DESIGN REPORT
CAMINADA HEADLANDS BACK BARRIER
MARSH CREATION INCREMENT II (BA-193)

LAFOURCHE & JEFFERSON PARISHES, LOUISIANA

September 19, 2018
File No.: 17-2810

Coastal Protection and Restoration Authority
P.O. Box 44027
Baton Rouge, LA 70804

Attention: Ms. Renee Bennett– PMP
Renee.s.bennett@la.gov

Re: Design Report
Caminada Headlands Back Barrier Marsh Creation Increment II (BA-193)
Lafourche & Jefferson Parishes, Louisiana

We have completed our geotechnical analyses associated with the Caminada Headlands Back Barrier Marsh Creation Increment II (BA-193) project. A summary of the results of our analyses and recommendations for the proposed marsh creation are provided herein. A portion of this work was authorized by Task #5 Notice to Proceed dated February 13, 2017 under our previous contract No. 4400005545, and by Task #2, Amendment #1 Notice to Proceed dated February 19, 2018 under our current contract No. 4400012418 with the Coastal Protection and Restoration Authority (CPRA).

Sincerely,
ARDAMAN & ASSOCIATES, INC.
LAPELS NO. EF.0001680

MARK L. WOODWARD, P.E.
PRINCIPAL GEOTECHNICAL ENGINEER

GEORGE F. SEGRÉ QUILICHINI, P.E.
PROJECT ENGINEER
LOUISIANA LICENSE NO. 42229

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CAMINADA HEADLANDS BACK BARRIER MARSH CREATION INCREMENT II (BA-193)

LAFOURCHE & JEFFERSON PARISHES, LOUISIANA

This Design Report summarizes results of our geotechnical engineering analyses and presents basic design and construction recommendations for the proposed marsh creation area associated with the Caminada Headlands Back Barrier Marsh Creation Increment II (BA-193) project. Design recommendations were developed based on results of stability and settlement analyses that incorporated results of the geotechnical field exploration and laboratory testing phase of the project as documented in our April 17, 2018 Final Data Report. Copies of the previous Ardaman reports on which this design report is based are provided in Appendix A. Furnished reports by other consultants that were reviewed and used to supplement our data report are provided in Appendix B for reference. The calculation package for this report is provided in Appendix C, inclusive of slope stability and settlement calculations.

SECTION 1. GENERAL PROJECT INFORMATION

1.1 Project Description

According to the Coastal Protection and Restoration Authority (CPRA), the Caminada Headland has experienced some of the highest shoreline retreat rates in Louisiana, with recent measurements exceeding 80 feet per year between 2006 and 2011. These increased losses are said to have occured in the wake of Hurricanes, which formed breaches in the headlands that remained open for extended periods of time, thus increasing the net export of sediment from the headlands. The Caminada Headlands Back Barrier Marsh Creation Increment II (BA-193) project has two main goals: i) to create and/or nourish 444 acres of back barrier marsh through the use of pumped sediment from an offshore borrow site; and (ii) to create a platform upon which the beach and dune can migrate, thereby reducing the likelihood of breaching. The proposed project is expected to slow the current trend of degradation in the headland.

A detailed description of the field exploration and laboratory testing phases of the project, along with boring logs, boring location plans, subsurface profiles, and plots of laboratory data is presented in our Final Data Report, dated April 17, 2018. Borrow material selection and design properties are discussed in our Final Geotechnical Data Report – Offshore Borrow Investigation Report No. 17-2810A and dated February 9, 2018. Copies of these reports are provided in Appendix A of this report.

1.2 Site Location and Description

The site is located in Region 2 of the Barataria Basin in Lafourche and Jefferson Parishes. The entirety of the Caminada Headlands project lies between La Hwy. 3090 in Port Fourchon to the South and Caminada Pass to the Northwest, encompassing about 9 miles of beach dunes. The Increment II (BA-193) project encompasses an alignment of about six miles (Figure 1). Figures 2 through 4 depict the subsurface extent of the subsurface exploration across the site.

1.3 Site Geology

The site is located on a historical delta coast, which benefited from Bayou Lafourche, Bayou Moreau, and other distributaries to these bayous. In 1905, the flow into Bayou Lafourche from the Mississippi River was substantially reduced as a result of impounding efforts upstream near Donaldsonville, Louisiana. Geologically, the site is mainly comprised of Holocene Age barrier island type beach deposits in the near surface, which can be underlain by nearshore, intra-delta, or inter-distributary deposits to about Elev. -100 feet, NGVD. These are underlain by prodelta and nearshore deposits to about Elev. -180 to -200 feet, NGVD where Pleistocene Age substratum sands are encountered as can be seen on Figure 5.

SECTION 2. SOIL CONDITIONS

The subsurface conditions, in terms of soil classification, geotechnical index properties, effective stress history and undrained shear strength profiles, encountered at the boring locations in the marsh creation area exhibit some degree of variability within the project area. It should be noted that Ardaman's subsurface exploration was performed near the back of the Caminada Headlands (land side) and away from the dunes, which are located on the south side (Gulf Side) and are characteristically sandy. The marshlands were observed to vary along the alignment. Therefore, the project alignment was subdivided into three (3) discrete reaches.

- Reach 1 – Ranges from approximately CPT-28 to Boring B-10 (≈10,500 feet)
- Reach 2 – Ranges from approximately Boring B-10 to B-11 (≈8,500 feet)
- Reach 3 – Ranges from approximately Boring B-11 to CPT-53 (≈8,900 feet)

In general, the soil profiles encountered across the alignment were observed to consist of a very soft to soft silty clay (CL), clay (CH), or organic clay (OH) near surface layer ranging in thickness between 6 and 12 feet. These were generally underlain by a more competent and/or more granular soil consisting of clayey sands and silts. The remainder of the explored depth of 40 feet consisted of alternating layers of cohesive and granular soils. A detailed characterization of the site, along with supporting field exploration and laboratory testing results, is documented in our April 17, 2018 Final Data Report (Appendix A).

SECTION 3. FURNISHED DATA

The following sections present a brief description of previously performed subsurface investigations at the project site, which were furnished to Ardaman & Associates, Inc. (Ardaman) by CPRA.

3.1 Furnished Documents

Copies of the furnished reports listed below are provided in Appendix B.

1- A document entitled “BA-45 Caminada Headland Data Collection Report.pdf”, the Final Data Report provided by GeoEngineers for CPRA, dated September 8, 2010. The report contains a discussion of the site geology, and subsurface conditions. The report also contains the results of the laboratory testing phase in terms of soil boring logs, grain size curves, consolidation tests, and summary tables. The investigation consisted of eighteen (18) soil borings performed between Port Fourchon and Grand Isle on the Gulf Side or south side of the project alignment.

2- A document entitled “Barataria_Basin_Geotechnical_Investigation_Data_Report.pdf”, the Final Data Report provided by Professional Service Industries (PSI) for the Louisiana Department of Natural Resources (LA DNR), dated April 3, 2007. The report contains a discussion of the field exploration and laboratory testing phase of work. The report also details the results of the laboratory testing phase in terms of soil boring logs, Unconfimed Compression (UC) and Unconsolidated-Undrained Triaxial Compression (UU) test stress-strain curves, grain size curves, consolidation tests, specific gravity tests, hydrometer analyses, and summary tables. The investigation consisted of eight (8) soil borings performed between Port Fourchon and Grand Isle, the location of these where staggered between the dunes and the marshland. Soil borings B-1 through B-4 were sampled utilizing 5-inch dimeter Shelby Tubes, whereas borings B-5 through B-8 were obtained using 3-inch diameter Shelby Tubes.

3- A document entitled “Caminada Back Barrier Survey Methodology Report.pdf”, the Survey Methodology report prepared by HydroTerra Technologies, LLC. for CPRA, dated June 1, 2017. The report contains the methodology employed during a topographic, magnetometer, and healthy marsh survey of the Caminada marsh creation area.

4- A document entitled “BA-193 Caminada Headlands Back Barrier Marsh Creation Survey (Rev. 05-31-17).pdf”, the results of the survey prepared by HydroTerra Technologies, LLC for CPRA, dated May 31, 2017. This report contains a series of cross sections taken across the project site, shows the location of magnetometer anomalies, and provides the location of the healthy marsh survey.

3.2 Review of Furnished Information

In general, the subsurface exploration performed by GeoEngineers was located on the southern boundary of the project alignment and offset towards the dunes (beach). GeoEngineers performed a total of eighteen (18) soil borings, of which ten (10) are located within the Caminada Increment II project’s alignment. The subsurface exploration performed by PSI included a total of eight (8) soil borings, of which five (5) are located within the Increment II project’s alignment. These soil borings were somewhat staggered, having two (2) borings performed near the dunes, and three (3) borings performed approximately 300- to 600-feet landward towards the back barrier. Figure 4 presents a boring location plan for the PSI, GeoEngineers, and Ardaman subsurface exploration.

3.2.1 Review of Furnished Information – Consolidation Tests

A total of thirty (30) consolidation tests were performed by GeoEngineers and PSI. Plots depicting correlations between moisture content, liquid limit, and the compression index are provided on Figure 6. These correlations were employed in analyses to estimate the compression index of the subsoils. A plot depicting the maximum past pressure, or pre-consolidation pressure, obtained using the Casagrande reconstruction method is provided on Figure 7 alongside a computed vertical effective stress profile. The vertical effective stress profile is based on an average total unit weight of 90 pounds per cubic foot (pcf), and a water table located at the ground surface. As can be seen, a portion of test data plot below this line, which may indicate some degree of sample disturbance; under-consolidated conditions are not anticipated. However, most data plots above this line, suggesting a slightly overconsolidated stress history in general. Similarly, some of the undrained shear strength data are also significantly higher than what would be expected assuming the normalized behavior of a normally consolidated clay profile, thereby indicating that some of the cohesive soils located at depth are overconsolidated.

3.2.2 Review of Furnished Information – Subsurface Granular Layers

The presence of a subsurface granular strata such as silts, sand, or silty sands hydraulically connected to the Gulf of Mexico would provide a means to dissipate excess pore pressures at an accelerated rate. Specifically, the presence of such layers, if sufficiently persistent, would provide a double-drainage boundary condition to the overlying clays, which greatly accelerates consolidation settlements. Based on a review of the furnished borings, there are many intermediate granular layers that may provide a means for dissipation of excess pore-water pressure. Although it is not explicitly clear if these layers are connected to one another, or to the Gulf of Mexico, the number and thickness of these layers suggest that pore-water may flow relatively freely within these intermediate granular layers. It should be noted that the estimated consolidation settlements may vary significantly within the project alignment depending on the thickness of these granular layers. Figure 8 presents a simple “fence diagram” of all the borings located within the project limits. As can be seen, the thickness of the clay layers varies significantly between the western and eastern limits as well as between the dunes and back barrier. Figure 9 presents another fence diagram depicting the soil boring and cone penetration test (CPT) sounding data obtained during Ardaman’s field investigation and laboratory testing phases. As can be seen, the data indicate that the project alignment can be grouped into three (3) design reaches.

SECTION 4. ANALYSES

4.1 Marsh Creation Area Overview

The Caminada Headlands Back Barrier Marsh Creation project will consist of constructing an earthen containment dike around the perimeter of the marsh creation area. Within the containment dike, borrow material will be hydraulically pumped to create approximately 444 acres of emergent marsh. A typical containment dike/marsh creation cross section was developed in conjunction with the results of our stability and settlement analyses. Based on furnished information, the elevation of marsh platforms and the frequency with which they flood has a significant impact on the marsh vegetation, and in turn, marsh health. The target range for these marshlands should be between a 20% chance of inundation (flooding) and 80% chance of inundation with a 20-year eustatic and relative sea level rise of about 0.472 feet. Therefore, the target marsh elevation for this project was fixed between the 20% and 80% inundation elevation over the design life of this project. The target marsh elevations are summarized in the following table.

TABLE 1 – TARGET MARSH ELEVATION OVER TIME

Time (year)	80% Inundation (feet, NAVD88)	20% Inundation (feet, NAVD88)
0	-0.150	+0.750
20	+0.322	+1.222

The marsh creation containment dike should have a design freeboard of 1.0 foot above the marsh elevation at all times during the construction phase. Per CPRA guidance the containment dike should have a minimum crest width of 5 feet, minimum side slopes of 1V:4.0H, and a minimum 20-feet bench offset from the edge of a borrow area. It is further understood that a surcharge load on the order of 260 pounds per square foot (psf) should be considered between the toe of the containment dike and the borrow area when analyzing the stability of the containment dike. This surcharge load is intended to represent the equipment that will be used to construct the containment dike.

4.2 Settlement Evaluation

The natural ground clay deposits on which the proposed containment dikes and marsh fill areas will be constructed are characteristically soft and compressible. Detailed two-dimensional consolidation settlement calculations were performed for the containment dike geometry and one-dimensional analyses were undertaken for the marsh creation area. The analyses were performed in an iterative fashion, in conjunction with the stability analyses, to converge on the containment dike and marsh construction grades needed to: (i) achieve the target minimum 20-year marsh elevation; (ii) provide at least 1 foot of freeboard at all times; (iii) achieve intertidal marsh conditions within about 5 years after construction; and (iv) maintain adequate slope stability factors of safety.

4.2.1 Initial Undrained Settlement (During Containment Dike Construction)

When fill is placed to construct a containment dike, shear stresses induced in the underlying marsh clay may cause lateral deformations of the soil that result in a vertical settlement of the fill, particularly when those shear stresses approach the undrained shear strength of the clay. This initial undrained settlement was estimated using the method developed for a two-dimensional strip loading on soft plastic and organic clays by Foott and Ladd, 1981. The method utilizes undrained shear modulus values derived from the consolidated-undrained direct simple shear strength tests (CKoUDSS). This type of test was not performed for this project, however, Ardaman has performed several CKoUDSS tests on similar marsh soils in conjunction with other CPRA investigations.

The estimated initial undrained settlements for the Caminada Headlands Back Barrier Marsh Creation project containment dike ranges between 4 and 11 inches for a design dike crest between Elev. +3 and +4 feet, NAVD88 within Reach 1 and 2. It is estimated that Reach 3 may experience significantly more initial undrained settlements which may be reflected as a mud-wave. These estimates are based on shear stresses corresponding to the end of construction for dike sections built rapidly and a somewhat conservative undrained shear modulus obtained from the previous investigations and empirical relationships. The calculations are presented on Figures 10 through 15 alongside the bearing capacity calculation and summarized in the following table:

TABLE 2 – INITIAL UNDRAINED SETTLEMENT

Soil Profile	Mudline & Crest Elevation (feet, NAVD88)	Initial Undrained Settlement (inch)
Reach 1	-2.0 / +4.0	≈ 4
Reach 2	-2.0 / +4.0	≈ 7
Reach 3	-2.0 / +4.0	≈ 11

4.2.2 Consolidation Settlement – Containment Dike

Primary consolidation refers to volume changes in the foundation soils resulting from dissipation of load-induced excess pore-water pressures in the subgrade over time. A series of four (4) one-dimensional incremental consolidation tests were performed by Ardaman during the laboratory testing phase to enable assessment of the stress history and determination of one-dimensional stress-deformation and time-rate of consolidation characteristics of the marsh clay deposits, which dictate post-construction deformations. In addition, data obtained from previously performed subsurface explorations were also utilized in design.

Laboratory test data indicate, particularly within the upper few feet, that the preconsolidation is “apparent”, and most likely results from post-deposition drained creep, seasonal fluctuations of the water table, vegetation, and partial desiccation. Given that initial recompression behavior in the laboratory can be influenced by sample disturbance (sampling stress relaxation, etc.), an unload-reload sequence was included to enable better assessment of *in-situ* recompression behavior.

Elements with *in-situ* vertical effective stresses less than the maximum past pressure are considered to be overconsolidated. These two stresses define the stress history of a clay element which, in turn, influences its compression behavior when loaded (i.e., whether the clay exhibits virgin compression or recompression behavior).

Consolidation analyses were performed for the proposed containment dike and the underlying foundation soils using the computer program *Settle3D*, Version 4.014, from RocScience, Inc. The consolidation analyses consider the intermediate granular layers at depth, which influence the time-rate of consolidation. Additionally, they incorporate the maximum past pressure profile, which will reduce the magnitude of the estimate settlements wherever overconsolidated cohesive soils are present.

Based on idealized containment dikes with a crest width of 5 feet and crest elevations ranging between Elev. +3 and +4 feet, NAVD88, and 4H:1V side slopes, we estimated about 11 to 16 inches of consolidation settlement occurring within about 100 days of construction and a total of about 18 inches of post-construction settlement during the 20-year project life. Results of stability analyses discussed later in Section 4.3 suggest that the design side slopes may need to be flattened in parts of the project's alignment, which would slightly increase the calculated estimates. The following table summarizes the cases considered:

TABLE 3 – LONG-TERM CONSOLIDATION SETTLEMENTS

Soil Profile	Crest Elevation (feet, NAVD88)	Consolidation Settlements at 100-days (inches)	Consolidation Settlements at 20-years (inches)
Reach 1	+3.0 / +4.0	≈ 11 / ≈ 13	≈ 14 / ≈ 16
Reach 2	+3.0 / +4.0	≈ 13 / ≈ 16	≈ 14 / ≈ 18
Reach 3	+3.0 / +4.0	≈ 13 / ≈ 15	≈ 13 / ≈ 16

Long term post construction settlement of the containment dikes is expected to be less than the post-dredging subsidence of the marsh creation area surface, however, some of the dike settlement will occur prior to and during dredging. If the marsh creation area is to be subdivided into individual "cells", it is recommended that the cells be filled as soon as their containment dikes are completed. Should the containment berms for the various cells be completed in advance of the dredging operations, it may be necessary to periodically maintain the crest grade in order to compensate for post-construction settlements and maintain the design crest elevation and required minimum freeboard.

4.2.3 Consolidation Settlements - Marsh Creation Area

Post-construction subsidence of the marsh creation area will occur as a result of "self-weight" consolidation and drained creep of the dredged fill, primary and secondary consolidation of the *in-situ* marsh soils, and potential seasonal desiccation of the fill surface. Settlement analyses were performed using the U.S. Army Corps. Of Engineers (USACE) computer program "*Primary Consolidation, Secondary Compression, and Desiccation of Dredged Fill*", for Windows (*PSDDF-W*), Version 2.1 for the dredged fill material and the *Settle3D* program for the underlying *in-situ* soils. Consideration was given to assumed fill increments and ramp-loading rates.

The PSDDF program performs finite difference calculations considering a material coordinate system capable of observing the large strains associated with dredged material deposition and self-weight consolidation. The one-dimensional model is capable of considering a "multi-lift" sequencing of dredged fill placement, with the thickness of each "lift" being the thickness of the slurry immediately prior to the initiation of the consolidation process. Based on discussions with CPRA, the production rate of the dredger was assumed to be about 88 cfs and having a specific gravity of slurry equal to 1.2, which corresponds to a void ratio of about 6.5 for the material exiting the discharge pipe. Assuming ten (10) day construction periods for the fill increments, this corresponds to about 1.86 feet of material being place over this given period.

Consolidation parameters related to self-weight consolidation of the dredged materials, in terms of relationships between void ratio, effective stress, and permeability were selected based on results of the settling column and slurry consolidation tests presented in the February 9, 2018 Offshore Borrow Area Data Report (Appendix A). Pan evaporation rates applicable to desiccation shrinkage estimates were obtained from the LSU-Ben Hur Farm Station, and precipitation rates were obtained from the USC00163807 monitoring station located in Grand Isle, LA.

4.2.3.1 Marsh Creation Area - Primary Consolidation

Post construction subsidence of dredged fill surfaces resulting from primary consolidation of the underlying *in-situ* soil were calculated using Settle3D. The primary consolidation calculations are included in Appendix C and yielded a 20-year settlement magnitude of approximately 8 inches for the component related to primary consolidation of the foundation soils. Based on the calculations presented in Appendix C, the estimated time required for about 90% post-construction primary consolidation in the foundation soils is about 2 years. This primary foundation settlement component is included in the marsh area settlement curves provided on Figures 16 through 18.

4.2.3.2 Marsh Fill - Consolidation and Shrinkage

Marsh creation will be accomplished using hydraulic dredging of native clay from a designated offshore borrow area. Once deposited via dredge discharge into the marsh creation areas, the fill will initially settle under water and begin to compress under its own weight and subsequently under the weight of the gradually added fill. The initial gravity settling and subsequent "compression settling" behavior of the proposed borrow materials were characterized by the performance of three (3) settling column tests. Results of these tests are presented and discussed in our Offshore Borrow Area Investigation Data Report dated February 9, 2018 (Appendix A). Consolidation behavior of the fill was investigated by performing one (1) incremental one-dimensional slurry consolidation test on each of the three composite samples (i.e. Composite V-1, V-2, and V-3). Results of settling column and slurry consolidation tests were evaluated and used to estimate initial settled compressed void ratios, and to select fill properties and consolidation parameters for use in the settlement analyses included in Appendix C.

Primary consolidation calculations for the dredged fill are included in Appendix C. These calculations account for the fact that a portion of the self-weight consolidation occurs during the dredge fill placement process (and hence is compensated for through continued fill placement up until the design target fill elevation is achieved). Total post-construction marsh area subsidence related to primary consolidation of the dredged fill is estimated to be on the order of 4 feet from the idealized "cumulative lift thickness" and is expected to occur within the first few years after fill placement. Subsequent secondary compression is expected to result in about 1 to 2 additional inches of settlement over a 20-year post construction period. Based on discussions with CPRA only one case was considered for design; Target design fill elevation of +2.5 feet, NAVD88 based on the assumed fill rate of 88 cfs with a concentration equal to that of a 1.20 slurry at the discharge pipe. The following table provides a summary of the analyses.

TABLE 4 – SETTLEMENT CURVE CASES

Description	Specific Gravity of Dredge Fluid	Void Ratio of Dredge Slurry
30-Day Construction Period, 1-lift sequence	≈ 1.20	≈ 6.5

It is our understanding that the marsh containment berms will be breached at strategic locations at some time after construction to allow more natural inflow-outflow patterns. Until such time the newly created marsh area is expected to remain essentially saturated (considering particularly that rainfall normally exceeds evaporation in southern Louisiana). As illustrated in the settlement time curves on Figures 16 through 18, subsidence of the marsh surface occurs most rapidly during the early post-construction years. It seems likely that capillarity and rainfall will act to maintain essentially saturated conditions. Assuming that accumulation of organic matter approximately compensates for moisture content reduction within the vegetated root zone, desiccation and shrinkage will not have a significant impact on post-construction behavior of the marsh creation area. This being said, the probability of a particularly dry season where evaporation rates exceed rainfall is not out of the question.

4.3 Slope Stability

Slope stability analyses were performed for the containment dike/marsh creation design section. Because initial and long-term stability is influenced by the geometry, the stability analyses were initially performed in a parametric fashion to enable iterative convergence on design sections having end-of construction crown elevations at least 1 foot above the target fill elevation while also maintaining the borrow excavation geometry with an adequate slope stability factor of safety. Final slope stability analyses for each case were then performed using the over-built crown elevation determined to be required to achieve the 20-year target elevation and the borrow excavation geometry needed to generate the required in-place fill volume (accounting for the anticipated cut/fill ratio).

4.3.1 Method of Analysis

Two-dimensional limit equilibrium stability analyses for the containment dike/marsh creation cross sections were performed using the method of slices and Spencer's method (i.e. assuming a common inclination of inter-slice forces). The SLOPE/W (GeoStudio 2018 Version 9.0.3.15488) computer program was used for calculating slope stability factors of safety for trial failure surfaces. These programs incorporate search routines that, when properly managed, can systematically converge on statically and kinematically admissible critical circular arc and sliding wedge type failure surfaces. Results of the slope stability analyses for containment dike and borrow excavation cross sections are presented and discussed in the following sections.

4.3.2 Containment Dike Sections

A series of stability analyses were performed for the end of construction for the containment dike and during the initial fill phase for the marsh creation area. The marsh creation dike analyses and resulting design cross sections are summarized in the following tables and focused on the following three (3) cases:

- Case A-1 - Global stability check during borrow excavation;
- Case A-2 - Local stability check during borrow excavation with construction equipment surcharge; and
- Case B - Global stability during marsh construction with fluid level at berm crest.

These cases are shown on Figure 19. For all cases considered a 5-foot minimum width of crown was used along with a minimum 20-foot offset distance from the toe of the dike to the edge of the borrow source. For Case A-2, it was assumed that the surcharge would consist of two (2) 5-foot wide loads placed 5 feet apart. These are intended to simulate the tracks mounted on the marsh buggies and marsh excavators that may be utilized to excavate the borrow material and construct the containment dike. Calculated factors of safety for this configuration assumed the track nearest the containment dike would be adjacent to the toe. The computed factors of safety for tracks located at the edge of the excavation were deemed unsafe, therefore the excavator should not cut within 5 feet of the nearest track. In accordance with CPRA guidelines, a minimum design factor of safety of 1.2 was adopted for all cases considered.

The Reach 3 subsoil profile was based on three (3) CPT soundings and supplemented by information obtained from furnished documents. Since no soil borings were performed within this reach, the design parameters were selected somewhat more conservatively than those of Reach 1 and Reach 2. Given the presence of near surface granular material and based on discussions with CPRA, an additional "sand case" was considered for this reach. This case assumes that during the excavation and placement of the earthen containment berm, the sands are mixed thoroughly and are able to provide a frictional resistance to shearing.

The following tables present the minimum factors of safety for the three cases and considering various mudlines elevations, side slopes, and berm crest elevations.

