Green Station CCR Surface Impoundment

Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule
Structural Integrity Criteria for Existing CCR Surface Impoundments
Periodic Safety Factor Assessment

October 11, 2021

Prepared By:

ASSOCIATED ENGINEERS, INC.
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Project ID: 210094

Big Rivers Electric Corporation
Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule
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Periodic Safety Factor Assessment

CCR Surface Impoundment Information

Name:	Green Station CCR Surface Impoundment
Operator:	Sebree Generating Station
Address:	9000 Highway 2096 Robards, Kentucky 42452
CCR Unit Identification Number:	Kentucky State Dam Inventory System ID No. 0980

Qualified Professional Engineer

Name:	David A. Lamb
Company:	Associated Engineers, Inc.
Kentucky P.E. Number:	17822

Regulatory Applicability

As part of the § 257.73 Structural integrity criteria for existing CCR surface impoundments requirements, an owner or operator of an existing CCR surface impoundment must no later than October 17, 2016:

> Conduct an initial and periodic safety factor assessment for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified below for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations, documenting whether the CCR unit achieves the following minimum factors of safety:
>
> 1. The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.
>
> 2. The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.
>
> 3. The calculated seismic factor of safety must equal or exceed 1.00.

4. For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

From: VI. Development of the Final Rule - Technical Requirements

General Safety Factor Assessment Considerations

Generally accepted engineering methodologies specify that the determination of the structural stability factors of safety specified above is to be calculated by the qualified professional engineer using conventional analysis procedures or, if necessary, special analysis procedures. Conventional analysis procedures include, but are not limited to, limit equilibrium methods of slope stability analysis, whereas, special analysis procedures include, but are not limited to, finite element methods, finite difference methods, three-dimensional methods, or probabilistic methods. Whichever methodology is used to determine the factors of safety of the CCR surface impoundment, the qualified professional engineer must document the methodology used, as well as the basis for using that methodology, and the analysis must be supported by appropriate engineering calculations.

The Calculated Static Factor of Safety Under the Long-Term, Maximum Storage Pool Loading Condition

It is generally accepted practice to analyze the stability of the downstream slope of the dam embankment for steady-state seepage (or steady seepage) conditions with the reservoir at its normal operating pool elevation (usually the spillway crest elevation) since this is the loading condition the embankment will experience most. This condition is called steady seepage with maximum storage pool. The maximum storage pool loading is the maximum water level that can be maintained that will result in the full development of a steady-state seepage condition. Maximum storage pool loading conditions need to be calculated to ensure that the CCR surface impoundment can withstand a maximum expected pool elevation with full development of saturation in the embankment under long-term loading. The final rule requires that the calculated static factor of safety for the critical cross section of the CCR surface impoundment under the long-term maximum storage pool loading condition meet or exceed 1.5.

The Calculated Static Factor of Safety Under the Maximum Surcharge Pool Loading Condition

The maximum surcharge pool loading condition is calculated to evaluate the effect of a raised level (e.g., flood surcharge) on the stability of the downstream slope. This ensures that the CCR surface impoundment can withstand a temporary rise in pool elevation above the maximum storage pool elevation for which the CCR surface impoundment may normally be subject under inflow design flood stage, for a short-term until the inflow design flood is passed through the CCR surface impoundment. The final rule requires that the calculated static factor of safety for the critical cross section of the CCR surface impoundment under the long-term maximum surcharge pool loading condition meet or exceed 1.4.

The Calculated Seismic Factor of Safety

All CCR surface impoundments, including any lateral expansions that exceed the size threshold must meet a seismic factor of safety equal to or greater than 1.0. All CCR surface impoundments must also be capable of withstanding a design earthquake without damage to

the foundation or embankment that would cause a discharge of its contents. To further support the location criteria established in this rule, CCR surface impoundments and any lateral expansion exceeding a specific height and/or volume threshold must be assessed under seismic loading conditions for a seismic loading event with a 2% probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years, based on the USGS seismic hazard maps for seismic events with this return period for the region where the CCR unit is located. EPA chose the 2% exceedance probability in 50 years event based on its common use in seismic design criteria throughout engineering.

The Calculated Liquefaction Factor of Safety

All CCR surface impoundments, including any lateral expansions that exceed the size threshold and have been determined to contain soils susceptible to liquefaction must meet a liquefaction factor of safety equal to or greater than 1.20. A prudent engineering analysis of structural stability also includes a liquefaction potential analysis and analysis of post-liquefaction static factors of safety. As discussed previously, liquefaction is a phenomenon which typically occurs in loose, saturated or partially-saturated soils in which the effective stress of the soils reduces to zero, corresponding to a total loss of shear strength of the soil. The most common occurrence of liquefaction is in loose soils, typically sands. The liquefaction FOS determination in the final rule is used to determine if a CCR unit would remain stable if the soils of the embankment of the CCR unit were to experience liquefaction. Liquefaction analysis is only necessary in instances where CCR surface impoundments show, through representative soil sampling, construction documentation, or anecdotal evidence from personnel with knowledge of the CCR unit's construction, that soils of the embankment are susceptible to liquefaction.

Failure To Demonstrate Minimum Safety Factors or Failure To Complete a Timely Safety Factor Assessment

As previously discussed, the rule requires an owner or operator to document that the calculated factors of safety for each CCR surface impoundment achieve the minimum safety factors specified in the rule. For any CCR surface impoundment that does not meet these requirements, the owner or operator must either take any engineering measure necessary to ensure that the unit meets the requirements by the rule's deadlines, or cease placement of CCR and non-CCR waste into the unit and initiate closure of such CCR unit as provided in section 257.102 within six months. Similarly, if an owner or operator fails to complete the initial safety factor assessment or any subsequent periodic factor safety assessment by the deadlines established in the rule, the owner or operator must cease placing CCR and non-CCR waste into the unit and initiate closure within six months.

Description of Impoundment

An aerial photo of the CCR unit is provided as Attachment A and an excerpt from U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps showing the location of the CCR unit is provided as Attachment B.
The CCR unit has been in place for 40 plus years The CCR unit operator has general

maintenance and repair procedures in place as they determine necessary. There are no known occurrences of structural instability of the CCR unit.

The CCR unit has been in place for 40 plus years. The CCR unit is used for the placement of coal combustion residual material; currently slurried bottom ash. The immediate watershed that drains to the CCR unit, and in which the CCR unit is considered to be located, is unnamed and 54.13 acres in size. The unnamed watershed discharges from the CCR impoundment outflow structure and is routed to the Green River.

The CCR unit is a combined incised/earthen embankment structure. Embankments form the west, south and east sides of the impoundment and the north side is incised. The Green River is located approximately 400 feet east of the structure. Due to surface relief, only the toe area of the south dike is potentially subject to flooding. The predominant features were small stream valleys draining eastward to the Green River. Most of the central portion of the south dike was constructed on a subdued ridge. The toe of the outboard slope intersected a lower drainage area. Underlying preconstruction soils consisted of Loring-Grenada, Loring-Zanesville-Wellston (Henderson County) and Loring-Wellston-Zanesville (Webster County) soil associations which are generally characterized as well drained to moderately well drained soils on nearly level to sloping uplands.

The west dike is generally less than five feet in height and the south dike reaches a maximum height of 19.5 feet. The east dike reaches a maximum height of approximately eight feet and is buttressed with a secondary parallel embankment that serves as a 40-foot wide roadway. The Burns and Roe, Inc. Engineering and Consultants June 30, 1978 site grading plans show the original construction layout and ground contours for the impoundment site. Bottom ash has been placed above the normal pool along the inboard side, essentially creating reclaimed land

Depth of impounded water and CCR is 6 feet and 60 feet (at respective locations of maximum impounded water and CCR depths). Elevation of impounded water and CCR is 391.8 feet and 420 feet, respectively, above mean sea level. These approximate depths and respective elevations are based on the most recent (September 2021) aerial LiDAR derived topographic contours and bathymetric survey data.

The remaining storage capacity is approximately 86,750 cubic yards (if CCR can be placed to the spillway elevation of 393.8) (includes CCR material above the impoundment pool elevation) . This volume was calculated based on the maximum allowable storage volume and the current volume of CCR stored in the facility based on the most recent bathymetric survey.

The approximate volume of impounded water and CCR is 990,722 cubic yards (approximate water volume is 101,307 cubic yards and approximate CCR volume is 889,415 cubic yards). This volume was calculated based on the maximum storage capacity, the current amount of CCR stored in the facility based on the most recent bathymetric survey, and the best available as-built data for the structure construction prior to placement of CCR (includes CCR material above the impoundment pool elevation).

The impoundment discharge consists of two corrugated steel pipes, each 30 inches in diameter. The pipe intakes are through a concrete common headwall collection structure with a variable height steel debris deflector on each pipe intake.

Calculated Safety Factors

Results of the initial safety factor assessment for the critical cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments are supported by appropriate engineering calculations.

The safety factor analysis was conducted using the Rocscience Inc. Slide geotechnical software by evaluating four cross sections along the embankment. Slide provides numerical tools to analyze the stability of embankments using limit equilibrium methods. At each cross section, drilling, surveying, laboratory testing, and a slope stability analysis were performed. Based on the four analysis scenarios, the lowest factor of safety for all scenarios was not found at a single cross section; therefore, the results listed below are the lowest factor of safety realized from all analyzed cross sections for each scenario. The safety factor assessments are supported by appropriate engineering calculations and the Slide modeling results for the Green CCR impoundment are attached to this report. This analysis was performed under my review as a part of the Initial Safety Factor Assessment. I have reviewed the data, reports and inspected the facility and have found the data presented to be representative of the current facility condition and therefore suitable for the Periodic Safety Factor Review.

1. The calculated static factor of safety under the long-term, maximum storage pool loading condition equals: 1.800

2. The calculated static factor of safety under the maximum surcharge pool loading condition equals: 1.800

3. The calculated seismic factor of safety equals: 1.002

4. For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety equals: 1.800

Sources of Information

Geotechnical and other information provided by Associated Engineers, Inc.

Engineering design drawings and other information provided by Big Rivers Electric Corporation

United States Geological Survey U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps

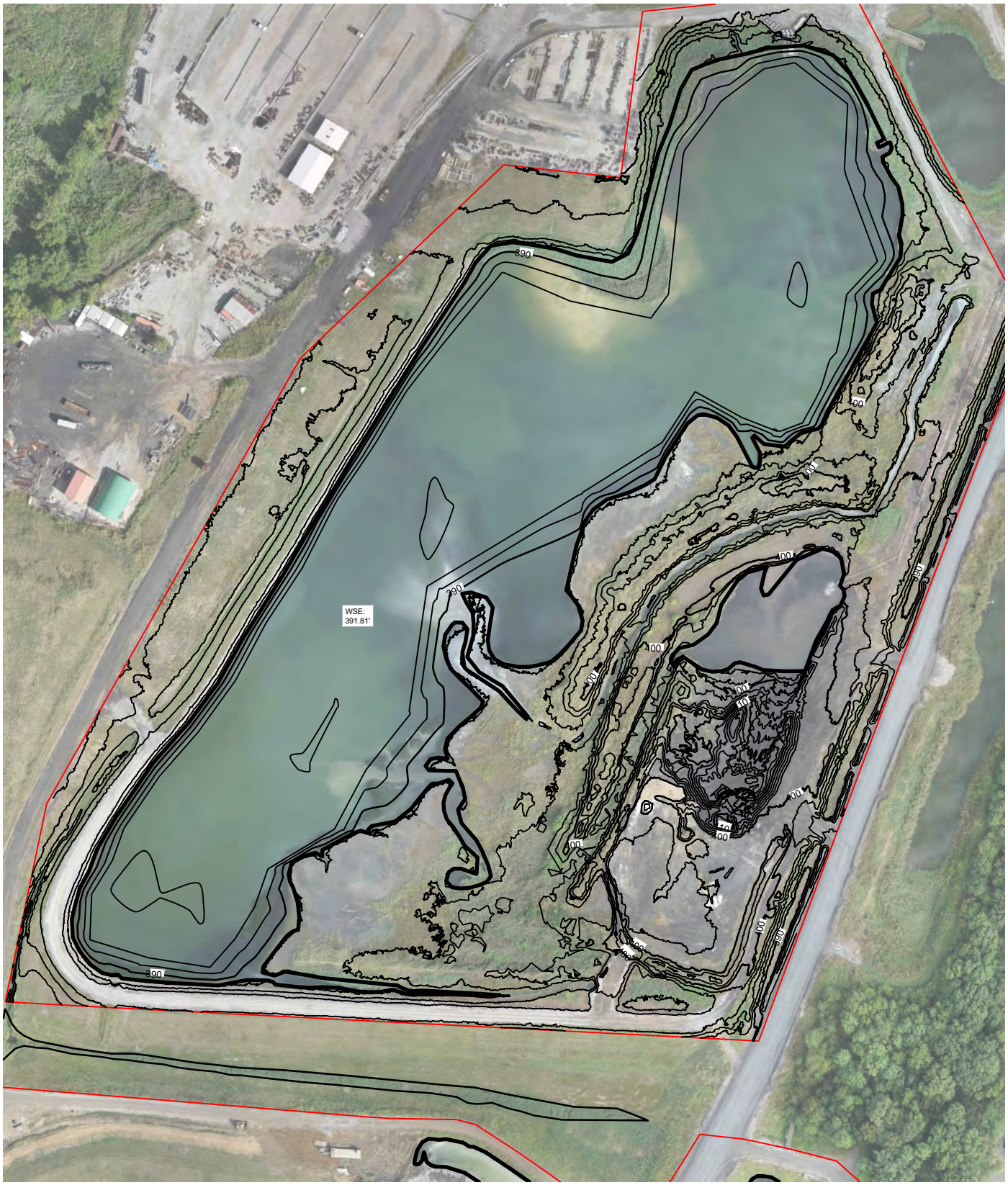
Professional Engineer Certification [Per 40 CFR § 257.73]
Green CCR Impoundment Periodic Safety Factor Assessment

I hereby certify that myself or an agent under my review has prepared this Periodic Safety Factor Assessment (Assessment), and being familiar with the provisions of the final rule to regulate the disposal of coal combustion residuals (CCR) as solid waste under subtitle D of the Resource Conservation and Recovery Act (RCRA), attest that this Assessment has been prepared in accordance with good engineering practices and meets the intent of 40 CFR Part 257.73. To the best of my knowledge and belief, the information contained in this Assessment is true, complete, and accurate.

David A. Lamb P.E.

State of Kentucky License No. 17822

Date: 10/11/21



BIG RIVERS ELECTRIC

Green CCR Surface Impoundment
Attachment A: Aerial

Job Number:	21-0096
Date:	10/06/2021
Scale:	1"=200'
Drawn By:	STAFF

Revisions:

ASSOCIATED ENGINEERS, INC.
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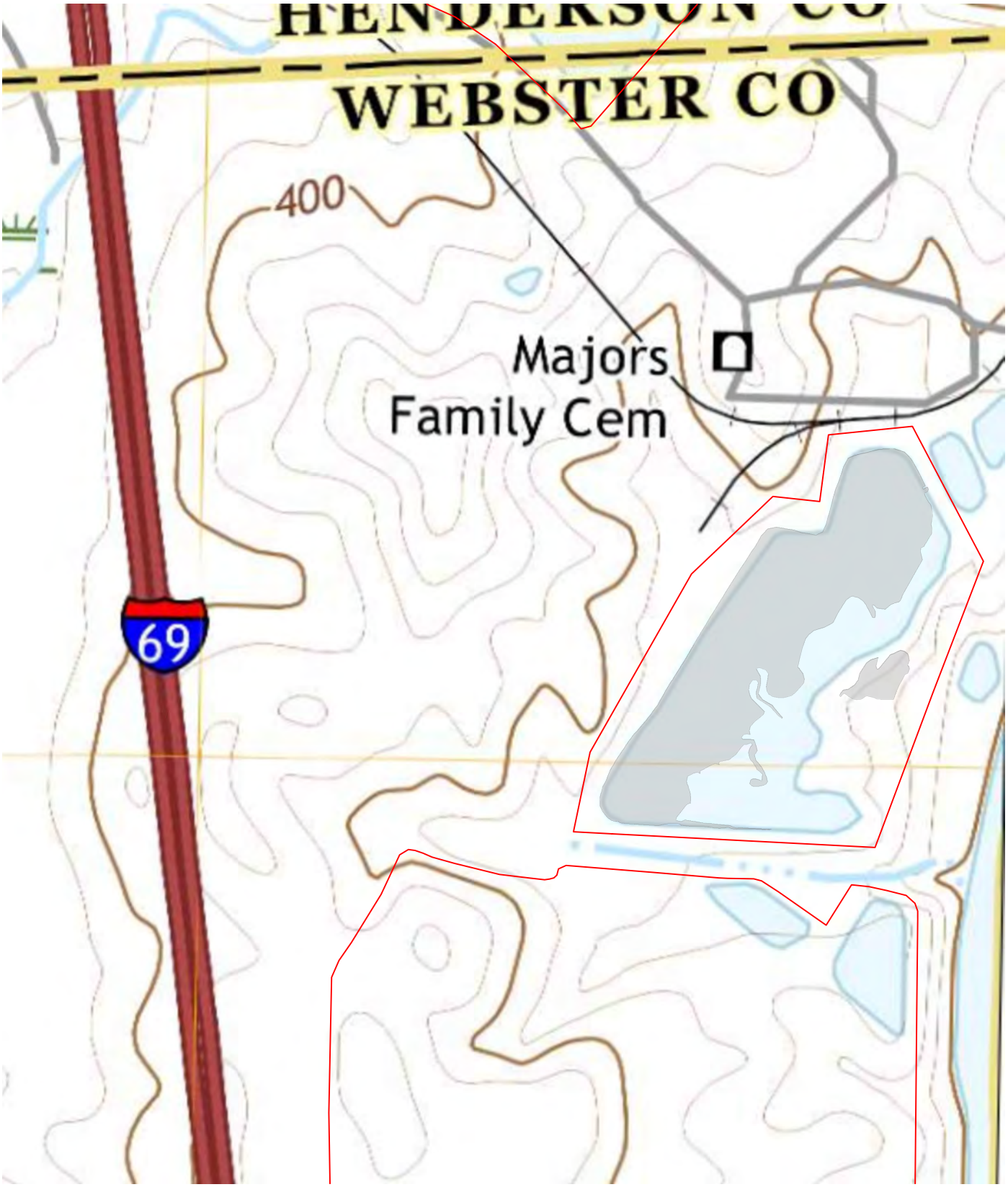

BIG RIVERS ELECTRIC

Green CCR Surface Impoundment
Attachment B: Topographic Map

Job Number:	21-0096
Date:	10/06/2021
Scale:	1"=500'
Drawn By:	STAFF

Revisions:

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Slide Analysis Information

BREC Green Station CCR Surface Impoundment

Project Summary

File Name: GR-1
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-1 Long-Term Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc
Date Created: 9/5/2016, 3:43:18 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Sandy Lean Clay (CL)	Clayey Sand (SC)	Lean Clay (CL)	Sandy Lean Clay With Gravel (CL) (Dam)
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	128.1	134.3	135.4	137.69
Cohesion [psf]	316.8	403.2	820.8	72
Friction Angle [deg]	24.3	30.2	24.6	27.4
Water Surface	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1

List Of Coordinates

Water Table

X	Y
0	379.185
31.955	379.172
36.551	377.695
50.832	376.221
54.305	375.6
58.684	376.406
70.171	377.906
76.996	378.317
84.12	378.983

85.7592	379.391
140.9	382.48
170.48	393.92

External Boundary

X	Y
0	349.5
55	349.6
77	352.7
153.14	361.4
170.48	362.8
170.48	366.698
170.48	369.698
170.48	374.816
170.48	376.396
170.48	393.967
161.556	396.809
153.137	396.9
143.057	396.719
119.757	389.859
96.35	382.029
84.12	378.983
76.996	378.317
70.171	377.906
58.684	376.406
54.305	375.6
50.832	376.221
36.551	377.695
20.651	382.805
0	391.212
0	374.3
0	355.7
0	353.7

