October 2014 to May 2015, Subcell 2D was constructed with a 3-foot thick compacted clay liner. A final cover grading plan for Cell 1 and Subcell 2D is shown in Drawing 3.

1.3 Organization of Report

The remainder of this report is organized as follows:

- Section 2 presents an evaluation of the CBL with respect to the unstable area location restriction (40 CFR §257.64);
- Section 3 presents a certification by a qualified professional engineer that this Location Restrictions Certification Report for the existing CBL meets the requirements of 40 CFR §257.64; and
- Section 4 provides a list of references cited in the report.

2. UNSTABLE AREAS

2.1 Location Restriction

In accordance with 40 CFR §257.64, an existing CCR landfill or the lateral expansion of a CCR landfill must not be located in an unstable area unless it is demonstrated that recognized and generally accepted good engineering practices have been incorporated into the design of the landfill to ensure that the integrity of the structural components of the landfill will not be disrupted. To assess whether an area is unstable, the following factors must be considered:

- on-site or local soil conditions that may result in significant differential settlement;
- on-site or local geologic or geomorphologic features; and
- on-site or local human-made features or events (both surface and subsurface).

"Unstable area" is defined in 40 CFR §257.53 as "a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity, including structural components of some or all of the CCR unit that are responsible for preventing releases from such unit. Unstable areas can include poor foundation conditions, areas susceptible to mass movements, and karst terrains." "Structural components" refers to "liners, leachate collection and removal systems, final covers, run-on and run-off systems, inflow design flood control systems, and any other component used in the construction and operation of the CCR unit that is necessary to ensure the integrity of the unit and that the contents of the unit are not released into the environment."

2.2 Unstable Areas Information

2.2.1 Geotechnical Investigations

Geotechnical investigations were conducted at the CBL site by McClelland Engineers, Inc. (1983), Brytest, Inc. (1984), Jones and Neuse, Inc. (1992), and Geosyntec [2011]. The investigations included logging soil borings, conducting standard penetration tests, and collecting soil samples for geotechnical laboratory testing. Based on the results of the geotechnical investigations, soils within the upper 100 feet of the subsurface are predominantly classified as clay (CL or CH) and clayey sand (SC and SM) in accordance with the Unified Soil Classification System (USCS). Natural water contents of clays were generally near the plastic limits, and consequently the clays are characterized as stiff to hard. Sands were generally characterized as medium to very dense.

Based on the low compressibility of the site soils, these soils will provide a good foundation for liner system construction and will be able to support the load of the CBL without significant differential settlement.

2.2.2 Slope Stability

The slope stability of the existing CBL at final grade and the associated perimeter berm were evaluated. The critical cross sections for slope stability analyses were found to occur where the landfill or the berm was the tallest. For the existing CBL, the critical cross is located along the south slope of the landfill. For the perimeter berm, it is located along the north side of the landfill. The locations of the critical cross sections are shown in Appendix A. The materials in the existing CBL were conceptualized as CCR on a clay liner or clay subgrade and abutted by a clay perimeter berm. The near surface soils and perimeter berm material are predominantly classified as high plasticity clays (CH).

For long-term (drained) slope stability analyses of soil slopes in high plasticity clays, analyses using fully-softened strength parameters are recommended (e.g., Skempton, 1970; Wright, 2005). The fully-softened strength parameters of the subgrade, liner system, and perimeter berm soils were estimated based on the site-specific geotechnical data in the vicinity of Cell 1 and Subcell 2D and, as applicable, the correlations presented in Wright (2005). The slope stability of the existing CBL was also evaluated considering the development of residual strengths in the clay. Residual strengths (representing the lower-bound shear strength envelope for a soil experiencing large strains) generally develop under conditions which is unlikely to occur at the existing CBL, but were considered in this analysis as an added measure of safety. The residual strength parameters were also estimated using the correlations presented in Wright (2005). The shear strength of the CCR was estimated based on the results of consolidated undrained triaxial compression tests conducted on CCR from FPP and on published data (e.g., Kim et al., 2005). The geotechnical properties used in the slope stability evaluation are summarized in Table 1.

Table 1. Geotechnical Properties Used in Slope Stability Analysis.

Material	Unit Weight (lbs/ft^3)	Fully-Softened Effective-Stress Friction Angle (°)	Residual Effective-Stress Friction Angle (°)
Clay Liner/Subgrade	105	20	13
CCR	105	30	30
Perimeter Berm	120	24	16

The slope stability of Section A was analyzed using a method of slices coded in the computer program SLIDE®, Version 6.029 [Rocscience, 2014]. SLIDE® is a two-dimensional slope stability program that can be used to evaluate the factor of safety of circular and non-circular (block-type) slip surfaces using the simplified Bishop method (1955). The simplified Bishop procedure satisfies moment equilibrium conditions, which is suitable for circular slip surfaces.

Three slope stability scenarios were considered: (i) potential circular slip surfaces through the CCR at the south landfill slope; (ii) potential circular slip surfaces through the CCR and into the underlying clay liner/subgrade at the south landfill slope; and (iii) potential circular slip surfaces through the CCR and perimeter berm and into the underlying subgrade clay on the north landfill slope. The results of SLIDE analysis for each of the critical cross-sections are summarized in Table 2 and in Appendix A. Table 2 also lists the minimum slope stability factor of safety recommended by the Texas Commission on Environmental Quality (TCEQ) for a Class 2 nonhazardous industrial waste landfill like the CBL (TCEQ, 2015).

Table 2. Results of Slope Stability Analysis.

Scenario	Factor of Safety			
	Fully-Softened Strength		Residual Strength	
	SLIDE Analysis	TCEQ Guideline	SLIDE Analysis	TCEQ Guideline
Circular Slip Surface Through CCR	1.77	1.3	1.77	1.0
Circular Slip Surface Into Subgrade Clay	1.56		1.17	
Circular Slip Surface Through CCR and North Perimeter Berm	1.65		1.09	

For the conditions analyzed, the critical slip surface using fully-softened strengths is a circular surface passing through the CCR material and into the subgrade clay at the south side of the landfill. The calculated slope stability factor of safety for this scenario is 1.56 using fully-softened strengths. The critical slip surface using residual strengths is a circular surface passing through the CCR material and the north perimeter berm. The calculated slope stability factor of safety for this scenario is 1.09 using residual strengths. All of the calculated factor of safety values exceed the TCEQ guidelines of 1.3 using fully-softened strengths and 1.0 using residual strengths.