TABLE 5 – SLOPE STABILITY SUMMARY – REACH 1

Mudline Elevation (feet, NAVD88)	Crest Elevation (feet, NAVD88)	Side Slopes	Case Number	Minimum Factor of Safety
-2.0	+3.5	4H:1V	A-1	1.37
			A-2	1.29
			B	1.33
-2.0	+4.0	4H:1V	A-1	1.25
			A-2	1.28
			B	1.22
-3.0	+4.0	4H:1V	A-1	1.26
			A-2	1.33
			B	1.23

Note: All cases considered a 5-foot wide crest width and a 20-foot wide offset from the edge of the containment dike toe to the edge of the borrow excavation

TABLE 6 – SLOPE STABILITY SUMMARY – REACH 2

Mudline Elevation (feet, NAVD88)	Crest Elevation (feet, NAVD88)	Side Slopes	Case Number	Minimum Factor of Safety
-2.0	+3.5	4H:1V	A-1	1.31
			A-2	1.43
			B	1.26
-2.0	+4.0	4H:1V	A-1	1.19
			A-2	1.29
			B	1.15
-2.0	+4.0	4.5H:1V	A-1	1.25
			A-2	1.28
			B	1.21
-3.0	+3.5	4H:1V	A-1	1.29
			A-2	1.43
			B	1.24
-3.0	+4.0	4.5H:1V	A-1	1.24
			A-2	1.43
			B	1.20

Note: All cases considered a 5-foot wide crest width and a 20-foot wide offset from the edge of the containment dike toe to the edge of the borrow excavation

TABLE 7 – SLOPE STABILITY SUMMARY – REACH 3

Mudline Elevation (feet, NAVD88)	Crest Elevation (feet, NAVD88)	Side Slopes	Case Number	Minimum Factor of Safety
-2.0	+3.5	4.5H:1V	A-1	1.27
			A-2	1.38
			B	1.24
-2.0	+4.0	5H:1V	A-1	1.22
			A-2	1.37
			B	1.20
-3.0	+3.5	4.5H:1V	A-1	1.29
			A-2	1.36
			B	1.26
-3.0	+4.0	5H:1V	A-1	1.24
			A-2	1.31
			B	1.22

Note: All cases considered a 5-foot wide crest width and a 25-foot wide offset from the edge of the containment dike toe to the edge of the borrow excavation.

TABLE 8 – SLOPE STABILITY SUMMARY – REACH 3 (SAND CASE)

Mudline Elevation (feet, NAVD88)	Crest Elevation (feet, NAVD88)	Side Slopes	Case Number	Minimum Factor of Safety
-2.0	+3.5	4H:1V	A-1	1.29
			A-2	1.39
			B	1.24
-2.0	+4.0	4H:1V	A-1	1.21
			A-2	1.39
			B	1.22
-3.0	+4.0	4H:1V	A-1	1.30
			A-2	1.34
			B	1.32

Note: All cases considered a 5-foot wide crest width and a 25-foot wide offset from the edge of the containment dike toe to the edge of the borrow excavation.

Given in the foregoing tables are the minimum factors of safety against developing a deep-seated failure as a result of the proposed earthen containment berm, marsh fill loads, and construction loads for the cross sections analyzed. As can be seen, the target minimum factor of safety of 1.20 recommended in the Geotechnical Standards established by CPRA (Version 1.0, dated December 21, 2017) can be achieved.

4.3.3 Borrow Excavation Cross Section

Slope stability analyses were conducted to develop slope and depth recommendations for the borrow excavation that will be required to generate the fill materials needed to construct the containment dikes. These analyses were performed using the same methodology as the containment dikes (See Section 4.3.2). It is recommended that a minimum side slope of two (2) horizontal to one (1) vertical (2H:1V) be maintained and that the equipment's tracks be at least 5 feet from the edge of the excavation in order to assure adequate stability.

4.4 Summary of Marsh Creation Cross Section

As previously mentioned, the marsh creation areas will consist of perimeter earthen containment dikes surrounding hydraulically dredged material from the offshore borrow site. Containment dike construction crown grade elevations, side slopes, and anticipated construction considerations are summarized in the following table.

TABLE 9 – SUMMARY OF MARSH CREATION DESIGN DATA (BERM CREST +3.5 FEET, NAVD88)

Reach	Construction Crest Elevation (feet, NAVD88)	Recommended Berm Side Slopes	Additional Considerations
Reach 1	+3.5	4.0H:1.0V	n/a
Reach 2	+3.5	4.0H:1.0V	n/a
Reach 3	+3.5	4.5H:1.0V	25-foot offset to borrow pit

The data provided in this table assumes that the maximum anticipated berm elevation is 1-foot higher than the design target fill elevation of +2.5 feet, NAVD88. Should the construction tolerances require that the berm elevation be slightly higher, the following table provides the adjusted side slopes to ensure the target factors of safety with regard to slope stability of the containment berms.

TABLE 10 – SUMMARY OF MARSH CREATION DESIGN DATA (BERM CREST +4.0 FEET, NAVD88)

Reach	Construction Crest Elevation (feet, NAVD88)	Recommended Berm Side Slopes	Additional Considerations
Reach 1	+4.0	4.5H:1.0V	n/a
Reach 2	+4.0	5.0H:1.0V	n/a
Reach 3	+4.0	5.0H:1.0V	25-foot offset to borrow pit

4.5 Borrow Excavation Cut to Containment Dike Fill Ratio

Although the expected initial total unit weight of the un-compacted dike fill materials is expected to be approximately equal to the existing *in situ* unit weight in the borrow area, the excavated borrow volume will need to exceed the neat design fill quantity in order to compensate for material "lost" to initial undrained settlement during construction. In addition, other "losses" can occur either during excavation of borrow soils from below water or due to loss after or during placement (e.g., material eroded or sloughed to areas outside the design cross section limits).

Considering a 1-foot segment of the containment dike, we have computed approximate total neat in-place design fill volumes for the typical containment dike sections. This neat fill volume, along with estimated cut volume requirement and corresponding cut/fill ratio are summarized in the following table.

TABLE 11 – SUMMARY OF BORROW EXCAVATION DESIGN DATA

Section	Berm Side Slopes	Design Fill Volume (Cubic Yards)	Required Cut Volume* (Cubic Yards)	Cut / Fill Ratio	Borrow Excavation Depth* (feet)
Reach 1	4.0H:1.0V	6.4	7.4	1.2	≈ 7
Reach 2	4.0H:1.0V	6.4	9.2	1.4	≈ 7
Reach 3	4.5H:1.0V	7.1	10.6	1.5	≈ 8

*Calculations based on 2H:1V borrow excavation side slopes and 15-foot wide excavation bottom.

A major component resulting in the difference between the neat design fill quantity and the required cut volume is compensation for initial undrained deformations. It was further assumed that some drying of the more organic soils would occur, since these may rapidly shrink once placed above the water line. Fill placement means and methods, lift sequencing and placement details will all be important considerations in construction planning and control to limit the cut/fill ratio, and hence construction costs. Fill placement should generally be undertaken in successive horizontal lifts that encompass the entire dike width and should be limited to heights that do not cause excessive local subsidence or mud-waving.

In order to achieve the target over-built dike crown elevation and required slope geometry with a phased construction approach, the required volume of borrow material would need to be accessible to an excavator situated within the 20 to 25-foot wide offset between the dike and borrow excavation. That volume will be dictated primarily by the ground-level reach of the excavator. It is anticipated that a sufficient volume of borrow materials can be accessed using a conventional marsh-compatible long-reach excavator (having a center-pin reach on the order of 60 feet).

4.6 Borrow Excavation Cut to Marsh Fill Ratio

Based on laboratory testing of the vibracores obtained from the offshore borrow area (Appendix A) the average *void ratio* of the soils within the upper 15 feet below the mudline in the proposed borrow area is about 1.35. The calculated average void ratio of the settled, compressed and consolidated fill in the marsh creation area obtained from PSDDF is about 2.3 (Appendix C). Assuming dredge fill placement conditions are carefully controlled to minimize “loss” of fines to carryover through the marsh area decant, the dredge fill-to-cut ratio is expected to be on the order 0.85 even after deposition and consolidation, given the expected bulking and swelling of these soils during the dredging and transportation phase.

SECTION 5. CONCLUSION AND ADDITIONAL RECOMMENDATIONS

The design cross section of the earthen containment dikes will vary across the project alignment based on the local subsoil conditions. However, it is believed that 1 foot of freeboard relative to the proposed marsh creation target fill elevations is achievable across the project's alignment. Consideration will need to be given to the local subsoil conditions during construction, given the somewhat abrupt delineation of reaches based on the data obtained during the subsoil investigation. Results of the settlement calculations indicate that the marsh creation fill area construction grade required to achieve the 20-year post-construction target elevations for a healthy marsh environment (i.e. between Elev. +0.322 and +1.222 feet, NAVD888) will depend on the actual filling sequence and is approximately +2.5 feet, NAVD88. Post construction settlement-time rate curves for the marsh creation area are shown on Figures 16 through 18. As shown on these figures, the computed marsh creation area is projected to fall below the forecasted 20% inundation water level within 2 years of construction. Hence, the marsh creation area would be intertidal for the majority of the project design life provided notches are cut in the containment dike in order to allow the free movement of water.

SECTION 6. REFERENCES

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FIGURES:

Figure 1 – Project Location Plan

Figure 2 – Ardaman Subsurface Exploration Location Map (Borings Only)

Figure 3 – Ardaman Subsurface Exploration Location Map (Borings & CPTs)

Figure 4 – Subsurface Exploration Location Map (Borings & CPTs)

Figure 5 – Geologic Profile

Figure 6 – Empirical Compression Index Correlations

Figure 7 – Maximum Past Pressure from Consolidation Test Data

Figure 8 – Fence diagram of furnished soil borings

Figure 9 – Fence diagram of Ardaman soil borings

Figure 10 through 15 – Immediate Settlement & Bearing Capacity Calculations

Figure 16 through 18 – Marsh Fill Time-Rate Settlement Curves

Figure 19 – Slope Stability Cases

Caminada H.L. Back Barrier Marsh Creation (BA-193)
Jefferson & Lafourche Parish, Louisiana

Ardaman & Associates, Inc.

Eng.:	Drawn By:	Checked By:
GFS	GFS	MLW
File No.:	Date:	Fig. No.:
17-2803	9/19/18	1

Title:

General Project Location Plan

Boring ID	Latitude (deg)	Longitude (deg)
B-10	29.15424	-90.11758
B-11	29.16747	-90.09609

Caminada H.L. Back Barrier Marsh Creation (BA-193)
Jefferson & Lafourche Parish, Louisiana

Ardaman & Associates, Inc.

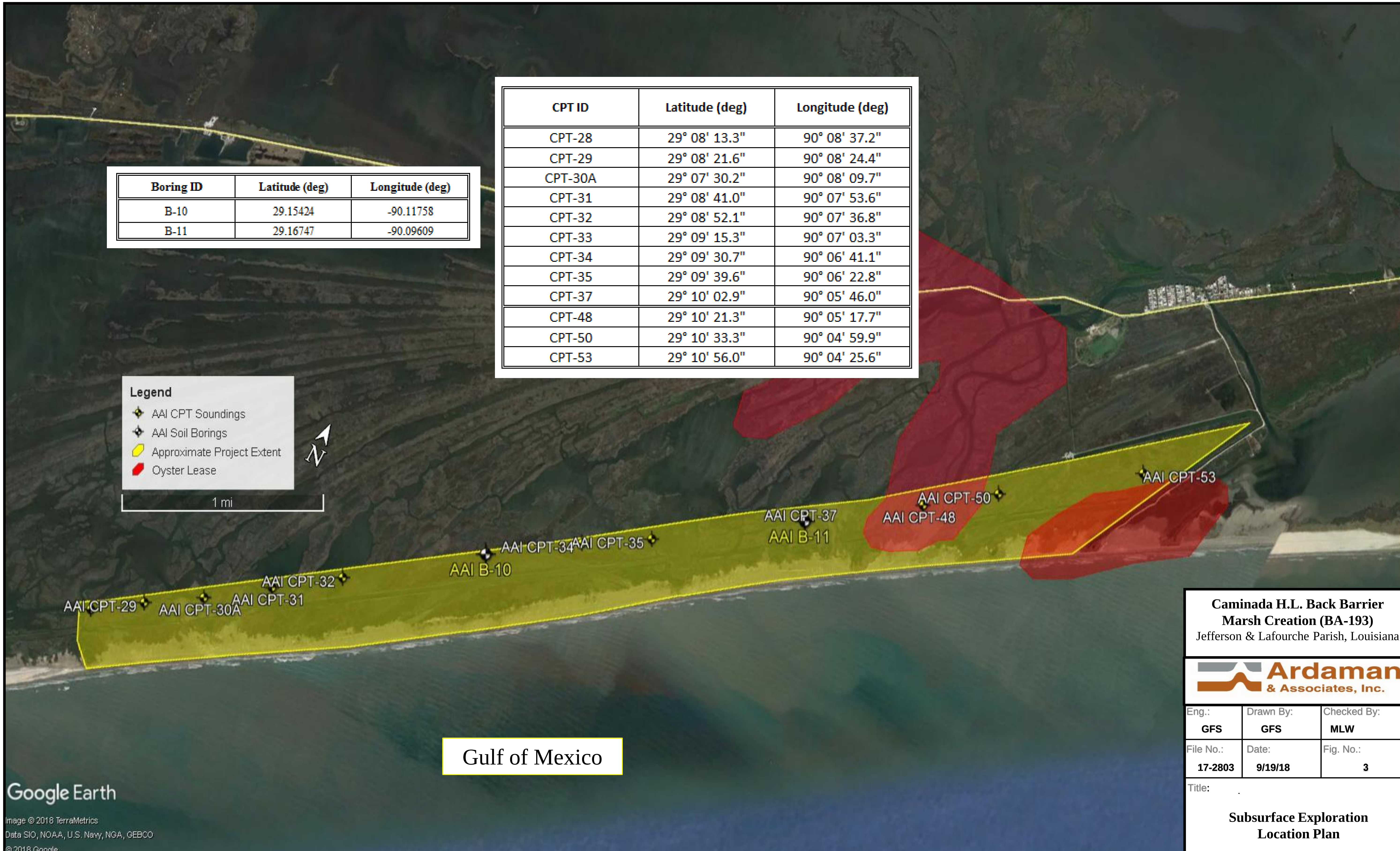
Eng.:	Drawn By:	Checked By:
GFS	GFS	MLW
File No.:	Date:	Fig. No.:
17-2803	9/19/18	2

Title:

Subsurface Exploration Location Plan

Boring ID	Latitude (deg)	Longitude (deg)
B-10	29.15424	-90.11758
B-11	29.16747	-90.09609

CPT ID	Latitude (deg)	Longitude (deg)
CPT-28	29° 08' 13.3"	90° 08' 37.2"
CPT-29	29° 08' 21.6"	90° 08' 24.4"
CPT-30A	29° 07' 30.2"	90° 08' 09.7"
CPT-31	29° 08' 41.0"	90° 07' 53.6"
CPT-32	29° 08' 52.1"	90° 07' 36.8"
CPT-33	29° 09' 15.3"	90° 07' 03.3"
CPT-34	29° 09' 30.7"	90° 06' 41.1"
CPT-35	29° 09' 39.6"	90° 06' 22.8"
CPT-37	29° 10' 02.9"	90° 05' 46.0"
CPT-48	29° 10' 21.3"	90° 05' 17.7"
CPT-50	29° 10' 33.3"	90° 04' 59.9"
CPT-53	29° 10' 56.0"	90° 04' 25.6"



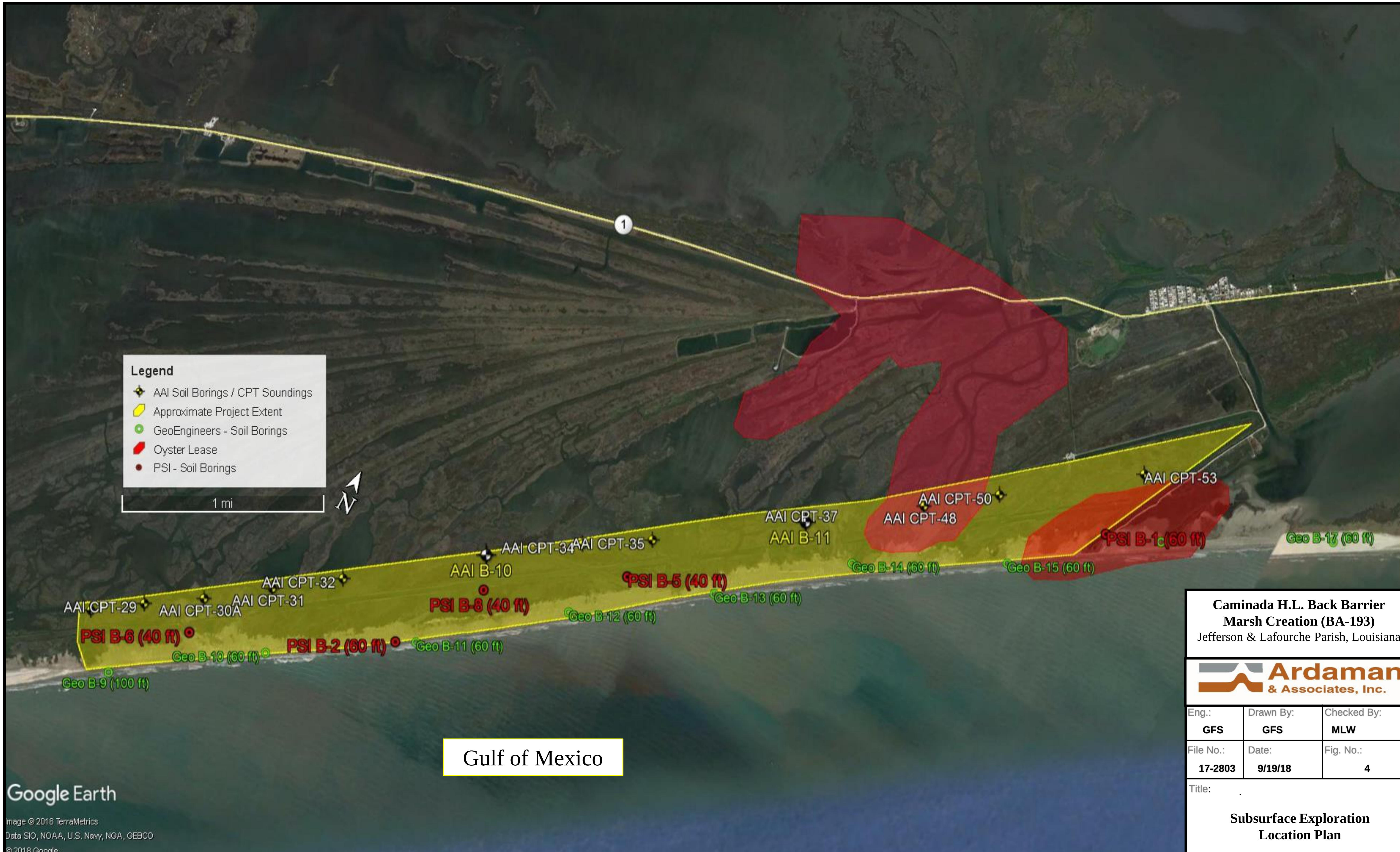
Caminada H.L. Back Barrier Marsh Creation (BA-193)
Jefferson & Lafourche Parish, Louisiana

Ardaman & Associates, Inc.

Eng.:	Drawn By:	Checked By:
GFS	GFS	MLW
File No.: 17-2803	Date: 9/19/18	Fig. No.: 3

Title:

Subsurface Exploration Location Plan



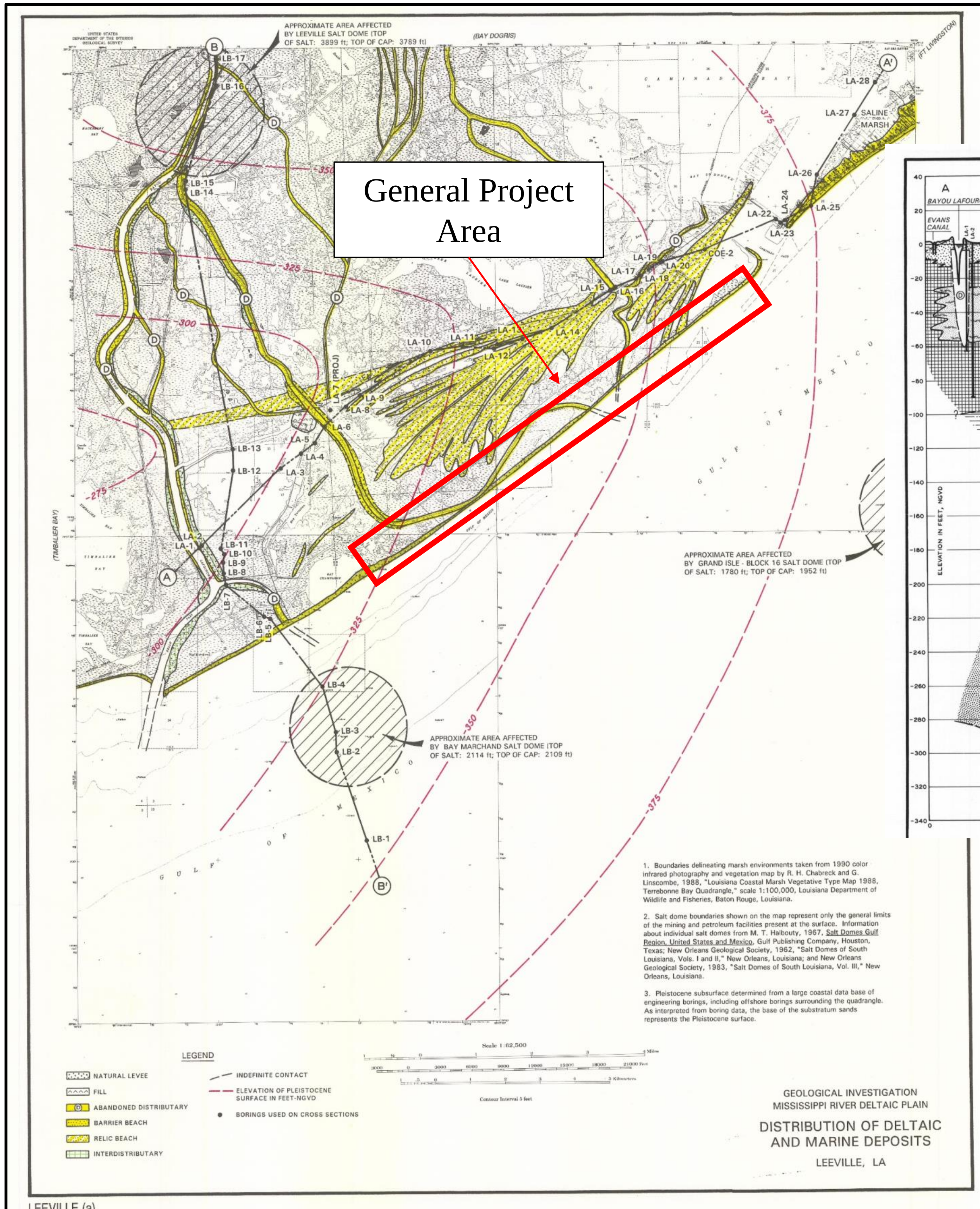
Caminada H.L. Back Barrier Marsh Creation (BA-193)
Jefferson & Lafourche Parish, Louisiana

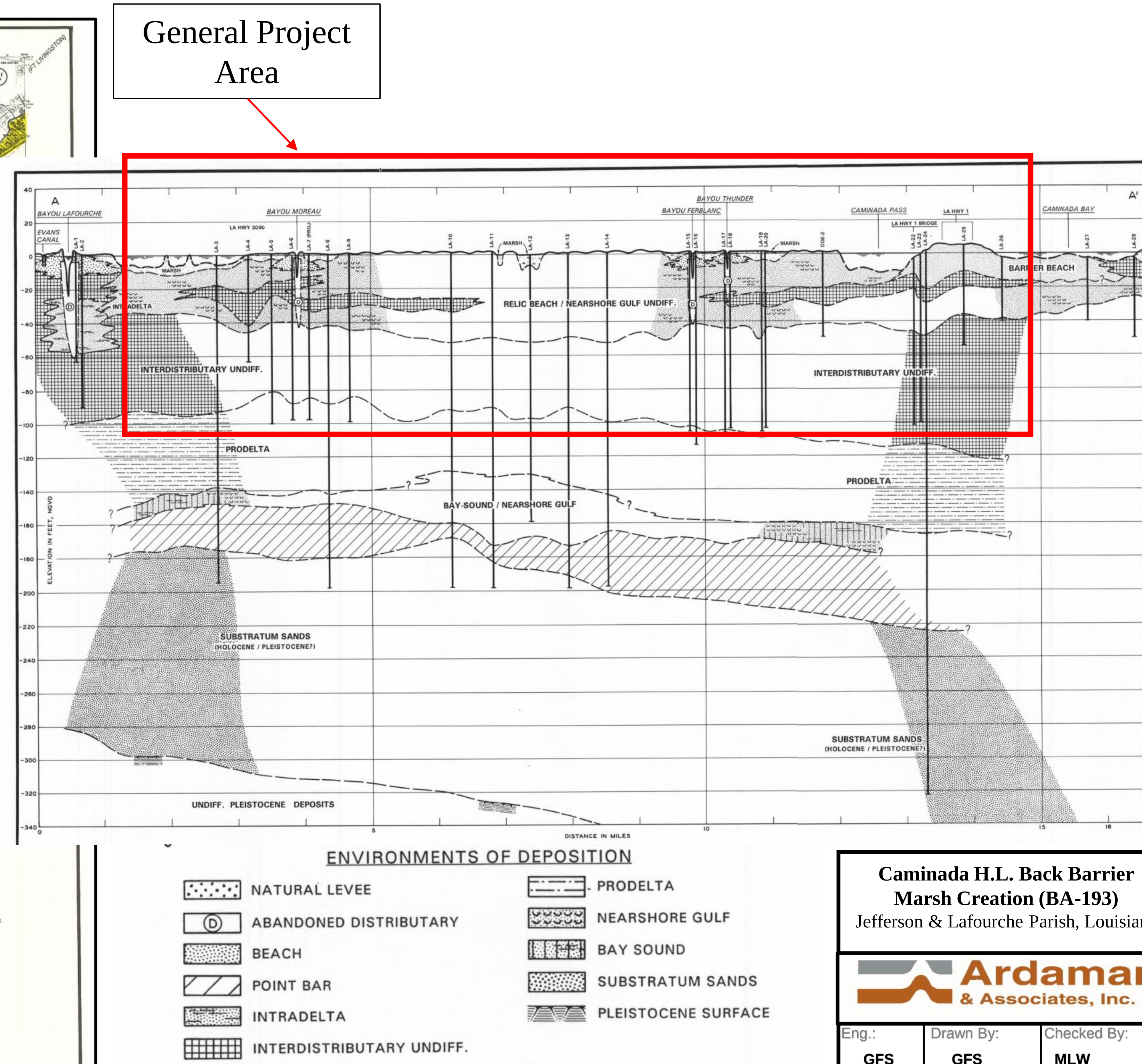
Ardaman & Associates, Inc.