Material Boundary

X	Y
0	353.7
55	353.7
77	356.8
153	364.9

170.48	366.698

Material Boundary

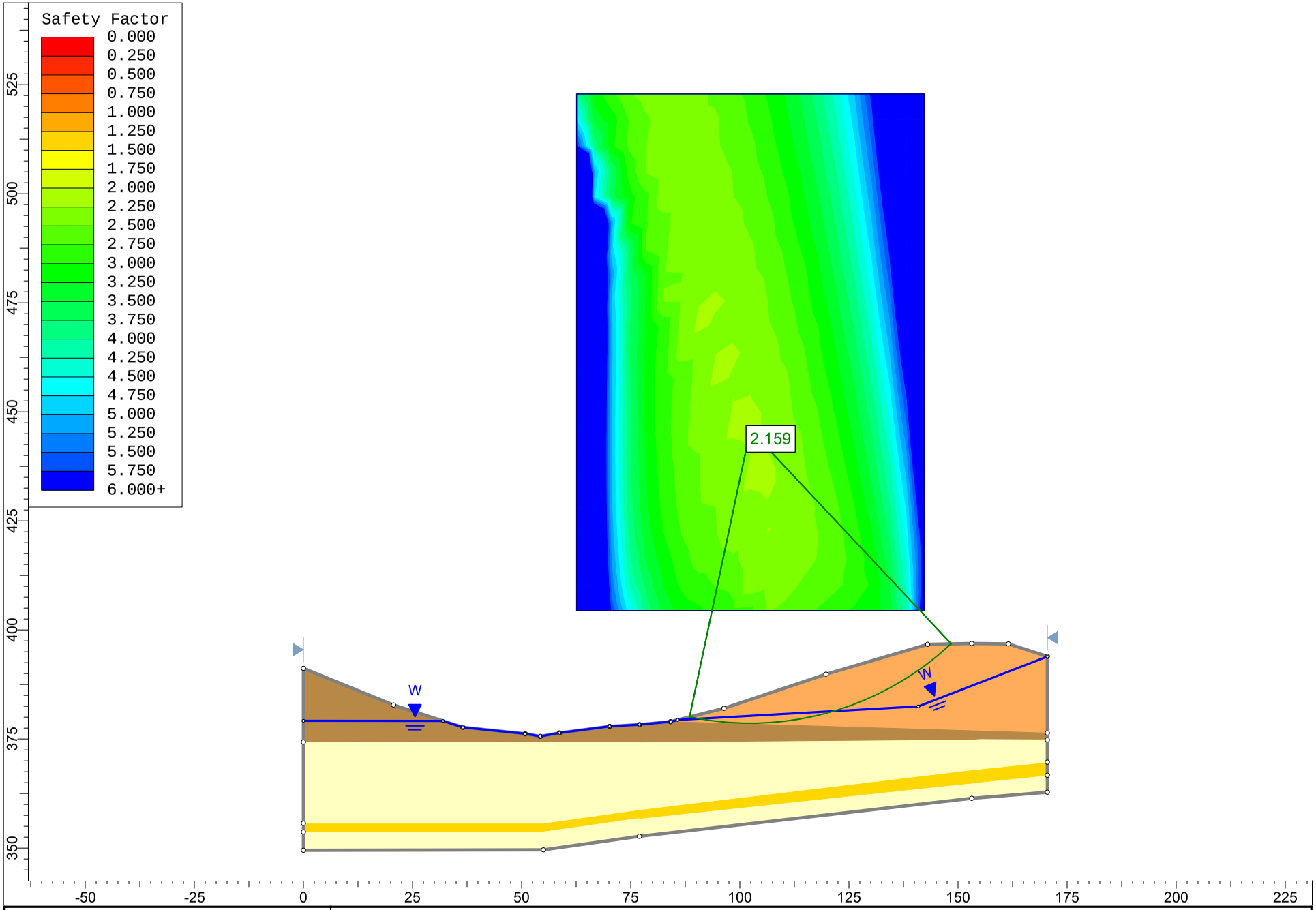
X	Y
0	355.7
55	355.7
77	358.8
153	367.9
170.48	369.698

Material Boundary

X	Y
0	374.3
77	374.3
153	374.9
170.48	374.816

Material Boundary

X	Y
84.12	378.983
153	376.9
170.48	376.396



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	Drawn By	Scale 1:360	Company Associated Engineers, Inc
	Date 9/5/2016, 3:43:18 PM		File Name GR-1.slim

Slide Analysis Information

BREC Green Station CCR Surface Impoundment

Project Summary

File Name: GR-1 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-1 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc
Date Created: 9/5/2016, 3:43:18 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Sandy Lean Clay (CL)	Clayey Sand (SC)	Lean clay (CL)	Sandy lean clay With Gravel (CL) (Dam)
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	128.1	134.3	135.4	137.69
Cohesion [psf]	316.8	403.2	820.8	72
Friction Angle [deg]	24.3	30.2	24.6	27.4
Water Surface	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1

List Of Coordinates

Water Table

X	Y
0	379.185
31.955	379.172
36.551	377.695
50.832	376.221
54.305	375.6
58.684	376.406
70.171	377.906
76.996	378.317
84.12	378.983

85.7592	379.391
140.9	382.48
165.719	395.483
170.48	395.48

External Boundary

X	Y
0	349.5
55	349.6
77	352.7
153.14	361.4
170.48	362.8
170.48	366.698
170.48	369.698
170.48	374.816
170.48	376.396
170.48	393.967
161.556	396.809
153.137	396.9
143.057	396.719
119.757	389.859
96.35	382.029
84.12	378.983
76.996	378.317
70.171	377.906
58.684	376.406
54.305	375.6
50.832	376.221
36.551	377.695
20.651	382.805
0	391.212
0	374.3
0	355.7
0	353.7

Material Boundary

X	Y
0	353.7
55	353.7
77	356.8

153	364.9
170.48	366.698

Material Boundary

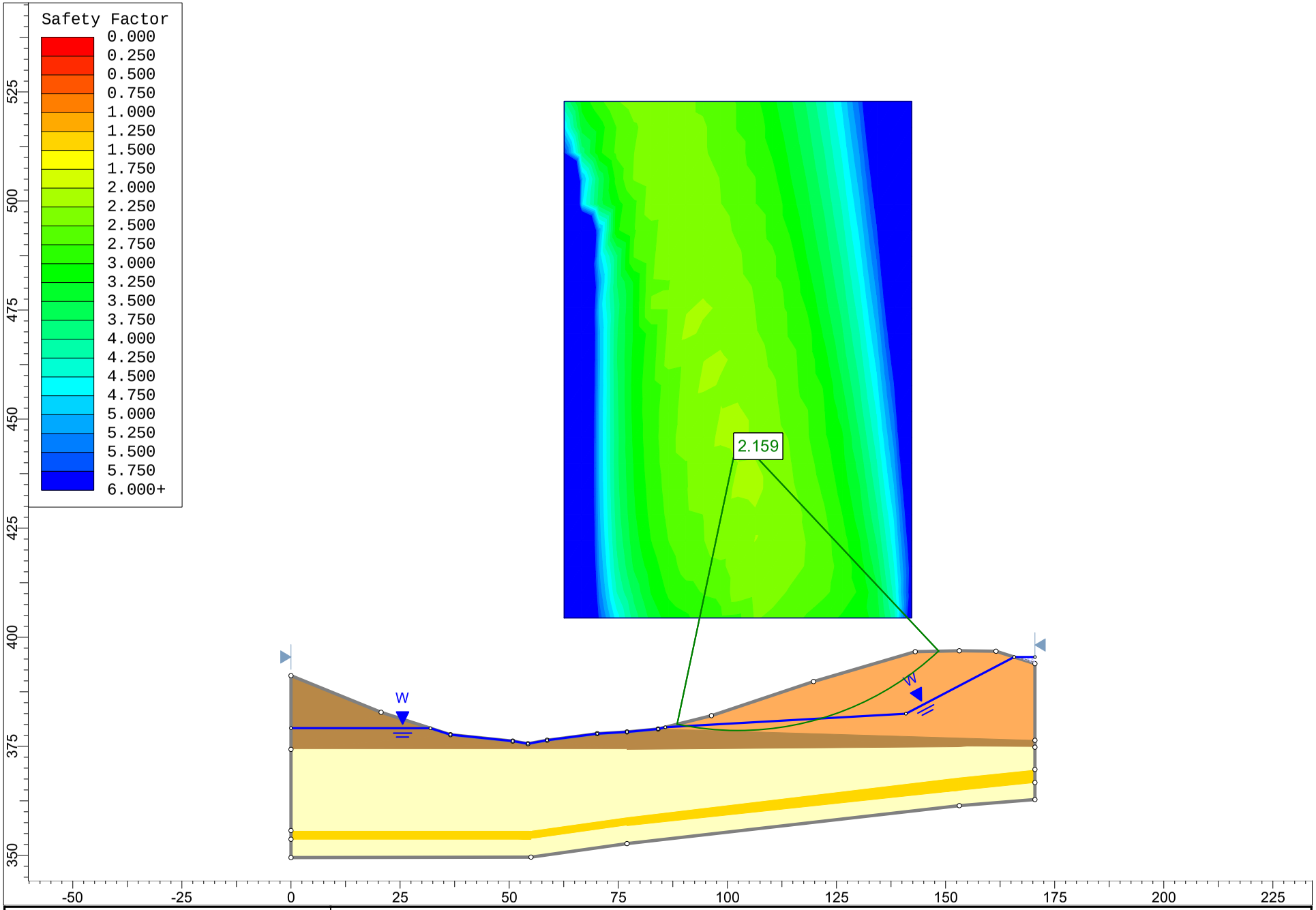
X	Y
0	355.7
55	355.7
77	358.8
153	367.9
170.48	369.698

Material Boundary

X	Y
0	374.3
77	374.3
153	374.9
170.48	374.816

Material Boundary

X	Y
84.12	378.983
153	376.9
170.48	376.396



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	Drawn By	Scale 1:360	Company Associated Engineers, Inc
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Slide Analysis Information

BREC Green Station CCR Surface Impoundment

Project Summary

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Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-1 Seismic Loading Condition
Company: Associated Engineers, Inc
Date Created: 9/5/2016, 3:43:18 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

Seismic Load Coefficient (Horizontal): 0.2364

Material Properties

Property	Sandy Lean Clay (CL)	Clayey Sand (SC)	Lean clay (CL)	Sandy Lean Clay With Gravel (CL) (Dam)
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	128.1	134.3	135.4	137.69
Cohesion [psf]	316.8	403.2	820.8	72
Friction Angle [deg]	24.3	30.2	24.6	27.4
Water Surface	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1

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54.305	375.6

58.684	376.406
70.171	377.906
76.996	378.317
84.12	378.983
85.7592	379.391
140.9	382.48
170.48	393.92

External Boundary

X	Y
0	349.5
55	349.6
77	352.7
153.14	361.4
170.48	362.8
170.48	366.698
170.48	369.698
170.48	374.816
170.48	376.396
170.48	393.967
161.556	396.809
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76.996	378.317
70.171	377.906
58.684	376.406
54.305	375.6
50.832	376.221
36.551	377.695
20.651	382.805
0	391.212
0	374.3
0	355.7
0	353.7

Material Boundary

X	Y

0	353.7
55	353.7
77	356.8
153	364.9
170.48	366.698

Material Boundary

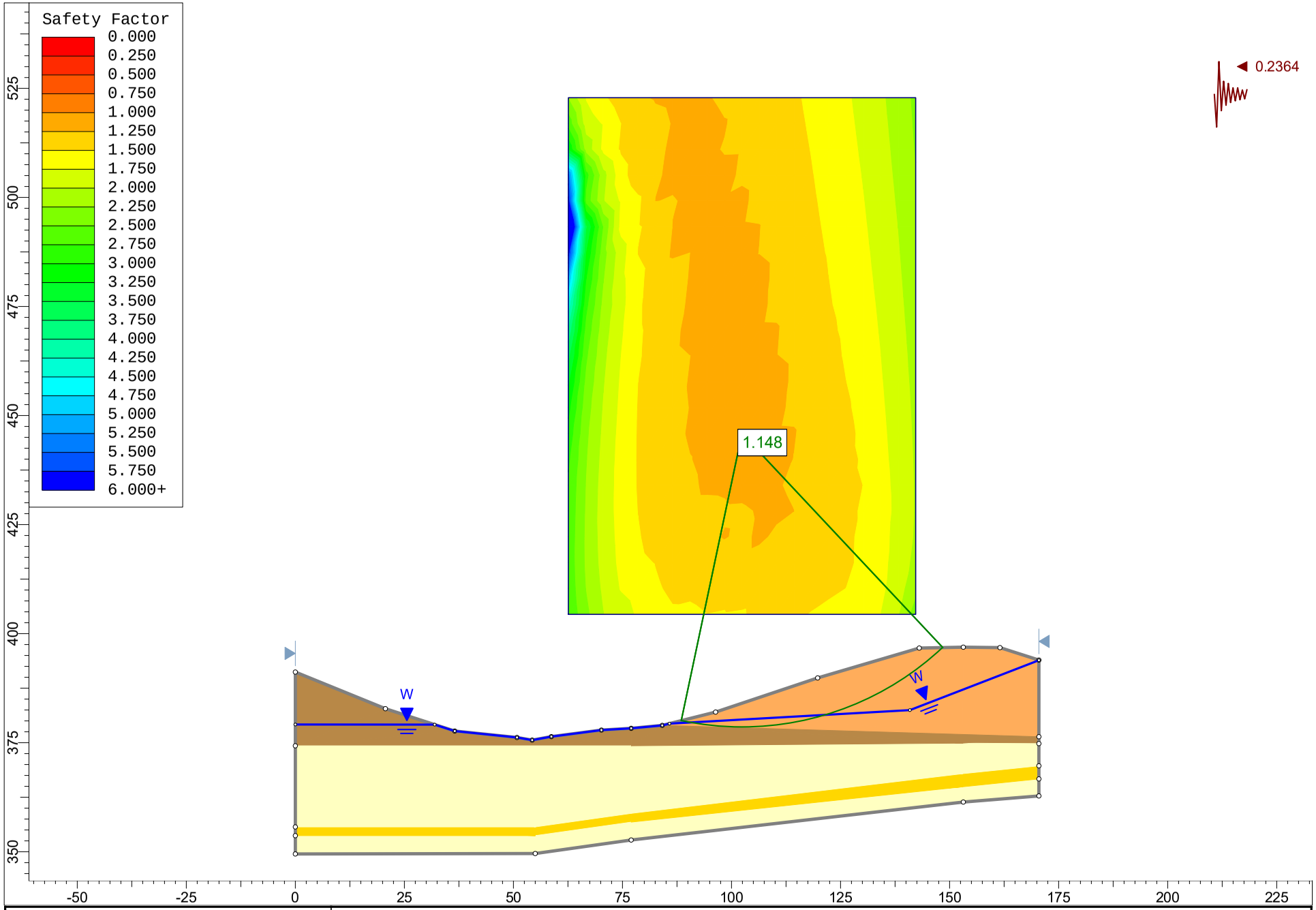
X	Y
0	355.7
55	355.7
77	358.8
153	367.9
170.48	369.698

Material Boundary

X	Y
0	374.3
77	374.3
153	374.9
170.48	374.816

Material Boundary

X	Y
84.12	378.983
153	376.9
170.48	376.396



rocscience	Project	BREC Green Station CCR Surface Impoundment		
	Analysis Description	Cross Section GR-1 Seismic Loading Condition		
	Drawn By		Scale 1:360	Company Associated Engineers, Inc
	Date	9/5/2016, 3:43:18 PM		File Name GR-1 Seis.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

BREC Green Station CCR Surface Impoundment

Project Summary

File Name: GR-2
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Sandy Lean Clay (CL)	Poorly Graded Sand With Silt (SP-SM)	Lean Clay with Sand (CL)	Lean clay (CL)	Lean Clay With Sand 2	Lean clay With Sand (Dam)
Color						
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	128.1	126	131.9	135.4	126.6	140.6
Cohesion [psf]	316.8	0	374	820.8	0	72
Friction Angle [deg]	24.3	33	27.7	24.6	30.8	24.1
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1

List Of Coordinates

Water Table

X	Y
0	373.571
10.818	375.37
27.54	376.571
42.515	377.335
44.31	377.146
48.515	378.327
102.8	382.2

128.457	393.92
130	393.92

External Boundary

X	Y
3.298e-013	348.3
7.98633	347.116
42.51	342
112.29	334.7
130	331.5
130	338
130	343
130	351.773
130	382.006
130	382.1
130	393.439
119.451	396.731
112.288	397.189
101.806	396.285
83.858	389.332
67.857	383.758
44.31	377.146
42.515	377.335
27.54	376.571
10.818	375.37
8.27071	374.946
0	373.571
0	371.3
0	363
0	359
3.10558e-013	349.774

Material Boundary

X	Y
7.98633	347.116
42.5	344.8
112.2	340
130	338

Material Boundary

X	Y
3.10558e-013	349.774
42.5	347.3
79	345.5
112.2	344.7
130	343

Material Boundary

X	Y
0	359
42.5	353.3
79	345.5

Material Boundary

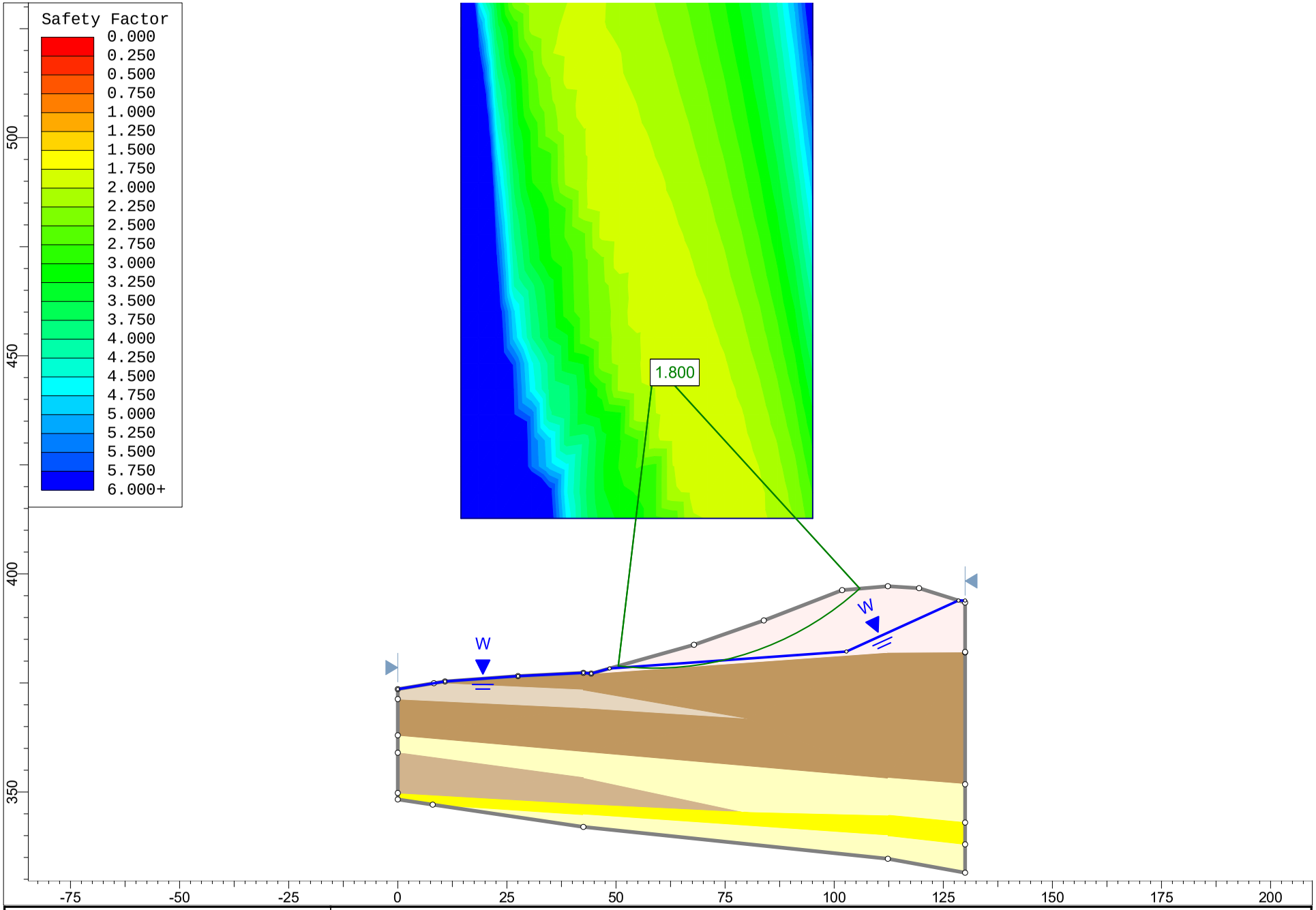
X	Y
0	363
42.5	359.3
112.2	353.2
130	351.773

Material Boundary

X	Y
0	371.3
42.5	369.3
80	366.9
42.5	373.4
8.27071	374.946

Material Boundary

X	Y
44.31	377.146
112.2	382
130	382.1



Project	BREC Green Station CCR Surface Impoundment		
Analysis Description	Cross Section GR-2 Maximum Storage Pool Loading Condition		
Drawn By		Scale 1:360	Company Associated Engineers, Inc.
Date	9/5/2016, 3:56:57 PM		File Name GR-2.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

BREC Green Station CCR Surface Impoundment

Project Summary

File Name: GR-2 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Sandy Lean Clay (CL)	Poorly Graded Sand With Silt (SP-SM)	Lean Clay with Sand (CL)	Lean clay (CL)	Lean Clay With Sand 2	Lean clay With Sand (Dam)
Color						
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	128.1	126	131.9	135.4	126.6	140.6
Cohesion [psf]	316.8	0	374	820.8	0	72
Friction Angle [deg]	24.3	33	27.7	24.6	30.8	24.1
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1

List Of Coordinates

Water Table

X	Y
0	373.571
10.818	375.37
27.54	376.571
42.515	377.335
44.31	377.146
48.515	378.327
102.8	382.2

123.45	395.483
130	395.48

External Boundary

X	Y
3.298e-013	348.3
7.98633	347.116
42.51	342
112.29	334.7
130	331.5
130	338
130	343
130	351.773
130	382.006
130	382.1
130	393.439
119.451	396.731
112.288	397.189
101.806	396.285
83.858	389.332
67.857	383.758
44.31	377.146
42.515	377.335
27.54	376.571
10.818	375.37
8.27071	374.946
0	373.571
0	371.3
0	363
0	359
3.10558e-013	349.774