2.2.3 Local Geologic Features

There are no known local geologic features that would classify the CBL site as an unstable area. Such features include active faults, seismic events, landslides, debris slides, karst terrain, and erosion by rivers. Further, the CBL is not located within the 500-year floodplain (FEMA FIRM 48149C0270C, October 2006).

2.2.4 Local Manmade Features or Events

There are no known local manmade features or events that would classify the CBL site as an unstable area. Such features and events include mining, cut and fill activities during construction, excessive drawdown of groundwater, and construction over fill.

2.3 Compliance Assessment

Based on the information provided in this section, the CBL is not situated in an unstable area and is therefore in compliance with the requirements of the location restriction for unstable areas.

3. PROFESSIONAL ENGINEER CERTIFICATION

Based on the demonstrations and evaluations presented in this Location Restrictions Certification Report for the existing Combustion Byproduct Landfill at LCRA's Fayette Power Project, it is my professional opinion that the report meets the requirements of 40 CFR §257.64.

GEOSYNTEC CONSULTANTS
F- 1182

Beth Ann Gross

Beth Ann Gross, Ph.D., P.E., D.GE

6/2/2017

Date

4. REFERENCES

Bishop, A.W. (1955). "The Use of the Slip Circle in the Stability Analysis of Slopes," *Géotechnique*, Vol. 5, pp. 7-17.

Brytest, Inc. (1984). "Soil Samples - FOB Laboratory," prepared for LCRA, June 12 and July 17.

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Kim, B., Prezzi, M., and Salgado, R. (2005). "Geotechnical Properties of Fly and Bottom Ash Mixtures for Use in Highway Embankments," *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 131, No. 7, pp. 914-924.

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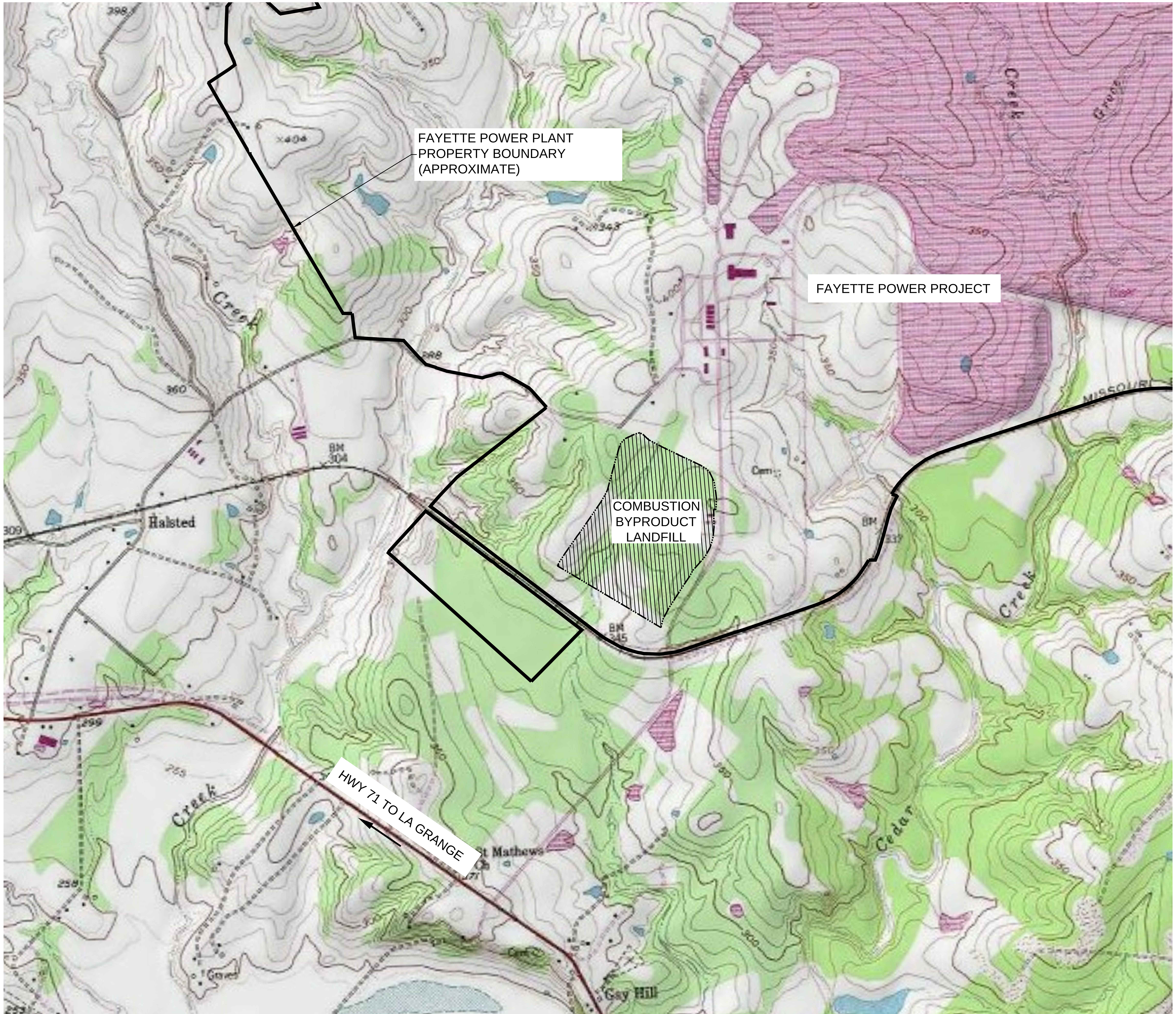
Skempton, A.W. (1970). "First-Time Slides in Over-Consolidated Clays," *Géotechnique, Vol.* 20, No. 3, pp. 320-324.