Eng.:	Drawn By:	Checked By:
GFS	GFS	MLW
File No.: 17-2803	Date: 9/19/18	Fig. No.: 4

Title:

Subsurface Exploration Location Plan





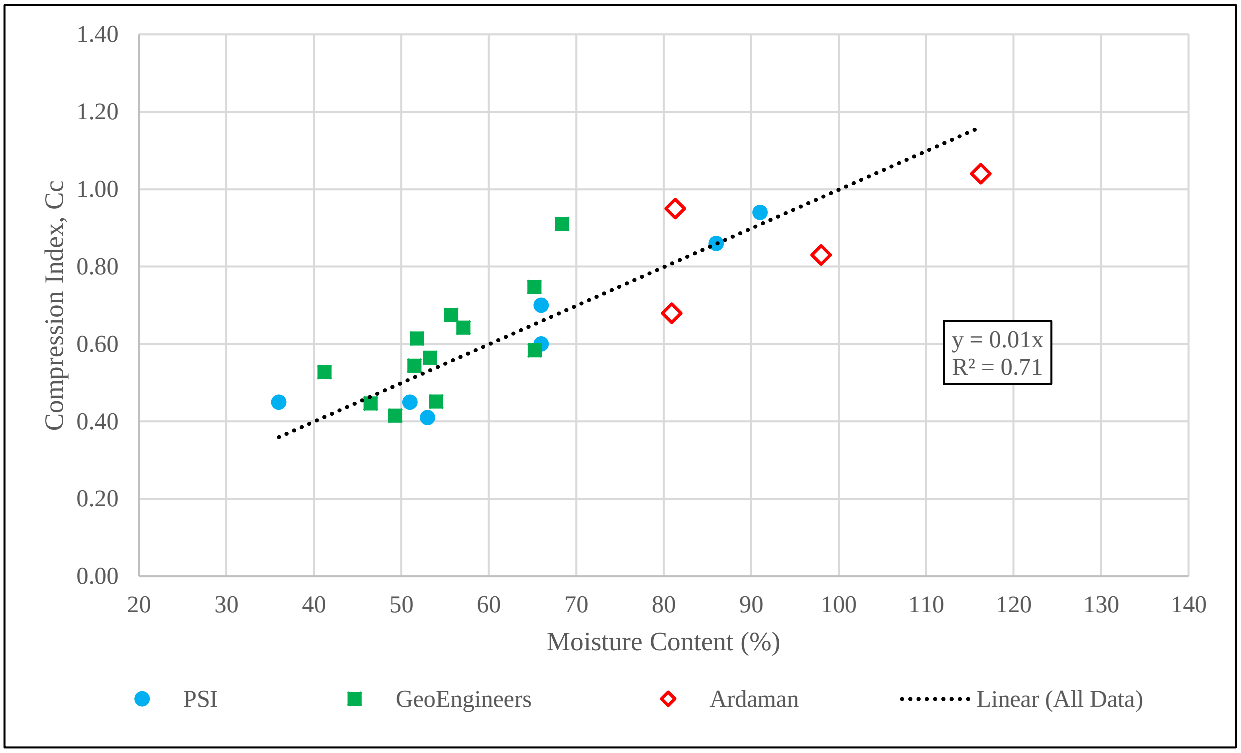
Caminada H.L. Back Barrier Marsh Creation (BA-193)
Jefferson & Lafourche Parish, Louisiana

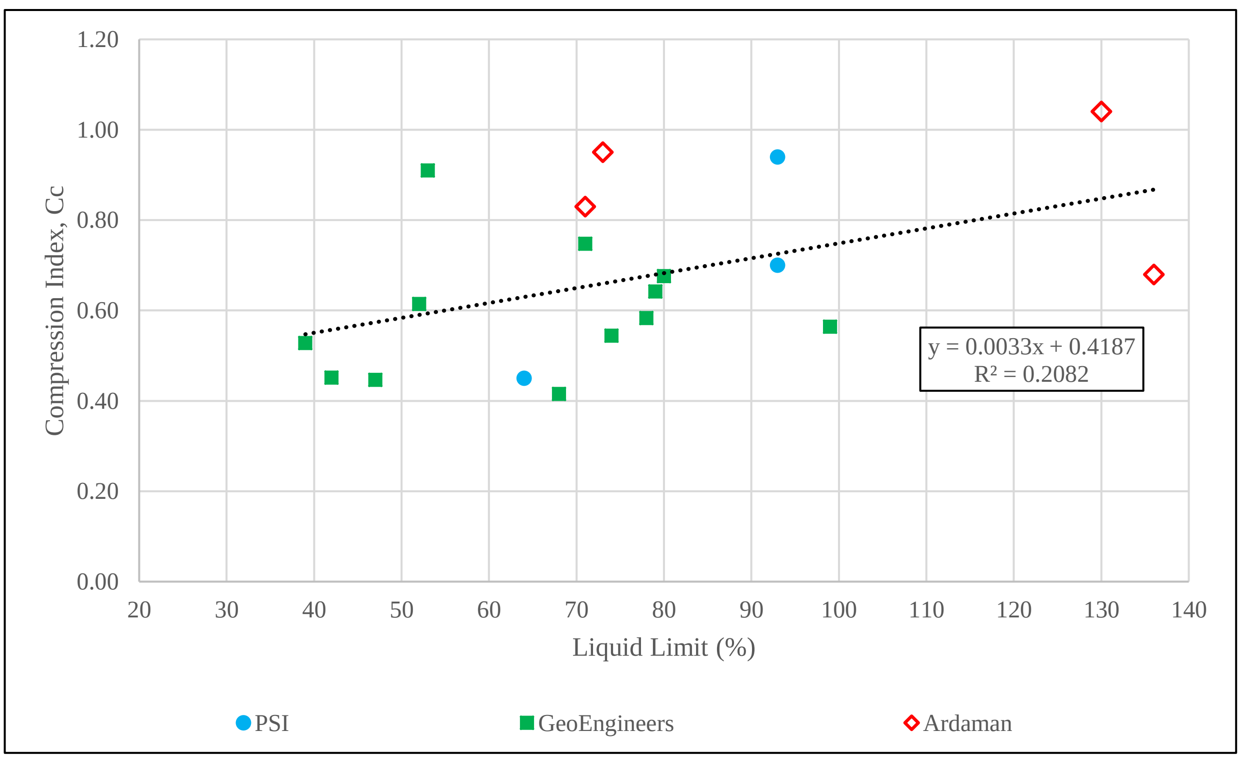
Ardaman & Associates, Inc.

Eng.:	Drawn By:	Checked By:
GFS	GFS	MLW
File No.:	Date:	Fig. No.:
17-2803	9/19/18	5

Title:

Geologic Investigation: Distribution of Deltaic & Marine Deposits Leeville, LA





$R^2 = 1 - \frac{\Sigma(y_i - \hat{y})^2}{\Sigma(y_i - \bar{y})^2}$; The Coefficient of Determination (R^2) is the proportion of the variability in the dependent variable that is predictable from the independent variable.

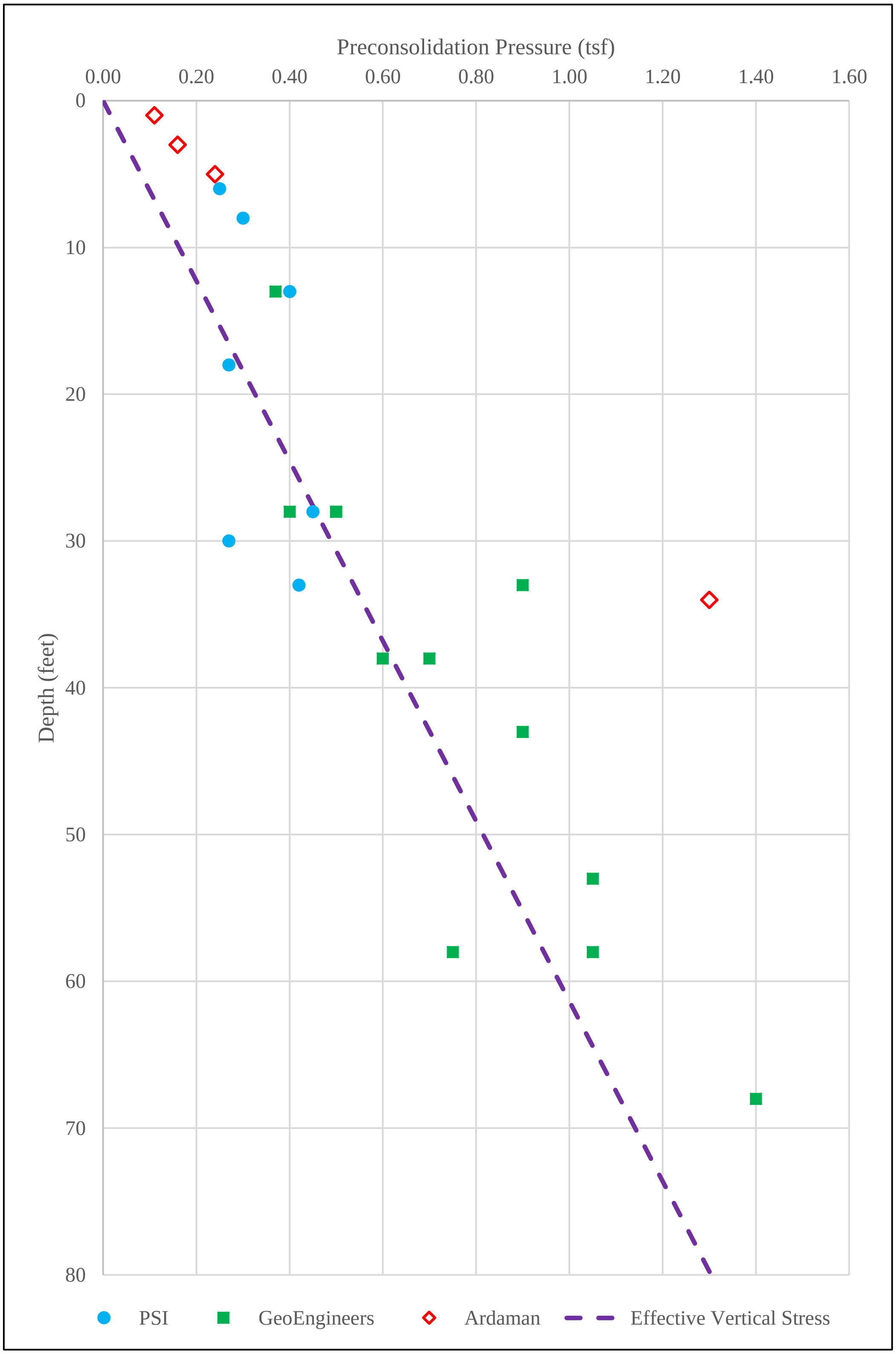


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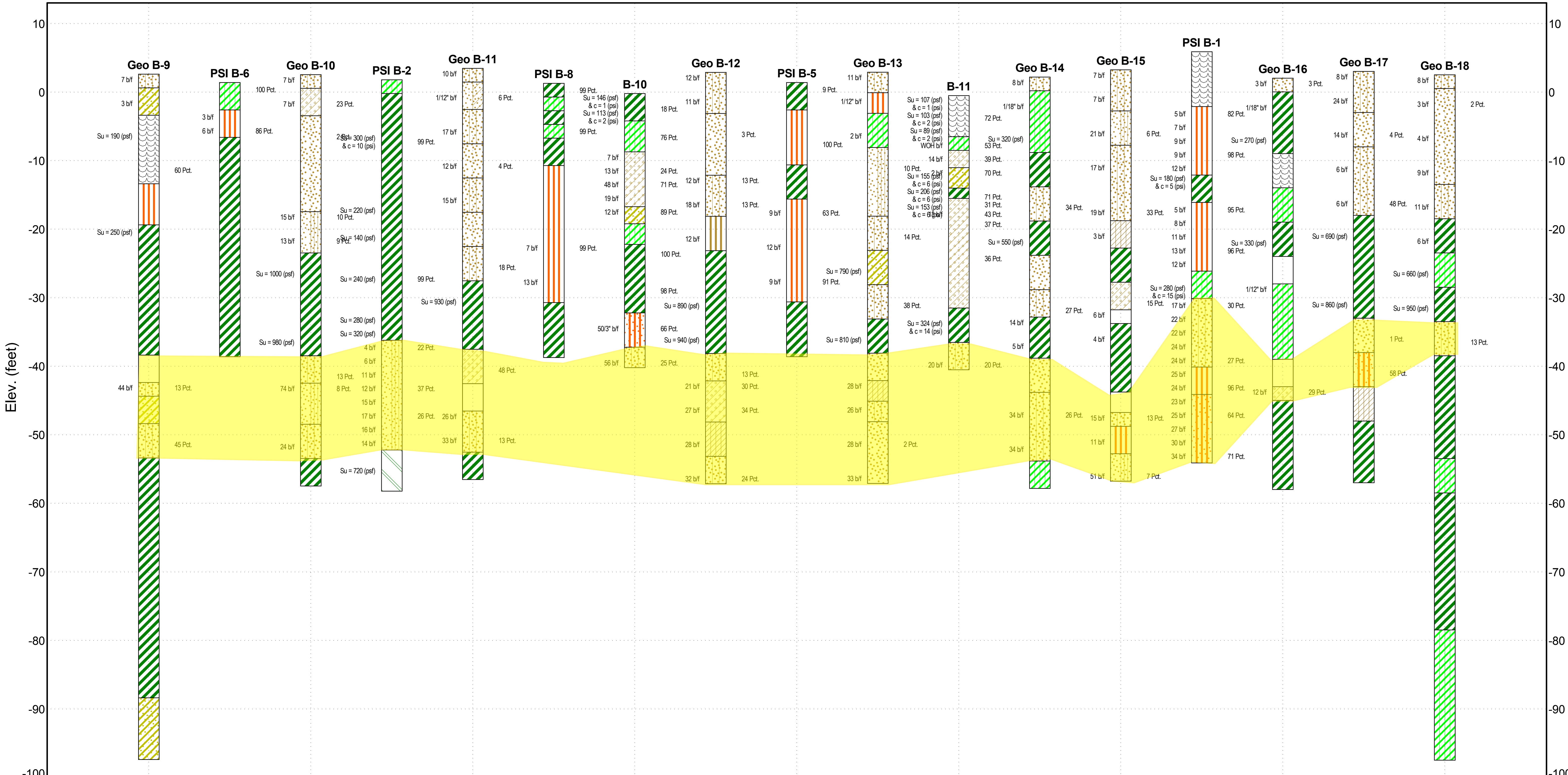
Figure No. 7

17-2810

Caminada Headlands Back Barrier Marsh Creation (BA-193)



Notes:

Su = Undrained Shear Strength
C = Confining Pressure
Pct. = Percent Passing the #200 Sieve

Ground Water Level Data

LITHOLOGY GRAPHICS

- USCS High Plasticity Clay
- USCS Low Plasticity Clay
- USCS Low to High Plasticity Clay
- USCS Low Plasticity Silty Clay
- USCS Low Plasticity Sandy Clay
- USCS Silt
- USCS Sandy Silt
- USCS High Plasticity Organic silt or clay
- USCS Clayey Sand
- USCS Silty Sand
- USCS Poorly-graded Sand
- USCS Poorly-graded Sand with Clay
- USCS Poorly-graded Sand with Silt

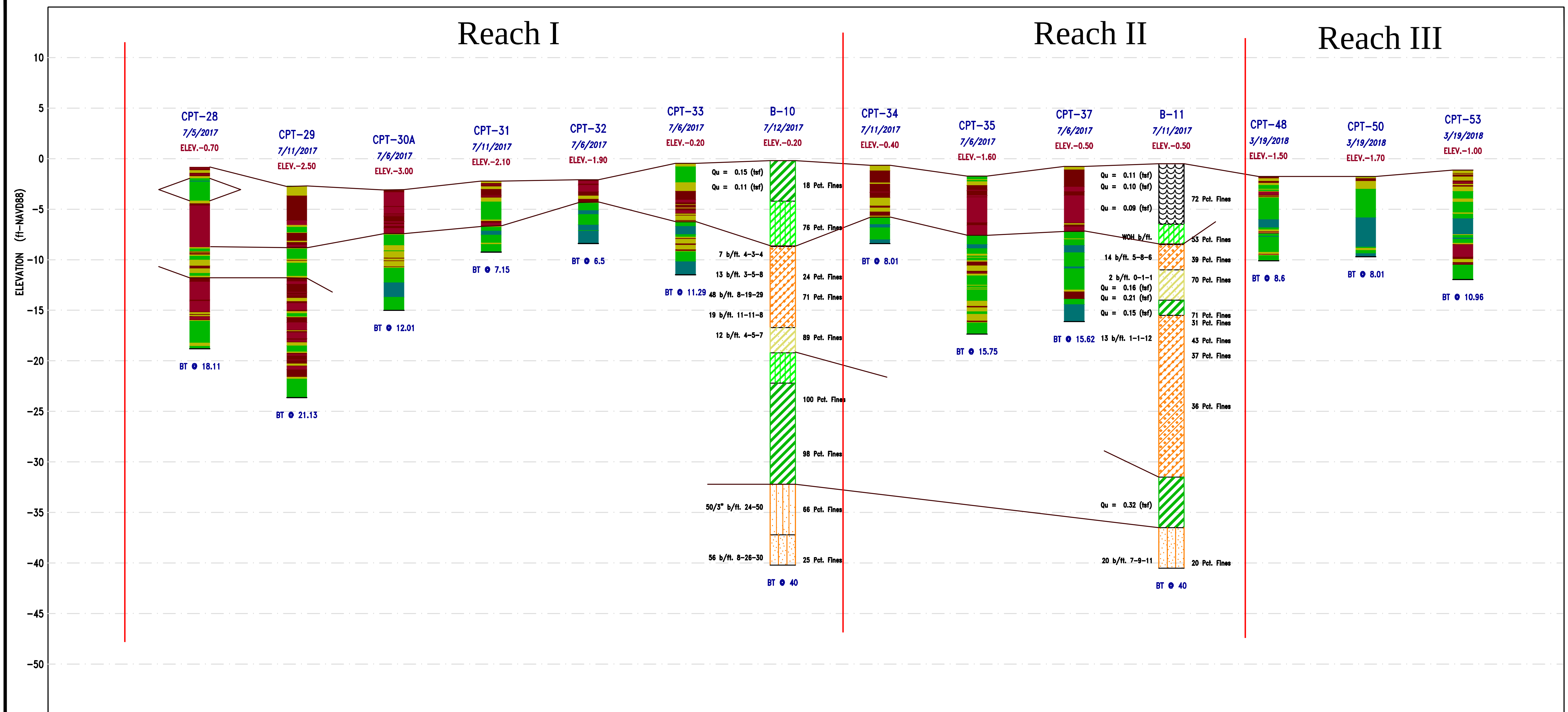
Caminada Headlands Back Barrier Marsh
Creation Increment II (BA-193)
Lafourche & Jefferson Parishes

Coastal Protection and Restoration Authority (CPRA)

Figure No. 8

Project Number: 17-2810

ARD CROSS SECTION - NO DESCRIPTION 2 17-84-2810.GPJ LOG01.GDT 4/22/18



CPT MATERIAL GRAPHICS

- sensitive fine grained
- organic material
- clay
- silty clay to clay
- sandy silt to clayey silt
- sand to silty sand
- gravelly sand to sand
- very stiff fine grained (*)
- sand to clayey sand (*)

Robertson et al (1990) Qt vs Fr – MAI = 1

LITHOLOGY GRAPHICS

- USCS High Plasticity Clay
- USCS High Plasticity Organic silt or clay
- USCS Low Plasticity Clay
- USCS Peat
- USCS Low Plasticity Sandy Clay
- USCS Clayey Sand
- USCS Silt
- USCS Poorly-graded Sand
- USCS Sandy Silt
- USCS Silty Clay

SUBSURFACE PROFILE

PROJECT:
Caminada Headlands Back Barrier
Marsh Creation Increment II (BA-193)

LOCATION:
Jefferson & Lafourche Parishes, Louisiana

JOB NO:
17-2810

DATE:

Ardaman & Associates, Inc.

Figure No. 9

Initial Undrained Settlement Calculations

Caminada Headlands Back Barrier Marsh Creation - Reach 1

Project No. 17-2810

Date: 9/15/2018

Berm Information:

Crown Elev.:	4.00	ft.	Crown Width (W):	5	ft.	Wet Weight (γ):	85	pcf.
Mudline Elev.	-2.00	ft.	Side Slopes (S):	4.0	H:1V	Water Table, Elev.:	0.2	ft., NAVD88
Height (H):	6.0	ft.	Base Width (B):	53	ft.	Weight of Berm =	8,722	lbs.

1) Determine the Equivalent Base Width of a Berm. Is the berm reinforced? = no

Equivalent Base Width (B') = 2*[1/2 * (S)(H)] + W

B' = 29 ft. use B' = 29 ft.

2) Determine the applied stress.

Applied Stess (q) = Weight / B'

q = 510 psf. q' = 300.766 psf. (taking into account submerged portion)

3) Determine parameters for settlement calculation.

Applied Shear Stress Ratio (τ/Su) = 1/F.S. where F.S. = factor of safety at end of construction.

Factor of Safety (F.S.): 2.32 (τ/Su) = 0.43

Determine the modulus of the soil, Eu

Shear Strength (Su): 93 psf. (Average of Compressible Layers)

E_u/Su: 180 (assumed) From Figure 5 = 187

E_u = 16,778.6 psf.

Shape Parameters, D/B' where D is the thickness of the layer being compressed

D: 7 ft. El. -9 ft., NAVD88 (Bottom of Compressible Layer)

D/B' = 1.00 (#)

Influence factor, Ip

Load applied is considered: Strip Load

Ip = 0.38 From Figure 6

Elastic Settlement, ρe

ρ_e = (q * B' * Ip) / (E_u) = 0.20 ft. 2.36 in.

Initial Undrained Settlement, ρ_i

Average OCR: 1.20 q / q_{ult} = 0.43

From Figure 7, f = 0.40 Settlement Ratio, S_r = 0.60 From Figure 8

$\rho_i = \rho_e / S_r$ = 0.33 ft. 3.93 in.

Reference: Undrained Settlement of Plastic and Organic Clays by Foott & Ladd (1981)

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Caminada Headlands Back Barrier Marsh Creation - Reach 1

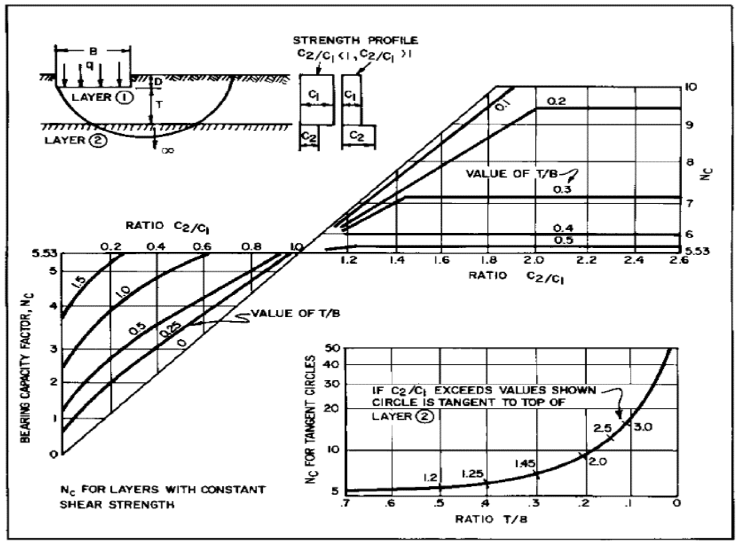

FIGURE 5
Ultimate Bearing Capacity of Two Layer Cohesive Soil (Ø=0)

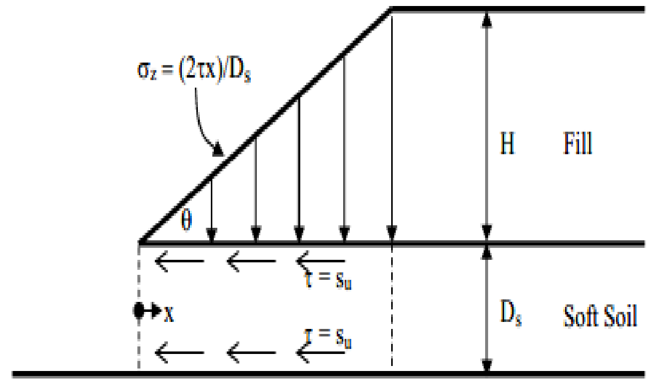

Figure 7-20. Definitions for calculating safety factor against lateral squeeze (after Silvestri, 1983).