Material Boundary

X	Y
7.98633	347.116
42.5	344.8
112.2	340
130	338

Material Boundary

X	Y
3.10558e-013	349.774
42.5	347.3
79	345.5
112.2	344.7
130	343

Material Boundary

X	Y
0	359
42.5	353.3
79	345.5

Material Boundary

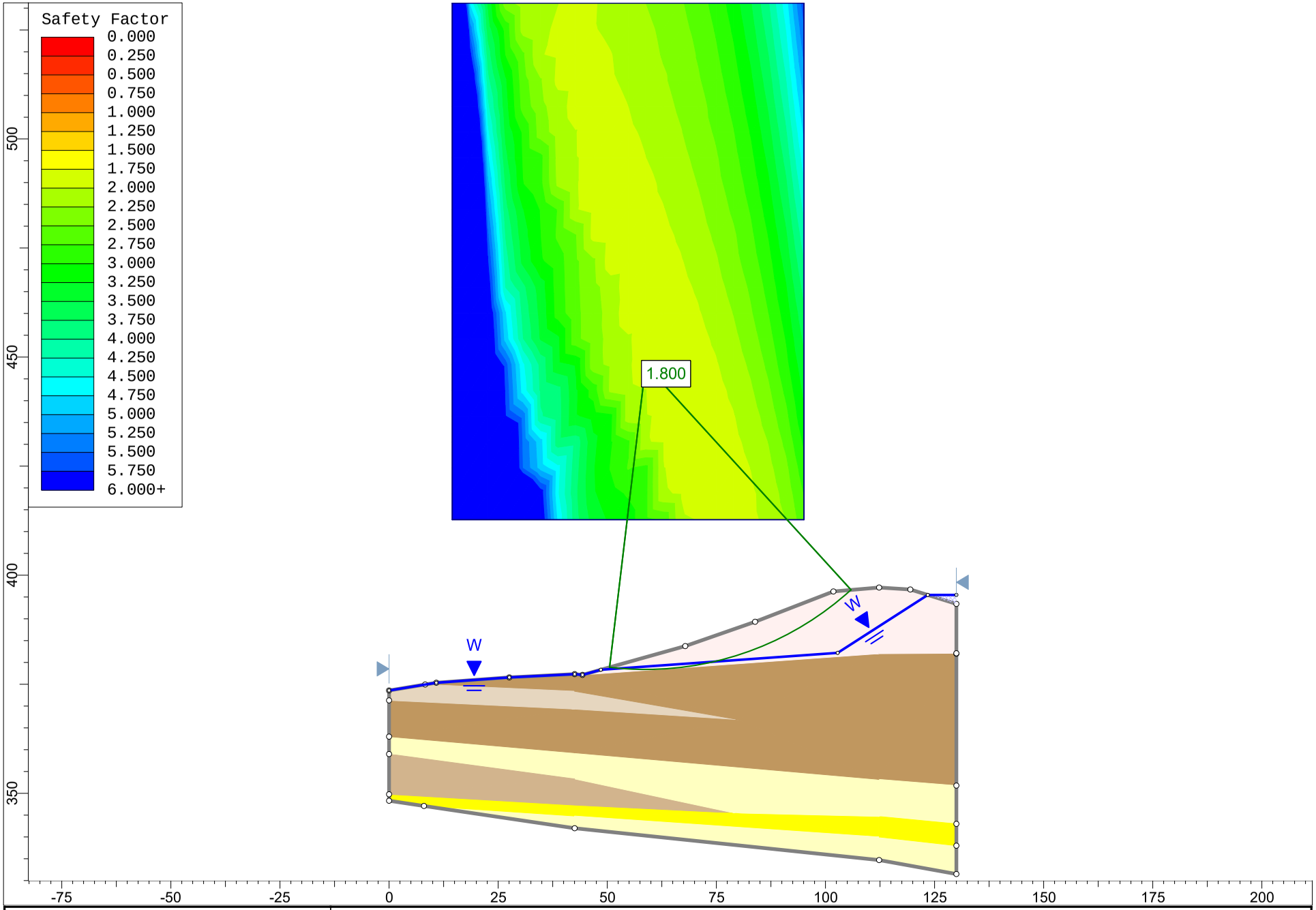
X	Y
0	363
42.5	359.3
112.2	353.2
130	351.773

Material Boundary

X	Y
0	371.3
42.5	369.3
80	366.9
42.5	373.4
8.27071	374.946

Material Boundary

X	Y
44.31	377.146
112.2	382
130	382.1



Project	BREC Green Station CCR Surface Impoundment		
Analysis Description	Cross Section GR-2 Maximum Surcharge Pool Loading Condition		
Drawn By		Scale 1:360	Company Associated Engineers, Inc.
Date	9/5/2016, 3:56:57 PM		File Name GR-2 Surcharge.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

BREC Green Station CCR Surface Impoundment

Project Summary

File Name: GR-2 Seis 2
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Seismic Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

Seismic Load Coefficient (Horizontal): 0.2364

Material Properties

Property	Sandy Lean Clay (CL)	Poorly Graded Sand With Silt (SP-SM)	Lean Clay with Sand (CL)	Lean clay (CL)	Lean Clay With Sand 2	Lean clay With Sand (Dam)
Color						
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	128.1	126	131.9	135.4	126.6	140.6
Cohesion [psf]	316.8	0	374	820.8	0	72
Friction Angle [deg]	24.3	33	27.7	24.6	30.8	24.1
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1

List Of Coordinates

Water Table

X	Y
0	373.571
10.818	375.37

27.54	376.571
42.515	377.335
44.31	377.146
48.515	378.327
102.8	382.2
128.457	393.92
130	393.92

External Boundary

X	Y
3.298e-013	348.3
7.98633	347.116
42.51	342
112.29	334.7
130	331.5
130	338
130	343
130	351.773
130	382.006
130	382.1
130	393.439
119.451	396.731
112.288	397.189
101.806	396.285
83.858	389.332
67.857	383.758
44.31	377.146
42.515	377.335
27.54	376.571
10.818	375.37
8.27071	374.946
0	373.571
0	371.3
0	363
0	359
3.10558e-013	349.774

Material Boundary

X	Y
7.98633	347.116

42.5	344.8
112.2	340
130	338

Material Boundary

X	Y
3.10558e-013	349.774
42.5	347.3
79	345.5
112.2	344.7
130	343

Material Boundary

X	Y
0	359
42.5	353.3
79	345.5

Material Boundary

X	Y
0	363
42.5	359.3
112.2	353.2
130	351.773

Material Boundary

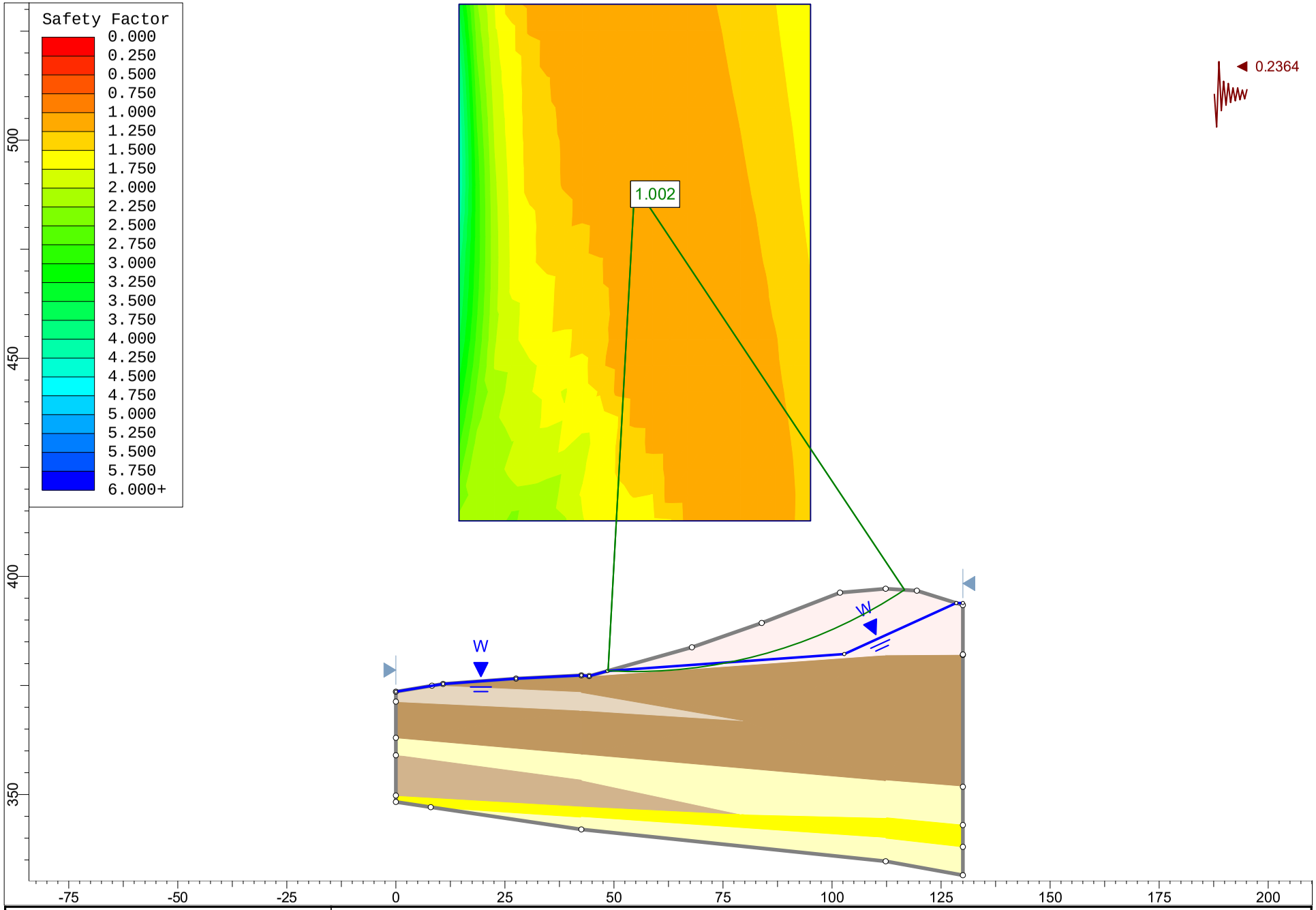
X	Y
0	371.3
42.5	369.3
80	366.9
42.5	373.4
8.27071	374.946

Material Boundary

X	Y
44.31	377.146
112.2	382
130	382.1

rocscience	Project: BREC Green Station CCR Surface Impoundment		
	Analysis Description: Cross Section GR-2 Seismic Loading Condition		
	Drawn By:	Scale:	Company: Associated Engineers, Inc.
	Date: 9/5/2016, 3:56:57 PM		File Name: GR-2 Seis 2.slim

SLIDE 6.039



Project	BREC Green Station CCR Surface Impoundment		
Analysis Description	Cross Section GR-2 Seismic Loading Condition		
Drawn By		Scale 1:360	Company Associated Engineers, Inc.
Date	9/5/2016, 3:56:57 PM		File Name GR-2 Seis 2.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

BREC Green Station CCR Surface Impoundment

Project Summary

File Name: GR-2 Liq
Last saved with Slide version: 6.039
Project Title: BREC Green Station CCR Surface Impoundment
Analysis: Cross Section GR-2 Liquefaction Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:56:57 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Sandy Lean Clay (CL)	Poorly Graded Sand With Silt (SP-SM)	Lean Clay with Sand (CL)	Lean clay (CL)	Lean Clay With Sand 2	Lean clay With Sand (Dam)
Color						
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	128.1	126	131.9	135.4	126.6	140.6
Cohesion [psf]	316.8	0	374	820.8	0	72
Friction Angle [deg]	24.3	0	27.7	24.6	30.8	24.1
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1

List Of Coordinates

Water Table

X	Y
0	373.571
10.818	375.37
27.54	376.571
42.515	377.335
44.31	377.146
48.515	378.327
102.8	382.2

128.457	393.92
130	393.92

External Boundary

X	Y
3.298e-013	348.3
7.98633	347.116
42.51	342
112.29	334.7
130	331.5
130	338
130	343
130	351.773
130	382.006
130	382.1
130	393.439
119.451	396.731
112.288	397.189
101.806	396.285
83.858	389.332
67.857	383.758
44.31	377.146
42.515	377.335
27.54	376.571
10.818	375.37
8.27071	374.946
0	373.571
0	371.3
0	363
0	359
3.10558e-013	349.774

Material Boundary

X	Y
7.98633	347.116
42.5	344.8
112.2	340
130	338

Material Boundary

X	Y
3.10558e-013	349.774
42.5	347.3
79	345.5
112.2	344.7
130	343

Material Boundary

X	Y
0	359
42.5	353.3
79	345.5

Material Boundary

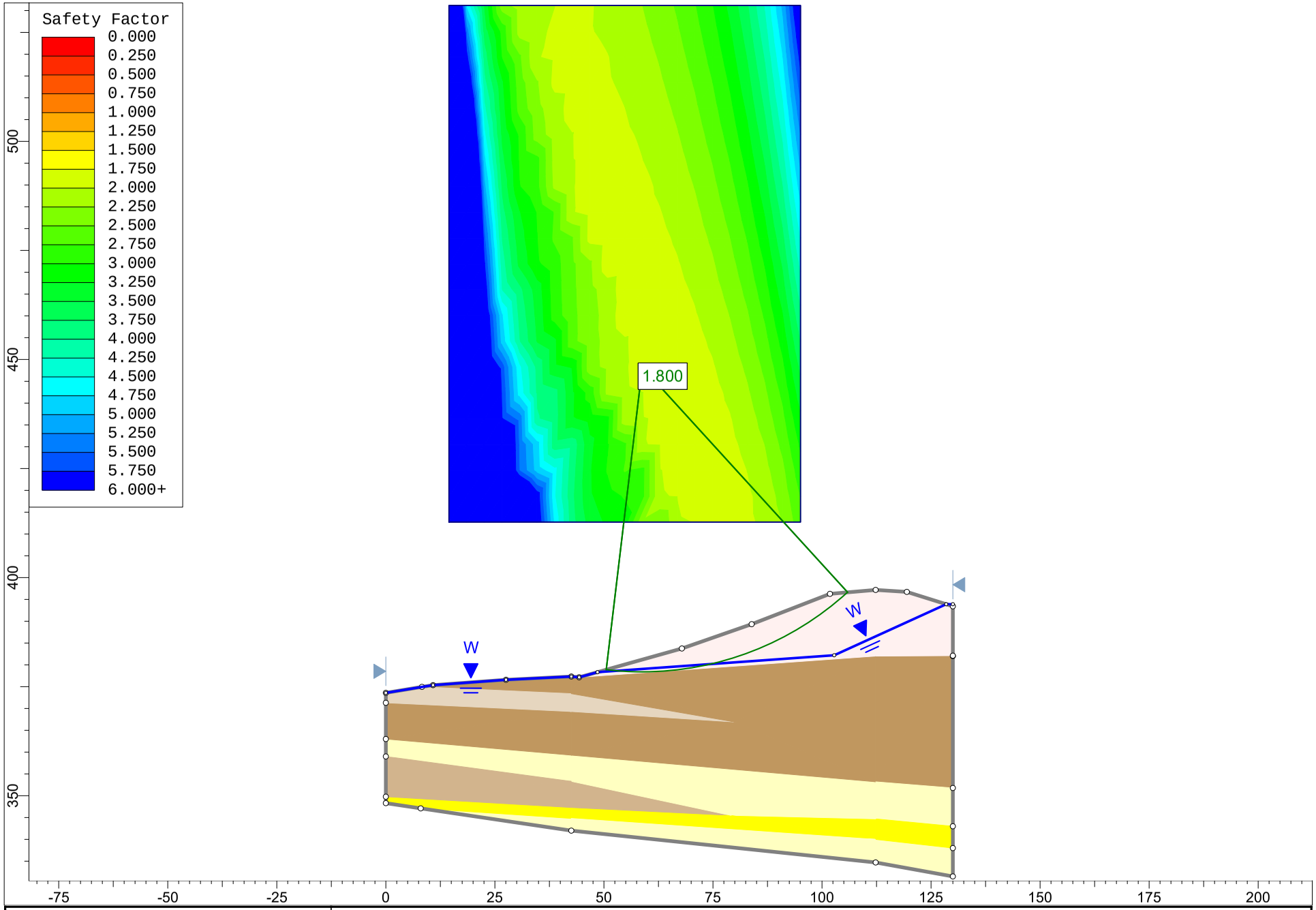
X	Y
0	363
42.5	359.3
112.2	353.2
130	351.773

Material Boundary

X	Y
0	371.3
42.5	369.3
80	366.9
42.5	373.4
8.27071	374.946

Material Boundary

X	Y
44.31	377.146
112.2	382
130	382.1



Project	BREC Green Station CCR Surface Impoundment		
Analysis Description	Cross Section GR-2 Liquefaction Condition		
Drawn By		Scale 1:360	Company Associated Engineers, Inc.
Date	9/5/2016, 3:56:57 PM		File Name GR-2 Liq.slim

SLIDEINTERPRET 6.039

Reid/HMPL Station CCR Surface Impoundment

Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule
Structural Integrity Criteria for Existing CCR Surface Impoundments
Periodic Safety Factor Assessment

October 11, 2021

Prepared By:

ASSOCIATED ENGINEERS, INC.
2740 North Main St. • Madisonville, KY 42431
Phone: (270) 821-7732 • Fax: (270) 821-7789

Project ID: 210094

Big Rivers Electric Corporation
Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule
Structural Integrity Criteria for Existing CCR Surface Impoundments
Periodic Safety Factor Assessment

CCR Surface Impoundment Information

Name:	Reid/HMPL Station CCR Surface Impoundment
Operator:	Sebree Generating Station
Address:	9000 Highway 2096 Robards, Kentucky 42452
CCR Unit Identification Number:	Kentucky State Dam Inventory System ID No. 0855

Qualified Professional Engineer

Name:	David A. Lamb
Company:	Associated Engineers, Inc.
Kentucky P.E. Number:	17822

Regulatory Applicability

As part of the § 257.73 Structural integrity criteria for existing CCR surface impoundments requirements, an owner or operator of an existing CCR surface impoundment must no later than October 17, 2016:

> Conduct an initial and periodic safety factor assessment for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified below for the critical cross section of the embankment.
>
> The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations, documenting whether the CCR unit achieves the following minimum factors of safety:
>
> 1. The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.
>
> 2. The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.

3. The calculated seismic factor of safety must equal or exceed 1.00.

4. For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

From: VI. Development of the Final Rule - Technical Requirements

General Safety Factor Assessment Considerations

Generally accepted engineering methodologies specify that the determination of the structural stability factors of safety specified above is to be calculated by the qualified professional engineer using conventional analysis procedures or, if necessary, special analysis procedures. Conventional analysis procedures include, but are not limited to, limit equilibrium methods of slope stability analysis, whereas, special analysis procedures include, but are not limited to, finite element methods, finite difference methods, three-dimensional methods, or probabilistic methods. Whichever methodology is used to determine the factors of safety of the CCR surface impoundment, the qualified professional engineer must document the methodology used, as well as the basis for using that methodology, and the analysis must be supported by appropriate engineering calculations.

The Calculated Static Factor of Safety Under the Long-Term, Maximum Storage Pool Loading Condition

It is generally accepted practice to analyze the stability of the downstream slope of the dam embankment for steady-state seepage (or steady seepage) conditions with the reservoir at its normal operating pool elevation (usually the spillway crest elevation) since this is the loading condition the embankment will experience most. This condition is called steady seepage with maximum storage pool. The maximum storage pool loading is the maximum water level that can be maintained that will result in the full development of a steady-state seepage condition. Maximum storage pool loading conditions need to be calculated to ensure that the CCR surface impoundment can withstand a maximum expected pool elevation with full development of saturation in the embankment under long-term loading. The final rule requires that the calculated static factor of safety for the critical cross section of the CCR surface impoundment under the long-term maximum storage pool loading condition meet or exceed 1.5.

The Calculated Static Factor of Safety Under the Maximum Surcharge Pool Loading Condition

The maximum surcharge pool loading condition is calculated to evaluate the effect of a raised level (e.g., flood surcharge) on the stability of the downstream slope. This ensures that the CCR surface impoundment can withstand a temporary rise in pool elevation above the maximum storage pool elevation for which the CCR surface impoundment may normally be subject under inflow design flood stage, for a short-term until the inflow design flood is passed through the CCR surface impoundment. The final rule requires that the calculated static factor of safety for the critical cross section of the CCR surface impoundment under the long-term maximum surcharge pool loading condition meet or exceed 1.4.

The Calculated Seismic Factor of Safety

All CCR surface impoundments, including any lateral expansions that exceed the size threshold must meet a seismic factor of safety equal to or greater than 1.0. All CCR surface impoundments must also be capable of withstanding a design earthquake without damage to the foundation or embankment that would cause a discharge of its contents. To further support the location criteria established in this rule, CCR surface impoundments and any lateral expansion exceeding a specific height and/or volume threshold must be assessed under seismic loading conditions for a seismic loading event with a 2% probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years, based on the USGS seismic hazard maps for seismic events with this return period for the region where the CCR unit is located. EPA chose the 2% exceedance probability in 50 years event based on its common use in seismic design criteria throughout engineering.

The Calculated Liquefaction Factor of Safety

All CCR surface impoundments, including any lateral expansions that exceed the size threshold and have been determined to contain soils susceptible to liquefaction must meet a liquefaction factor of safety equal to or greater than 1.20. A prudent engineering analysis of structural stability also includes a liquefaction potential analysis and analysis of post-liquefaction static factors of safety. As discussed previously, liquefaction is a phenomenon which typically occurs in loose, saturated or partially-saturated soils in which the effective stress of the soils reduces to zero, corresponding to a total loss of shear strength of the soil. The most common occurrence of liquefaction is in loose soils, typically sands. The liquefaction FOS determination in the final rule is used to determine if a CCR unit would remain stable if the soils of the embankment of the CCR unit were to experience liquefaction. Liquefaction analysis is only necessary in instances where CCR surface impoundments show, through representative soil sampling, construction documentation, or anecdotal evidence from personnel with knowledge of the CCR unit's construction, that soils of the embankment are susceptible to liquefaction.