Spencer, E. (1967). "A Method of Analysis of the Stability of Embankments Assuming Parallel Inter-Slice Forces," *Géotechnique,* Vol. 17, No. 1, pp. 11-26.

Texas Commission on Environmental Quality (2015). "Nonhazardous Industrial Solid Waste Landfills," Draft Technical Guideline No. 3.

Wright, S.G. (2005). "Evaluation of Soil Shear Strengths for Slope and Retaining Wall Stability Analyses with Emphasis on High Plasticity Clays," Project No. 5-1874-01, Center for Transportation Research, The University of Texas at Austin.

DRAWINGS



NOTE:

BASE MAP SOURCE: UNITED STATES GEOLOGIC SURVEY (USGS), 7.5 MINUTE SERIES QUADRANGLE (TOPOGRAPHIC) MAP OF LA GRANGE EAST, TEXAS 1957, REVISED 1981 AND FAYETTEVILLE, TEXAS 1958, REVISED 1981

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TITLE: OVERALL SITE PLAN

PROJECT: LOCATION RESTRICTIONS CERTIFICATION

SITE: FAYETTE POWER PROJECT
COMBUSTION BYPRODUCT LANDFILL

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

6/2/2017
DATE

STATE OF TEXAS
M. ZAHIRUL ISLAM
109989
LICENSED
PROFESSIONAL ENGINEER

DESIGN BY:	ZI	DATE:	JUNE 2017
DRAWN BY:	JJV	PROJECT NO.:	TXL0225.09
CHECKED BY:	ZI	FILE:	TXL0225LRC-01
REVIEWED BY:	BG	DRAWING NO.:	
APPROVED BY:	ZI		1 OF 3

ENGINEERING DESIGN DRAWING

LEGEND

350	EXISTING GROUND ELEVATION (FT,MSL) (NOTES 1,2)
350	EXISTING TOP OF CLAY LINER ELEVATION (FT,MSL) (NOTE 2)
	EXISTING ROAD
	EXISTING BUILDING
	EXISTING RAILROAD
	EXISTING VEGETATION / TREE
N 9949000 E 3428000	COORDINATE GRID (NOTE 2)
	EXISTING FENCE
	EXISTING LIMIT OF LANDFILL
	EXISTING LIMIT OF FINAL COVER
P P	EXISTING POWER POLE AND OVERHEAD POWER LINE
	EXISTING COMBUSTION WASTE FORCE MAIN
	PROPOSED PHASE BOUNDARY
	PROPOSED LIMIT OF WASTE

NOTES:

1. THE EXISTING CONTOUR BASE MAP SHOWN ON THIS DRAWING WAS COMPILED USING AN AERIAL SURVEY BASED ON PHOTOGRAPHY PERFORMED ON 29 SEPTEMBER 2014 BY SURDEX CORPORATION AND LIDAR DATA PUBLISHED DECEMBER 2008 AND PROVIDED BY LCRA SURVEYING, MAPPING, AND GIS.
2. ELEVATIONS ARE IN FEET (FT) AS DEFINED BY THE NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD-83) 1983.
3. EXISTING COMBUSTION WASTE FORCE MAIN CONVEYS WATER FROM EXISTING RUNOFF RETENTION POND TO RECLAIM POND.

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TITLE: EXISTING SITE CONDITIONS

PROJECT: LOCATION RESTRICTIONS CERTIFICATION

SITE: FAYETTE POWER PROJECT
COMBUSTION BYPRODUCT LANDFILL

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SIGNATURE

6/2/2017
DATE

STATE OF TEXAS
M. ZAHIRUL ISLAM
109989
LICENSED
PROFESSIONAL ENGINEER

DESIGN BY:	ZI	DATE:	JUNE 2017
DRAWN BY:	JJV	PROJECT NO.:	TXL0225.09
CHECKED BY:	ZI	FILE:	TXL0225LRC-02
REVIEWED BY:	BG	DRAWING NO.:	2 OF 3
APPROVED BY:	ZI		

ENGINEERING DESIGN DRAWING

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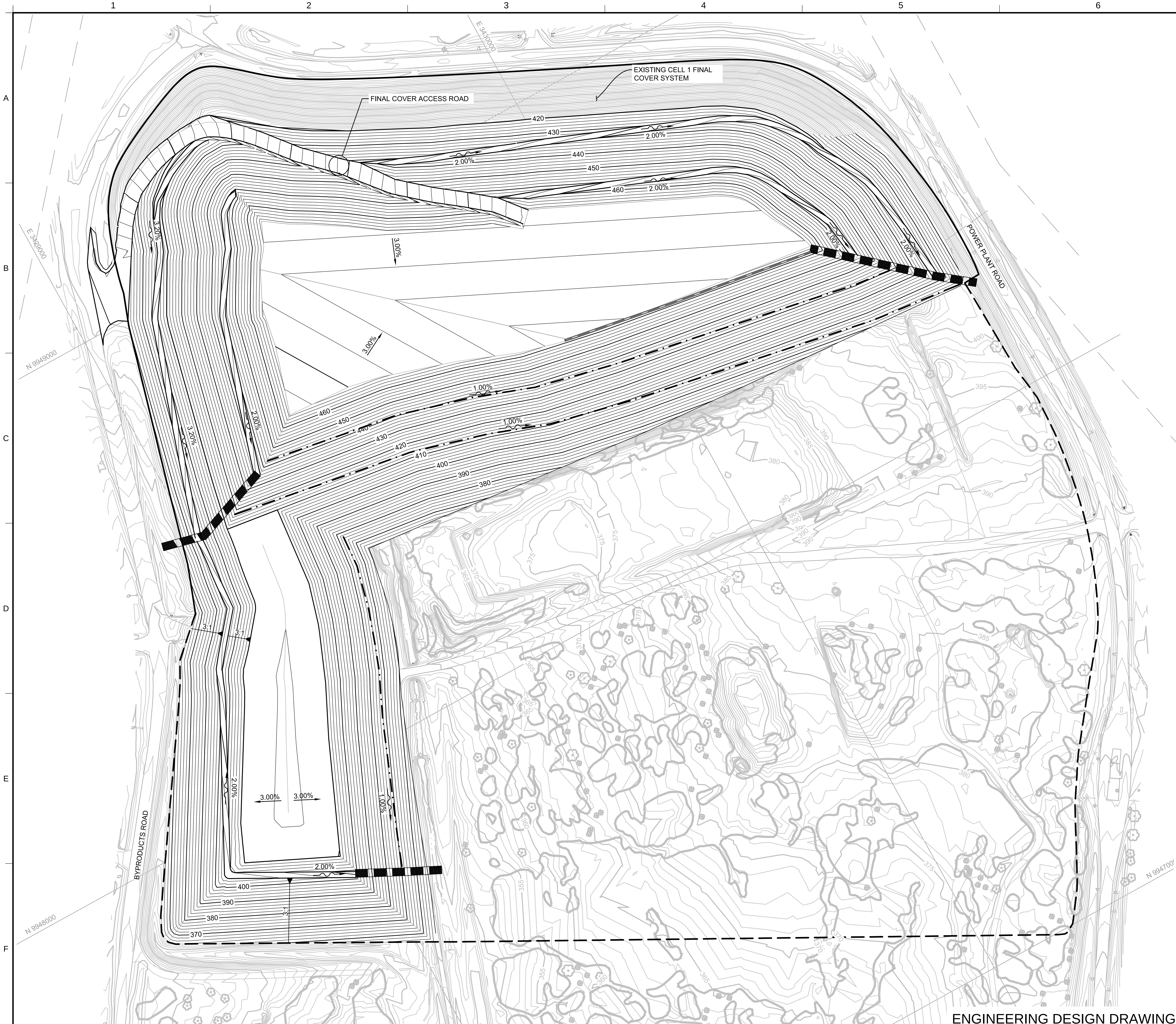