Bearing Capacity based on NAVFAC DM 7.2

C_1 = 70 (psf)   B' = 29.0 (ft)

C_2 = 103 (psf)   T = 7 (ft)

C_2 / C_1 = 1.46 (#)   T/B = 0.24 (#)

N_c = 7.5   FS = 1.20

Q_u = 525 = $C_1 * N_c$ (psf)

Q_{all} = 438 = Q_u / FS (psf)

$Q_{\text{berm contact pressure}}$ = 301 (psf)

Actual Factor of Safety = 1.75

Lateral Squeezing based on NHI-06-088 December 2006

Side Slopes (S): 4 H:1V

Angle of Slope, (Θ): 14.04 (deg)

Undrained Shear Strength, S_u: 93.2 (psf)

Height of Slope, H: 6.0 (ft)

Unit Weight of Fill, γ: 85 (psf)

Depth of Soft Soil, D_s: 7 (ft)

b = 24 = H/tan(Θ) (ft) [base width at end of slope]

b > Ds; consider lateral squeeze

Factor of Safety of Lateral Squeeze, FS_{SQ} = 2.01

Initial Undrained Settlement Calculations

Caminada Headlands Back Barrier Marsh Creation - Reach 2

Project No. 17-2810

Date: 9/15/2018

Berm Information:

Crown Elev.:	4.00	ft.	Crown Width (W):	5	ft.	Wet Weight (γ):	85	pcf.
Mudline Elev.	-2.00	ft.	Side Slopes (S):	4.0	H:1V	Water Table, Elev.:	0.2	ft., NAVD88
Height (H):	6.0	ft.	Base Width (B):	53	ft.	Weight of Berm =	8,722	lbs.

1) Determine the Equivalent Base Width of a Berm. Is the berm reinforced? = no

Equivalent Base Width (B') = 2*[1/2 * (S)(H)] + W

B' = 29 ft. use B' = 29 ft.

2) Determine the applied stress.

Applied Stess (q) = Weight / B'

q = 510 psf. q' = 300.766 psf. (taking into account submerged portion)

3) Determine parameters for settlement calculation.

Applied Shear Stress Ratio (τ/Su) = 1/F.S. where F.S. = factor of safety at end of construction.

Factor of Safety (F.S.): 1.63 (τ/Su) = 0.61

Determine the modulus of the soil, Eu

Shear Strength (Su): 85 psf. (Average of Compressible Layers)

E_u/Su: 120 (assumed) From Figure 5 = 115

E_u = 10,200.0 psf.

Shape Parameters, D/B' where D is the thickness of the layer being compressed

D: 6 ft. El. -8 ft., NAVD88 (Bottom of Compressible Layer)

D/B' = 1.00 (#)

Influence factor, Ip

Load applied is considered: Strip Load

Ip = 0.38 From Figure 6

Elastic Settlement, ρe

ρ_e = (q * B' * Ip) / (E_u) = 0.32 ft. 3.88 in.

Initial Undrained Settlement, ρ_i

Average OCR: 1.20 q / q_{ult} = 0.61

From Figure 7, f = 0.40 Settlement Ratio, S_r = 0.60 From Figure 8

$\rho_i = \rho_e / S_r$ = 0.54 ft. 6.46 in.

Reference: Undrained Settlement of Plastic and Organic Clays by Foott & Ladd (1981)

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Figure No. 12

Caminada Headlands Back Barrier Marsh Creation - Reach 2

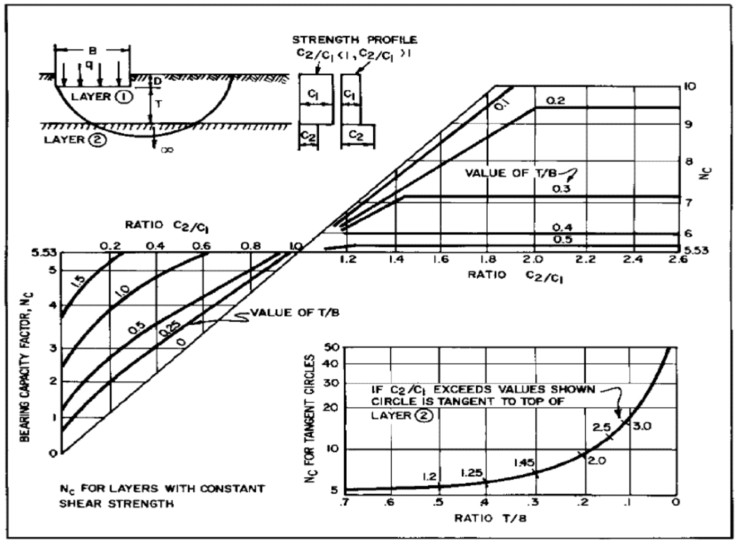

FIGURE 5
Ultimate Bearing Capacity of Two Layer Cohesive Soil (ϕ=0)

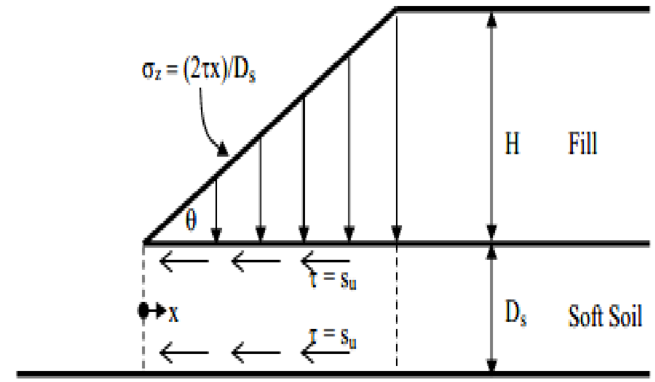

Figure 7-20. Definitions for calculating safety factor against lateral squeeze (after Silvestri, 1983).

Bearing Capacity based on NAVFAC DM 7.2

Lateral Squeezing based on NHI-06-088 December 2006

C_1 = 80 (psf)
C_2 = 95 (psf)
C_2 / C_1 = 1.19 (#)

B' = 29.0 (ft)
T = 6 (ft)
T/B = 0.21 (#)

N_c = 6.5   FS = 1.20
Q_u = 520 = $C_1 * N_c$ (psf)
Q_{all} = 433 = Q_u / FS (psf)

$Q_{berm\ contact\ pressure}$ = 301 (psf)

Actual Factor of Safety = 1.73

Side Slopes (S): 4 H:1V
Angle of Slope, (Θ): 14.04 (deg)
Undrained Shear Strength, S_u: 85.0 (psf)
Height of Slope, H: 6.0 (ft)
Unit Weight of Fill, γ: 85 (psf)
Depth of Soft Soil, D_s: 6 (ft)

b = 24 = H/tan(Θ) (ft) [base width at end of slope]

b > Ds; consider lateral squeeze

Factor of Safety of Lateral Squeeze, FS_{SQ} = 2.02

Initial Undrained Settlement Calculations

Caminada Headlands Back Barrier Marsh Creation - Reach 3

Project No. 17-2810

Date: 9/15/2018

Berm Information:

Crown Elev.:	4.00	ft.	Crown Width (W):	5	ft.	Wet Weight (γ):	85	pcf.
Mudline Elev.	-2.00	ft.	Side Slopes (S):	4.0	H:1V	Water Table, Elev.:	0.2	ft., NAVD88
Height (H):	6.0	ft.	Base Width (B):	53	ft.	Weight of Berm =	8,722	lbs.

1) Determine the Equivalent Base Width of a Berm. Is the berm reinforced? = no

Equivalent Base Width (B') = 2*[1/2 * (S)(H)] + W

B' = 29 ft. use B' = 29 ft.

2) Determine the applied stress.

Applied Stess (q) = Weight / B'

q = 510 psf. q' = 300.766 psf. (taking into account submerged portion)

3) Determine parameters for settlement calculation.

Applied Shear Stress Ratio (τ/Su) = 1/F.S. where F.S. = factor of safety at end of construction.

Factor of Safety (F.S.): 1.36 (τ/Su) = 0.73

Determine the modulus of the soil, Eu

Shear Strength (Su): 60 psf. (Average of Compressible Layers)

E_u/Su: 100 (assumed) From Figure 5 = 82

E_u = 6,000.0 psf.

Shape Parameters, D/B' where D is the thickness of the layer being compressed

D: 3 ft. El. -5 ft., NAVD88 (Bottom of Compressible Layer)

D/B' = 1.00 (#)

Influence factor, Ip

Load applied is considered: Strip Load

Ip = 0.38 From Figure 6

Elastic Settlement, ρe

$\rho_e = (q * B' * Ip) / (E_u) =$ 0.55 ft. 6.59 in.

Initial Undrained Settlement, ρ_i

Average OCR: 1.20 $q / q_{ult} =$ 0.73

From Figure 7, f = 0.40 Settlement Ratio, S_r = 0.60 From Figure 8

$\rho_i = \rho_e / S_r =$ 0.92 ft. 10.98 in.

Reference: Undrained Settlement of Plastic and Organic Clays by Foott & Ladd (1981)

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Figure No. 14

Caminada Headlands Back Barrier Marsh Creation - Reach 3

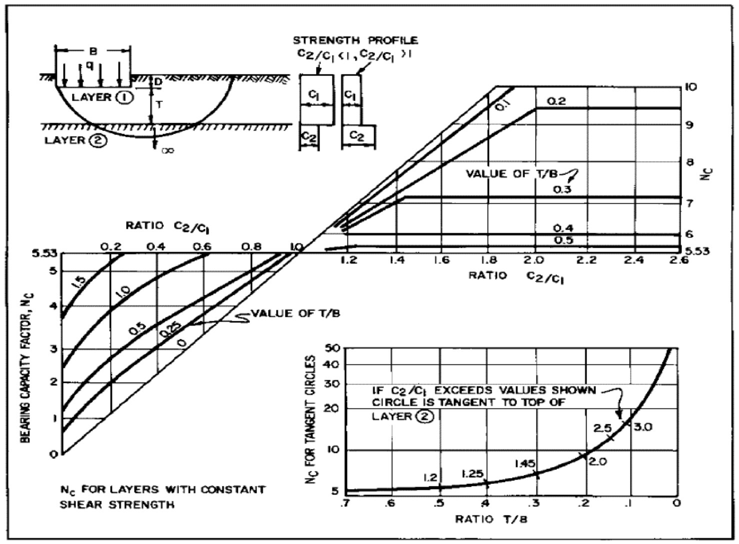

FIGURE 5
Ultimate Bearing Capacity of Two Layer Cohesive Soil (∅=0)

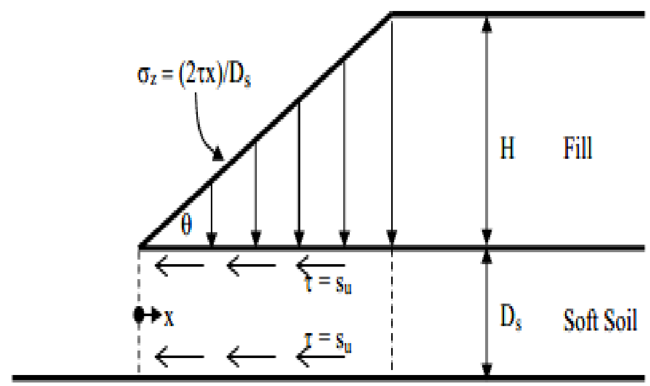

Figure 7-20. Definitions for calculating safety factor against lateral squeeze (after Silvestri, 1983).

Bearing Capacity based on NAVFAC DM 7.2

Lateral Squeezing based on NHI-06-088 December 2006

C_1 =	60	(psf)	B' =	29.0	(ft)
C_2 =	150	(psf)	T =	3	(ft)
C_2 / C_1 =	2.50	(#)	T/B =	0.10	(#)

*C_2 = Assume dense sand

N_c = 8 FS = 1.20

Q_u = 480 $= C_1 * N_c$ (psf)

Q_{all} = 400 $= Q_u / FS$ (psf)

$Q_{\text{berm contact pressure}}$ = 301 (psf)

Actual Factor of Safety = 1.60

Side Slopes (S):	4	H:1V
Angle of Slope, (ϴ):	14.04	(deg)
Undrained Shear Strength, S_u:	60.0	(psf)
Height of Slope, H:	6.0	(ft)
Unit Weight of Fill, γ:	85	(psf)
Depth of Soft Soil, D_s:	3	(ft)

b = 24 = H/tan(ϴ) (ft) [base width at end of slope]

b > Ds; consider lateral squeeze

Factor of Safety of Lateral Squeeze, FS_{SQ} = 2.37

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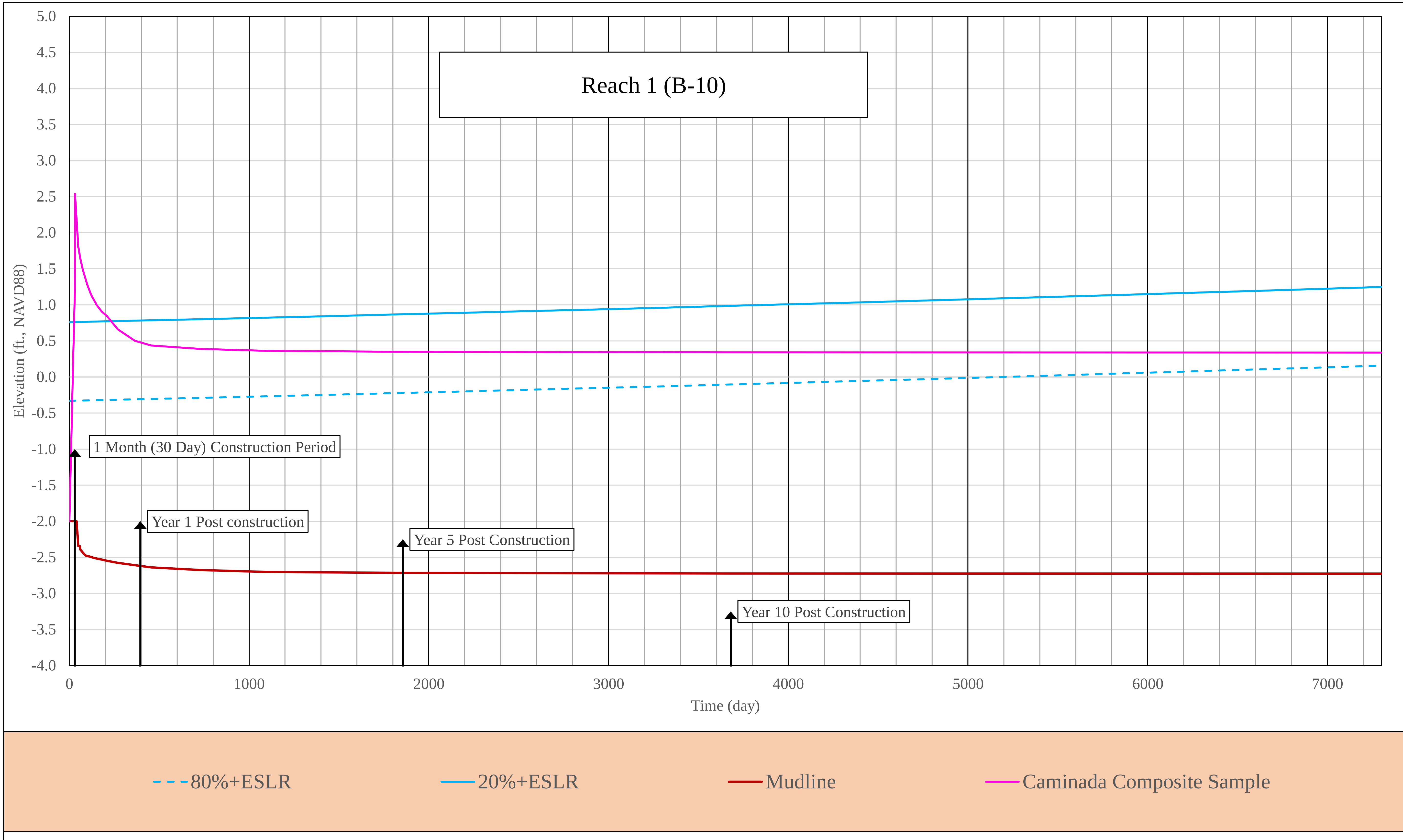

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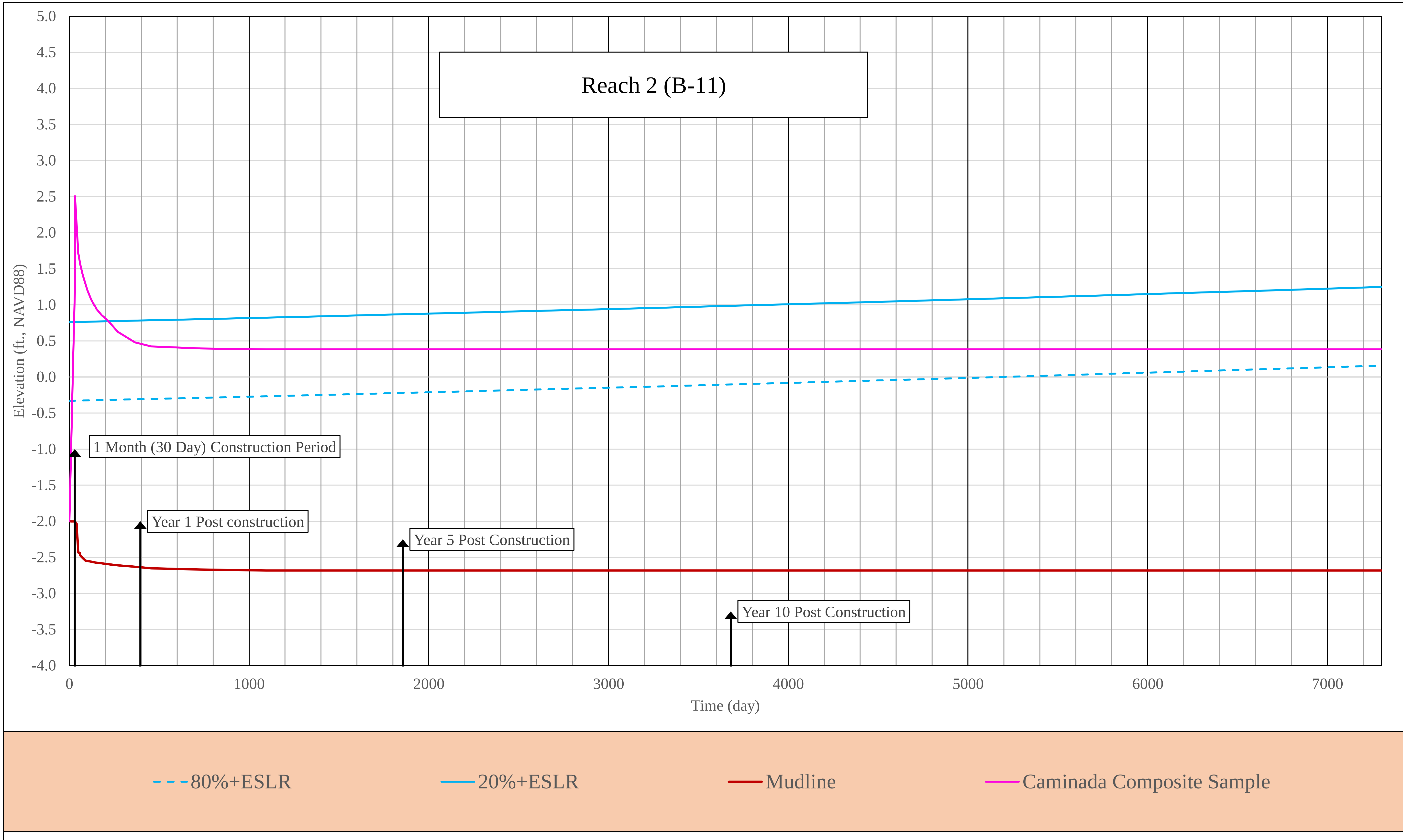
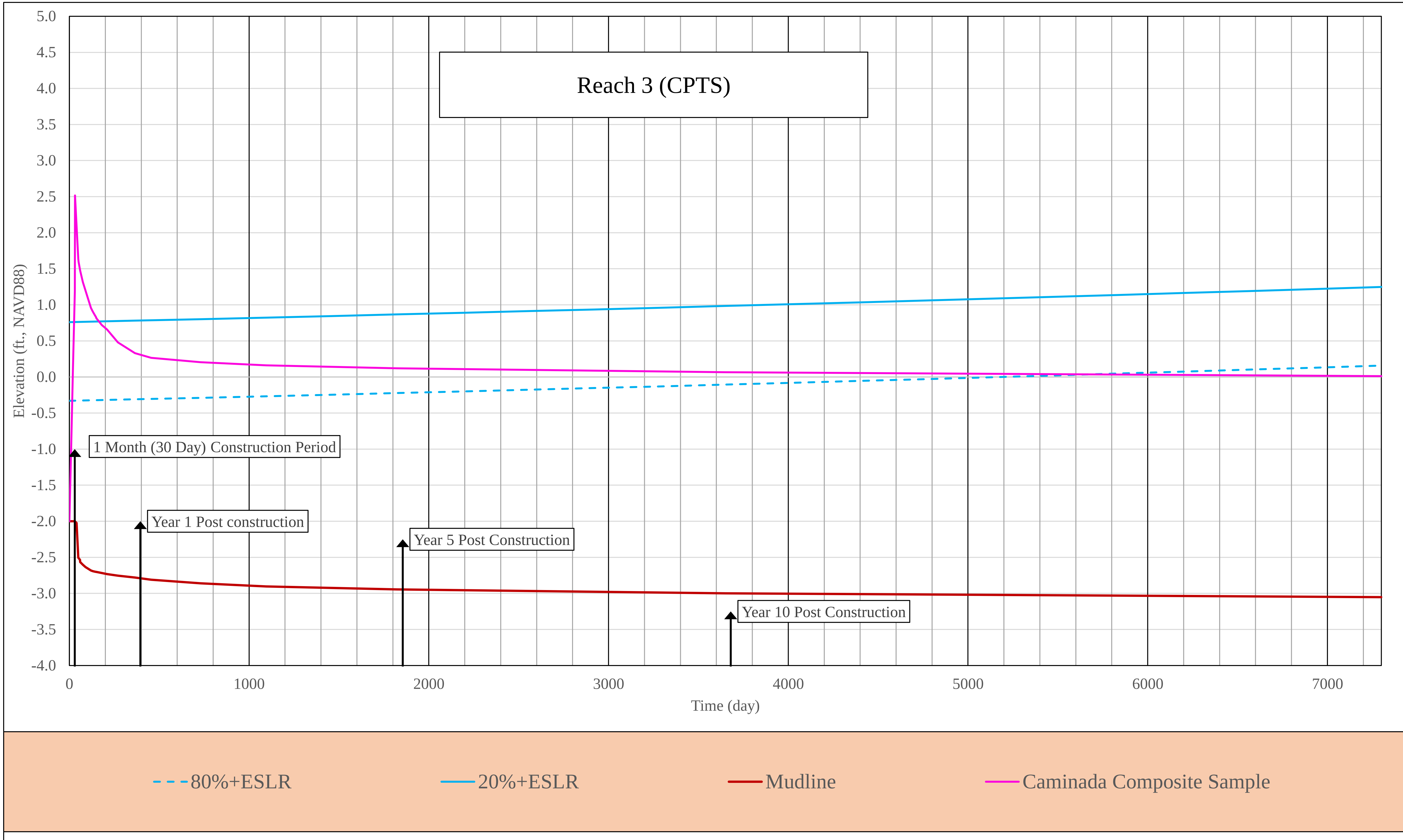
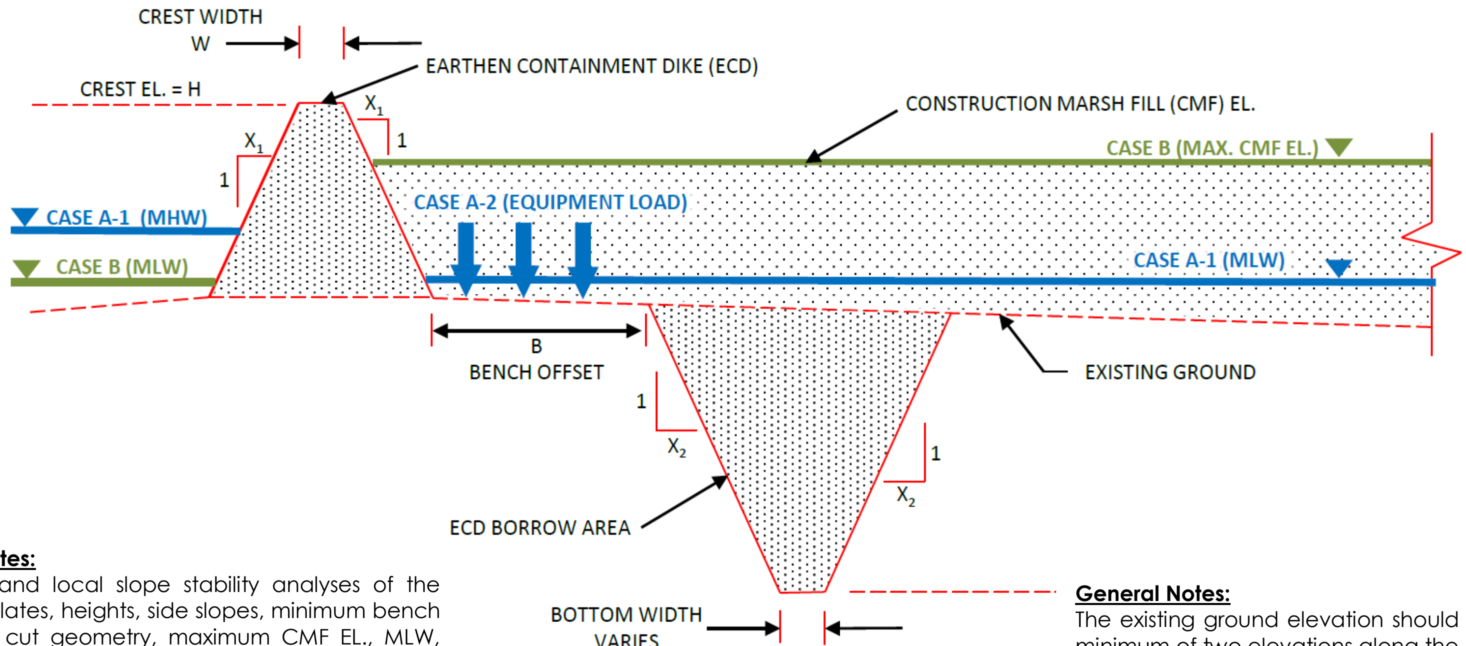
Figure No. 16


Reach 2 (B-11)
Elevation (ft., NAVD88)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
0
1000
2000
3000
4000
5000
6000
7000
Time (day)
1 Month (30 Day) Construction Period
Year 1 Post construction
Year 5 Post Construction
Year 10 Post Construction
80%+ESLR
20%+ESLR
Mudline
Caminada Composite Sample


Reach 3 (CPTS)
Elevation (ft., NAVD88)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
0
1000
2000
3000
4000
5000
6000
7000
Time (day)
1 Month (30 Day) Construction Period
Year 1 Post construction
Year 5 Post Construction
Year 10 Post Construction
80%+ESLR
20%+ESLR
Mudline
Caminada Composite Sample

Coastal Protection and Restoration Authority:
Geotechnical Standards for Marsh Creation and Coastal Restoration Projects

Typical Earthen Containment Dike
Slope Stability Cases



Stability Analyses Notes:
Conduct a global and local slope stability analyses of the proposed ECD templates, heights, side slopes, minimum bench offset, borrow area cut geometry, maximum CMF EL., MLW, multi-lift CMF if required, and other cases deemed necessary to ensure ECD stability.