Failure To Demonstrate Minimum Safety Factors or Failure To Complete a Timely Safety Factor Assessment

As previously discussed, the rule requires an owner or operator to document that the calculated factors of safety for each CCR surface impoundment achieve the minimum safety factors specified in the rule. For any CCR surface impoundment that does not meet these requirements, the owner or operator must either take any engineering measure necessary to ensure that the unit meets the requirements by the rule's deadlines, or cease placement of CCR and non-CCR waste into the unit and initiate closure of such CCR unit as provided in section 257.102 within six months. Similarly, if an owner or operator fails to complete the initial safety factor assessment or any subsequent periodic factor safety assessment by the deadlines established in the rule, the owner or operator must cease placing CCR and non-CCR waste into the unit and initiate closure within six months.

Description of Impoundment

An aerial photo of the CCR unit is provided as Attachment A and an excerpt from U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps showing the location of the CCR unit is provided as Attachment B.

The CCR unit has been in place for 40 plus years The CCR unit operator has general maintenance and repair procedures in place as they determine necessary. There are no known occurrences of structural instability of the CCR unit.

The CCR unit was used for the placement of coal combustion residual material; slurried bottom,ash, until its retirement January 31, 2019. The immediate watershed that drains to the CCR unit, and in which the CCR unit is considered to be located, is unnamed and 25.45 acres in size. The unnamed watershed discharges from the CCR impoundment outflow structure and is routed to the Green River.

The CCR unit is a combined incised/earthen embankment structure. Embankments form the west, south and east sides of the impoundment and the north side is incised. The original terrain on which the pond was constructed generally sloped toward the west. Although the Green River is located less than 0.5 miles from the site, the structure does not extend significantly into the floodplain. Underlying preconstruction soils consisted of Loring-Grenada, Loring-Zanesville-Wellston (Henderson County) and Loring-Wellston-Zanesville (Webster County) soil associations which are generally characterized as well drained to moderately well drained soils on nearly level to sloping uplands.

The embankment reaches its greatest relief of approximately 42 feet on the west side. The Burns & McDonnell Engineering Co. October 8, 1971 design drawings show the inboard slope and central core portion of the dike to be constructed of compacted soil fill and the outboard slope to be consisted of sand fill. A sand blanket drain was designed for the outboard third of the base of the dike for the majority of the length and the plans show a crushed limestone drainage layer with a minimum thickness of 18 inches topped with a minimum six inches thick sand layer which extends across the entire width of the dike cross section in the southwest corner. The plans also show a cut-off trench in the original ground below dike crest and extending for the entire length of the dike.

Depth of impounded water and CCR is 16.3 feet and 40.7 feet (at respective locations of maximum impounded water and CCR depths). Elevation of impounded water and CCR is 426.4 feet and 433 feet, respectively, above mean sea level. These approximate depths and respective elevations are based on the most recent (September 2020) flight derived topographic contours and bathymetric survey data.

The remaining storage capacity is approximately 38,102 cubic yards (if CCR can be placed to the elevation of 425.8). This volume was calculated based on the maximum allowable storage volume and the current volume of CCR stored in the facility based on the most recent bathymetric survey.

The approximate volume of impounded water and CCR is 787,668 cubic yards (approximate water volume is 66,957 cubic yards and approximate CCR volume is 720,711 cubic yards). This volume was calculated based on the maximum storage capacity, the current amount of CCR stored in the facility based on the most recent bathymetric survey, and the best available as-built data for the structure construction prior to placement of CCR.

The impoundment discharge consists of a rectangular concrete drop structure with a variable height steel debris skimmer. The pool elevation can be controlled by adding or removing stop logs. The discharge structure connects to a 24-inch diameter smooth walled metal pipe underground conveyance.

Calculated Safety Factors

Results of the initial and periodic safety factor assessment for the critical cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments are supported by appropriate engineering calculations.

The safety factor analysis was conducted using the Rocscience Inc. Slide geotechnical software by evaluating four cross sections along the embankment. Slide provides numerical tools to analyze the stability of embankments using limit equilibrium methods. At each cross section, drilling, surveying, laboratory testing, and a slope stability analysis were performed. Based on the four analysis scenarios, the lowest factor of safety for all scenarios was not found at a single cross section; therefore, the results listed below are the lowest factor of safety realized from all analyzed cross sections for each scenario. The safety factor assessments are supported by appropriate engineering calculations and the Slide modeling results for the Reid/HMPL CCR impoundment are attached to this report. This analysis was performed under my review as a part of the Initial Safety Factor Assessment. I have reviewed the data, reports and inspected the facility and have found the data presented to be representative of the current facility condition and therefore suitable for the Periodic Safety Factor Review.

1. The calculated static factor of safety under the long-term, maximum storage pool loading condition equals: 2.053

2. The calculated static factor of safety under the maximum surcharge pool loading condition equals: 2.052

3. The calculated seismic factor of safety equals: 1.075

4. For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety equals: 1.585

Sources of Information

Geotechnical and other information provided by Associated Engineers, Inc.

Engineering design drawings and other information provided by Big Rivers Electric Corporation

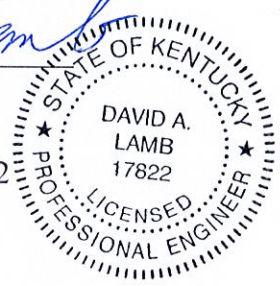
United States Geological Survey U.S. Geological Survey (USGS) 7.5 minute Robards and Delaware topographic quadrangle maps

Professional Engineer Certification [Per 40 CFR § 257.73]
Reid/HMPL CCR Impoundment Periodic Safety Factor Assessment

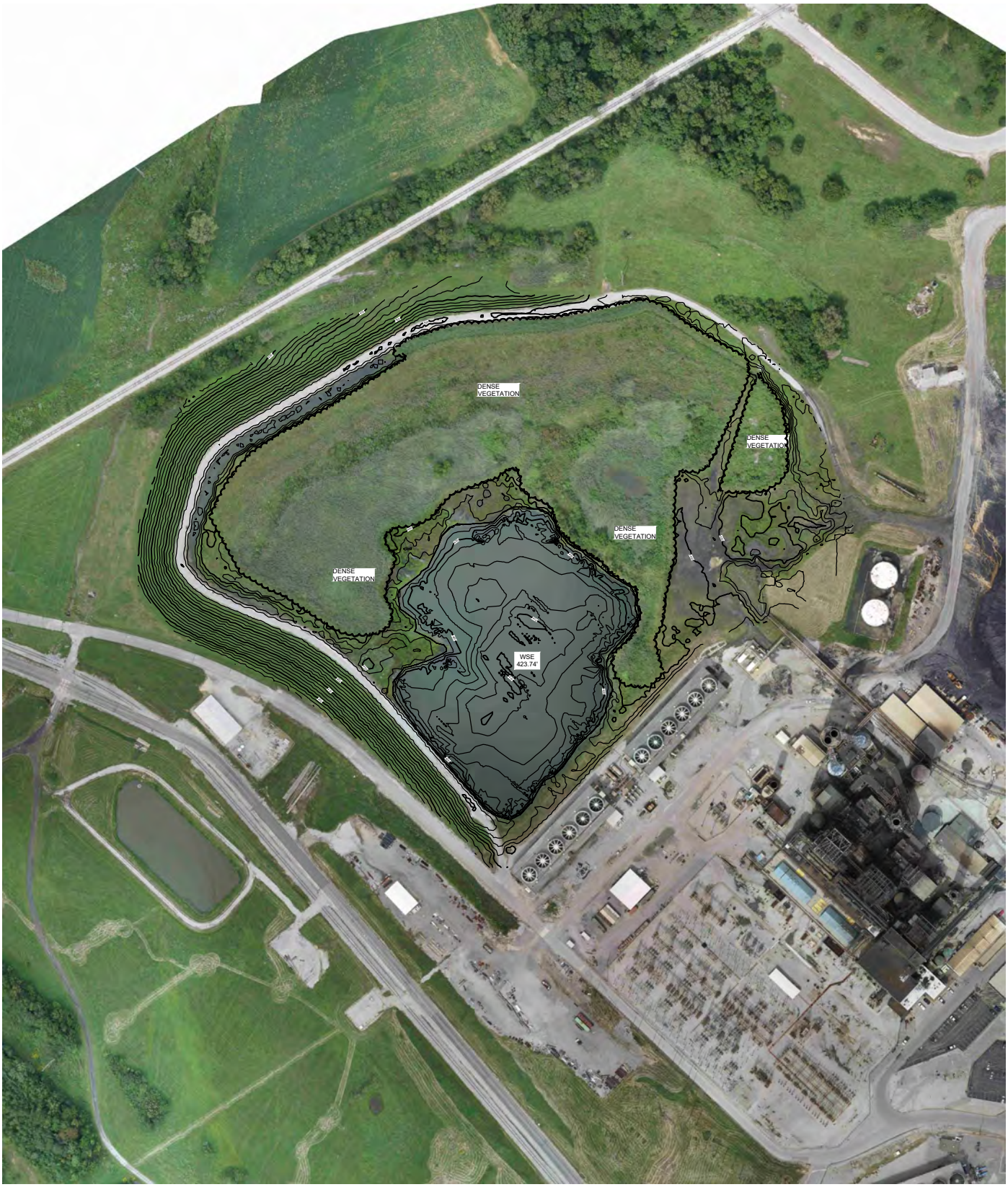
I hereby certify that myself or an agent under my review has prepared this Periodic Safety Factor Assessment (Assessment) and being familiar with the provisions of the final rule to regulate the disposal of coal combustion residuals (CCR) as solid waste under subtitle D of the Resource Conservation and Recovery Act (RCRA), attest that this Assessment has been prepared in accordance with good engineering practices and meets the intent of 40 CFR Part 257.73. To the best of my knowledge and belief, the information contained in this Assessment is true, complete, and accurate.

David A. Lamb P.E.

State of Kentucky License No. 17822



Date: 10/11/2021



BIG RIVERS ELECTRIC

Reid/HMPL CCR Surface Impoundment
Attachment A: Aerial

Job Number:	21-0094
Date:	10/01/2020
Scale:	1"=300'
Drawn By:	STAFF

Revisions:

ASSOCIATED ENGINEERS, INC.
ENGINEERS • GEOLOGISTS • SURVEYORS

Owensboro, KY
Phone: (270) 684-8450

2740 North Main St. • Madisonville, KY 42431
Phone: (270) 821-7732 • Fax: (270) 821-7789
www.associatedengineers.com

Lexington, KY
Phone: (859) 286-3000

BIG RIVERS ELECTRIC

Reid/HMPL CCR Surface Impoundment
Attachment B: Topographic Map

Job Number:	21-0094
Date:	10/01/2020
Scale:	1"=500'
Drawn By:	STAFF

Revisions:

ASSOCIATED ENGINEERS, INC.
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Phone: (859) 286-3000

Slide Analysis Information

Big Rivers Electric Corporation

Project Summary

File Name: RH-1
Last saved with Slide version: 6.039
Project Title: Big Rivers Electric Corporation
Analysis: Reid/HMPL Pond RH-1 Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 2:31:54 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Sandy Lean Clay (CL)	Lean Clay (CL)	Lean Clay (CL), Silty	Silt With Sand (ML)	Silty Clay (CL-ML)	Lean Clay (CL) 2	Sandy Lean Clay (Dam)	Lean Clay (CL) (Dam)
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	132.7	134.1	126	123	125.8	129.7	134.6	125.8
Cohesion [psf]	120	72	72	72	200	14.4	14.4	220
Friction Angle [deg]	32.3	30.4	30.4	31	33.7	28.7	33.3	30.4
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1	1	1

Property	Outslope Material (Dam)	Silty Sand (SM)	Sandy Lean Clay (CL) 2
Color			
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	128	130	124.6
Cohesion [psf]	200	0	740
Friction Angle [deg]	30	33	23.2
Water Surface	Water Table	Water Table	Water Table
Hu Value	1	1	1

List Of Coordinates

Water Table

X	Y
0	392.5
30.9	392.24
85.846	396.532

153	397.3
187.5	416.24
197.467	426.28
210	426.28

External Boundary

X	Y
0	371.5
43.37	372.6
180.89	373.8
210	374.1
210	381.6
210	384.6
210	388.7
210	395.8
210	397.8
210	419.644
206.306	421.6
198.751	425.6
191.136	429.632
180.794	429.579
169.909	425.6
148.327	417.711
116.257	406.72
99.1875	401.002
91.5524	398.444
85.846	396.532
83.24	397.044
77.457	398.595
71.748	398.856
47.962	398.89
43.367	398.519
32.528	396.852
18.716	394.794
0	395.066
0	393.5
0	392.5
0	384.5
0	381.5
0	372

Material Boundary

X	Y

0	372
43.3	375.5
140	381.6
180.9	381.6
210	381.6

Material Boundary

X	Y
0	381.5
43.3	381.5
140	381.6

Material Boundary

X	Y
0	384.5
43.3	384.5
102.292	384.543
180	384.6
210	384.6

Material Boundary

X	Y
0	392.5
43.3	392.5
102.672	391.249
180.9	389.6
210	388.7

Material Boundary

X	Y
0	393.5
43.3	393.5
180.9	395.6
210	395.8

Material Boundary

X	Y
85.846	396.532
153	397.3
180.9	397.6

210	397.8

Material Boundary

X	Y
99.1875	401.002
153	401.5
153	401.333
153	401.333
153	397.3

Material Boundary

X	Y
153	401.333
171.018	419.644
172.943	421.6
176.879	425.6
180.794	429.579

Material Boundary

X	Y
180.9	425.6
198.751	425.6

Material Boundary

X	Y
172.943	421.6
180.9	421.6

Material Boundary

X	Y
180.9	421.6
206.306	421.6

Material Boundary

X	Y
171.018	419.644
210	419.644
180.9	419.6

Material Boundary

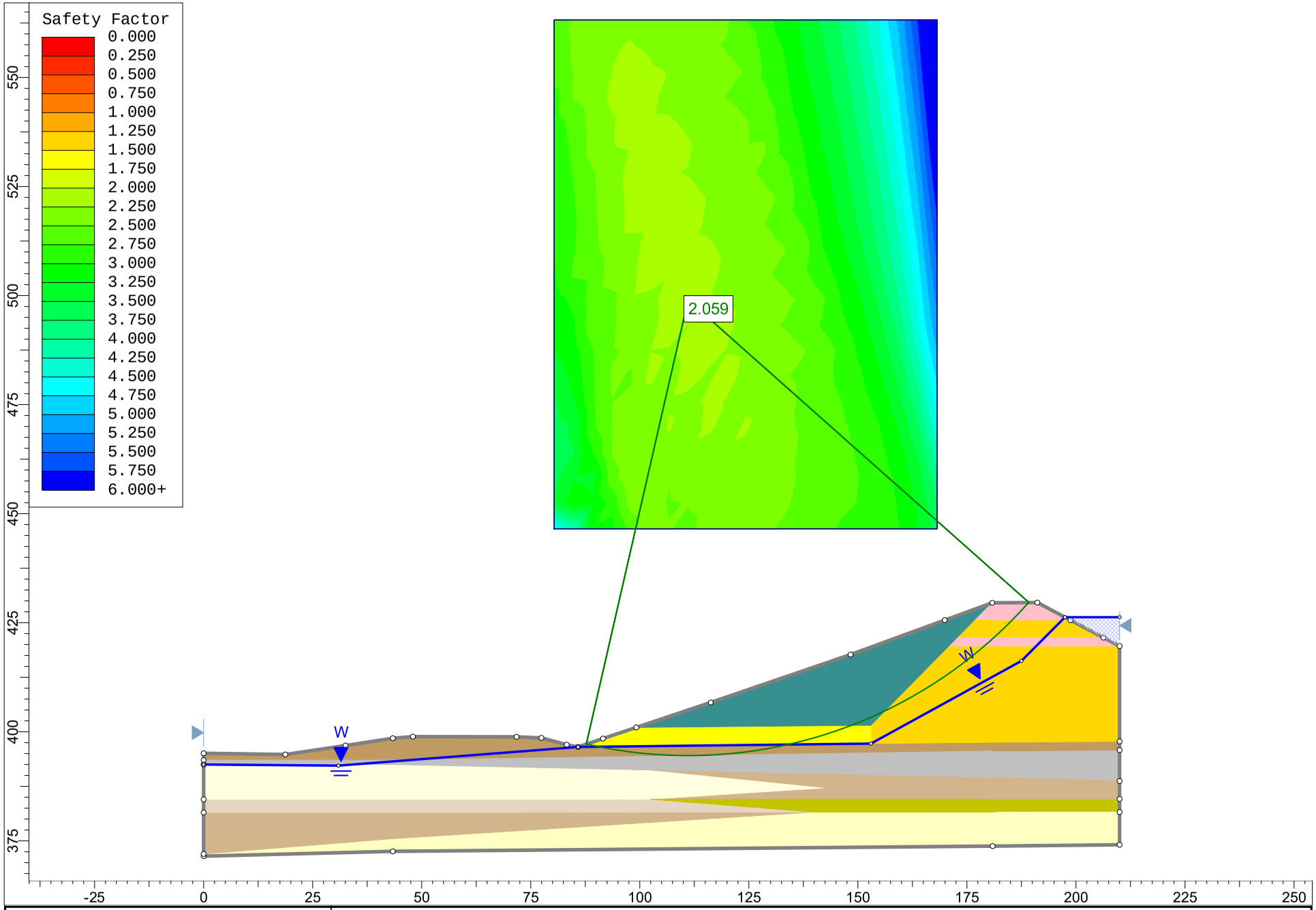
X	Y
102.292	384.543
140	381.6

Material Boundary

X	Y
102.292	384.543
142.735	387.164
102.672	391.249

Material Boundary

X	Y
176.879	425.6
180.9	425.6



rocscience	Project	Big Rivers Electric Corporation		
	Analysis Description	Reid/HMPL Pond RH-1 Maximum Storage Pool Loading Condition		
	Drawn By		Scale 1:360	Company Associated Engineers, Inc.
	Date	9/5/2016, 2:31:54 PM		File Name RH-1.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

BREC Reid/HMPL Station CCR Surface Impoundment

Project Summary

File Name: RH-1 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-1 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 2:31:54 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Sandy Lean Clay (CL)	Lean Clay (CL)	Lean Clay (CL), Silty	Silt With Sand (ML)	Silty Clay (CL-ML)	Lean Clay (CL) 2	Sandy Lean Clay (Dam)	Lean Clay (CL) (Dam)
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	132.7	134.1	126	123	125.8	129.7	134.6	125.8
Cohesion [psf]	120	72	72	72	200	14.4	14.4	220
Friction Angle [deg]	32.3	30.4	30.4	31	33.7	28.7	33.3	30.4
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1	1	1

Property	Outslope Material (Dam)	Silty Sand (SM)	Sandy Lean Clay (CL) 2
Color			
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	128	130	124.6
Cohesion [psf]	200	0	740
Friction Angle [deg]	30	33	23.2
Water Surface	Water Table	Water Table	Water Table
Hu Value	1	1	1

List Of Coordinates

Water Table

X	Y
0	392.5
30.9	392.24
85.846	396.532

153	397.3
187.5	416.24
194.956	427.61
210	427.61

External Boundary

X	Y
0	371.5
43.37	372.6
180.89	373.8
210	374.1
210	381.6
210	384.6
210	388.7
210	395.8
210	397.8
210	419.644
206.306	421.6
198.751	425.6
191.136	429.632
180.794	429.579
169.909	425.6
148.327	417.711
116.257	406.72
99.1875	401.002
91.5524	398.444
85.846	396.532
83.24	397.044
77.457	398.595
71.748	398.856
47.962	398.89
43.367	398.519
32.528	396.852
18.716	394.794
0	395.066
0	393.5
0	392.5
0	384.5
0	381.5
0	372