LEGEND

- 350 — EXISTING GROUND ELEVATION (FT,MSL) (NOTES 1,2)
- EXISTING ROAD
- EXISTING VEGETATION / TREE
- N 9949000 / E 3428000 — COORDINATE GRID (NOTE 2)
- EXISTING FENCE
- EXISTING UNDERGROUND RUNOFF DISCHARGE PIPE
- EXISTING LIMIT OF LANDFILL
- PROPOSED LIMIT OF LANDFILL
- 420 — PROPOSED TOP OF FINAL COVER ELEVATION (FT,MSL)
- PROPOSED DRAINAGE DOWNCHUTE
- PROPOSED DRAINAGE TERRACE
- PROPOSED DRAINAGE BENCH
- PROPOSED PERIMETER DRAINAGE CHANNEL
- PROPOSED TACK-ON BERM

NOTES:

1. THE EXISTING CONTOUR BASE MAP SHOWN ON THIS DRAWING WAS COMPILED USING AN AERIAL SURVEY BASED ON PHOTOGRAPHY PERFORMED ON 29 SEPTEMBER 2014 BY SURDEX CORPORATION AND LIDAR DATA PUBLISHED DECEMBER 2008 AND PROVIDED BY LCRA SURVEYING, MAPPING, AND GIS.
2. ELEVATIONS ARE IN FEET (FT) AS DEFINED BY THE NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD-83) 1983.
3. THE STORMWATER MANAGEMENT SYSTEM SHOWN FOR THE CBL IS GENERALIZED AND NEEDS TO BE DESIGNED PRIOR TO CBL CLOSURE.

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TITLE: FINAL COVER GRADING PLAN FOR CELL 1 AND SUBCELL 2D

PROJECT: LOCATION RESTRICTIONS CERTIFICATION

SITE: FAYETTE POWER PROJECT
COMBUSTION BYPRODUCT LANDFILL

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SIGNATURE
6/2/2017
DATE

STATE OF TEXAS
M. ZAHIRUL ISLAM
109989
LICENSED
PROFESSIONAL ENGINEER

DESIGN BY:	ZI	DATE:	JUNE 2017
DRAWN BY:	JJV	PROJECT NO.:	TXL0225.09
CHECKED BY:	ZI	FILE:	TXL0225LRC-03
REVIEWED BY:	BG	DRAWING NO.:	
APPROVED BY:	ZI		3 OF 3