A minimum FOS of 1.20 is required during construction.

CASE A-1: Global stability check; During ECD borrow excavation; MHW (opposite side of borrow), MLW (borrow side).

CASE A-2: Local stability check; During ECD borrow excavation; Distributed load from excavation equipment, MLW (borrow side).

CASE B: Dredged Material placed to CMF EL.; CMF (max. elevation), MLW (opposite side of borrow).

General Notes:
The existing ground elevation should be analyzed at a minimum of two elevations along the ECD; 1) the lowest bottom elevation/critical condition 2) the average open water and/or existing marsh elevation/general conditions.

The ECD unit weight and cohesion is typically expressed as a percentage of the ECD Borrow Area soil parameters.

A distributed load of 260 psf is typically used based on large marsh hoe/marsh buggy equipment. The ECD is constructed in several lifts.

A geosynthetic reinforcement fabric may be utilized to achieve the minimum FOS.

Figure No. 19

APPENDIX A. PREVIOUS ARDAMAN REPORTS

This Appendix contains the following:

- A.1 – 17-2810 Final Data Report
- A.2 – 17-2810A Final Offshore Borrow Area Data Report

APPENDIX B. FURNISHED REPORTS

This Appendix contains the following:

- B.1 - BA-45 Caminada Headland Data Collection Report
- B.2 – Barataria Basin Geotechnical Investigation Data Report
- B.3 - Caminada Back Barrier Survey Methodology Report
- B.4 - BA-193 Caminada Headlands Back Barrier Marsh Creation Survey (Rev. 05-31-17)

APPENDIX C. CALCULATION PACKAGE

This Appendix contains the following:

- Design Parameters
  - Reach 1
  - Reach 2
  - Reach 3

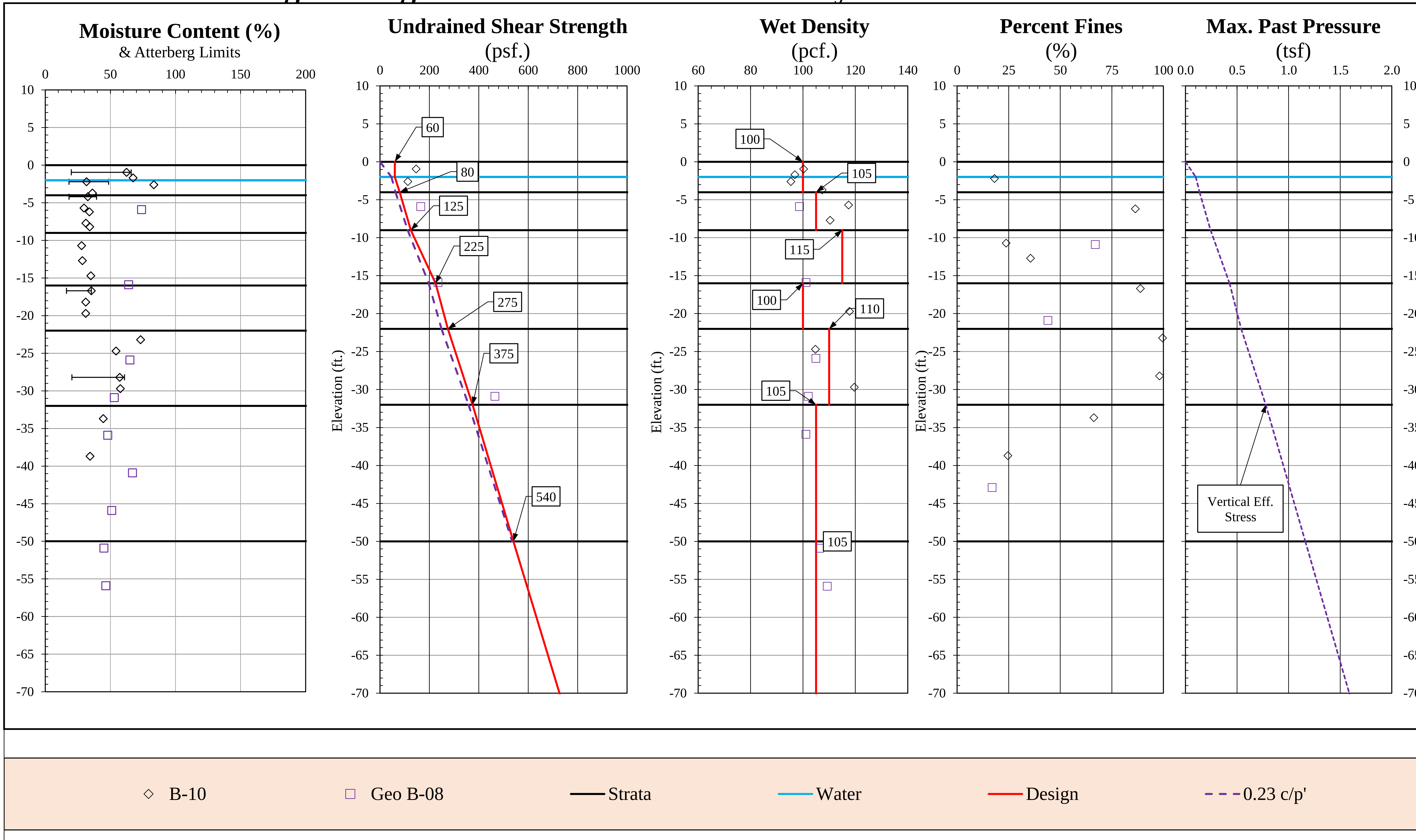
- Slope Stability Analyses
  - Reach 1
  - Reach 2
  - Reach 3 – Clay Case
  - Reach 3 – Sand Case

- Initial Undrained Settlements, Lateral Squeeze & Bearing Capacity
  - Reach 1
  - Reach 2
  - Reach 3

- Estimates of Consolidation Settlements
  - Long-term foundation subsoil settlements
    - Containment Berm Loads
    - Marsh Fill Load
  - Self-Weight Consolidation
    - Composite Sample V-2

- Cut/Fill Volume Calculations
  - Offshore Borrow Area
  - Reach 1 Containment Berms
  - Reach 2 Containment Berms
  - Reach 3 Containment Berms

Design Strength Parameters - Idealized "Clay Case" Marsh Fill Reach I



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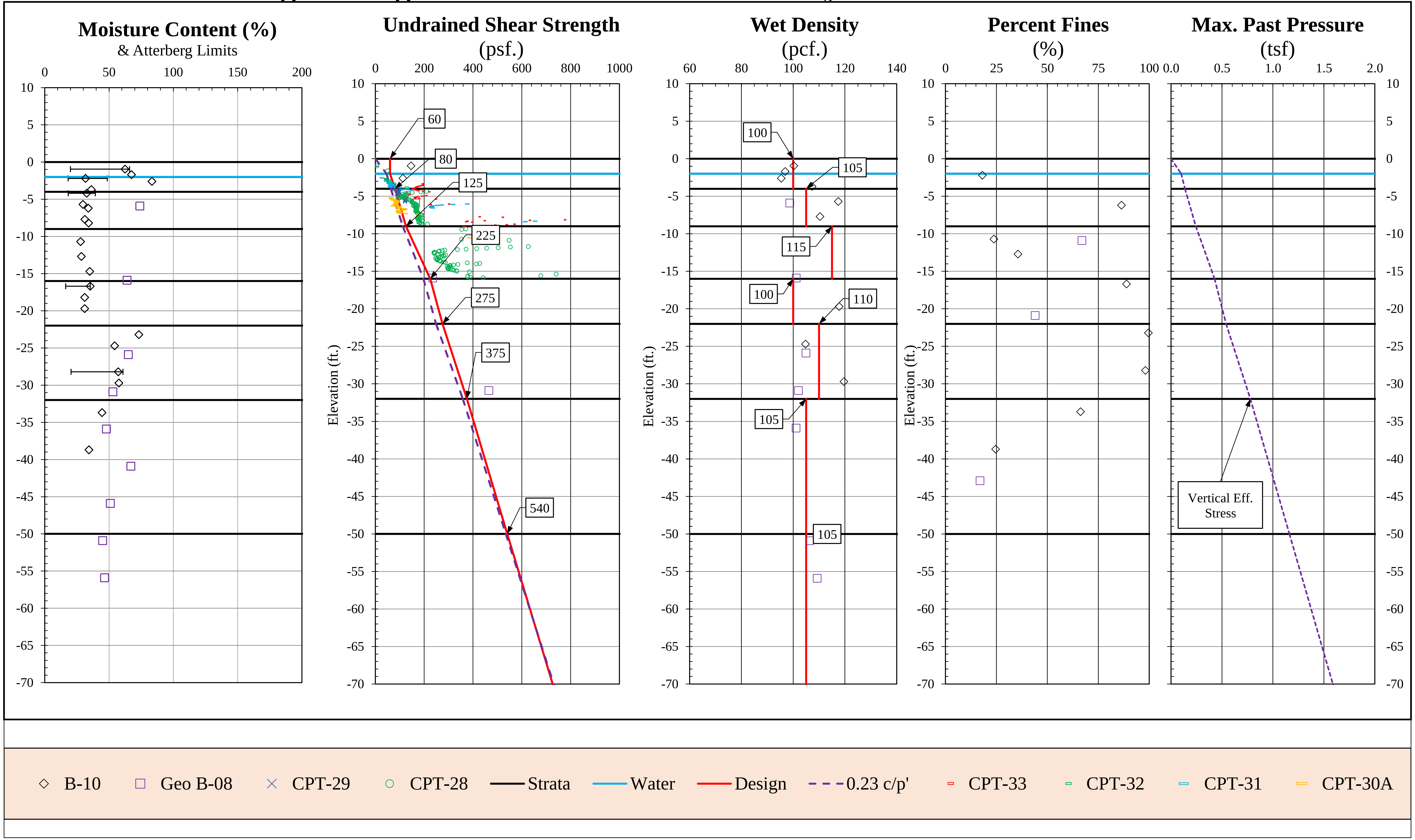
AAI No. 17-2810

Design Strength Parameters - Idealized "Clay Case" Marsh Fill Reach I



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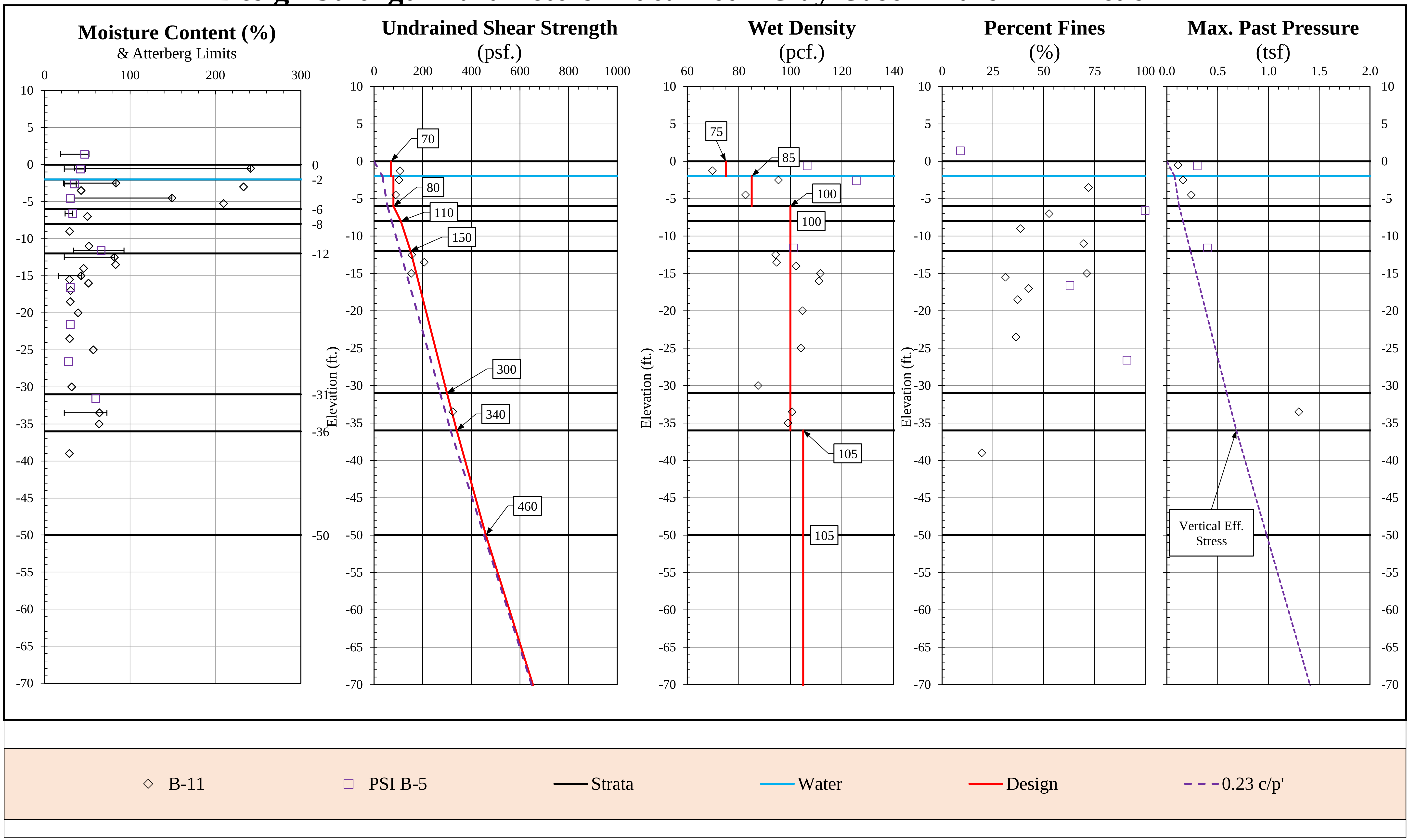
Design Strength Parameters - Idealized "Clay Case" Marsh Fill Reach II



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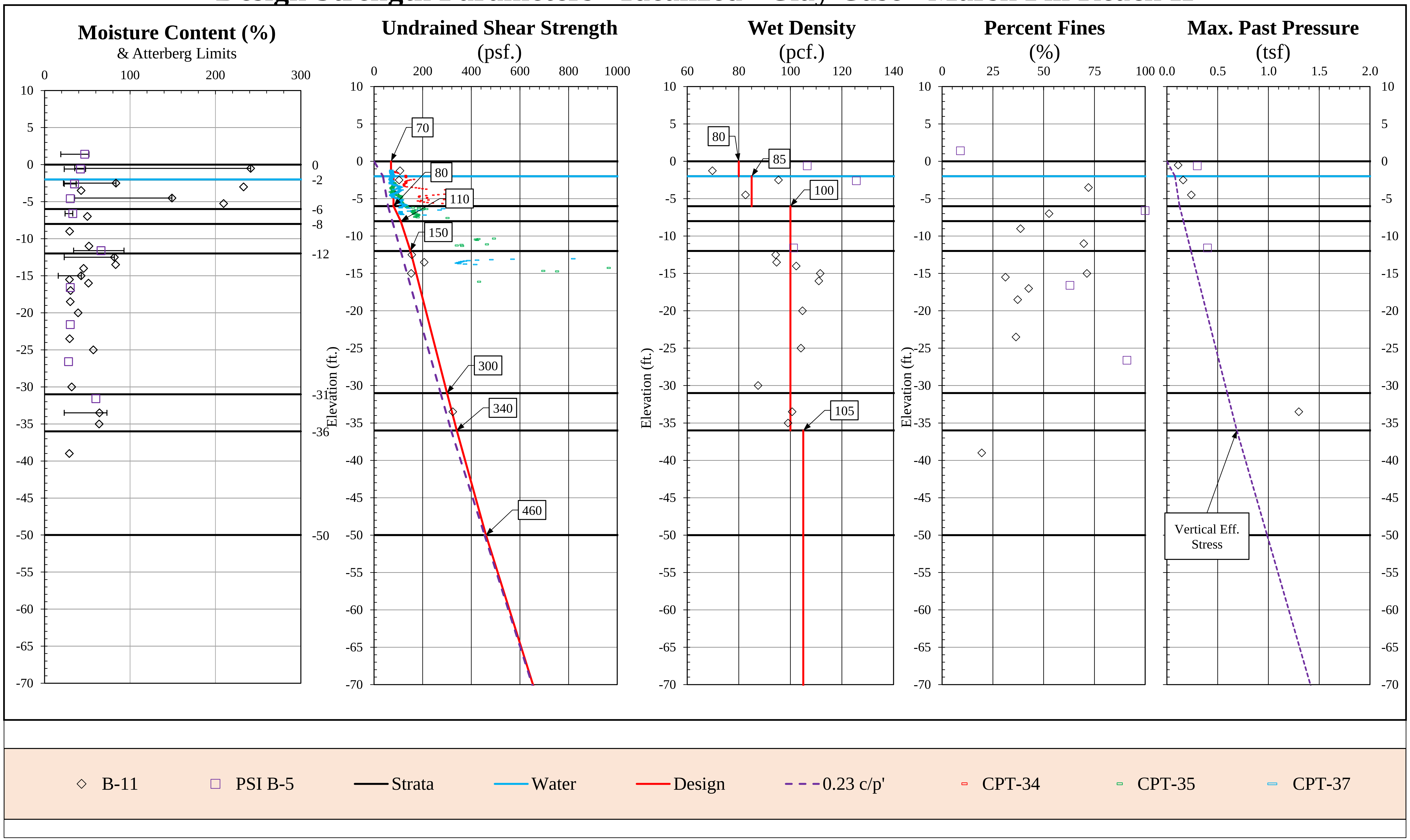
AAI No. 17-2810

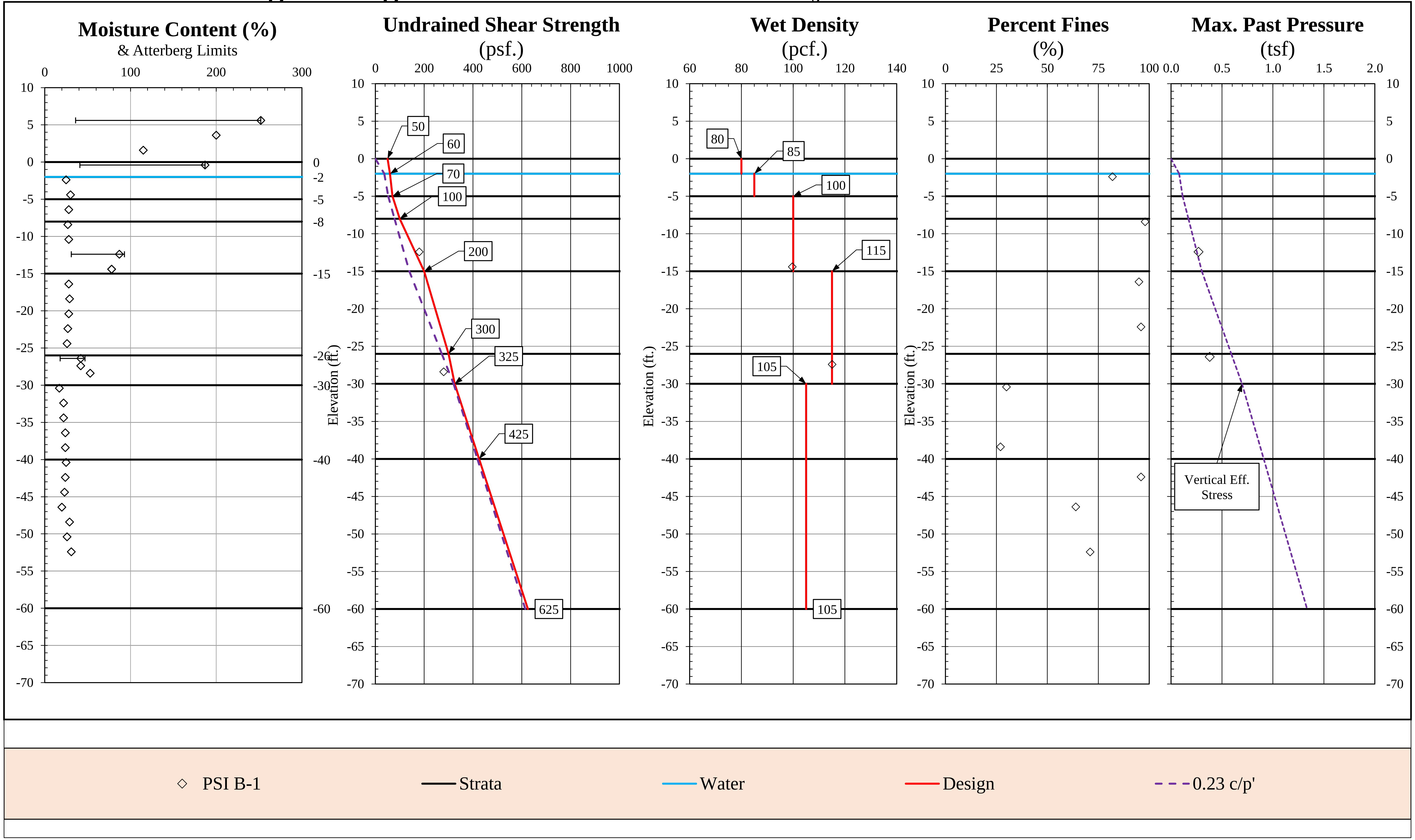
Design Strength Parameters - Idealized "Clay Case" Marsh Fill Reach II



Ardaman & Associates, Inc.