Material Boundary

X	Y

0	372
43.3	375.5
140	381.6
180.9	381.6
210	381.6

Material Boundary

X	Y
0	381.5
43.3	381.5
140	381.6

Material Boundary

X	Y
0	384.5
43.3	384.5
102.292	384.543
180	384.6
210	384.6

Material Boundary

X	Y
0	392.5
43.3	392.5
102.672	391.249
180.9	389.6
210	388.7

Material Boundary

X	Y
0	393.5
43.3	393.5
180.9	395.6
210	395.8

Material Boundary

X	Y
85.846	396.532
153	397.3
180.9	397.6

210	397.8

Material Boundary

X	Y
99.1875	401.002
153	401.5
153	401.333
153	401.333
153	397.3

Material Boundary

X	Y
153	401.333
171.018	419.644
172.943	421.6
176.879	425.6
180.794	429.579

Material Boundary

X	Y
180.9	425.6
198.751	425.6

Material Boundary

X	Y
172.943	421.6
180.9	421.6

Material Boundary

X	Y
180.9	421.6
206.306	421.6

Material Boundary

X	Y
171.018	419.644
210	419.644
180.9	419.6

Material Boundary

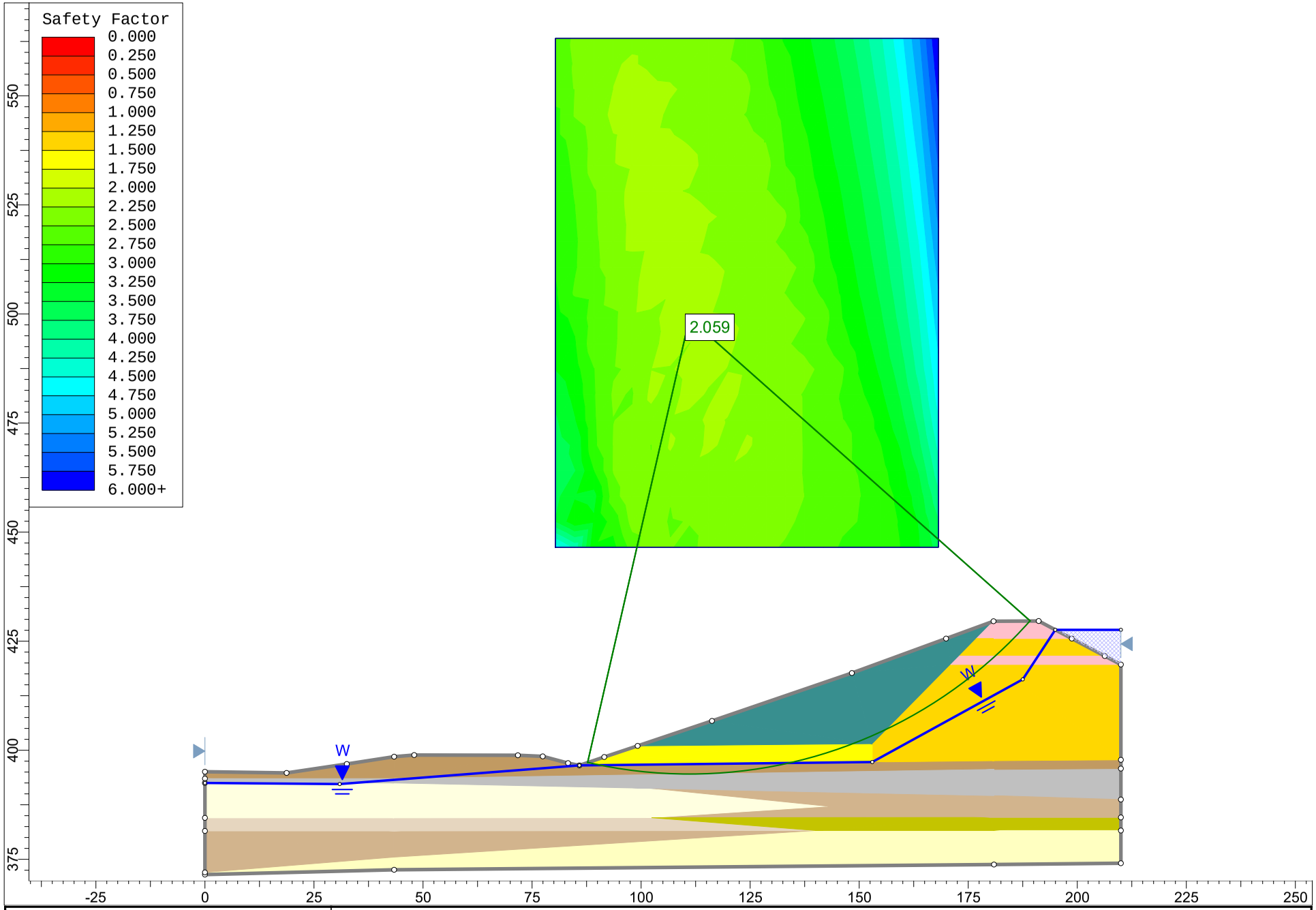
X	Y
102.292	384.543
140	381.6

Material Boundary

X	Y
102.292	384.543
142.735	387.164
102.672	391.249

Material Boundary

X	Y
176.879	425.6
180.9	425.6



rocscience	Project	BREC Reid/HMPL Station CCR Surface Impoundment	
	Analysis Description	Cross Section RH-1 Maximum Surcharge Pool Loading Condition	
	Drawn By	Scale 1:360	Company Associated Engineers, Inc.
	Date 9/5/2016, 2:31:54 PM		File Name RH-1 Surcharge.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

BREC Reid/HMPL Station CCR Surface Impoundment

Project Summary

File Name: RH-1 Seis
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-1 Seismic Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 2:31:54 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

Seismic Load Coefficient (Horizontal): 0.2377

Material Properties

Property	Sandy Lean Clay (CL)	Lean Clay (CL)	Lean Clay (CL), Silty	Silt With Sand (ML)	Silty Clay (CL-ML)	Lean Clay (CL) 2	Sandy Lean Clay (Dam)	Lean Clay (CL) (Dam)
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	132.7	134.1	126	123	125.8	129.7	134.6	125.8
Cohesion [psf]	120	72	72	72	200	14.4	14.4	220
Friction Angle [deg]	32.3	30.4	30.4	31	33.7	28.7	33.3	30.4
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1	1	1

Property	Outslope Material (Dam)	Silty Sand (SM)	Sandy Lean Clay (CL) 2
Color			
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	128	130	124.6
Cohesion [psf]	200	0	740
Friction Angle [deg]	30	33	23.2
Water Surface	Water Table	Water Table	Water Table
Hu Value	1	1	1

List Of Coordinates

Water Table

X	Y
0	392.5
30.9	392.24
85.846	396.532
153	397.3
187.5	416.24
197.467	426.28
210	426.28

External Boundary

X	Y
0	371.5
43.37	372.6
180.89	373.8
210	374.1
210	381.6
210	384.6
210	388.7
210	395.8
210	397.8
210	419.644
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198.751	425.6
191.136	429.632
180.794	429.579
169.909	425.6
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116.257	406.72
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83.24	397.044
77.457	398.595
71.748	398.856
47.962	398.89
43.367	398.519
32.528	396.852
18.716	394.794
0	395.066
0	393.5
0	392.5
0	384.5

0	381.5
0	372

Material Boundary

X	Y
0	372
43.3	375.5
140	381.6
180.9	381.6
210	381.6

Material Boundary

X	Y
0	381.5
43.3	381.5
140	381.6

Material Boundary

X	Y
0	384.5
43.3	384.5
102.292	384.543
180	384.6
210	384.6

Material Boundary

X	Y
0	392.5
43.3	392.5
102.672	391.249
180.9	389.6
210	388.7

Material Boundary

X	Y
0	393.5
43.3	393.5
180.9	395.6
210	395.8

Material Boundary

X	Y
85.846	396.532
153	397.3
180.9	397.6
210	397.8

Material Boundary

X	Y
99.1875	401.002
153	401.5
153	401.333
153	401.333
153	397.3

Material Boundary

X	Y
153	401.333
171.018	419.644
172.943	421.6
176.879	425.6
180.794	429.579

Material Boundary

X	Y
180.9	425.6
198.751	425.6

Material Boundary

X	Y
172.943	421.6
180.9	421.6

Material Boundary

X	Y
180.9	421.6
206.306	421.6

Material Boundary

X	Y
171.018	419.644
210	419.644
180.9	419.6

Material Boundary

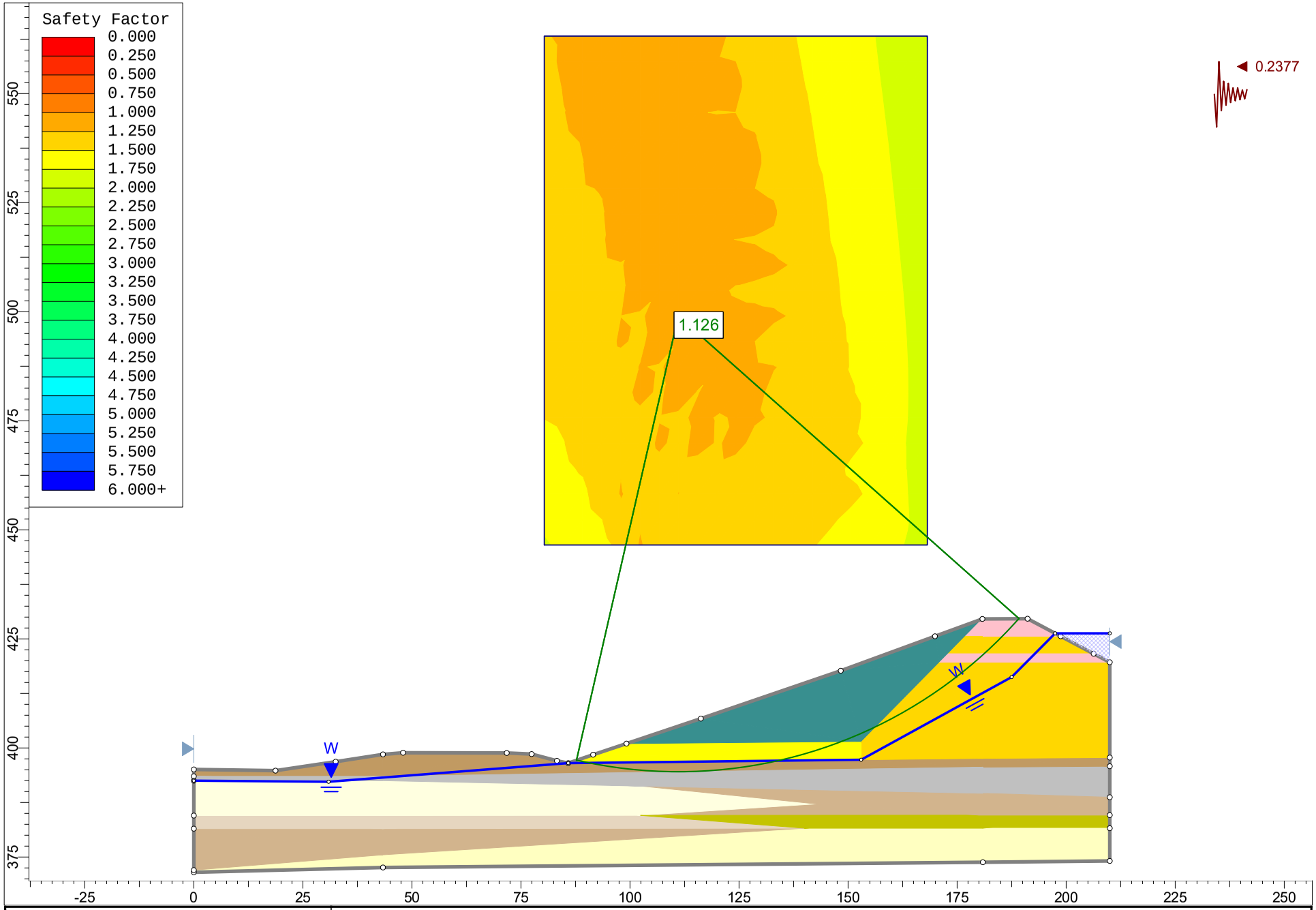
X	Y
102.292	384.543
140	381.6

Material Boundary

X	Y
102.292	384.543
142.735	387.164
102.672	391.249

Material Boundary

X	Y
176.879	425.6
180.9	425.6



Project	BREC Reid/HMPL Station CCR Surface Impoundment		
Analysis Description	Cross Section RH-1 Seismic Loading Condition		
Drawn By		Scale 1:360	Company Associated Engineers, Inc.
Date	9/5/2016, 2:31:54 PM		File Name RH-1 Seis.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

BREC Reid/HMPL Station CCR Surface Impoundment

Project Summary

File Name: RH-1 Seis Liq
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-1 Liquefaction Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 2:31:54 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Sandy Lean Clay (CL)	Lean Clay (CL)	Lean Clay (CL), Silty	Silt With Sand (ML)	Silty Clay (CL-ML)	Lean Clay (CL) 2	Sandy Lean Clay (Dam)	Lean Clay (CL) (Dam)
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	132.7	134.1	126	123	125.8	129.7	134.6	125.8
Cohesion [psf]	120	72	72	0	200	14.4	14.4	220
Friction Angle [deg]	32.3	30.4	30.4	0	33.7	28.7	33.3	30.4
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1	1	1

Property	Outslope Material (Dam)	Silty Sand (SM)	Sandy Lean Clay (CL) 2
Color			
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	128	130	124.6
Cohesion [psf]	200	0	740
Friction Angle [deg]	30	33	23.2
Water Surface	Water Table	Water Table	Water Table
Hu Value	1	1	1

List Of Coordinates

Water Table

X	Y
0	392.5
30.9	392.24
85.846	396.532

153	397.3
187.5	416.24
197.467	426.28
210	426.28

External Boundary

X	Y
0	371.5
43.37	372.6
180.89	373.8
210	374.1
210	381.6
210	384.6
210	388.7
210	395.8
210	397.8
210	419.644
206.306	421.6
198.751	425.6
191.136	429.632
180.794	429.579
169.909	425.6
148.327	417.711
116.257	406.72
99.1875	401.002
91.5524	398.444
85.846	396.532
83.24	397.044
77.457	398.595
71.748	398.856
47.962	398.89
43.367	398.519
32.528	396.852
18.716	394.794
0	395.066
0	393.5
0	392.5
0	384.5
0	381.5
0	372

Material Boundary

X	Y

0	372
43.3	375.5
140	381.6
180.9	381.6
210	381.6

Material Boundary

X	Y
0	381.5
43.3	381.5
140	381.6

Material Boundary

X	Y
0	384.5
43.3	384.5
102.292	384.543
180	384.6
210	384.6

Material Boundary

X	Y
0	392.5
43.3	392.5
102.672	391.249
180.9	389.6
210	388.7

Material Boundary

X	Y
0	393.5
43.3	393.5
180.9	395.6
210	395.8

Material Boundary

X	Y
85.846	396.532
153	397.3
180.9	397.6

210	397.8

Material Boundary

X	Y
99.1875	401.002
153	401.5
153	401.333
153	401.333
153	397.3

Material Boundary

X	Y
153	401.333
171.018	419.644
172.943	421.6
176.879	425.6
180.794	429.579

Material Boundary

X	Y
180.9	425.6
198.751	425.6

Material Boundary

X	Y
172.943	421.6
180.9	421.6

Material Boundary

X	Y
180.9	421.6
206.306	421.6

Material Boundary

X	Y
171.018	419.644
210	419.644
180.9	419.6

Material Boundary

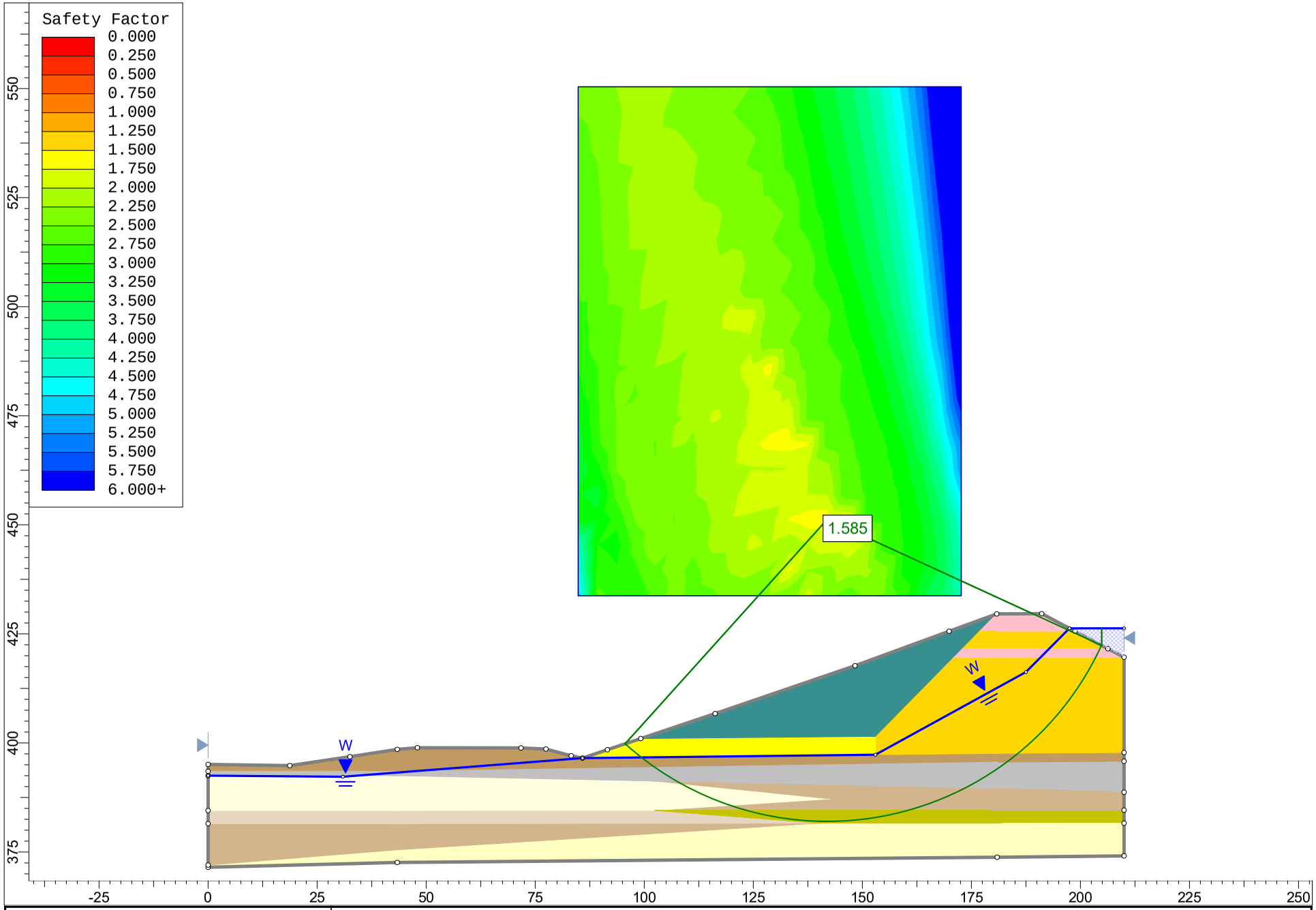
X	Y
102.292	384.543
140	381.6

Material Boundary

X	Y
102.292	384.543
142.735	387.164
102.672	391.249

Material Boundary

X	Y
176.879	425.6
180.9	425.6



Project	BREC Reid/HMPL Station CCR Surface Impoundment		
Analysis Description	Cross Section RH-1 Liquefaction Condition		
Drawn By		Scale 1:360	Company Associated Engineers, Inc.
Date	9/5/2016, 2:31:54 PM		File Name RH-1 Seis Liq.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

BREC Reid/HMPL Station CCR Surface Impoundment

Project Summary

File Name: RH-2
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-2 Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:14:15 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Sandy Lean Clay (CL)	Clayey Sand (SC)	Lean Clay (CL)	Granular Fill	Silty Sand (SC)	Lean Clay (CL) (Dam)	Lean clay With Sand (Dam)	Sandy Lean Clay (Dam)
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	132.7	125.5	129.7	132	130	125.8	133.5	134.6
Cohesion [psf]	120	0	14.4	0	0	220	260	14.4
Friction Angle [deg]	32.3	33.7	28.7	31	33	30.4	30.6	33.3
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1	1	1

Property	Outslope Material	Sandy Lean Clay 2
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	128	125.8
Cohesion [psf]	200	80
Friction Angle [deg]	30	29.6
Water Surface	Water Table	Water Table
Hu Value	1	1

List Of Coordinates

Water Table

X	Y
0	391.358

87.066	391.358
166.755	395.192
170.864	397.272
208.5	416.24
219.309	426.28
230	426.28

External Boundary

X	Y
6.548e-013	364.6
45.37	364.6
208.52	387.9
230	390.5
230	395.894
230	397.852
230	398.726
230	401.3
230	409.9
230	412.9
230	418.69
230	420.43
224.631	423.368
223.845	423.798
220.564	425.593
214.627	428.842
208.516	429.175
202.208	429.134
186.355	423.878
183.639	422.977
179.243	421.45
160.601	414.973
154.822	412.965
142.317	408.632
132.449	405.213
123.342	402.058
100.934	395.448
92.3437	392.915
90.2895	392.309
87.066	391.358
79.843	393.667
75.206	394.003
51.068	393.78
45.366	393.402
32.987	392.813