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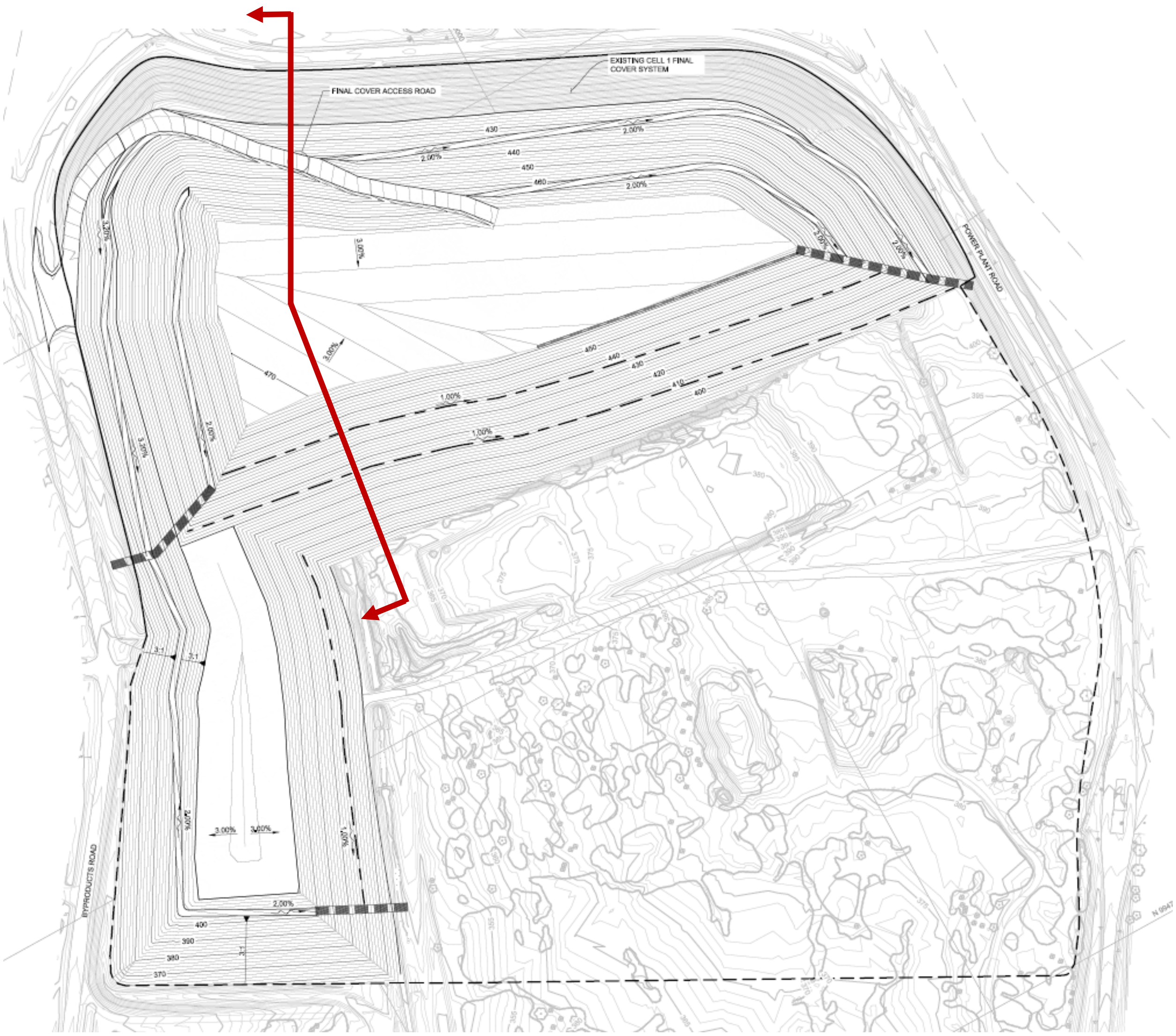
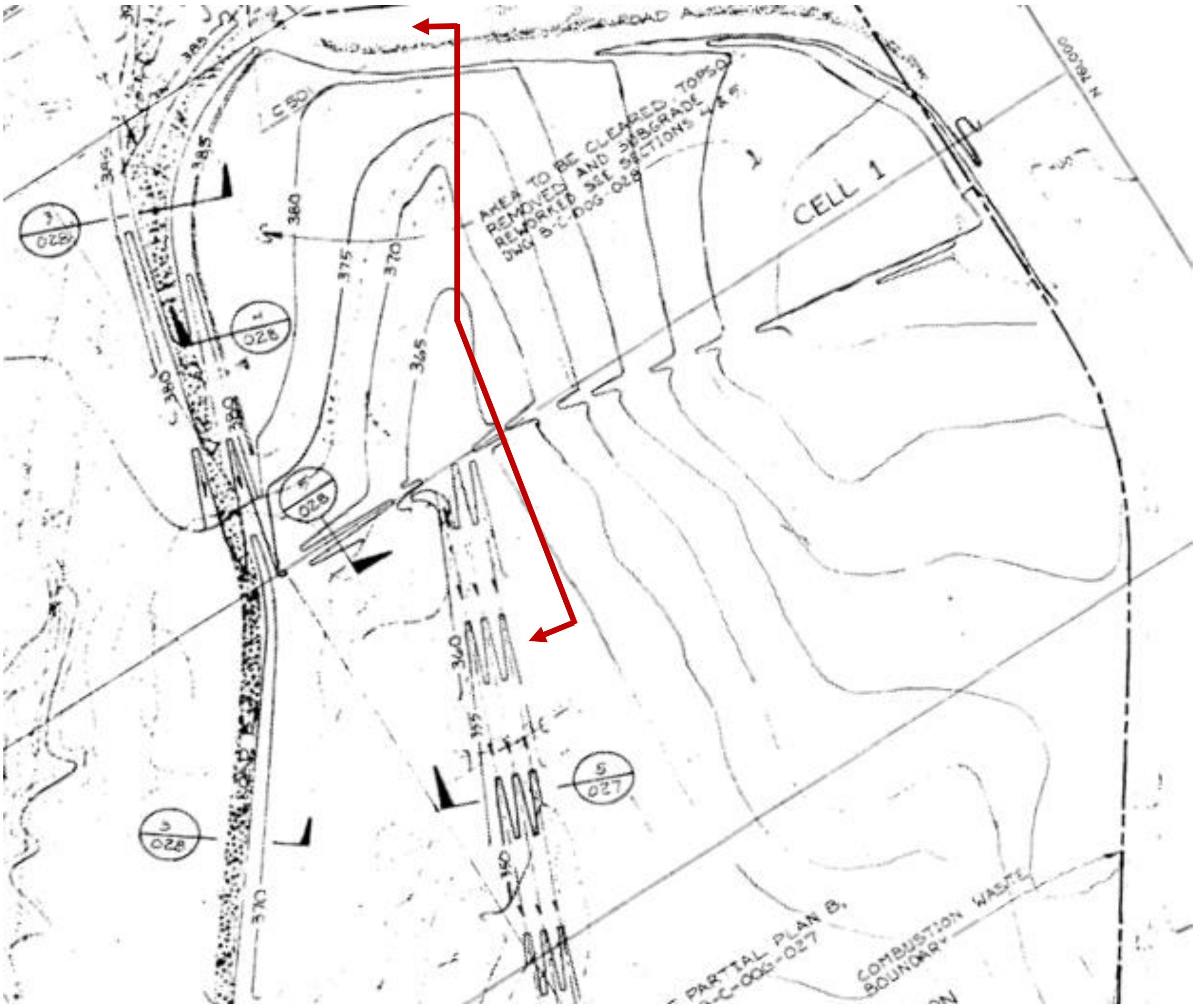
APPENDIX A