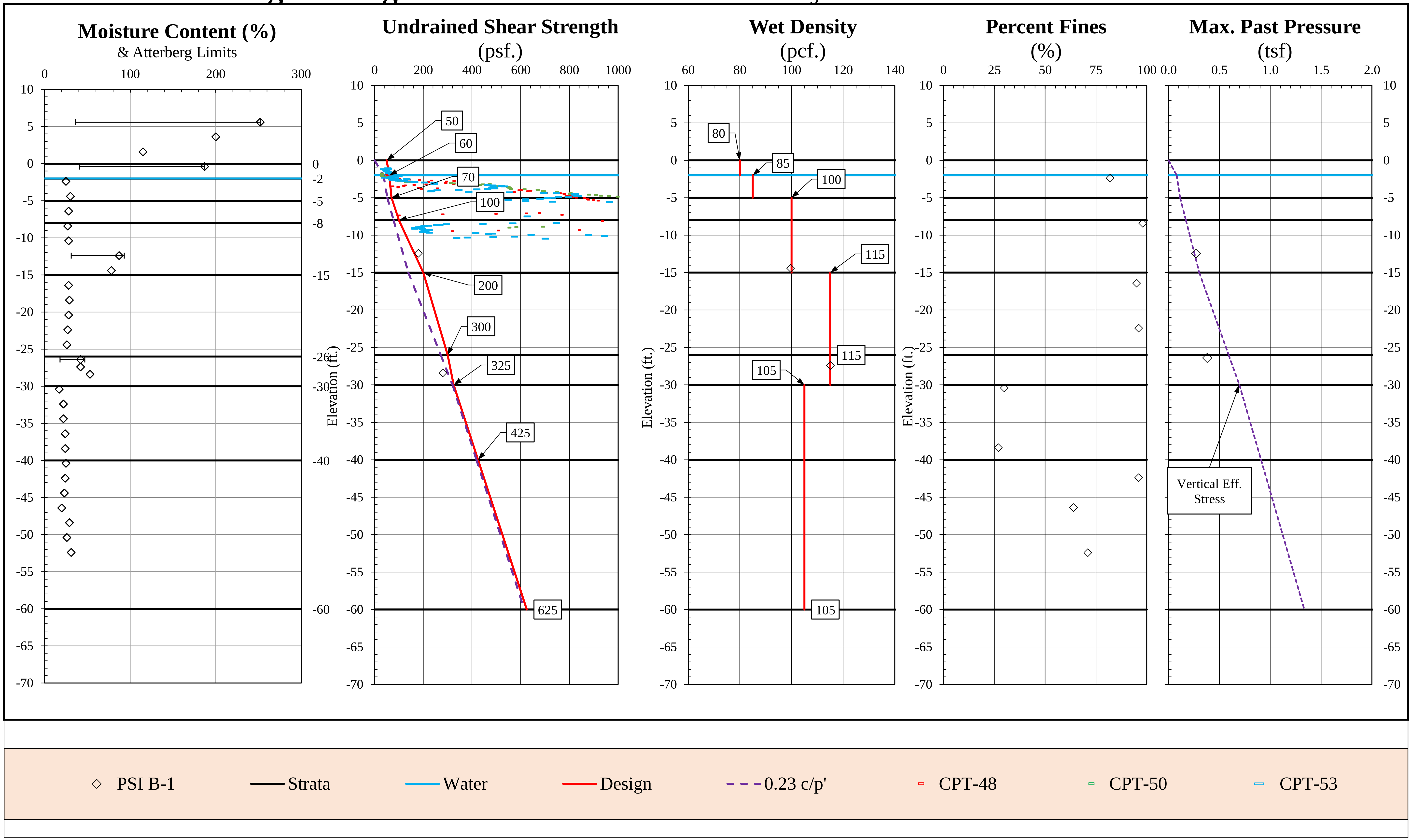
AAI No. 17-2810

Design Strength Parameters - Idealized "Clay Case" Marsh Fill Reach III



AAI No. 17-2810

Design Strength Parameters - Idealized "Clay Case" Marsh Fill Reach III



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AAI No. 17-2810

Initial Undrained Settlement Calculations

Caminada Headlands Back Barrier Marsh Creation - Reach 1

Project No. 17-2810

Date: 9/15/2018

Berm Information:

Crown Elev.:	4.00	ft.	Crown Width (W):	5	ft.	Wet Weight (γ):	85	pcf.
Mudline Elev.	-2.00	ft.	Side Slopes (S):	4.0	H:1V	Water Table, Elev.:	0.2	ft., NAVD88
Height (H):	6.0	ft.	Base Width (B):	53	ft.	Weight of Berm =	8,722	lbs.

1) Determine the Equivalent Base Width of a Berm. Is the berm reinforced? = no

Equivalent Base Width (B') = 2*[1/2 * (S)(H)] + W

B' = 29 ft. use B' = 29 ft.

2) Determine the applied stress.

Applied Stess (q) = Weight / B'

q = 510 psf. q' = 300.766 psf. (taking into account submerged portion)

3) Determine parameters for settlement calculation.

Applied Shear Stress Ratio (τ/Su) = 1/F.S. where F.S. = factor of safety at end of construction.

Factor of Safety (F.S.): 2.32 (τ/Su) = 0.43

Determine the modulus of the soil, Eu

Shear Strength (Su): 93 psf. (Average of Compressible Layers)

E_u/Su: 180 (assumed) From Figure 5 = 187

E_u = 16,778.6 psf.

Shape Parameters, D/B' where D is the thickness of the layer being compressed

D: 7 ft. El. -9 ft., NAVD88 (Bottom of Compressible Layer)

D/B' = 1.00 (#)

Influence factor, Ip

Load applied is considered: Strip Load

Ip = 0.38 From Figure 6

Elastic Settlement, ρe

ρ_e = (q * B' * Ip) / (E_u) = 0.20 ft. 2.36 in.

Initial Undrained Settlement, ρ_i

Average OCR: 1.20 q / q_{ult} = 0.43

From Figure 7, f = 0.40 Settlement Ratio, S_r = 0.60 From Figure 8

$\rho_i = \rho_e / S_r$ = 0.33 ft. 3.93 in.

Reference: Undrained Settlement of Plastic and Organic Clays by Foott & Ladd (1981)

Ardaman & Associates, Inc.

Caminada Headlands Back Barrier Marsh Creation - Reach 1

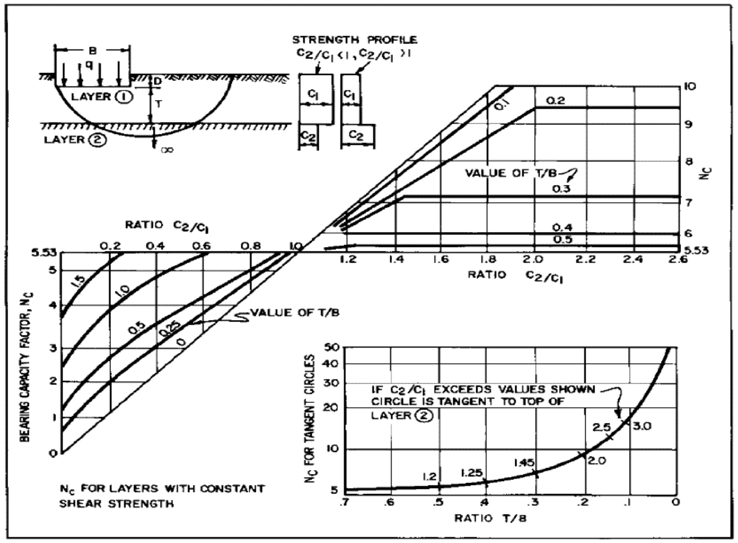

FIGURE 5
Ultimate Bearing Capacity of Two Layer Cohesive Soil (Ø=0)

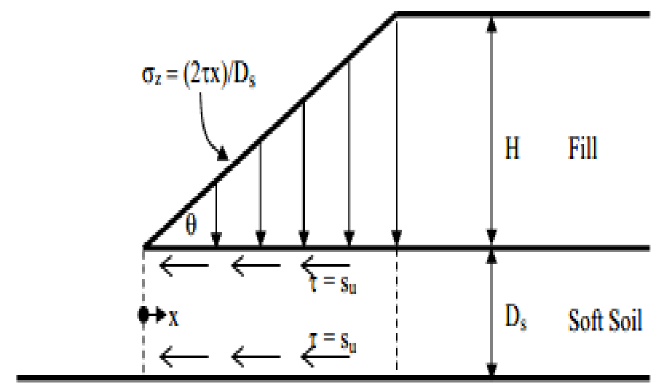

Figure 7-20. Definitions for calculating safety factor against lateral squeeze (after Silvestri, 1983).

Bearing Capacity based on NAVFAC DM 7.2

Lateral Squeezing based on NHI-06-088 December 2006

C_1 =	70	(psf)	B' =	29.0	(ft)
C_2 =	103	(psf)	T =	7	(ft)
C_2 / C_1 =	1.46	(#)	T/B =	0.24	(#)

Side Slopes (S):	4	H:1V
Angle of Slope, (Θ):	14.04	(deg)
Undrained Shear Strength, S_u:	93.2	(psf)
Height of Slope, H:	6.0	(ft)
Unit Weight of Fill, γ:	85	(psf)
Depth of Soft Soil, D_s:	7	(ft)

N_c = 7.5 FS = 1.20

Q_u = 525 $= C_1 * N_c$ (psf)

Q_{all} = 438 $= Q_u / FS$ (psf)

$Q_{\text{berm contact pressure}}$ = 301 (psf)

b = 24 = H/tan(Θ) (ft) [base width at end of slope]

b > Ds; consider lateral squeeze

Actual Factor of Safety = 1.75

Factor of Safety of Lateral Squeeze, FS_{SQ} = 2.01

Initial Undrained Settlement Calculations

Caminada Headlands Back Barrier Marsh Creation - Reach 2

Project No. 17-2810

Date: 9/15/2018

Berm Information:

Crown Elev.:	4.00	ft.	Crown Width (W):	5	ft.	Wet Weight (γ):	85	pcf.
Mudline Elev.	-2.00	ft.	Side Slopes (S):	4.0	H:1V	Water Table, Elev.:	0.2	ft., NAVD88
Height (H):	6.0	ft.	Base Width (B):	53	ft.	Weight of Berm =	8,722	lbs.

1) Determine the Equivalent Base Width of a Berm. Is the berm reinforced? = no

Equivalent Base Width (B') = 2*[1/2 * (S)(H)] + W

B' = 29 ft. use B' = 29 ft.

2) Determine the applied stress.

Applied Stess (q) = Weight / B'

q = 510 psf. q' = 300.766 psf. (taking into account submerged portion)

3) Determine parameters for settlement calculation.

Applied Shear Stress Ratio (τ/Su) = 1/F.S. where F.S. = factor of safety at end of construction.

Factor of Safety (F.S.): 1.63 (τ/Su) = 0.61

Determine the modulus of the soil, Eu

Shear Strength (Su): 85 psf. (Average of Compressible Layers)

E_u/Su: 120 (assumed) From Figure 5 = 115

E_u = 10,200.0 psf.

Shape Parameters, D/B' where D is the thickness of the layer being compressed

D: 6 ft. El. -8 ft., NAVD88 (Bottom of Compressible Layer)

D/B' = 1.00 (#)

Influence factor, Ip

Load applied is considered: Strip Load

Ip = 0.38 From Figure 6

Elastic Settlement, ρe

ρ_e = (q * B' * Ip) / (E_u) = 0.32 ft. 3.88 in.

Initial Undrained Settlement, ρ_i

Average OCR: 1.20 q / q_{ult} = 0.61

From Figure 7, f = 0.40 Settlement Ratio, S_r = 0.60 From Figure 8

$\rho_i = \rho_e / S_r$ = 0.54 ft. 6.46 in.

Reference: Undrained Settlement of Plastic and Organic Clays by Foott & Ladd (1981)

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Caminada Headlands Back Barrier Marsh Creation - Reach 2

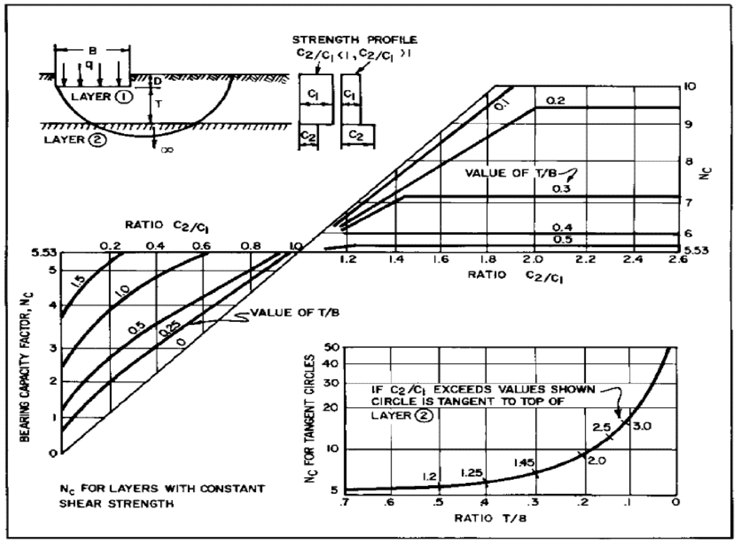

FIGURE 5
Ultimate Bearing Capacity of Two Layer Cohesive Soil (Ø=0)

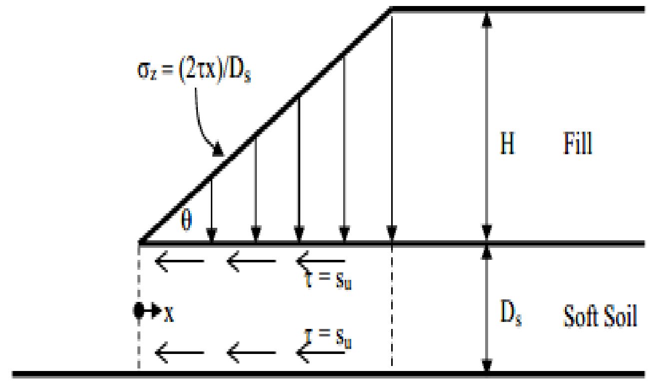

Figure 7-20. Definitions for calculating safety factor against lateral squeeze (after Silvestri, 1983).

Bearing Capacity based on NAVFAC DM 7.2

Lateral Squeezing based on NHI-06-088 December 2006

C_1 =	80	(psf)	B' =	29.0	(ft)
C_2 =	95	(psf)	T =	6	(ft)
C_2 / C_1 =	1.19	(#)	T/B =	0.21	(#)

Side Slopes (S):	4	H:1V
Angle of Slope, (Θ):	14.04	(deg)
Undrained Shear Strength, S_u:	85.0	(psf)
Height of Slope, H:	6.0	(ft)
Unit Weight of Fill, γ:	85	(psf)
Depth of Soft Soil, D_s:	6	(ft)

N_c = 6.5   FS = 1.20

Q_u = 520 = $C_1 * N_c$ (psf)

Q_{all} = 433 = Q_u / FS (psf)

$Q_{\text{berm contact pressure}}$ = 301 (psf)

b = 24 = H/tan(Θ) (ft) [base width at end of slope]

b > Ds; consider lateral squeeze

Actual Factor of Safety = 1.73

Factor of Safety of Lateral Squeeze, FS_{SQ} = 2.02

Initial Undrained Settlement Calculations

Caminada Headlands Back Barrier Marsh Creation - Reach 3

Project No. 17-2810

Date: 9/15/2018

Berm Information:

Crown Elev.:	4.00	ft.	Crown Width (W):	5	ft.	Wet Weight (γ):	85	pcf.
Mudline Elev.	-2.00	ft.	Side Slopes (S):	4.0	H:1V	Water Table, Elev.:	0.2	ft., NAVD88
Height (H):	6.0	ft.	Base Width (B):	53	ft.	Weight of Berm =	8,722	lbs.

1) Determine the Equivalent Base Width of a Berm. Is the berm reinforced? = no

Equivalent Base Width (B') = 2*[1/2 * (S)(H)] + W

B' = 29 ft. use B' = 29 ft.

2) Determine the applied stress.

Applied Stess (q) = Weight / B'

q = 510 psf. q' = 300.766 psf. (taking into account submerged portion)

3) Determine parameters for settlement calculation.

Applied Shear Stress Ratio (τ/Su) = 1/F.S. where F.S. = factor of safety at end of construction.

Factor of Safety (F.S.): 1.36 (τ/Su) = 0.73

Determine the modulus of the soil, Eu

Shear Strength (Su): 60 psf. (Average of Compressible Layers)

E_u/Su: 100 (assumed) From Figure 5 = 82

E_u = 6,000.0 psf.

Shape Parameters, D/B' where D is the thickness of the layer being compressed

D: 3 ft. El. -5 ft., NAVD88 (Bottom of Compressible Layer)

D/B' = 1.00 (#)

Influence factor, Ip

Load applied is considered: Strip Load

Ip = 0.38 From Figure 6

Elastic Settlement, ρe

ρ_e = (q * B' * Ip) / (E_u) = 0.55 ft. 6.59 in.

Initial Undrained Settlement, ρ_i

Average OCR: 1.20 q / q_{ult} = 0.73

From Figure 7, f = 0.40 Settlement Ratio, S_r = 0.60 From Figure 8

$\rho_i = \rho_e / S_r$ = 0.92 ft. 10.98 in.

Reference: Undrained Settlement of Plastic and Organic Clays by Foott & Ladd (1981)

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Caminada Headlands Back Barrier Marsh Creation - Reach 3

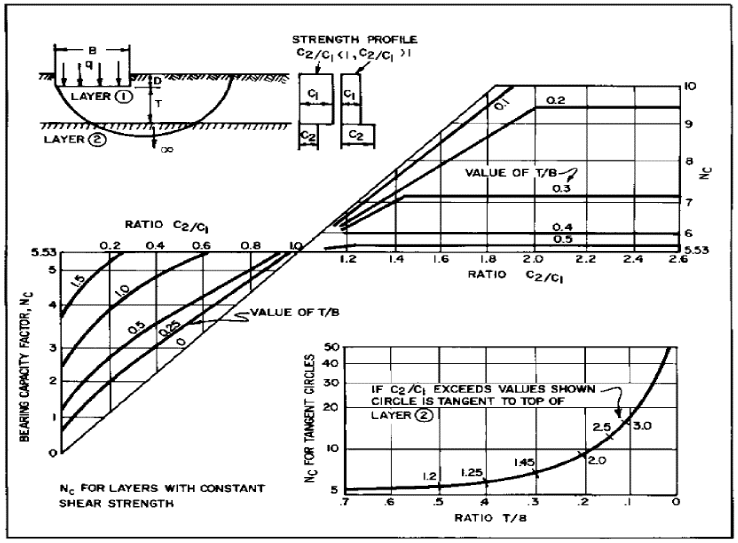


FIGURE 5
Ultimate Bearing Capacity of Two Layer Cohesive Soil (Ø=0)

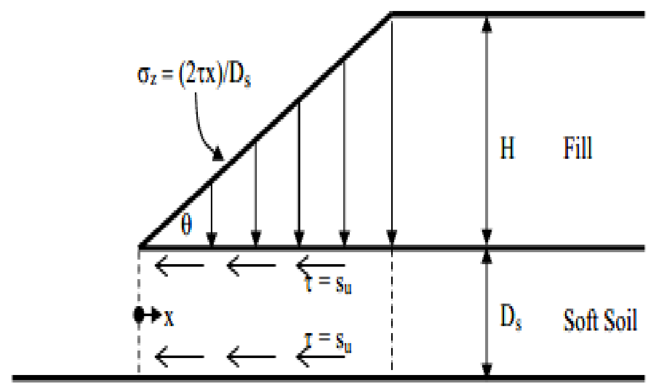


Figure 7-20. Definitions for calculating safety factor against lateral squeeze (after Silvestri, 1983).

Bearing Capacity based on NAVFAC DM 7.2

C_1 =	60	(psf)	B' =	29.0	(ft)
C_2 =	150	(psf)	T =	3	(ft)
C_2 / C_1 =	2.50	(#)	T/B =	0.10	(#)

*C_2 = Assume dense sand

N_c =	8		FS =	1.20
Q_u =	480	= $C_1 * N_c$	(psf)	
Q_{all} =	400	= Q_u / FS	(psf)	

$Q_{\text{berm contact pressure}}$ = 301 (psf)

Actual Factor of Safety = 1.60

Lateral Squeezing based on NHI-06-088 December 2006

Side Slopes (S):	4	H:1V
Angle of Slope, (Θ):	14.04	(deg)
Undrained Shear Strength, S_u:	60.0	(psf)
Height of Slope, H:	6.0	(ft)
Unit Weight of Fill, γ:	85	(psf)
Depth of Soft Soil, D_s:	3	(ft)

b = 24 = H/tan(Θ) (ft) [base width at end of slope]

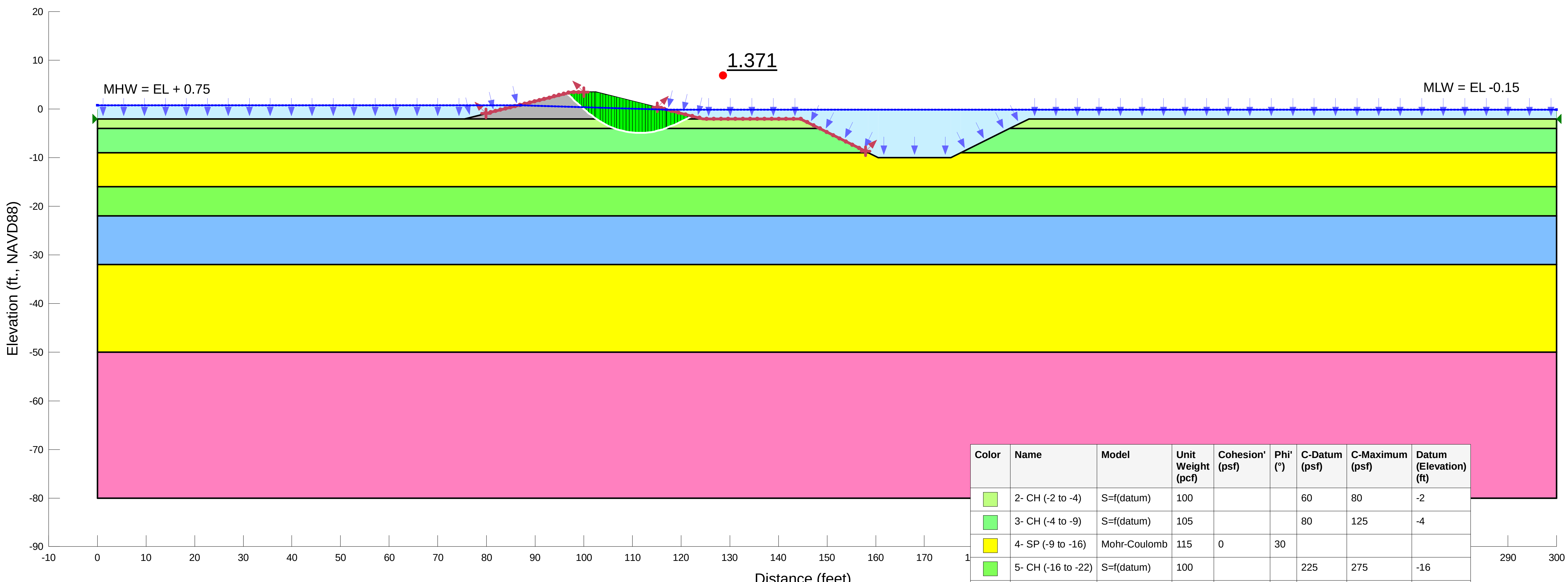
b > Ds; consider lateral squeeze

Factor of Safety of Lateral Squeeze, FS_{SQ} = 2.37

Berm Crest @ EL +3.5
Berm Side Slope 1V:4.0H
Mudline @ -2.0
Excavation Side Slope 1V:2.0H

5 ft   20 ft

Case A-1: MHW outside ECD and MLW inside ECD



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- CH (-2 to -4)	S=f(datum)	100			60	80	-2
	3- CH (-4 to -9)	S=f(datum)	105			80	125	-4
	4- SP (-9 to -16)	Mohr-Coulomb	115	0	30			
	5- CH (-16 to -22)	S=f(datum)	100			225	275	-16
	6- CH (-22 to -32)	S=f(datum)	110			275	375	-22
	7- SP (-32 to -50)	Mohr-Coulomb	105	0	30			
	8- CH (-50 to -80)	S=f(datum)	105			540	820	-50
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 1 (TOB @ 3.5) SS 1V4-00H ML-2 (B=20) Borrow.gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.371

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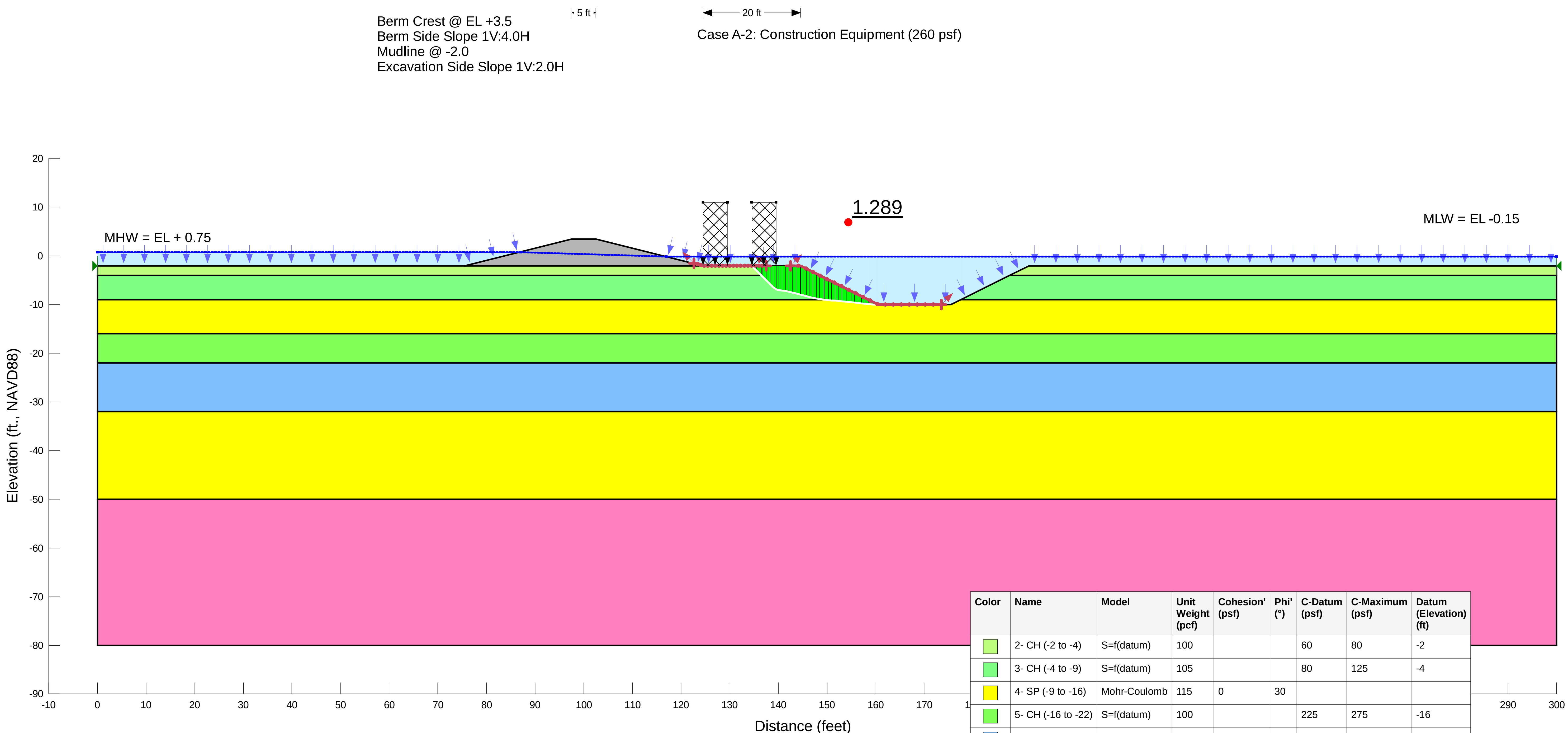