0	393.493
0	377.4
0	370.4

Material Boundary

X	Y
0	370.4
45.4	370.4
100.5	377.5
45.4	377.4
0	377.4

Material Boundary

X	Y
87.066	391.358
68	389.6
87.5	389
96.6043	389.467
205.063	395.024
208.5	395.2
230	395.894

Material Boundary

X	Y
87.066	391.358
208.5	397.2
230	397.852

Material Boundary

X	Y
90.2895	392.309
208.5	398
230	398.726

Material Boundary

X	Y
208.5	425.2
220.564	425.593

Material Boundary

X	Y
208.5	423.2
223.845	423.798

Material Boundary

X	Y
208.5	400.7
230	401.3

Material Boundary

X	Y
92.3437	392.915
155.8	395.9
170.864	397.272
208.5	400.7

Material Boundary

X	Y
170.864	397.272
181.19	407.768
184.264	410.894
189.983	416.707
195.612	422.429
197.704	424.555
202.208	429.134

Material Boundary

X	Y
197.704	424.555
208.5	425.2

Material Boundary

X	Y
195.612	422.429
208.5	423.2

Material Boundary

X	Y
181.19	407.768

208.5	409.2
230	409.9

Material Boundary

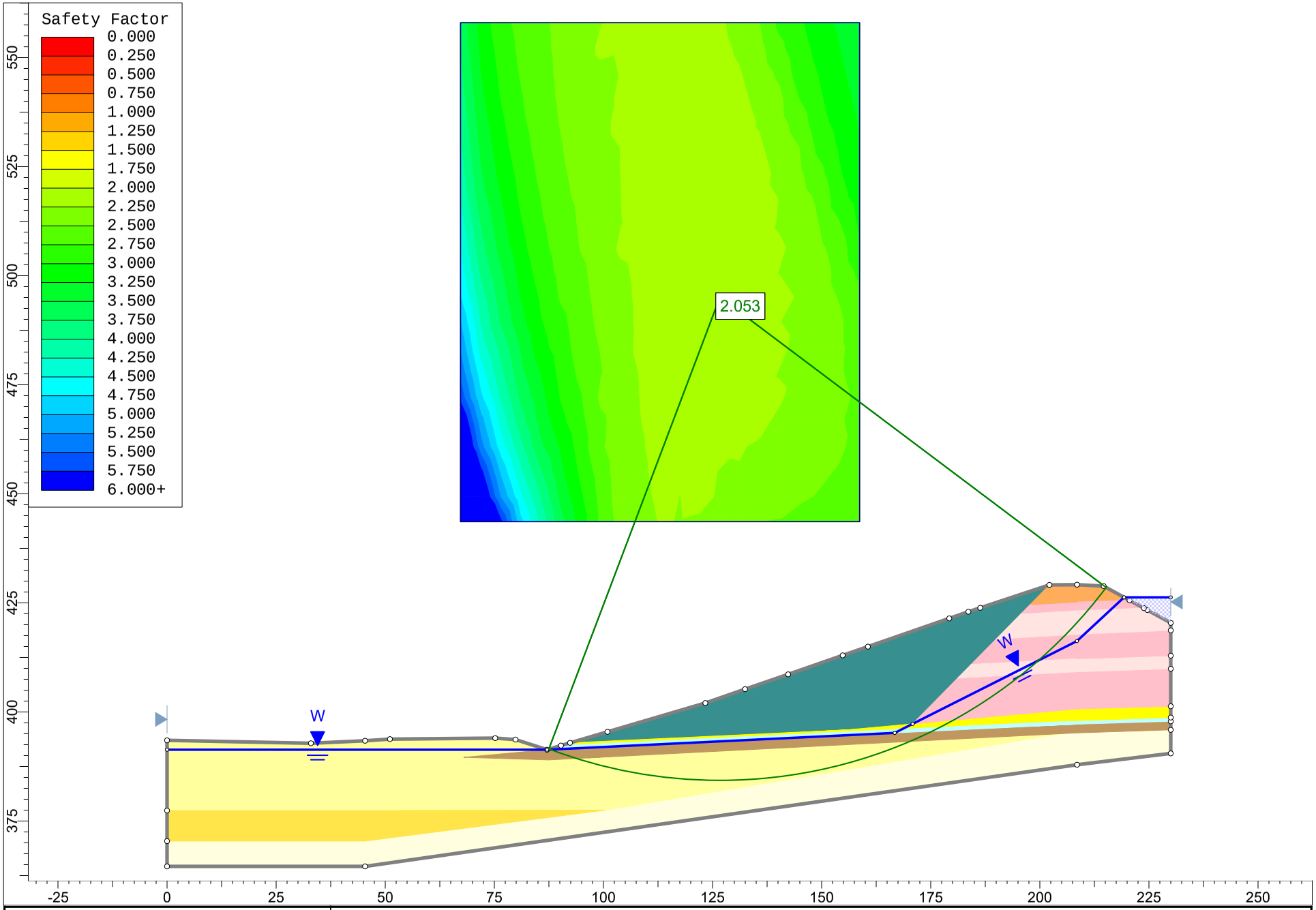
X	Y
184.264	410.894
208.5	412.2
230	412.9

Material Boundary

X	Y
189.983	416.707
208.5	417.8
230	418.69

Material Boundary

X	Y
100.5	377.5
205.063	395.024



rocscience	Project: BREC Reid/HMPL Station CCR Surface Impoundment		
	Analysis Description: Cross Section RH-2 Maximum Storage Pool Loading Condition		
	Drawn By:	Scale: 1:360	Company: Associated Engineers, Inc.
	Date: 9/5/2016, 3:14:15 PM		File Name: RH-2.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

BREC Reid/HMPL Station CCR Surface Impoundment

Project Summary

File Name: RH-2 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-2 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:14:15 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Sandy Lean Clay (CL)	Clayey Sand (SC)	Lean Clay (CL)	Granular Fill	Silty Sand (SC)	Lean Clay (CL) (Dam)	Lean clay With Sand (Dam)	Sandy Lean Clay (Dam)
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	132.7	125.5	129.7	132	130	125.8	133.5	134.6
Cohesion [psf]	120	0	14.4	0	0	220	260	14.4
Friction Angle [deg]	32.3	33.7	28.7	31	33	30.4	30.6	33.3
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1	1	1

Property	Outslope Material	Sandy Lean Clay 2
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	128	125.8
Cohesion [psf]	200	80
Friction Angle [deg]	30	29.6
Water Surface	Water Table	Water Table
Hu Value	1	1

List Of Coordinates

Water Table

X	Y
0	391.358

87.066	391.358
166.755	395.192
170.864	397.272
208.5	416.24
216.878	427.61
230	427.61

External Boundary

X	Y
6.548e-013	364.6
45.37	364.6
208.52	387.9
230	390.5
230	395.894
230	397.852
230	398.726
230	401.3
230	409.9
230	412.9
230	418.69
230	420.43
224.631	423.368
223.845	423.798
220.564	425.593
214.627	428.842
208.516	429.175
202.208	429.134
186.355	423.878
183.639	422.977
179.243	421.45
160.601	414.973
154.822	412.965
142.317	408.632
132.449	405.213
123.342	402.058
100.934	395.448
92.3437	392.915
90.2895	392.309
87.066	391.358
79.843	393.667
75.206	394.003
51.068	393.78
45.366	393.402
32.987	392.813

0	393.493
0	377.4
0	370.4

Material Boundary

X	Y
0	370.4
45.4	370.4
100.5	377.5
45.4	377.4
0	377.4

Material Boundary

X	Y
87.066	391.358
68	389.6
87.5	389
96.6043	389.467
205.063	395.024
208.5	395.2
230	395.894

Material Boundary

X	Y
87.066	391.358
208.5	397.2
230	397.852

Material Boundary

X	Y
90.2895	392.309
208.5	398
230	398.726

Material Boundary

X	Y
208.5	425.2
220.564	425.593

Material Boundary

X	Y
208.5	423.2
223.845	423.798

Material Boundary

X	Y
208.5	400.7
230	401.3

Material Boundary

X	Y
92.3437	392.915
155.8	395.9
170.864	397.272
208.5	400.7

Material Boundary

X	Y
170.864	397.272
181.19	407.768
184.264	410.894
189.983	416.707
195.612	422.429
197.704	424.555
202.208	429.134

Material Boundary

X	Y
197.704	424.555
208.5	425.2

Material Boundary

X	Y
195.612	422.429
208.5	423.2

Material Boundary

X	Y
181.19	407.768

208.5	409.2
230	409.9

Material Boundary

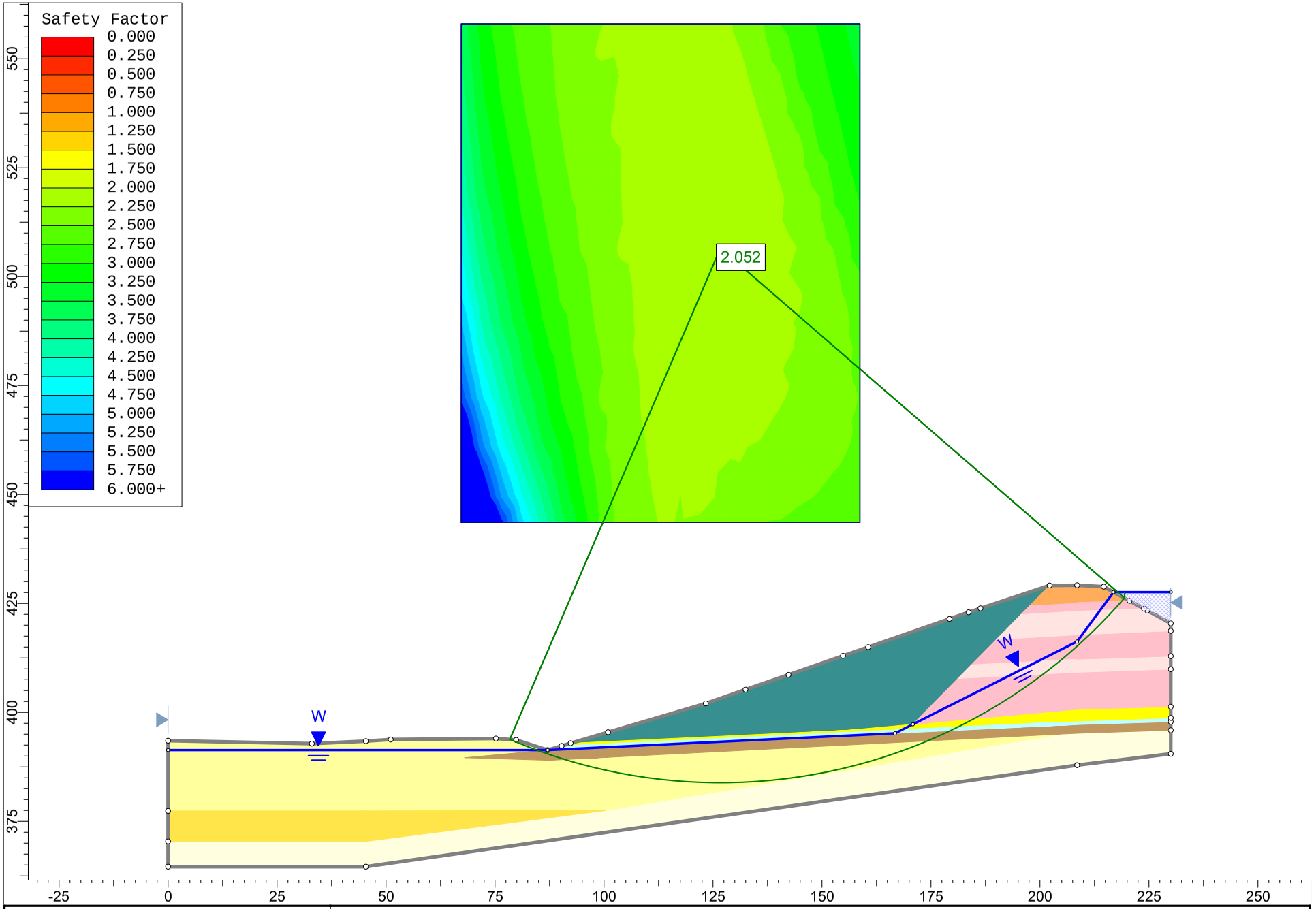
X	Y
184.264	410.894
208.5	412.2
230	412.9

Material Boundary

X	Y
189.983	416.707
208.5	417.8
230	418.69

Material Boundary

X	Y
100.5	377.5
205.063	395.024



	Project	BREC Reid/HMPL Station CCR Surface Impoundment	
	Analysis Description	Cross Section RH-2 Maximum Surcharge Pool Loading Condition	
	Drawn By	Scale 1:360	Company Associated Engineers, Inc.
SLIDEINTERPRET 6.039	Date 9/5/2016, 3:14:15 PM		File Name RH-2 Surcharge.slim

Slide Analysis Information

BREC Reid/HMPL Station CCR Surface Impoundment

Project Summary

File Name: RH-2 Seis
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-2 Seismic Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/5/2016, 3:14:15 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified
Janbu simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

Seismic Load Coefficient (Horizontal): 0.2377

Material Properties

Property	Sandy Lean Clay (CL)	Clayey Sand (SC)	Lean Clay (CL)	Granular Fill	Silty Sand (SC)	Lean Clay (CL) (Dam)	Lean clay With Sand (Dam)	Sandy Lean Clay (Dam)
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	132.7	125.5	129.7	132	130	125.8	133.5	134.6
Cohesion [psf]	120	0	14.4	0	0	220	260	14.4
Friction Angle [deg]	32.3	33.7	28.7	31	33	30.4	30.6	33.3
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1	1	1

Property	Outslope Material	Sandy Lean Clay 2
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	128	125.8
Cohesion [psf]	200	80
Friction Angle [deg]	30	29.6
Water Surface	Water Table	Water Table
Hu Value	1	1

List Of Coordinates

Water Table

X	Y
0	391.358
87.066	391.358
166.755	395.192
170.864	397.272
208.5	416.24
219.309	426.28
230	426.28

External Boundary

X	Y
6.548e-013	364.6
45.37	364.6
208.52	387.9
230	390.5
230	395.894
230	397.852
230	398.726
230	401.3
230	409.9
230	412.9
230	418.69
230	420.43
224.631	423.368
223.845	423.798
220.564	425.593
214.627	428.842
208.516	429.175
202.208	429.134
186.355	423.878
183.639	422.977
179.243	421.45
160.601	414.973
154.822	412.965
142.317	408.632
132.449	405.213
123.342	402.058
100.934	395.448
92.3437	392.915
90.2895	392.309
87.066	391.358
79.843	393.667

75.206	394.003
51.068	393.78
45.366	393.402
32.987	392.813
0	393.493
0	377.4
0	370.4

Material Boundary

X	Y
0	370.4
45.4	370.4
100.5	377.5
45.4	377.4
0	377.4

Material Boundary

X	Y
87.066	391.358
68	389.6
87.5	389
96.6043	389.467
205.063	395.024
208.5	395.2
230	395.894

Material Boundary

X	Y
87.066	391.358
208.5	397.2
230	397.852

Material Boundary

X	Y
90.2895	392.309
208.5	398
230	398.726

Material Boundary

X	Y

208.5	425.2
220.564	425.593

Material Boundary

X	Y
208.5	423.2
223.845	423.798

Material Boundary

X	Y
208.5	400.7
230	401.3

Material Boundary

X	Y
92.3437	392.915
155.8	395.9
170.864	397.272
208.5	400.7

Material Boundary

X	Y
170.864	397.272
181.19	407.768
184.264	410.894
189.983	416.707
195.612	422.429
197.704	424.555
202.208	429.134

Material Boundary

X	Y
197.704	424.555
208.5	425.2

Material Boundary

X	Y
195.612	422.429
208.5	423.2

Material Boundary

X	Y
181.19	407.768
208.5	409.2
230	409.9

Material Boundary

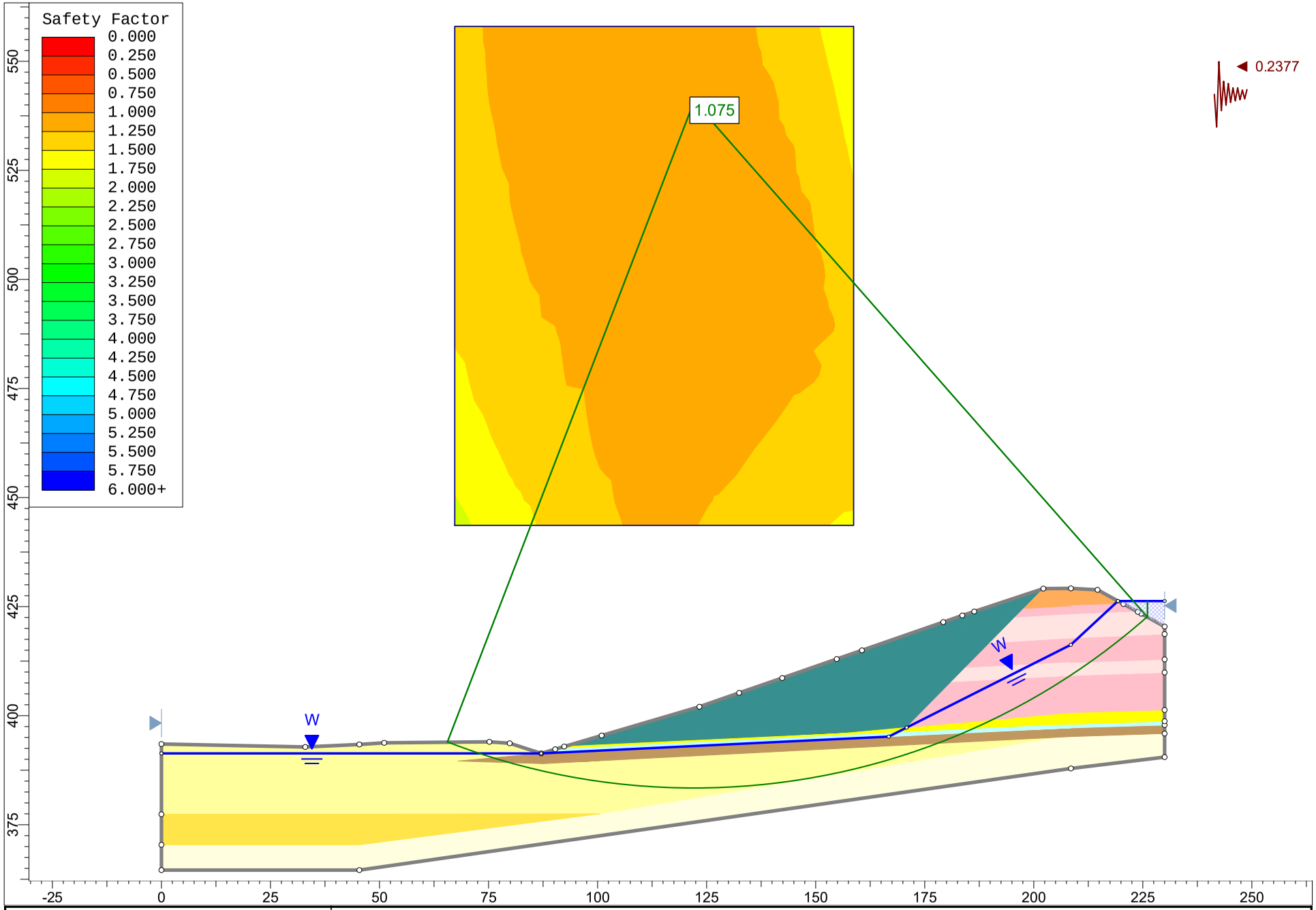
X	Y
184.264	410.894
208.5	412.2
230	412.9

Material Boundary

X	Y
189.983	416.707
208.5	417.8
230	418.69

Material Boundary

X	Y
100.5	377.5
205.063	395.024



rocscience	Project: BREC Reid/HMPL Station CCR Surface Impoundment		
	Analysis Description: Cross Section RH-2 Seismic Loading Condition		
	Drawn By:	Scale: 1:360	Company: Associated Engineers, Inc.
	Date: 9/5/2016, 3:14:15 PM		File Name: RH-2 Seis.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

BREC Reid/HMPL Station CCR Surface Impoundment

Project Summary

File Name: RH-3
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-3 Maximum Storage Pool Loading Conditon
Company: Associated Engineers, Inc.
Date Created: 8/29/2016, 2:56:23 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Sandy Lean Clay	Lean Clay	Silty Clay (CL-ML)	Granular Fill and Lean Clay	Outslope Material (Dam)	Lean Clay with Sand (CL) (Dam)	Sandy Lean Clay (CL)(Dike)	Lean Clay (CL) (Dam)
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	132.7	134.1	125.8	132	128	133.5	134.6	125.8
Cohesion [psf]	120	72	200	0	200	260	14.4	220
Friction Angle [deg]	32.3	30.4	33.7	31	30	30.6	33.3	30.4
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1	1	1

Property	Lean Clay (CL) 2
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	129.7
Cohesion [psf]	14.4
Friction Angle [deg]	28.7
Water Surface	Water Table
Hu Value	1

List Of Coordinates

Water Table

X	Y
-1.11022e-016	380.175
75.344	380.175
77.002	383.846
82.5127	384.456
217.136	388.922
221.8	391.3
267.7	412.21
276.537	426.277
285	426.28

External Boundary

X	Y
276.537	426.277
270.621	429.244
264.923	429.374
259.45	429.143
250.06	425.382
237.754	421.038
216.209	413.372
187.674	403.549
156.481	394.047
133.994	390.347
132.225	390.139
106.149	387.073
82.5127	384.456
77.002	383.846
75.344	380.175
68.53	380.645
67.51	383.799
59.536	386.037
0	385.411
0	383.8
1.38778e-017	375.3
0	371.5
0	366.9
0	359.5
40	359.5
132.2	367
172.029	370.145
265	377.7
285	378.7
285	383.6
285	390.6