Slope Stability Analyses Results

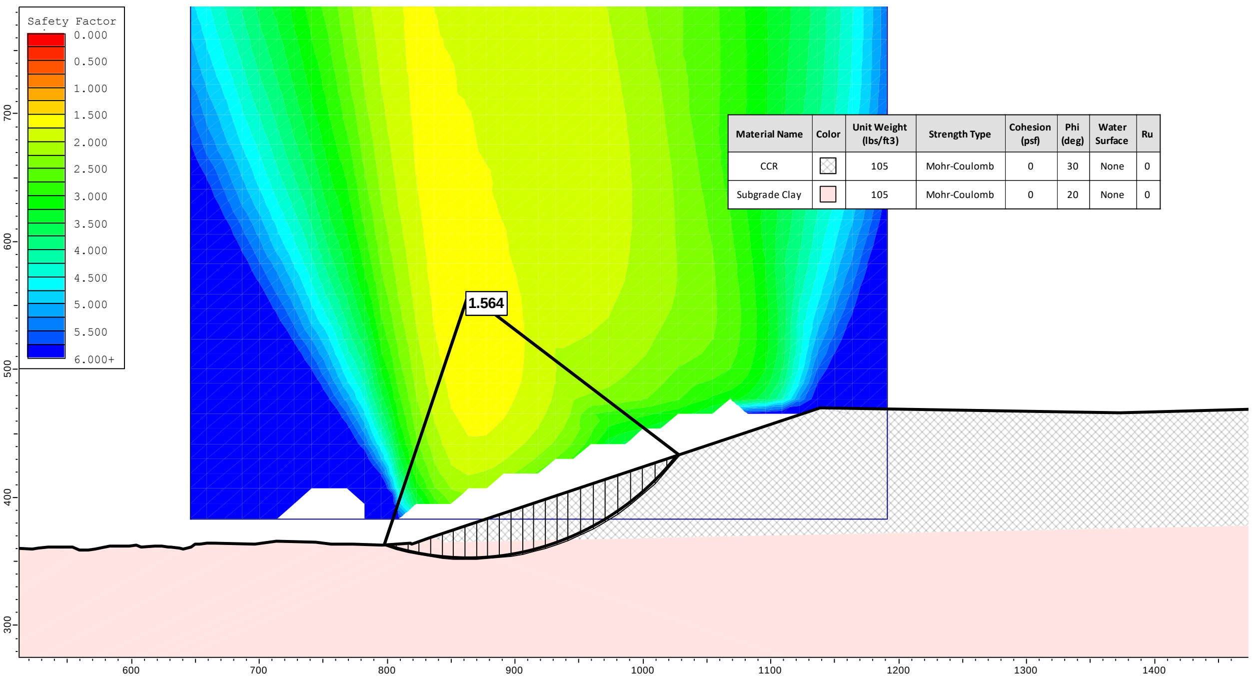


Approximate Location of Critical Cross Section on Final Cover Grading Plan.



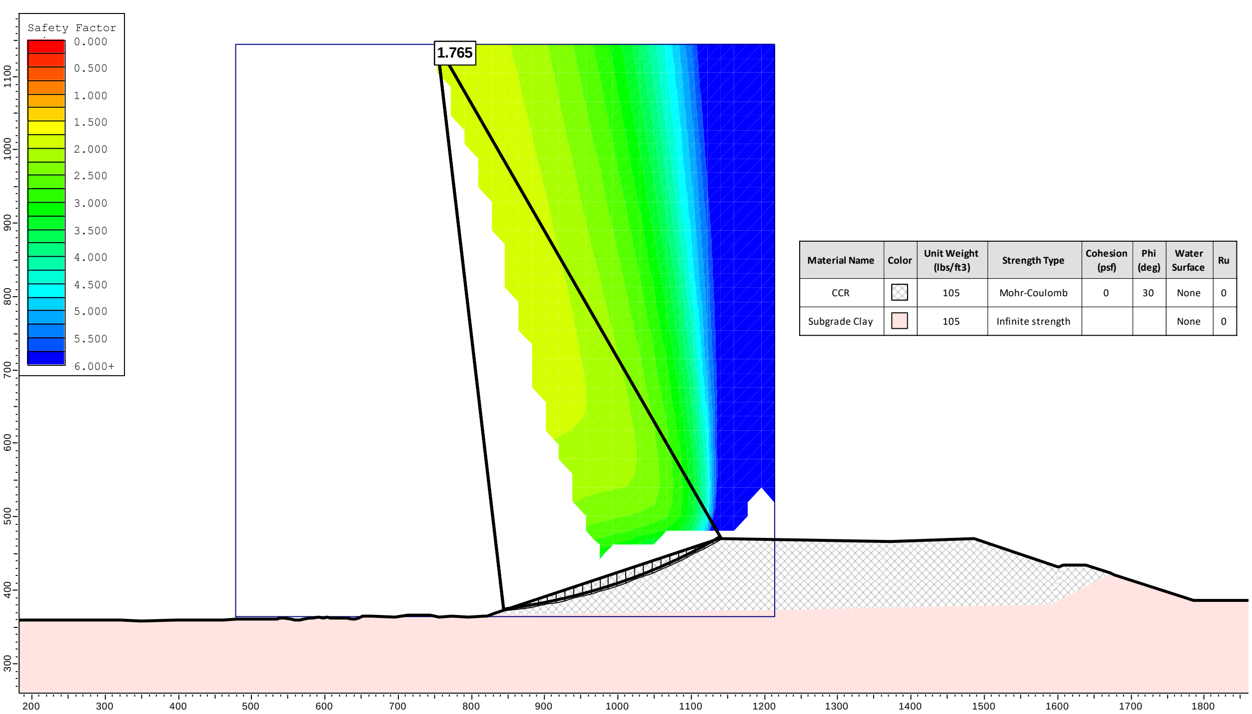
Approximate Location of Critical Cross Section on Base Grading Plan (Base Grades are from Drawing SK-00G-032, prepared by Black & Veatch in 1984)

Circular Slip Surface Into Subgrade Clay (Fully-Softened Shear Strengths)