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- CH (-2 to -4)	S=f(datum)	100			60	80	-2
	3- CH (-4 to -9)	S=f(datum)	105			80	125	-4
	4- SP (-9 to -16)	Mohr-Coulomb	115	0	30			
	5- CH (-16 to -22)	S=f(datum)	100			225	275	-16
	6- CH (-22 to -32)	S=f(datum)	110			275	375	-22
	7- SP (-32 to -50)	Mohr-Coulomb	105	0	30			
	8- CH (-50 to -80)	S=f(datum)	105			540	820	-50
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 1 (TOB @ 3.5) SS 1V4-00H ML-2 (B=20) Borrow.gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.289

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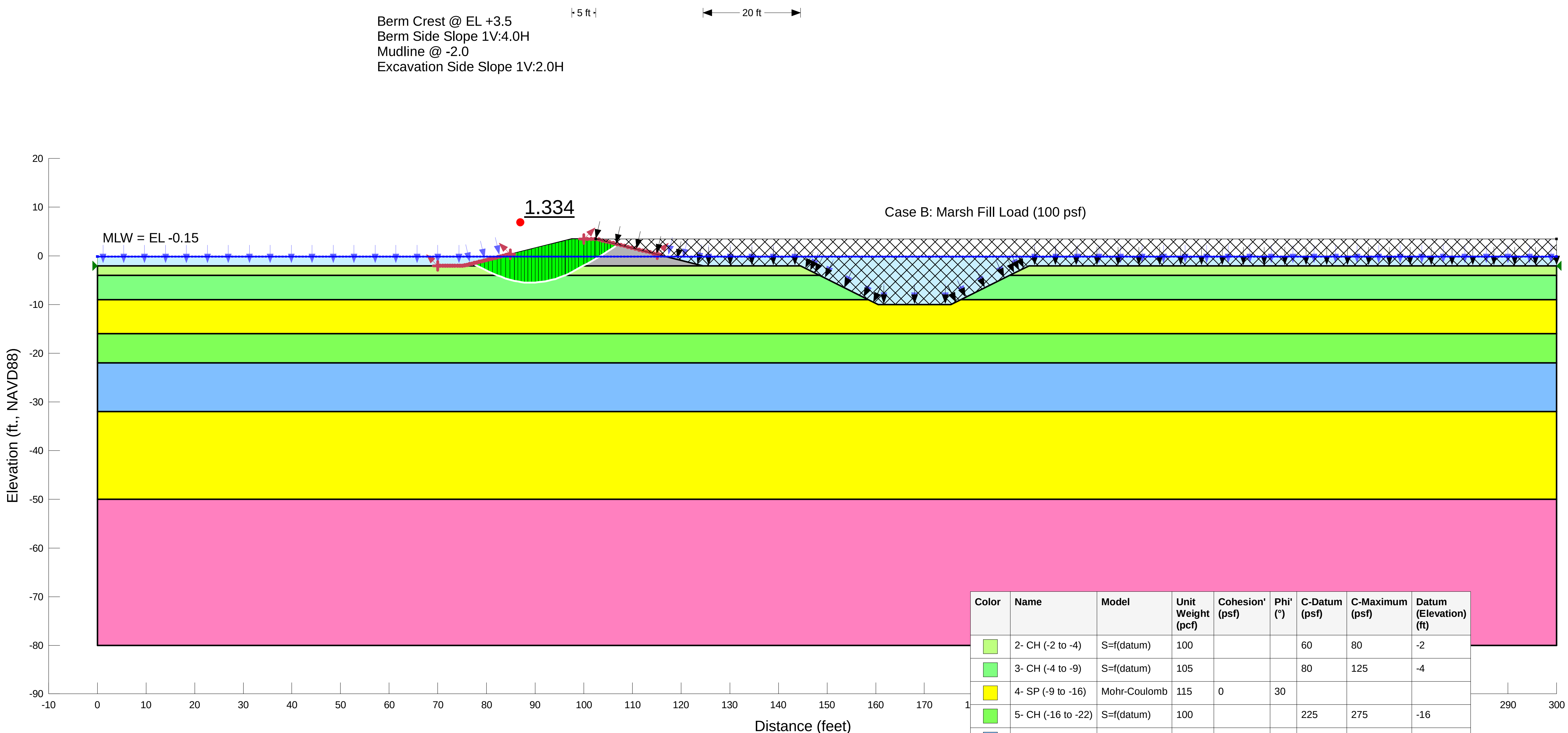
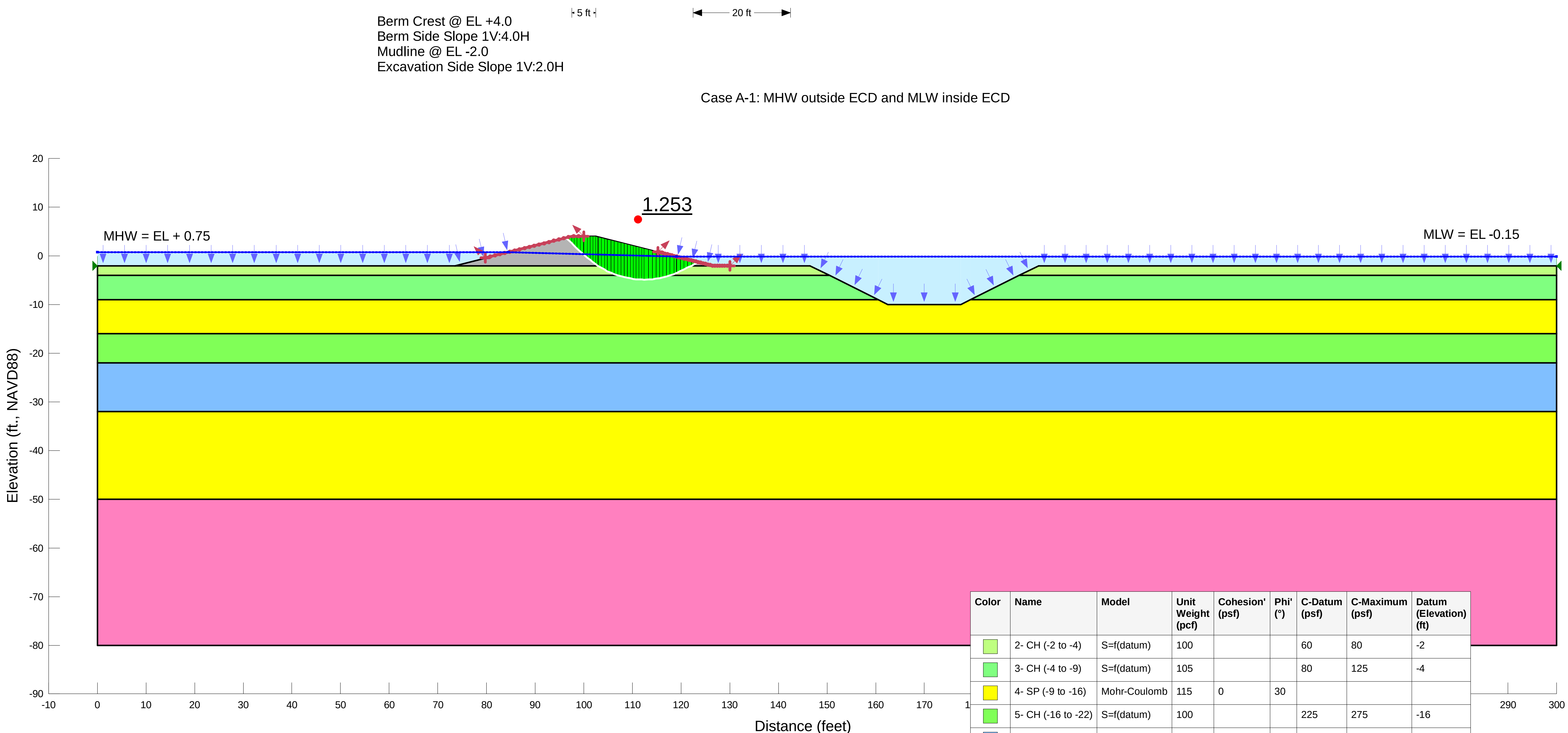


Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- CH (-2 to -4)	S=f(datum)	100			60	80	-2
	3- CH (-4 to -9)	S=f(datum)	105			80	125	-4
	4- SP (-9 to -16)	Mohr-Coulomb	115	0	30			
	5- CH (-16 to -22)	S=f(datum)	100			225	275	-16
	6- CH (-22 to -32)	S=f(datum)	110			275	375	-22
	7- SP (-32 to -50)	Mohr-Coulomb	105	0	30			
	8- CH (-50 to -80)	S=f(datum)	105			540	820	-50
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 1 (TOB @ 3.5) SS 1V4-00H ML-2 (B=20) Borrow.gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.334

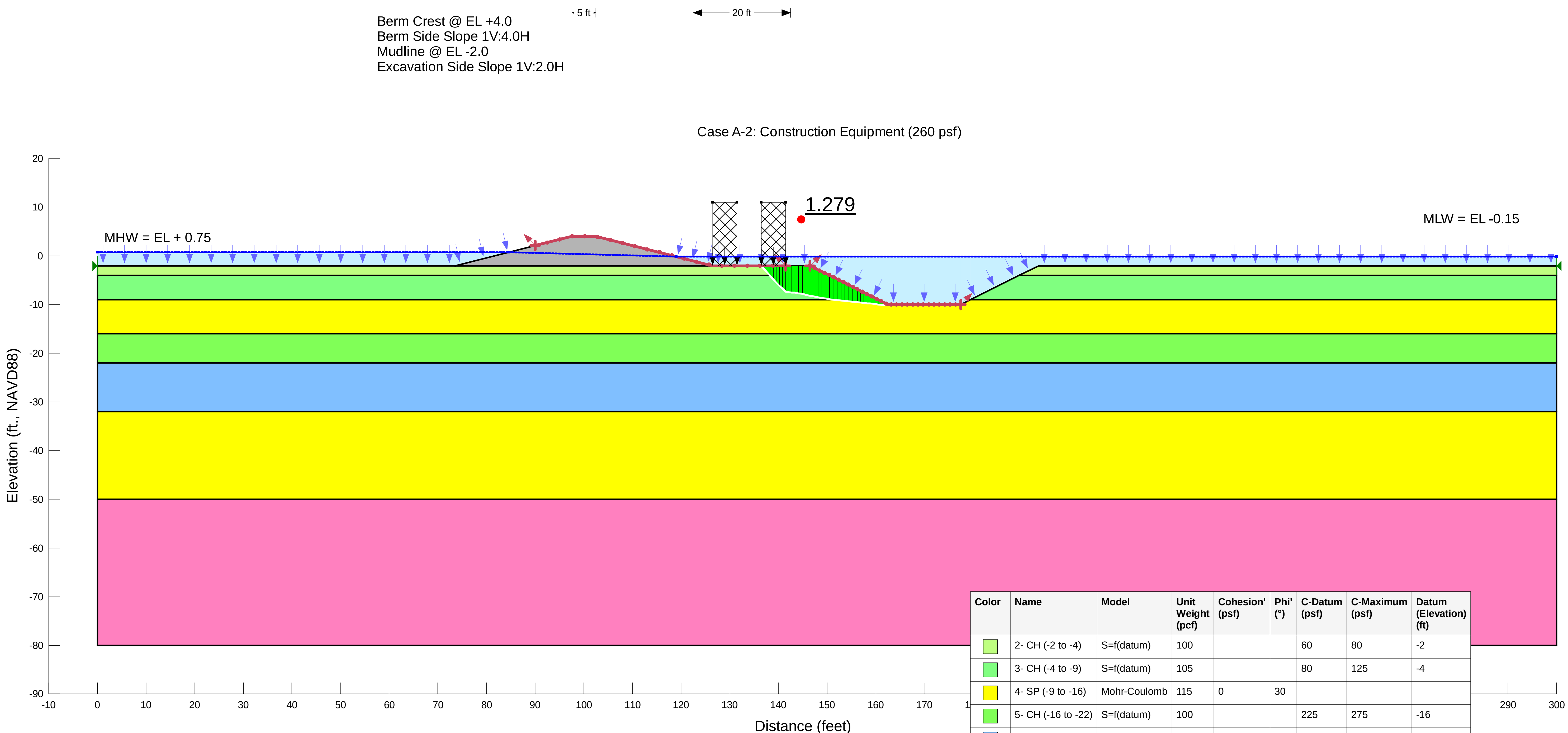
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- CH (-2 to -4)	S=f(datum)	100			60	80	-2
	3- CH (-4 to -9)	S=f(datum)	105			80	125	-4
	4- SP (-9 to -16)	Mohr-Coulomb	115	0	30			
	5- CH (-16 to -22)	S=f(datum)	100			225	275	-16
	6- CH (-22 to -32)	S=f(datum)	110			275	375	-22
	7- SP (-32 to -50)	Mohr-Coulomb	105	0	30			
	8- CH (-50 to -80)	S=f(datum)	105			540	820	-50
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 1 (TOB @ 4.0) SS 1V4-00H ML-2 (B=20) Borrow.gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.253

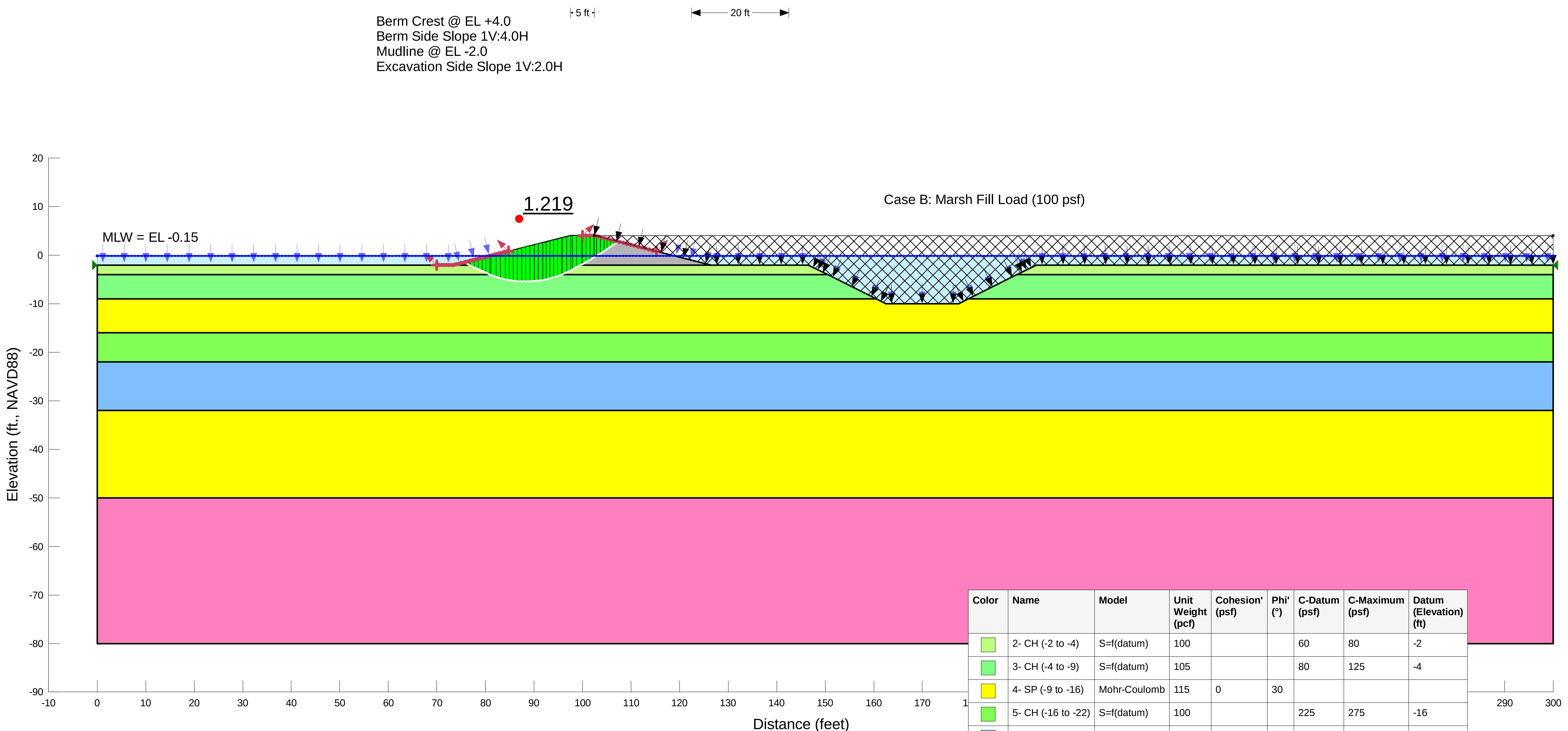
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- CH (-2 to -4)	S=f(datum)	100			60	80	-2
	3- CH (-4 to -9)	S=f(datum)	105			80	125	-4
	4- SP (-9 to -16)	Mohr-Coulomb	115	0	30			
	5- CH (-16 to -22)	S=f(datum)	100			225	275	-16
	6- CH (-22 to -32)	S=f(datum)	110			275	375	-22
	7- SP (-32 to -50)	Mohr-Coulomb	105	0	30			
	8- CH (-50 to -80)	S=f(datum)	105			540	820	-50
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 1 (TOB @ 4.0) SS 1V4-00H ML-2 (B=20) Borrow.gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.279

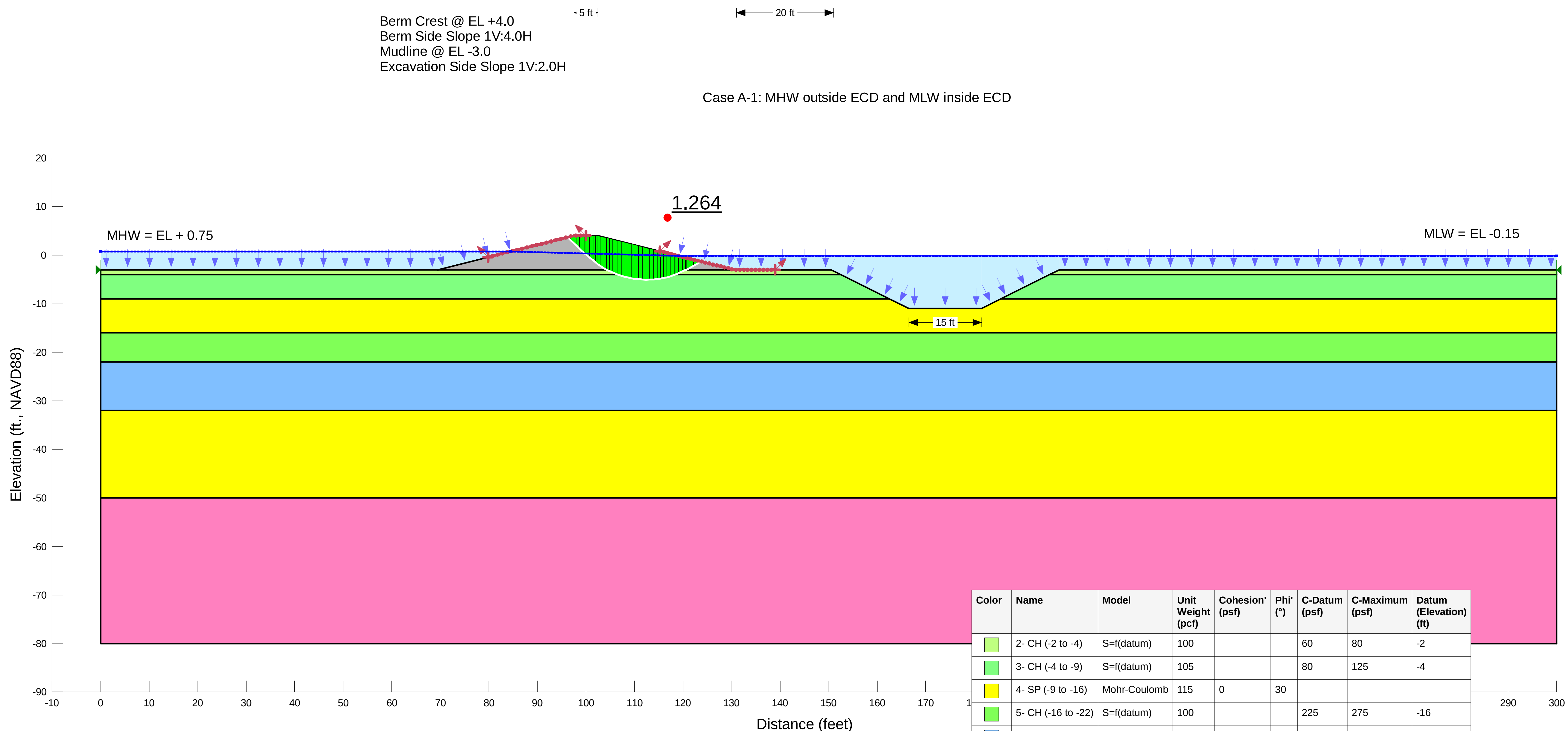
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- CH (-2 to -4)	S=f(datum)	100			60	80	-2
	3- CH (-4 to -9)	S=f(datum)	105			80	125	-4
	4- SP (-9 to -16)	Mohr-Coulomb	115	0	30			
	5- CH (-16 to -22)	S=f(datum)	100			225	275	-16
	6- CH (-22 to -32)	S=f(datum)	110			275	375	-22
	7- SP (-32 to -50)	Mohr-Coulomb	105	0	30			
	8- CH (-50 to -80)	S=f(datum)	105			540	820	-50
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 1 (TOB @ 4.0) SS 1V4-00H ML-2 (B=20) Borrow.gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.219

Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- CH (-2 to -4)	S=f(datum)	100			60	80	-2
	3- CH (-4 to -9)	S=f(datum)	105			80	125	-4
	4- SP (-9 to -16)	Mohr-Coulomb	115	0	30			
	5- CH (-16 to -22)	S=f(datum)	100			225	275	-16
	6- CH (-22 to -32)	S=f(datum)	110			275	375	-22
	7- SP (-32 to -50)	Mohr-Coulomb	105	0	30			
	8- CH (-50 to -80)	S=f(datum)	105			540	820	-50
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 1 (TOB @ 4.0) SS 1V4-00H ML-3 (B=20) Borrow.gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.264

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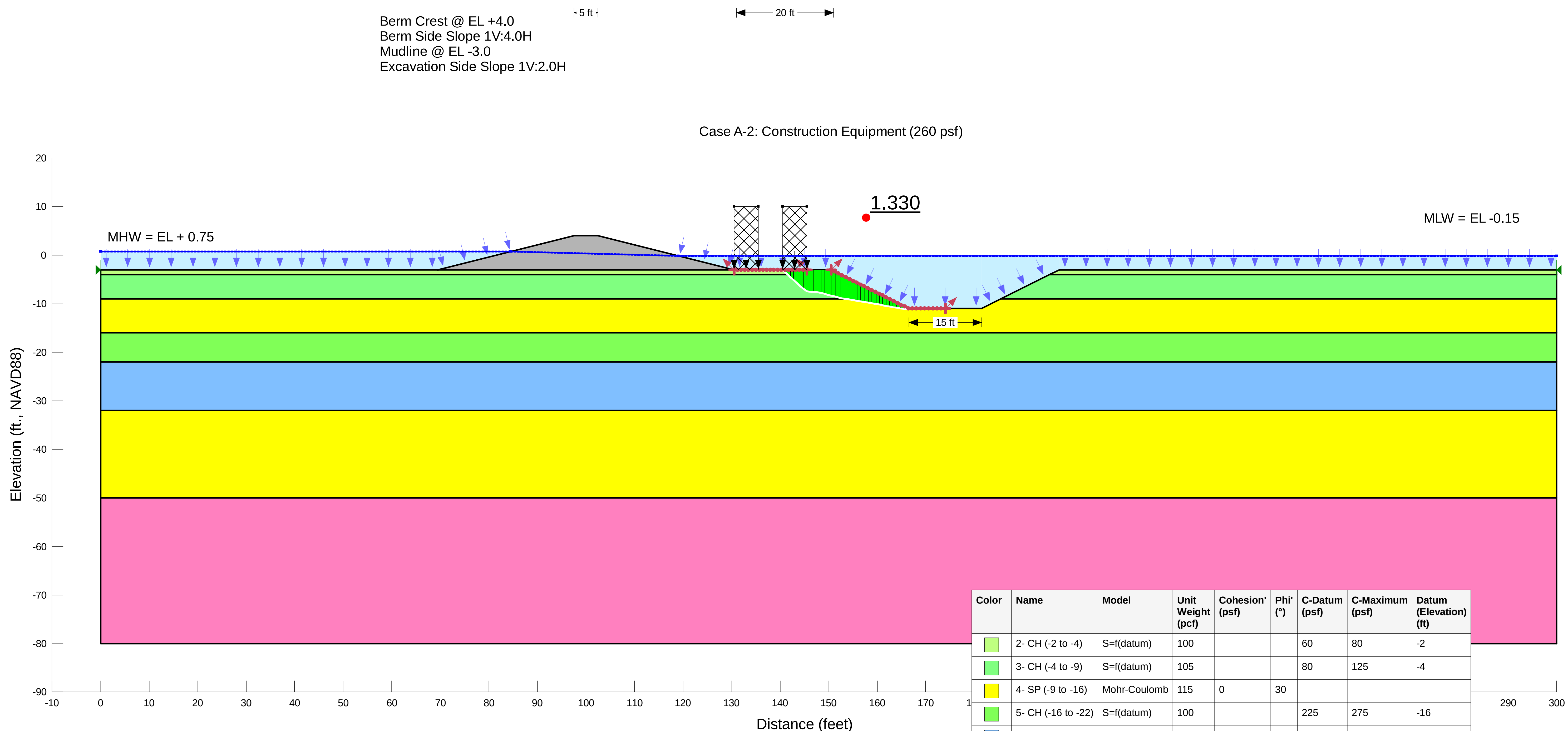
Berm Crest @ EL +4.0
Berm Side Slope 1V:4.0H
Mudline @ EL -3.0
Excavation Side Slope 1V:2.0H