285	393.6
285	396.6
285	399.6
285	422.033

Material Boundary

X	Y
0	366.9
40	366.9
132.2	371.3
201	376.8
172.029	370.145

Material Boundary

X	Y
1.38778e-017	375.3
40	375.3
132.2	378.3
265	383.4
285	383.6

Material Boundary

X	Y
82.5127	384.456
132.2	386.3
265	390.4
285	390.6

Material Boundary

X	Y
0	383.8
40	383.8
67.51	383.799

Material Boundary

X	Y
106.149	387.073
132.2	388.3
221.8	391.3
265	393.4

285	393.6

Material Boundary

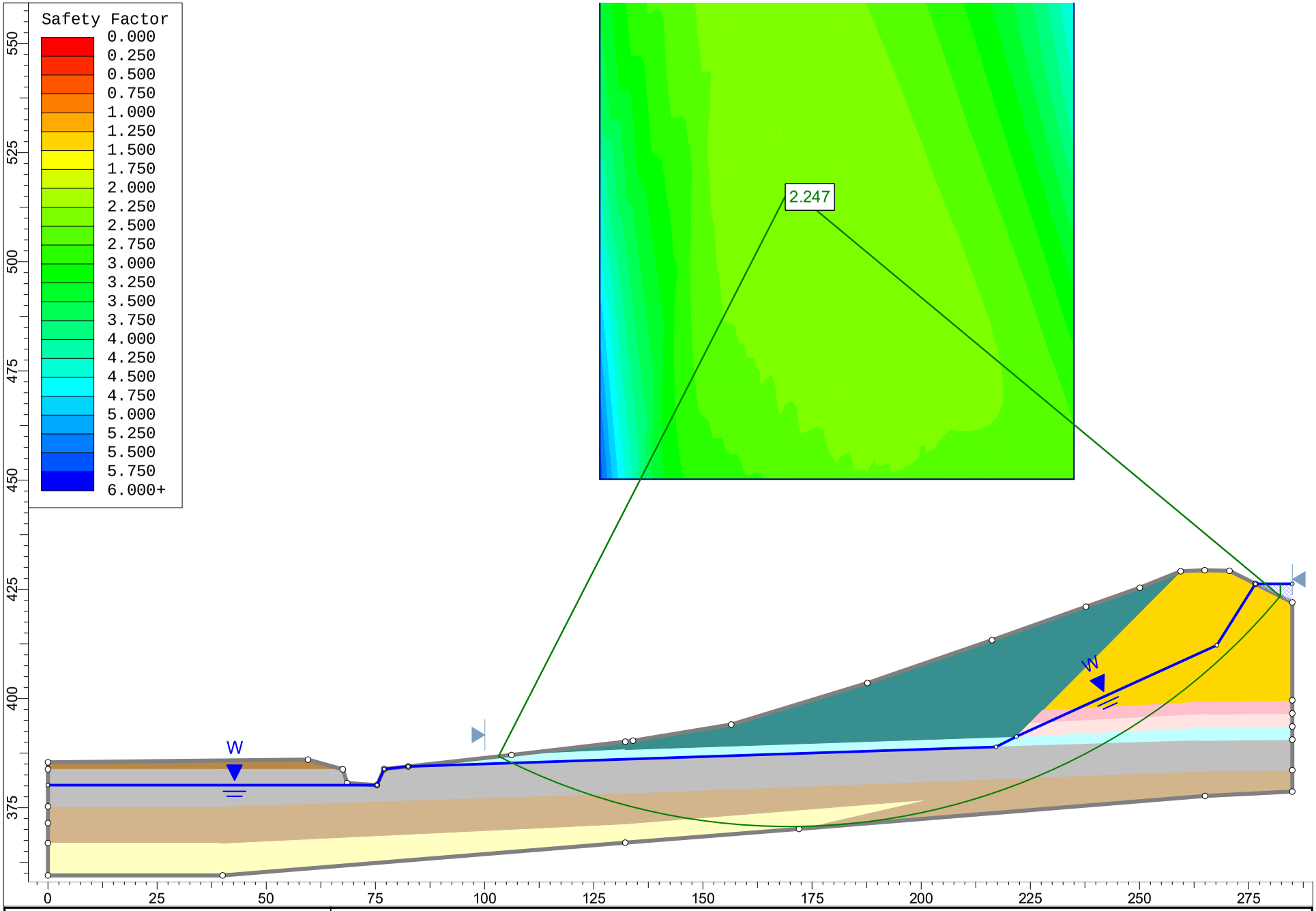
X	Y
221.8	391.3
224.786	394.301
227.81	397.341
259.45	429.143

Material Boundary

X	Y
224.786	394.301
265	396.4
285	396.6

Material Boundary

X	Y
227.81	397.341
265	399.4
285	399.6



rocscience	Project: BREC Reid/HMPL Station CCR Surface Impoundment		
	Analysis Description: Cross Section RH-3 Maximum Storage Pool Loading Conditon		
	Drawn By:	Scale: 1:360	Company: Associated Engineers, Inc.
	Date: 8/29/2016, 2:56:23 PM		File Name: RH-3.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

BREC Reid/HMPL Station CCR Surface Impoundment

Project Summary

File Name: RH-3 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-3 Maximum Surcharge Pool Loading Conditon
Company: Associated Engineers, Inc.
Date Created: 8/29/2016, 2:56:23 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Sandy Lean Clay	Lean Clay	Silty Clay (CL-ML)	Granular Fill and Lean Clay	Outslope Material (Dam)	Lean Clay with Sand (CL) (Dam)	Sandy Lean Clay (CL)(Dike)	Lean Clay (CL) (Dam)
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	132.7	134.1	125.8	132	128	133.5	134.6	125.8
Cohesion [psf]	120	72	200	0	200	260	14.4	220
Friction Angle [deg]	32.3	30.4	33.7	31	30	30.6	33.3	30.4
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1	1	1

Property	Lean Clay (CL) 2
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	129.7
Cohesion [psf]	14.4
Friction Angle [deg]	28.7
Water Surface	Water Table
Hu Value	1

List Of Coordinates

Water Table

Project	BREC Reid/HMPL Station CCR Surface Impoundment
Analysis Description	Cross Section RH-3 Maximum Surcharge Pool Loading Conditon
Drawn By	Scale
Company	Associated Engineers, Inc.
Date	8/29/2016, 2:56:23 PM
File Name	RH-3 Surcharge.slim

X	Y
-1.11022e-016	380.175
75.344	380.175
77.002	383.846
82.5127	384.456
217.136	388.922
221.8	391.3
267.7	412.21
273.872	427.613
285	427.61

External Boundary

X	Y
276.537	426.277
270.621	429.244
264.923	429.374
259.45	429.143
250.06	425.382
237.754	421.038
216.209	413.372
187.674	403.549
156.481	394.047
133.994	390.347
132.225	390.139
106.149	387.073
82.5127	384.456
77.002	383.846
75.344	380.175
68.53	380.645
67.51	383.799
59.536	386.037
0	385.411
0	383.8
1.38778e-017	375.3
0	371.5
0	366.9
0	359.5
40	359.5
132.2	367
172.029	370.145
265	377.7
285	378.7
285	383.6
285	390.6

285	393.6
285	396.6
285	399.6
285	422.033

Material Boundary

X	Y
0	366.9
40	366.9
132.2	371.3
201	376.8
172.029	370.145

Material Boundary

X	Y
1.38778e-017	375.3
40	375.3
132.2	378.3
265	383.4
285	383.6

Material Boundary

X	Y
82.5127	384.456
132.2	386.3
265	390.4
285	390.6

Material Boundary

X	Y
0	383.8
40	383.8
67.51	383.799

Material Boundary

X	Y
106.149	387.073
132.2	388.3
221.8	391.3
265	393.4

285	393.6

Material Boundary

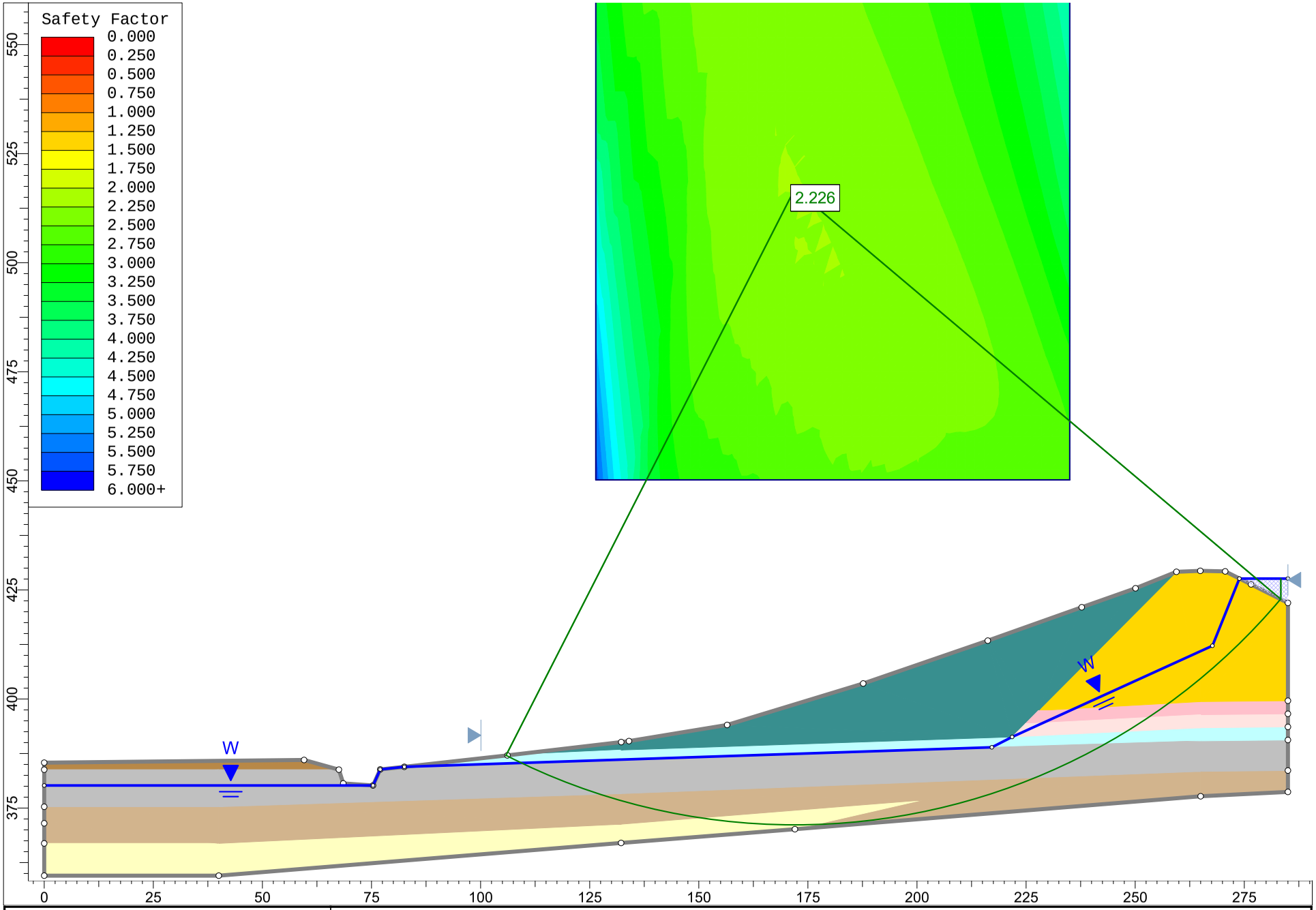
X	Y
221.8	391.3
224.786	394.301
227.81	397.341
259.45	429.143

Material Boundary

X	Y
224.786	394.301
265	396.4
285	396.6

Material Boundary

X	Y
227.81	397.341
265	399.4
285	399.6



Project	BREC Reid/HMPL Station CCR Surface Impoundment		
Analysis Description	Cross Section RH-3 Maximum Surcharge Pool Loading Conditon		
Drawn By		Scale 1:360	Company Associated Engineers, Inc.
Date	8/29/2016, 2:56:23 PM		File Name RH-3 Surcharge.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

BREC Reid/HMPL Station CCR Surface Impoundment

Project Summary

File Name: RH-3 Seis
Slide Modeler Version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-3 Seismic Loading Conditon
Company: Associated Engineers, Inc.
Date Created: 8/29/2016, 2:56:23 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular

Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

Seismic Load Coefficient (Horizontal): 0.2377

Material Properties

Property	Sandy Lean Clay	Lean Clay	Silty Clay (CL-ML)	Granular Fill and Lean Clay	Outslope Material (Dam)	Lean Clay with Sand (CL) (Dam)	Sandy Lean Clay (CL)(Dike)	Lean Clay (CL) (Dam)
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	132.7	134.1	125.8	132	128	133.5	134.6	125.8
Cohesion [psf]	120	72	200	0	200	260	14.4	220
Friction Angle [deg]	32.3	30.4	33.7	31	30	30.6	33.3	30.4
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1	1	1

Property	Lean Clay (CL) 2
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	129.7
Cohesion [psf]	14.4
Friction Angle [deg]	28.7
Water Surface	Water Table
Hu Value	1

Global Minimums

Method: bishop simplified

FS: 1.146920
Center: 169.832, 521.855
Radius: 150.630
Left Slip Surface Endpoint: 103.229, 386.750
Right Slip Surface Endpoint: 283.359, 422.856
Left Slope Intercept: 103.229 386.750
Right Slope Intercept: 283.359 426.279
Resisting Moment=4.1388e+007 lb-ft
Driving Moment=3.60862e+007 lb-ft

Total Slice Area=4300.6 ft2

Valid / Invalid Surfaces

Method: bishop simplified

Number of Valid Surfaces: 27798
Number of Invalid Surfaces: 813

Error Codes:

Error Code -103 reported for 812 surfaces
Error Code -108 reported for 1 surface

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

Slice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.14692

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	2.9517	339.413	Granular Fill and Lean Clay	0	31	80.4502	92.27	153.563	0	153.563
2	9.38923	5181.12	Silty Clay (CL-ML)	200	33.7	558.746	640.837	789.603	128.596	661.007
3	9.38923	10797.8	Silty Clay (CL-ML)	200	33.7	784.082	899.279	1423.39	374.861	1048.53
4	8.05892	13218.6	Lean Clay	72	30.4	715.465	820.581	1841.85	565.927	1275.92
5	8.05892	16561.5	Lean Clay	72	30.4	847.784	972.34	2244.15	709.561	1534.59
6	8.05892	19639.6	Lean Clay	72	30.4	970.425	1113	2598.53	824.191	1774.34
7	7.11739	19518.9	Sandy Lean Clay	120	32.3	1191.41	1366.45	2878.89	907.191	1971.7
8	7.11739	21628	Sandy Lean Clay	120	32.3	1296.89	1487.43	3125.23	962.17	2163.06
9	7.11739	23899.4	Sandy Lean Clay	120	32.3	1421.59	1630.45	3385.29	995.992	2389.3
10	7.11739	25852.9	Sandy Lean Clay	120	32.3	1527.15	1751.52	3589.6	1008.79	2580.81
11	7.97951	30912.3	Lean Clay	72	30.4	1474.5	1691.13	3758.42	998.688	2759.74
12	7.97951	32613.8	Lean Clay	72	30.4	1555.8	1784.38	3881.46	962.77	2918.69
13	7.97951	34074	Lean Clay	72	30.4	1630.67	1870.25	3964.78	899.728	3065.05
14	7.97951	35060.3	Lean Clay	72	30.4	1686.13	1933.86	3982.32	808.85	3173.47
15	7.97951	35547.6	Lean Clay	72	30.4	1722.09	1975.1	3932.9	689.137	3243.76
16	7.97951	35611.6	Lean Clay	72	30.4	1688.19	1936.22	3846.3	668.812	3177.49
17	8.30823	36828.4	Silty Clay (CL-ML)	200	33.7	1874.3	2149.67	3621.62	698.224	2923.4
18	8.30823	36298.1	Silty Clay (CL-ML)	200	33.7	1786.34	2048.79	3462.85	690.709	2772.14
19	4.95864	21118.6	Granular Fill and Lean Clay	0	31	1451.21	1664.42	3429.39	659.333	2770.06
20	5.12784	21134.1	Lean Clay with Sand (CL) (Dam)	260	30.6	1539.33	1765.49	3159.94	614.305	2545.64
21	4.73463	18862	Lean Clay (CL) (Dam)	220	30.4	1443.82	1655.95	3001.55	554.028	2447.52
22	6.60985	24515	Sandy Lean Clay (CL)(Dike)	14.4	33.3	1310.13	1502.61	2725.55	459.958	2265.59
23	6.60985	20127.3	Sandy Lean Clay (CL)(Dike)	14.4	33.3	1061.56	1217.53	2150.92	319.337	1831.59

24	6.60985	13526.4	Sandy Lean Clay (CL)(Dike)	14.4	33.3	565.291	648.343	1510.28	545.202	965.081
25	6.60985	5362.88	Sandy Lean Clay (CL)(Dike)	14.4	33.3	141.118	161.851	659.69	435.217	224.473

Interslice Data

Global Minimum Query (bishop simplified) - Safety Factor: 1.14692

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	103.229	386.75	0	0	0
2	106.18	385.335	374.121	0	0
3	115.57	381.338	7543.64	0	0
4	124.959	378.064	16998.2	0	0
5	133.018	375.793	23804.5	0	0
6	141.077	373.995	30733.8	0	0
7	149.136	372.654	37371.2	0	0
8	156.253	371.839	43557.5	0	0
9	163.37	371.364	49129.3	0	0
10	170.488	371.227	54029.8	0	0
11	177.605	371.426	58037.4	0	0
12	185.585	372.051	60103.9	0	0
13	193.564	373.107	60668.5	0	0
14	201.544	374.601	59653.7	0	0
15	209.523	376.549	57017.3	0	0
16	217.503	378.968	52794.3	0	0
17	225.482	381.882	46588	0	0
18	233.79	385.478	40381	0	0
19	242.099	389.693	31998	0	0
20	247.057	392.528	24451.6	0	0
21	252.185	395.731	17198.2	0	0
22	256.92	398.953	9880.41	0	0
23	263.53	403.914	-811.059	0	0
24	270.139	409.482	-10555.3	0	0
25	276.749	415.751	-19503.3	0	0
26	283.359	422.856	365.715	0	0

List Of Coordinates

Water Table

X	Y
-1.11022e-016	380.175
75.344	380.175
77.002	383.846
82.5127	384.456
217.136	388.922
221.8	391.3
267.7	412.21
276.537	426.277

285	426.28

External Boundary

X	Y
276.537	426.277
270.621	429.244
264.923	429.374
259.45	429.143
250.06	425.382
237.754	421.038
216.209	413.372
187.674	403.549
156.481	394.047
133.994	390.347
132.225	390.139
106.149	387.073
82.5127	384.456
77.002	383.846
75.344	380.175
68.53	380.645
67.51	383.799
59.536	386.037
0	385.411
0	383.8
1.38778e-017	375.3
0	371.5
0	366.9
0	359.5
40	359.5
132.2	367
172.029	370.145
265	377.7
285	378.7
285	383.6
285	390.6
285	393.6
285	396.6
285	399.6
285	422.033

Material Boundary

X	Y
0	366.9
40	366.9
132.2	371.3
201	376.8
172.029	370.145

Material Boundary

X	Y
1.38778e-017	375.3
40	375.3
132.2	378.3
265	383.4
285	383.6

Material Boundary

X	Y
82.5127	384.456
132.2	386.3
265	390.4
285	390.6

Material Boundary

X	Y
0	383.8
40	383.8
67.51	383.799

Material Boundary

X	Y
106.149	387.073
132.2	388.3
221.8	391.3
265	393.4
285	393.6

Material Boundary

X	Y
221.8	391.3
224.786	394.301
227.81	397.341
259.45	429.143

Material Boundary

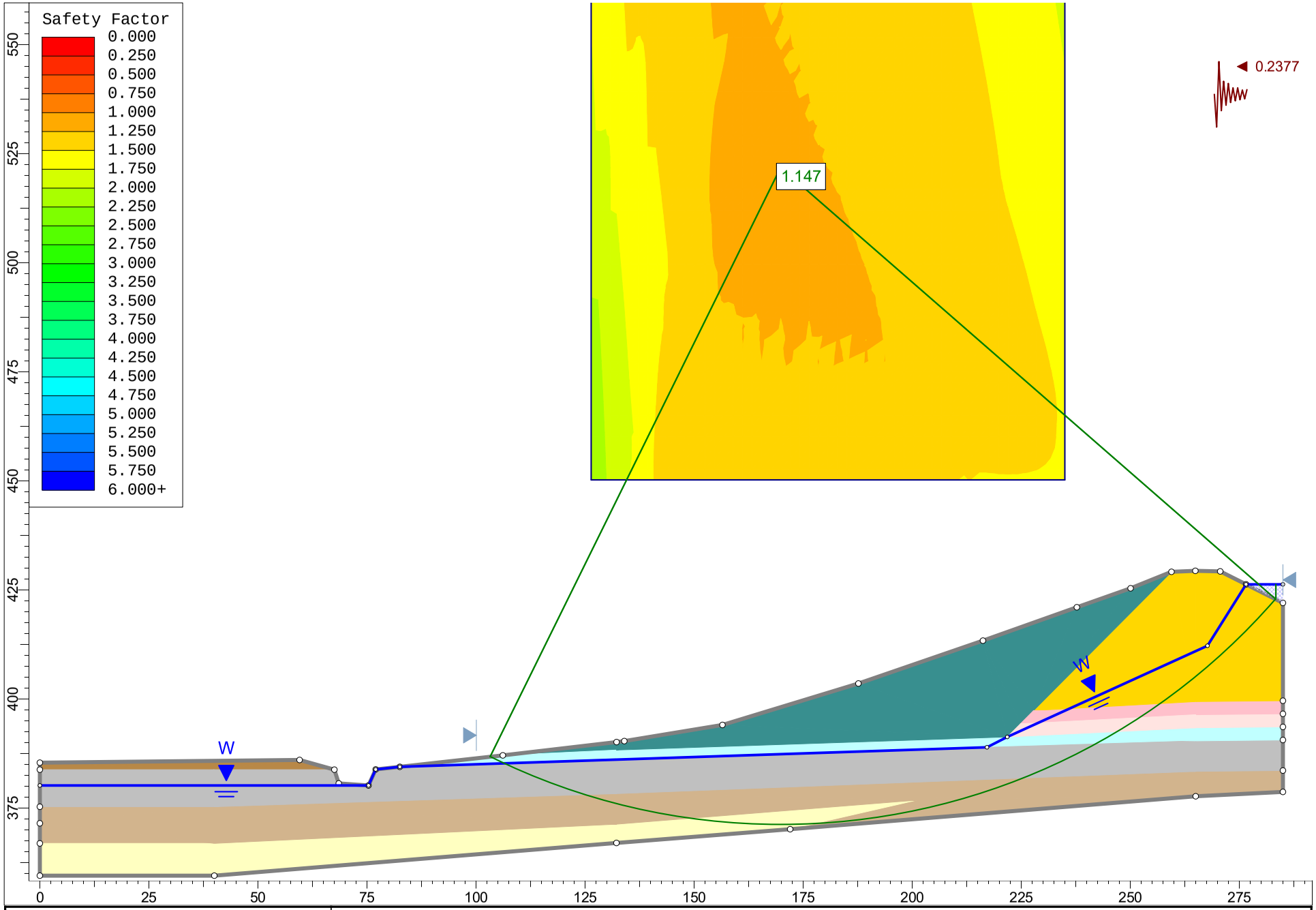
X	Y
224.786	394.301
265	396.4
285	396.6

Material Boundary

X	Y

227.81	397.341
265	399.4
285	399.6

SLIDEINTERPRET 6.039	*Project* BREC Reid/HMPL Station CCR Surface Impoundment		
	Analysis Description Cross Section RH-3 Seismic Loading Conditon		
	Drawn By	*Scale*	*Company* Associated Engineers, Inc.
	Date 8/29/2016, 2:56:23 PM		*File Name* RH-3 Seis.slim