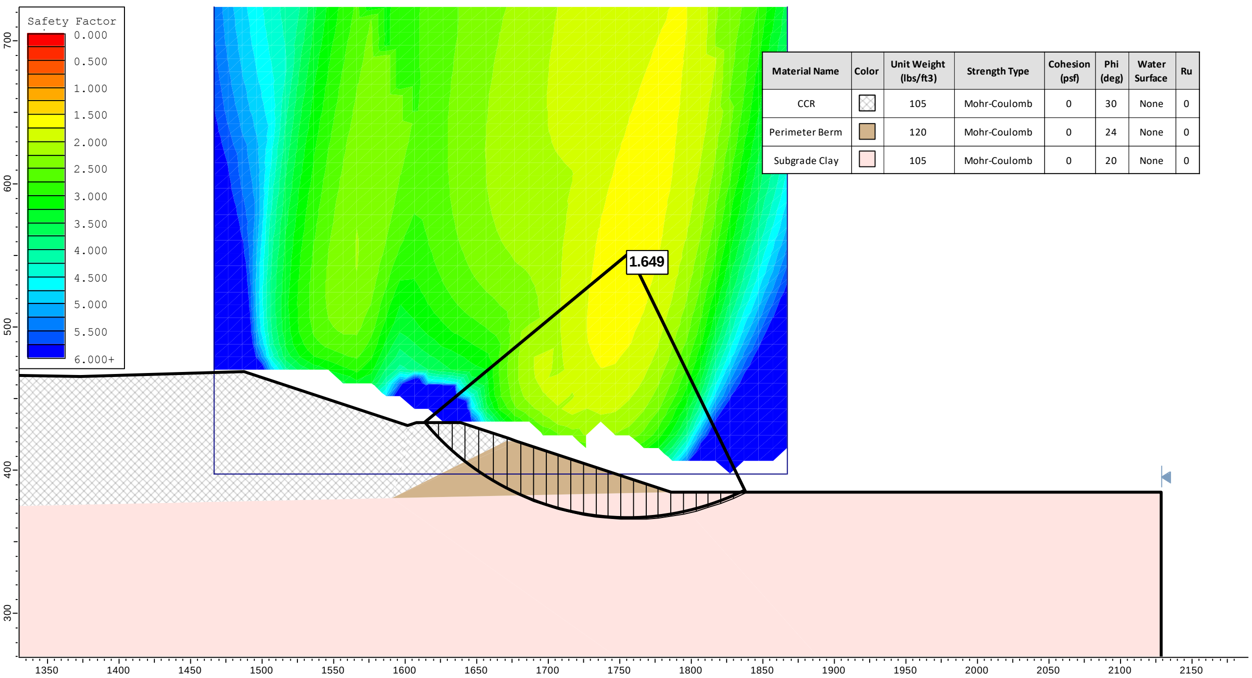
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
CCR		105	Mohr-Coulomb	0	30	None	0
Subgrade Clay		105	Mohr-Coulomb	0	20	None	0

Circular Slip Surface Through CCR Material (Fully-Softened Shear Strengths)



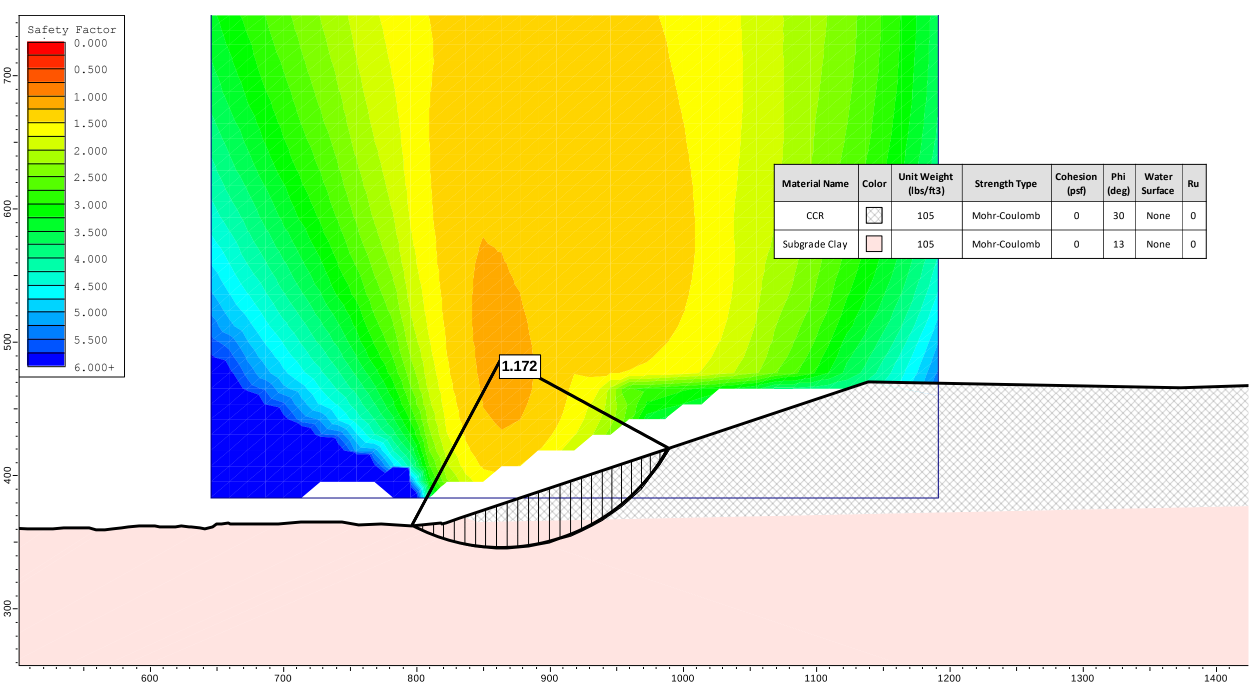
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
CCR		105	Mohr-Coulomb	0	30	None	0
Subgrade Clay		105	Infinite strength			None	0

Circular Slip Surface Through CCR Material and North Perimeter Berm (Fully-Softened Shear Strengths)



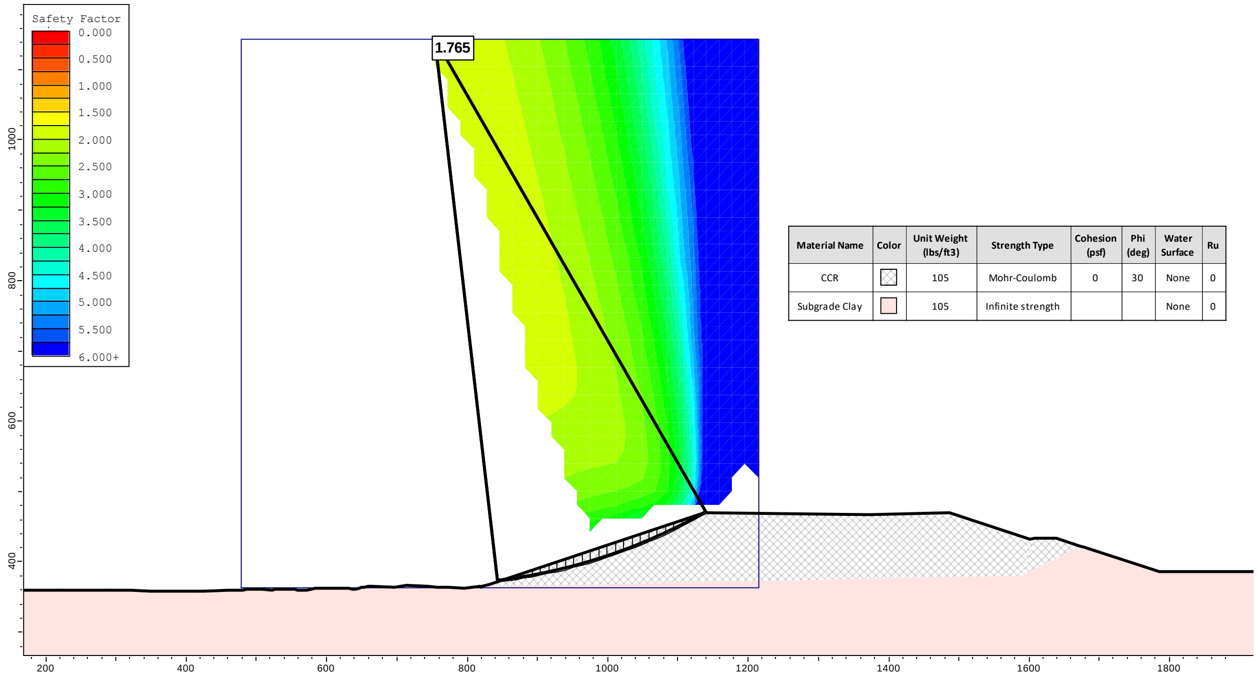
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
CCR		105	Mohr-Coulomb	0	30	None	0
Perimeter Berm		120	Mohr-Coulomb	0	24	None	0
Subgrade Clay		105	Mohr-Coulomb	0	20	None	0

Circular Slip Surface Into Subgrade Clay (Residual Shear Strengths)



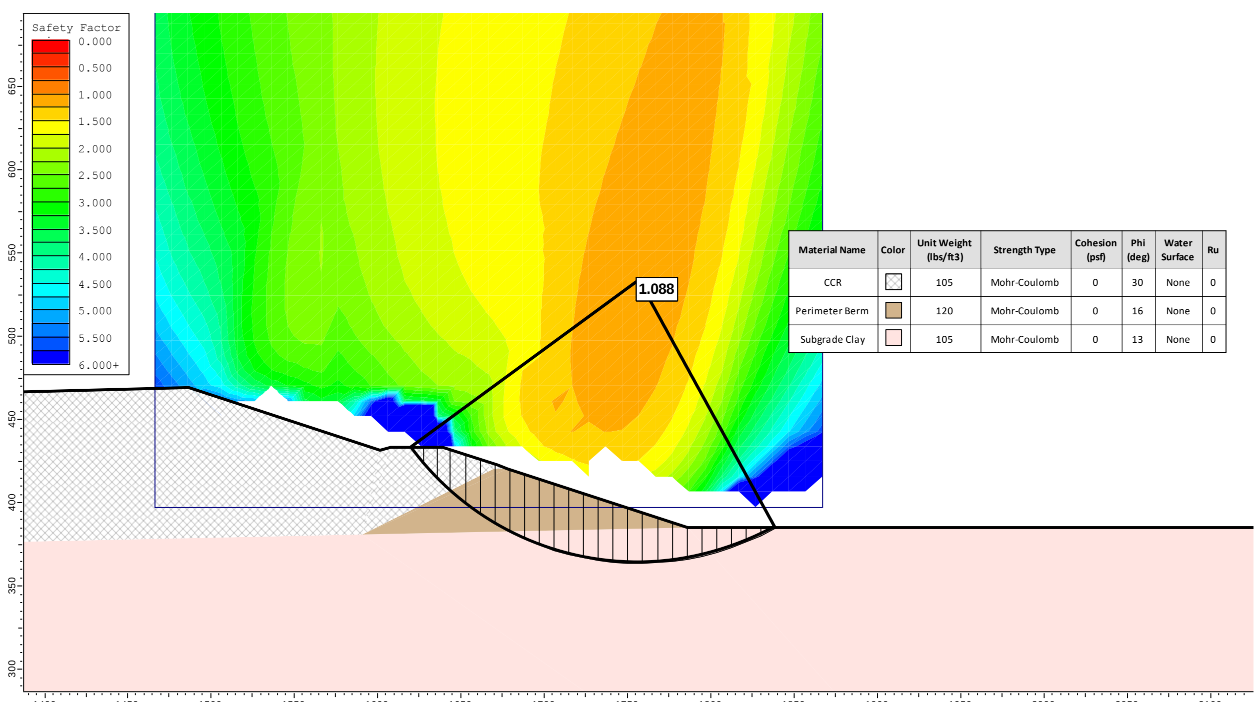
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
CCR		105	Mohr-Coulomb	0	30	None	0
Subgrade Clay		105	Mohr-Coulomb	0	13	None	0

Circular Slip Surface Through CCR Material (Residual Shear Strengths)



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
CCR		105	Mohr-Coulomb	0	30	None	0
Subgrade Clay		105	Infinite strength			None	0

Circular Slip Surface Through CCR Material and North Perimeter Berm (Residual Shear Strengths)



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
CCR		105	Mohr-Coulomb	0	30	None	0
Perimeter Berm		120	Mohr-Coulomb	0	16	None	0
Subgrade Clay		105	Mohr-Coulomb	0	13	None	0