	Project: BREC Reid/HMPL Station CCR Surface Impoundment		
	Analysis Description: Cross Section RH-3 Seismic Loading Conditon		
	Drawn By:	Scale: 1:360	Company: Associated Engineers, Inc.
SLIDEINTERPRET 6.039	Date: 8/29/2016, 2:56:23 PM		File Name: RH-3 Seis.slim

Slide Analysis Information

BREC Reid HMPL Station CCR Surface Impoundment

Project Summary

File Name: RH-4
Last saved with Slide version: 6.039
Project Title: BREC Reid HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-4 Maximum Storage Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/4/2016, 12:09:41 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Lean Clay (CL)	Silty Clay (CL-ML)	Lean Clay With Sand (CL) (Dam)	Lean Clay (CL) (Dam)	Silty Sand (SM)	Outslope Material (Dam)	Lean Clay (CL) (1)	Lean Clay (CL)/Clayey Sand (SC)
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	134.1	125.8	133.5	125.8	130	128	129.7	125.8
Cohesion [psf]	72	200	260	220	0	200	14.4	80
Friction Angle [deg]	30.4	33.7	30.6	30.4	33	30	28.7	29.6
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1	1	1

List Of Coordinates

Water Table

X	Y
2.77556e-017	393.033
55.19	393.033
71.2842	395.917
141	397
151.1	397
185.3	405.78
200.877	426.28
215	426.28

External Boundary

X	Y
215	418.777
213.982	419.318
205.956	423.582
196.055	428.841
189.723	429.373
183.027	428.888
164.711	421.366
139.268	413.482
115.733	405.895
88.257	398.958
75.6909	396.706
71.2842	395.917
55.19	393.033
31.267	393.626
21.125	395.865
0	405.212
2.77556e-017	393.033
0	375.2
70.69	375.4
189.72	377.7
215	377.9
215	385.1
215	398.2
215	409.5

Material Boundary

X	Y
141	400
141	397
145.463	397
151.1	397
163.168	409.053
173.086	418.959
177.455	423.323
183.027	428.888

Material Boundary

X	Y
163.168	409.053
189.8	409.4

215	409.5

Material Boundary

X	Y
151.1	397
189.8	398
215	398.2

Material Boundary

X	Y
141	397
70.7	392.8
36.8	391
70.7	389.5
79.6711	389.266
189.8	386.4
215	385.1

Material Boundary

X	Y
71.2842	395.917
141	397

Material Boundary

X	Y
88.257	398.958
141	400

Material Boundary

X	Y
173.086	418.959
189.8	419.1

Material Boundary

X	Y
189.8	419.1
213.982	419.318

Material Boundary

X	Y
177.455	423.323
189.8	423.4

Material Boundary

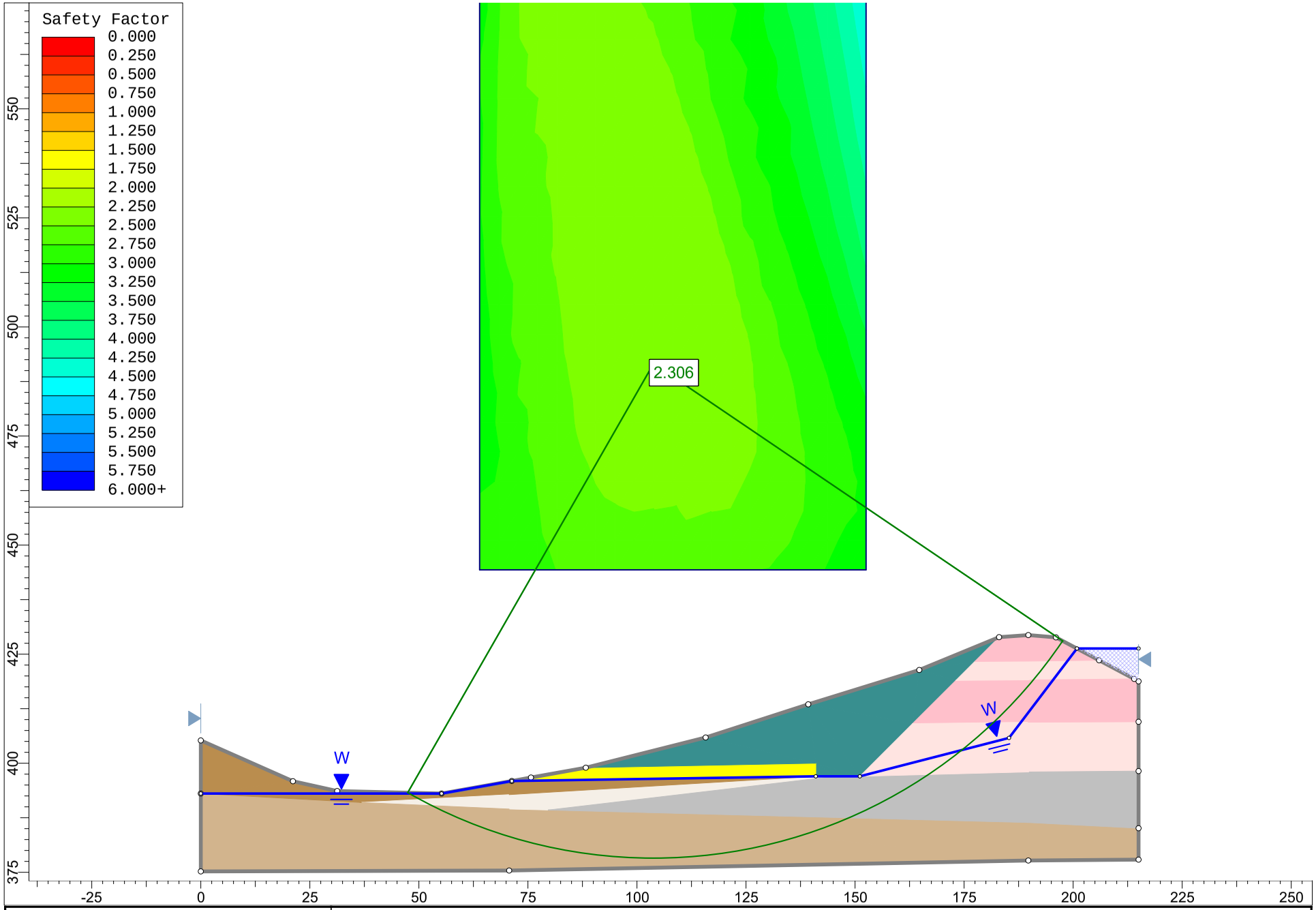
X	Y
189.8	423.4
205.956	423.582

Material Boundary

X	Y
2.77556e-017	393.033
36.8	391

Material Boundary

X	Y
79.6711	389.266
145.463	397



Project	BREC Reid HMPL Station CCR Surface Impoundment		
Analysis Description	Cross Section RH-4 Maximum Storage Pool Loading Condition		
Drawn By		Scale 1:360	Company Associated Engineers, Inc.
Date	9/4/2016, 12:09:41 PM		File Name RH-4.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

BREC Reid/HMPL Station CCR Surface Impoundment

Project Summary

File Name: RH-4 Surcharge
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-4 Maximum Surcharge Pool Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/4/2016, 12:09:41 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Lean Clay (CL)	Silty Clay (CL-ML)	Lean Clay With Sand (CL) (Dam)	Lean Clay (CL) (Dam)	Silty Sand (SM)	Outslope Material (Dam)	Lean Clay (CL) (1)	Lean Clay (CL)/Clayey Sand (SC)
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	134.1	125.8	133.5	125.8	130	128	129.7	125.8
Cohesion [psf]	72	200	260	220	0	200	14.4	80
Friction Angle [deg]	30.4	33.7	30.6	30.4	33	30	28.7	29.6
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1	1	1

List Of Coordinates

Water Table

X	Y
2.77556e-017	393.033
55.19	393.033
71.2842	395.917
141	397
151.1	397
185.3	405.78
198.372	427.61
215	427.61

External Boundary

X	Y
215	418.777
213.982	419.318
205.956	423.582
196.055	428.841
189.723	429.373
183.027	428.888
164.711	421.366
139.268	413.482
115.733	405.895
88.257	398.958
75.6909	396.706
71.2842	395.917
55.19	393.033
31.267	393.626
21.125	395.865
0	405.212
2.77556e-017	393.033
0	375.2
70.69	375.4
189.72	377.7
215	377.9
215	385.1
215	398.2
215	409.5

Material Boundary

X	Y
141	400
141	397
145.463	397
151.1	397
163.168	409.053
173.086	418.959
177.455	423.323
183.027	428.888

Material Boundary

X	Y
163.168	409.053
189.8	409.4

215	409.5

Material Boundary

X	Y
151.1	397
189.8	398
215	398.2

Material Boundary

X	Y
141	397
70.7	392.8
36.8	391
70.7	389.5
79.6711	389.266
189.8	386.4
215	385.1

Material Boundary

X	Y
71.2842	395.917
141	397

Material Boundary

X	Y
88.257	398.958
141	400

Material Boundary

X	Y
173.086	418.959
189.8	419.1

Material Boundary

X	Y
189.8	419.1
213.982	419.318

Material Boundary

X	Y
177.455	423.323
189.8	423.4

Material Boundary

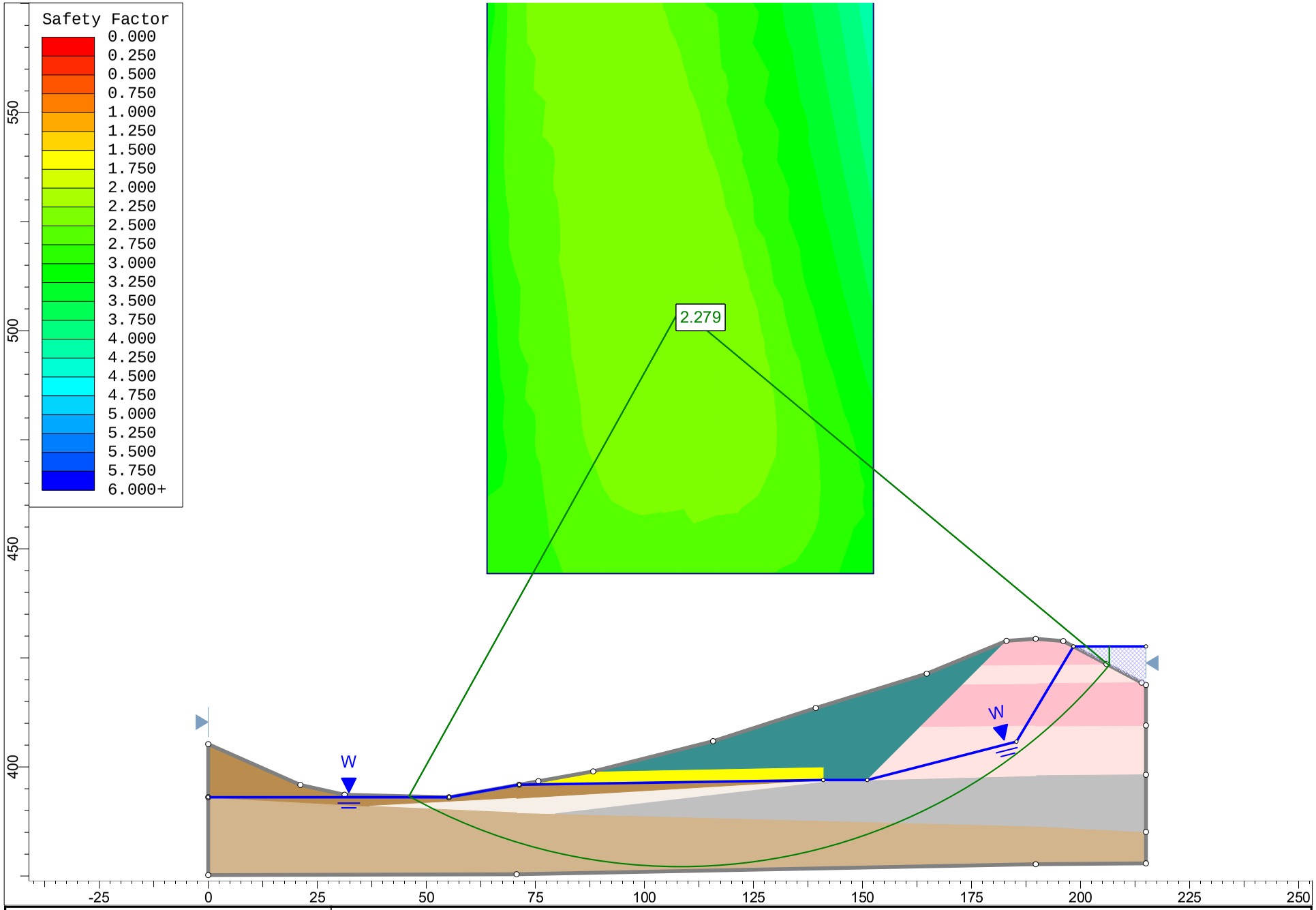
X	Y
189.8	423.4
205.956	423.582

Material Boundary

X	Y
2.77556e-017	393.033
36.8	391

Material Boundary

X	Y
79.6711	389.266
145.463	397



rocscience	Project	BREC Reid/HMPL Station CCR Surface Impoundment		
	Analysis Description	Cross Section RH-4 Maximum Surcharge Pool Loading Condition		
	Drawn By		Scale 1:360	Company Associated Engineers, Inc.
	Date	9/4/2016, 12:09:41 PM		File Name RH-4 Surcharge.slim

SLIDEINTERPRET 6.039

Slide Analysis Information

BREC Reid/HMPL Station CCR Surface Impoundment

Project Summary

File Name: RH-4 Seis 2
Last saved with Slide version: 6.039
Project Title: BREC Reid/HMPL Station CCR Surface Impoundment
Analysis: Cross Section RH-4 Seismic Loading Condition
Company: Associated Engineers, Inc.
Date Created: 9/4/2016, 12:09:41 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

Seismic Load Coefficient (Horizontal): 0.2377

Material Properties

Property	Lean clay	Silty clay	Lean Clay with sand (dike)	Lean clay (dike)	Silty sand (SM)	Sandy wedge	Lean clay OG	Lean clay with sand
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	134.1	125.8	133.5	125.8	130	130	129.7	125.8
Cohesion [psf]	72	200	260	220	0	200	14.4	80
Friction Angle [deg]	30.4	33.7	30.6	30.4	33	30	28.7	29.6
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1	1	1	1

List Of Coordinates

Water Table

X	Y
2.77556e-017	393.033
55.19	393.033
71.2842	395.917
141	397
151.1	397
185.3	405.78
200.877	426.28
215	426.28

External Boundary

X	Y
215	418.777
213.982	419.318
205.956	423.582
196.055	428.841
189.723	429.373
183.027	428.888
164.711	421.366
139.268	413.482
115.733	405.895
88.257	398.958
75.6909	396.706
71.2842	395.917
55.19	393.033
31.267	393.626
21.125	395.865
0	405.212
2.77556e-017	393.033
0	375.2
70.69	375.4
189.72	377.7
215	377.9
215	385.1
215	398.2
215	409.5

Material Boundary

X	Y
141	400
141	397
145.463	397
151.1	397
163.168	409.053
173.086	418.959
177.455	423.323
183.027	428.888

Material Boundary

X	Y
163.168	409.053

189.8	409.4
215	409.5

Material Boundary

X	Y
151.1	397
189.8	398
215	398.2

Material Boundary

X	Y
141	397
70.7	392.8
36.8	391
70.7	389.5
79.6711	389.266
189.8	386.4
215	385.1

Material Boundary

X	Y
71.2842	395.917
141	397

Material Boundary

X	Y
88.257	398.958
141	400

Material Boundary

X	Y
173.086	418.959
189.8	419.1

Material Boundary

X	Y
189.8	419.1
213.982	419.318

Material Boundary

X	Y
177.455	423.323
189.8	423.4

Material Boundary

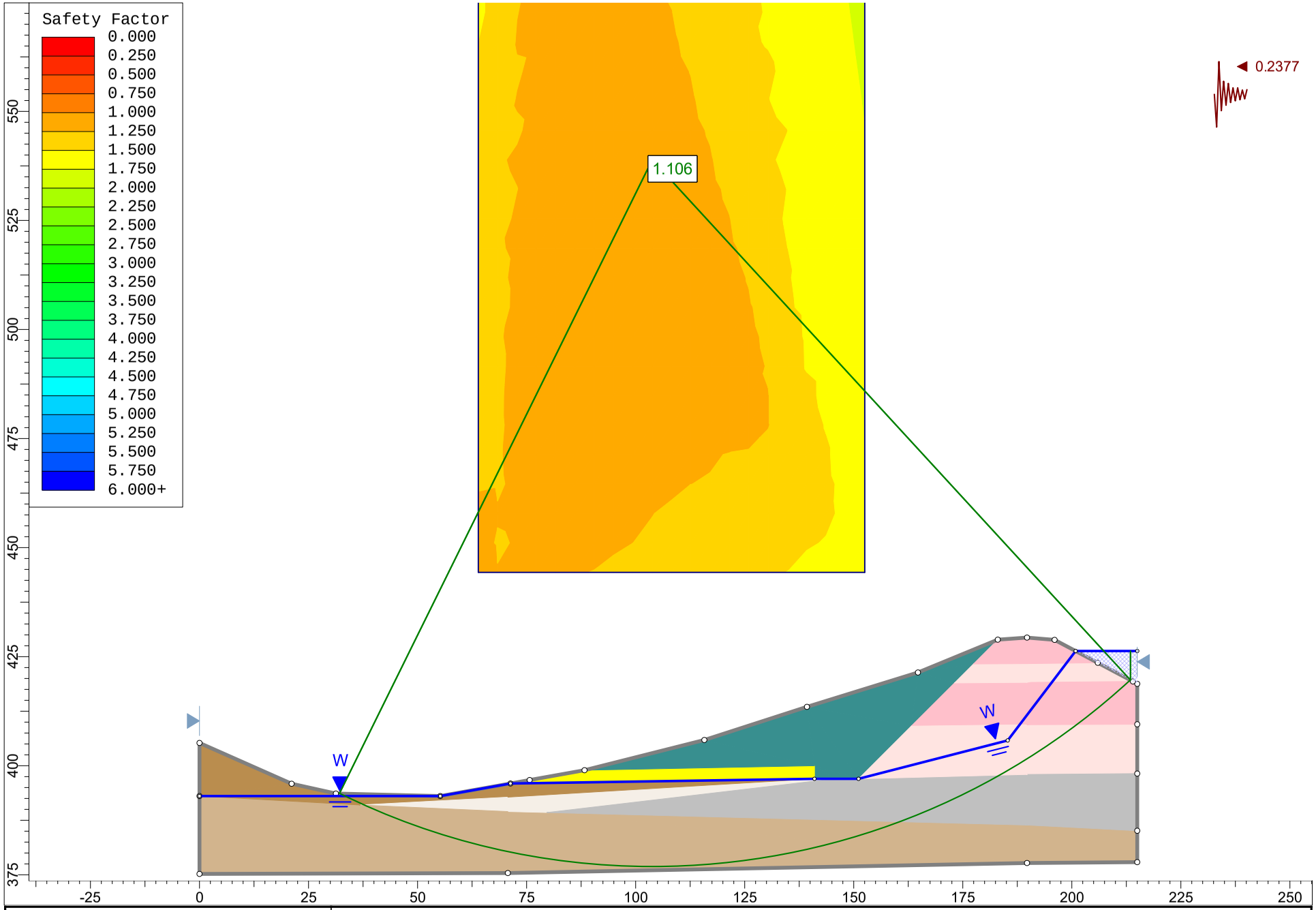
X	Y
189.8	423.4
205.956	423.582

Material Boundary

X	Y
2.77556e-017	393.033
36.8	391

Material Boundary

X	Y
79.6711	389.266
145.463	397



rocscience	Project: BREC Reid/HMPL Station CCR Surface Impoundment		
	Analysis Description: Cross Section RH-4 Seismic Loading Condition		
	Drawn By:	Scale: 1:360	Company: Associated Engineers, Inc.
	Date: 9/4/2016, 12:09:41 PM		File Name: RH-4 Seis 2.slim

SLIDEINTERPRET 6.039