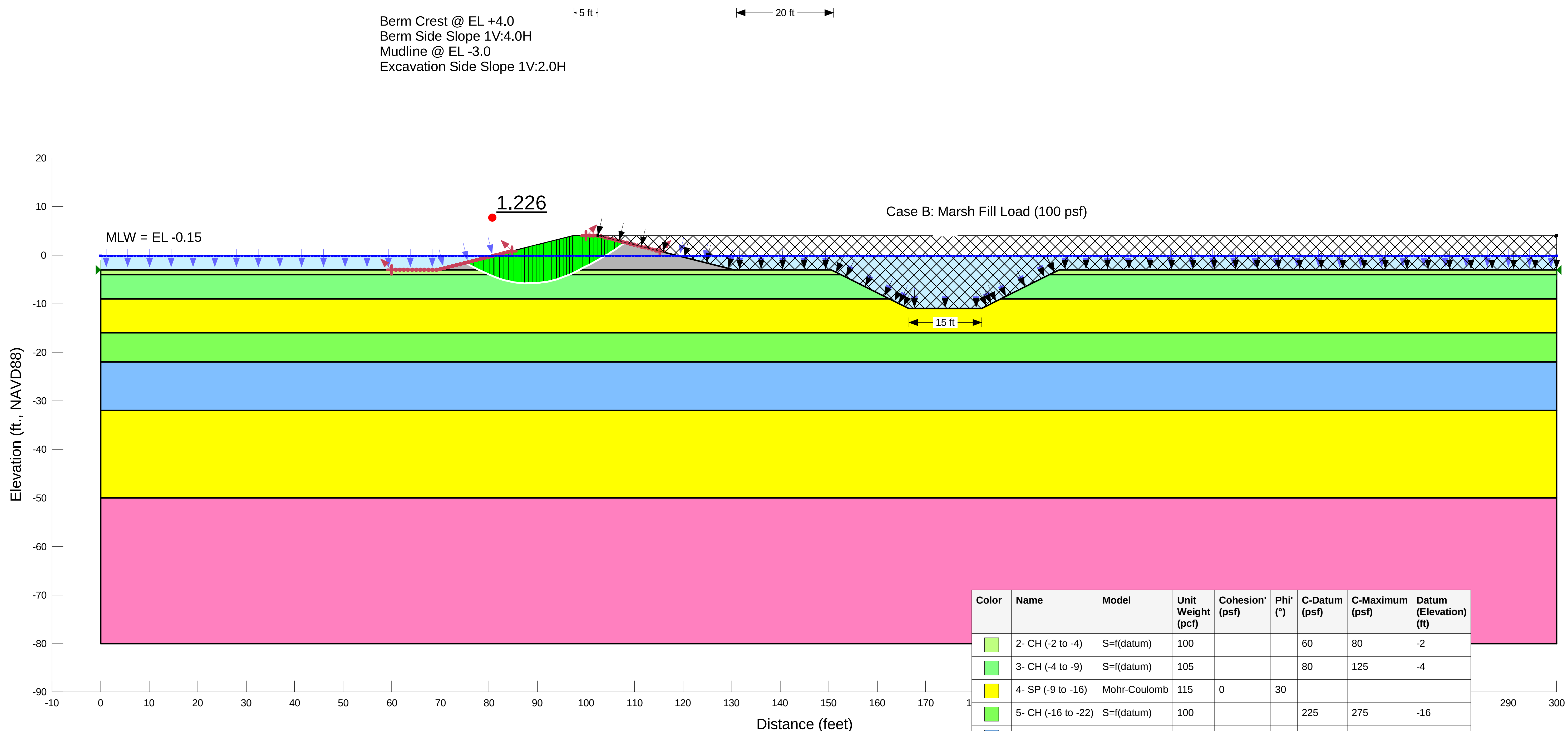
Case A-2: Construction Equipment (260 psf)



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- CH (-2 to -4)	S=f(datum)	100			60	80	-2
	3- CH (-4 to -9)	S=f(datum)	105			80	125	-4
	4- SP (-9 to -16)	Mohr-Coulomb	115	0	30			
	5- CH (-16 to -22)	S=f(datum)	100			225	275	-16
	6- CH (-22 to -32)	S=f(datum)	110			275	375	-22
	7- SP (-32 to -50)	Mohr-Coulomb	105	0	30			
	8- CH (-50 to -80)	S=f(datum)	105			540	820	-50
	ECD	Mohr-Coulomb	90	70	0			

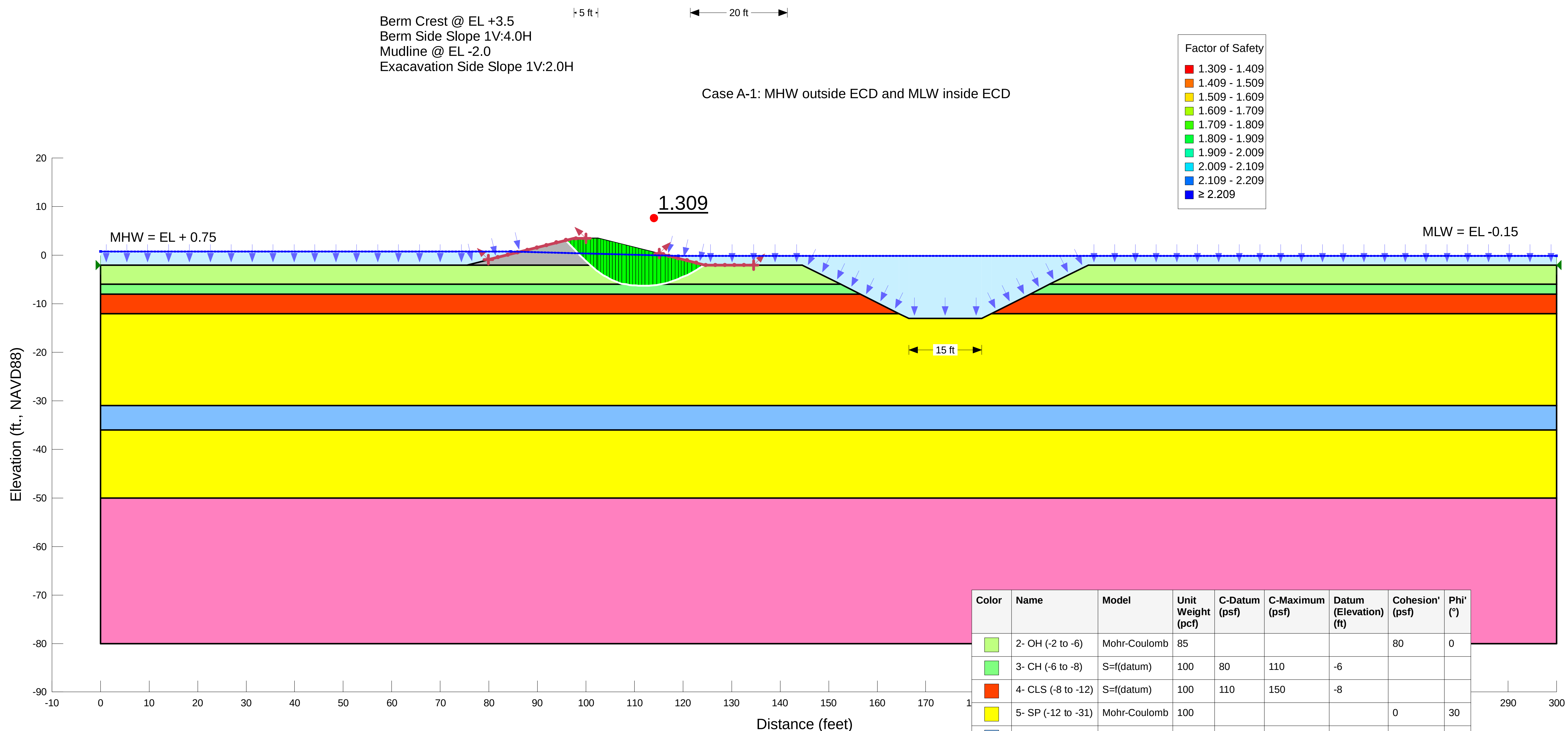
File Name: 17-2810 Reach 1 (TOB @ 4.0) SS 1V4-00H ML-3 (B=20) Borrow.gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.330

Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- CH (-2 to -4)	S=f(datum)	100			60	80	-2
	3- CH (-4 to -9)	S=f(datum)	105			80	125	-4
	4- SP (-9 to -16)	Mohr-Coulomb	115	0	30			
	5- CH (-16 to -22)	S=f(datum)	100			225	275	-16
	6- CH (-22 to -32)	S=f(datum)	110			275	375	-22
	7- SP (-32 to -50)	Mohr-Coulomb	105	0	30			
	8- CH (-50 to -80)	S=f(datum)	105			540	820	-50
	ECD	Mohr-Coulomb	90	70	0			

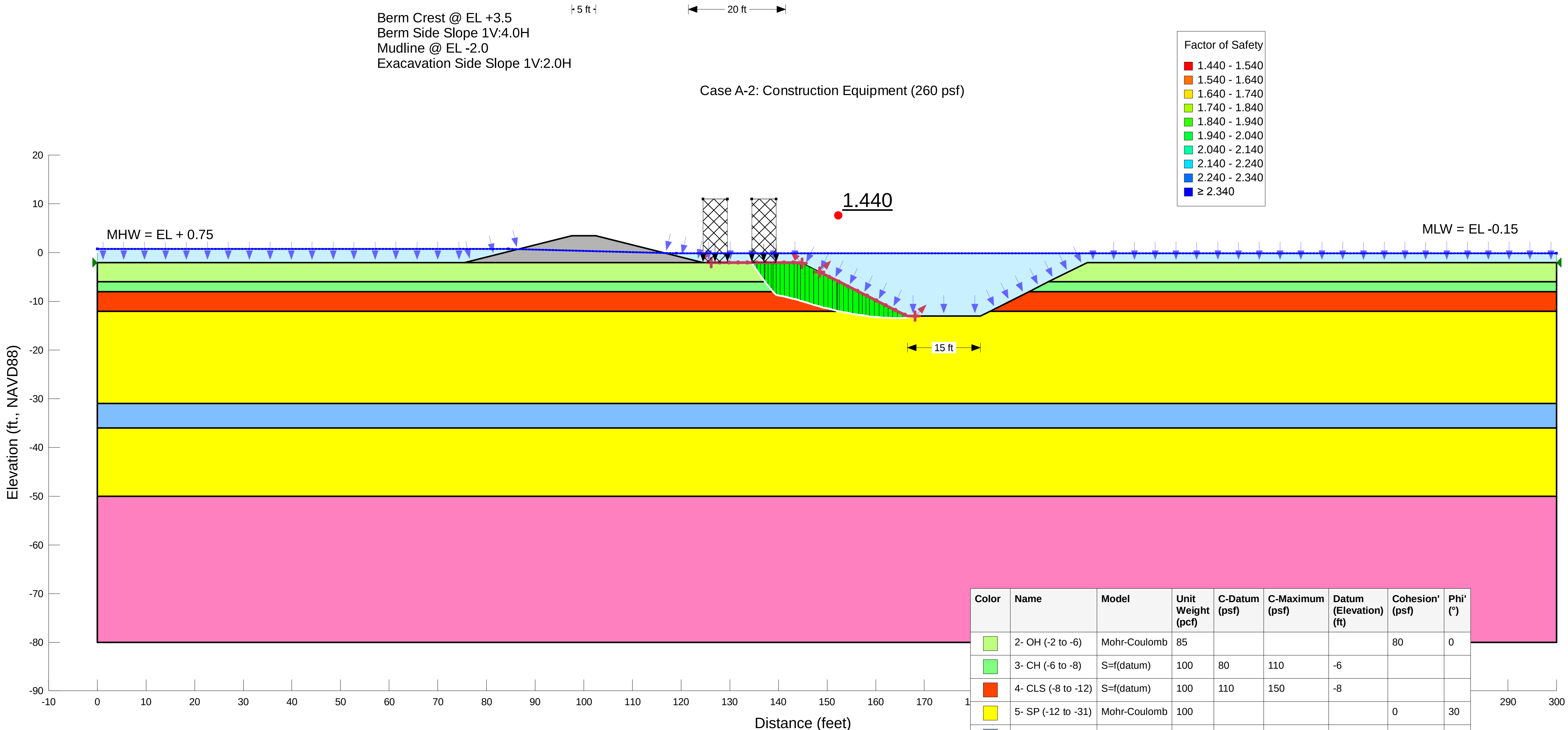
File Name: 17-2810 Reach 1 (TOB @ 4.0) SS 1V4-00H ML-3 (B=20) Borrow.gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.226



Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

File Name: 17-2810 Reach 2 (TOB @ 3.5) SS 1V4-00H ML-2 (B=20) Borrow.gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.309

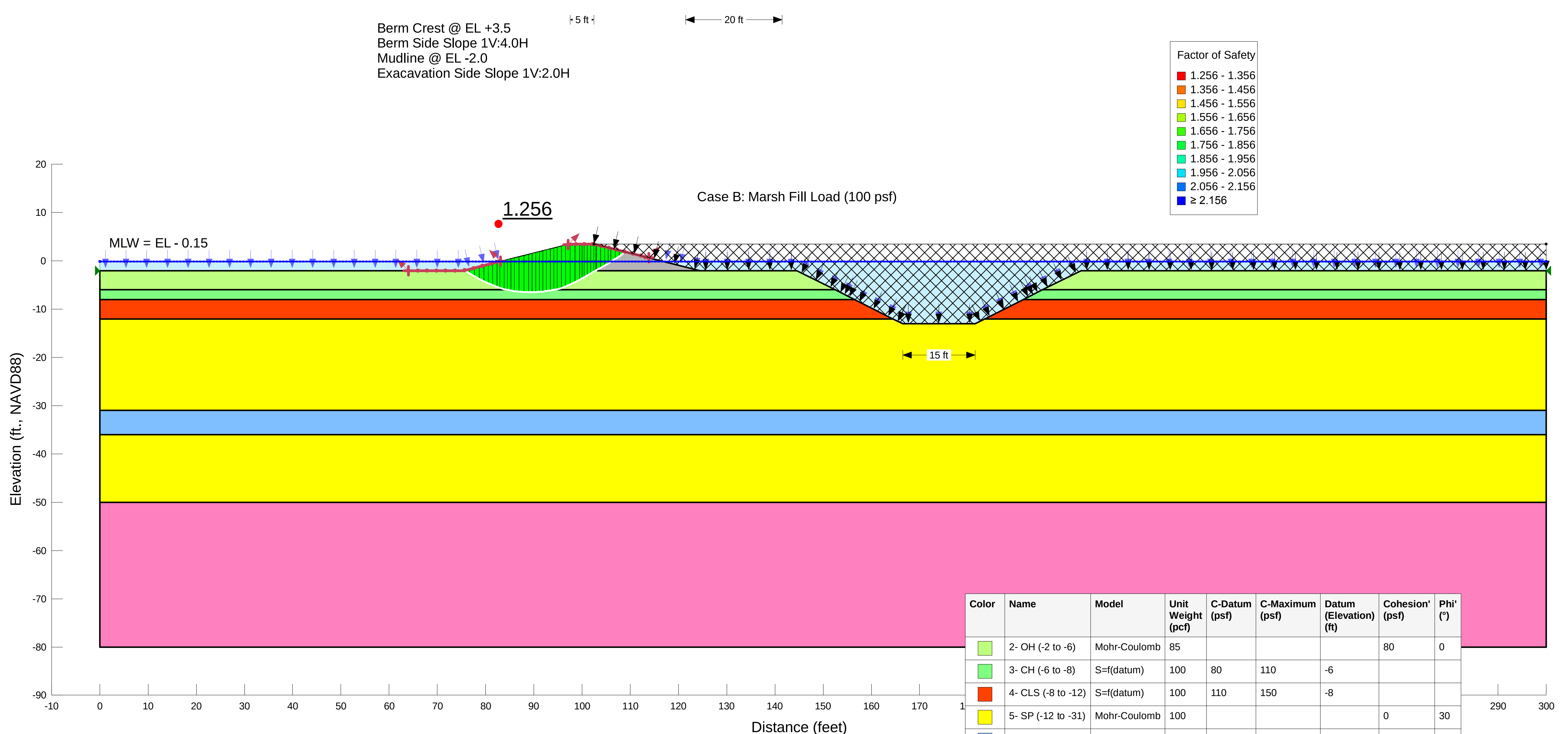
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

File Name: 17-2810 Reach 2 (TOB @ 3.5) SS 1V4-00H ML-2 (B=20) Borrow.gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.440

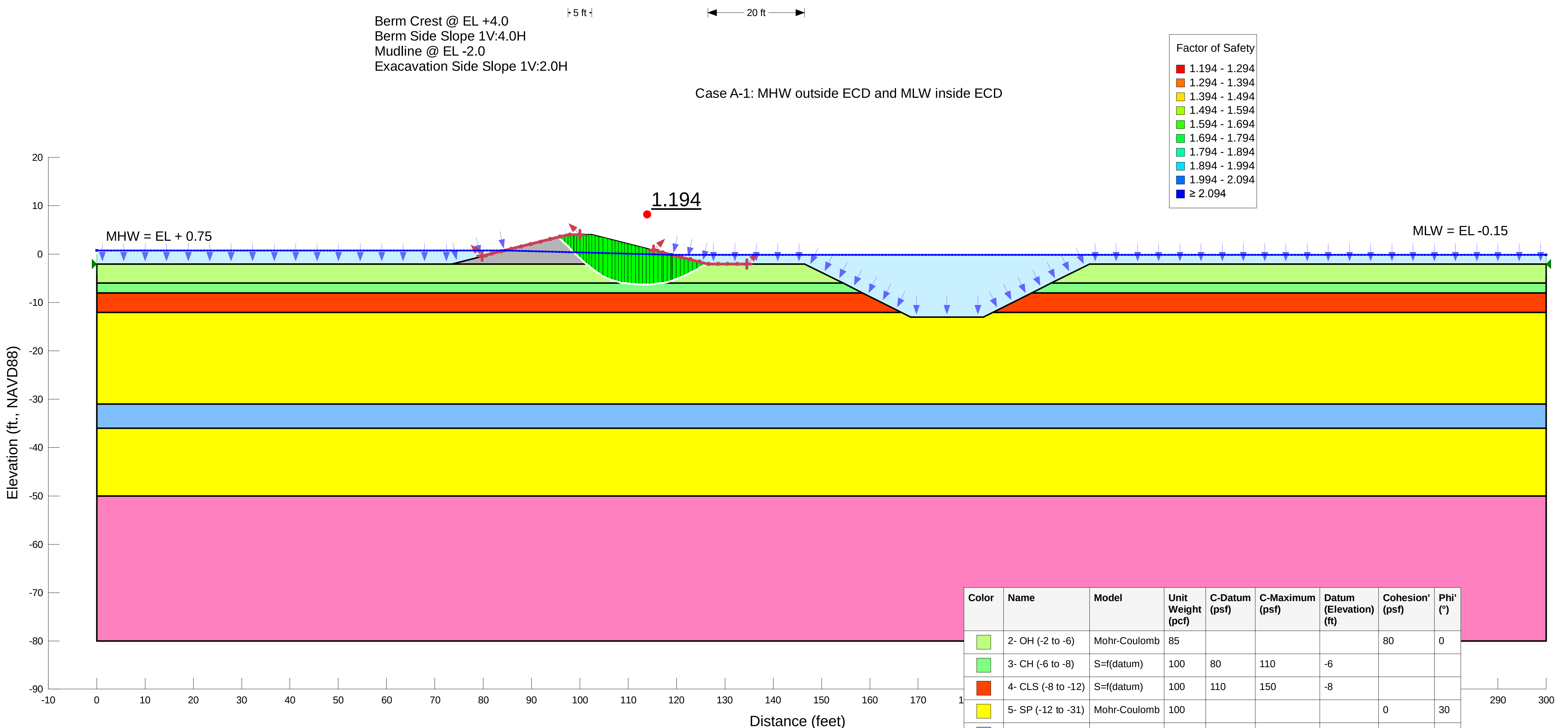
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

File Name: 17-2810 Reach 2 (TOB @ 3.5) SS 1V4-00H ML-2 (B=20) Borrow.gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.256

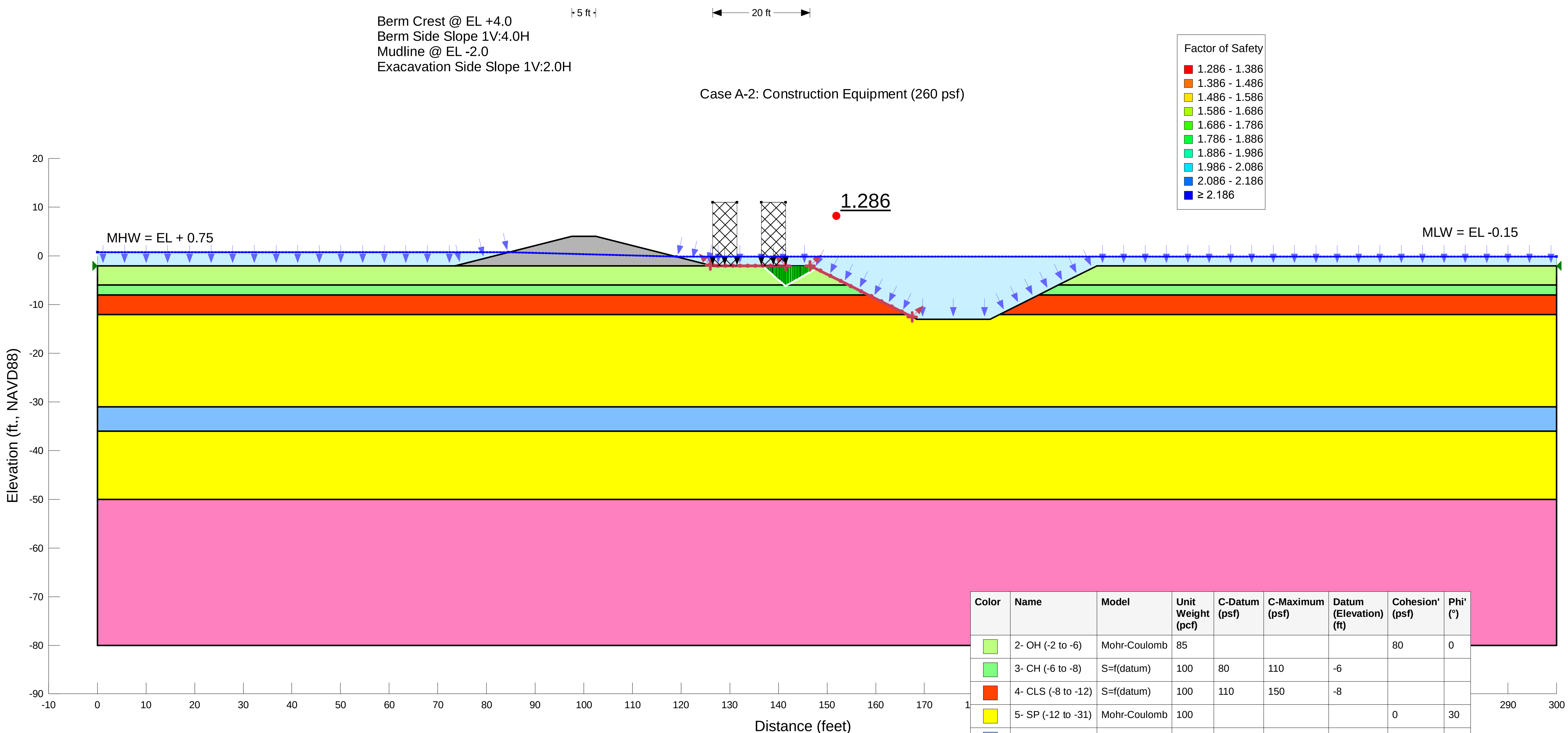
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

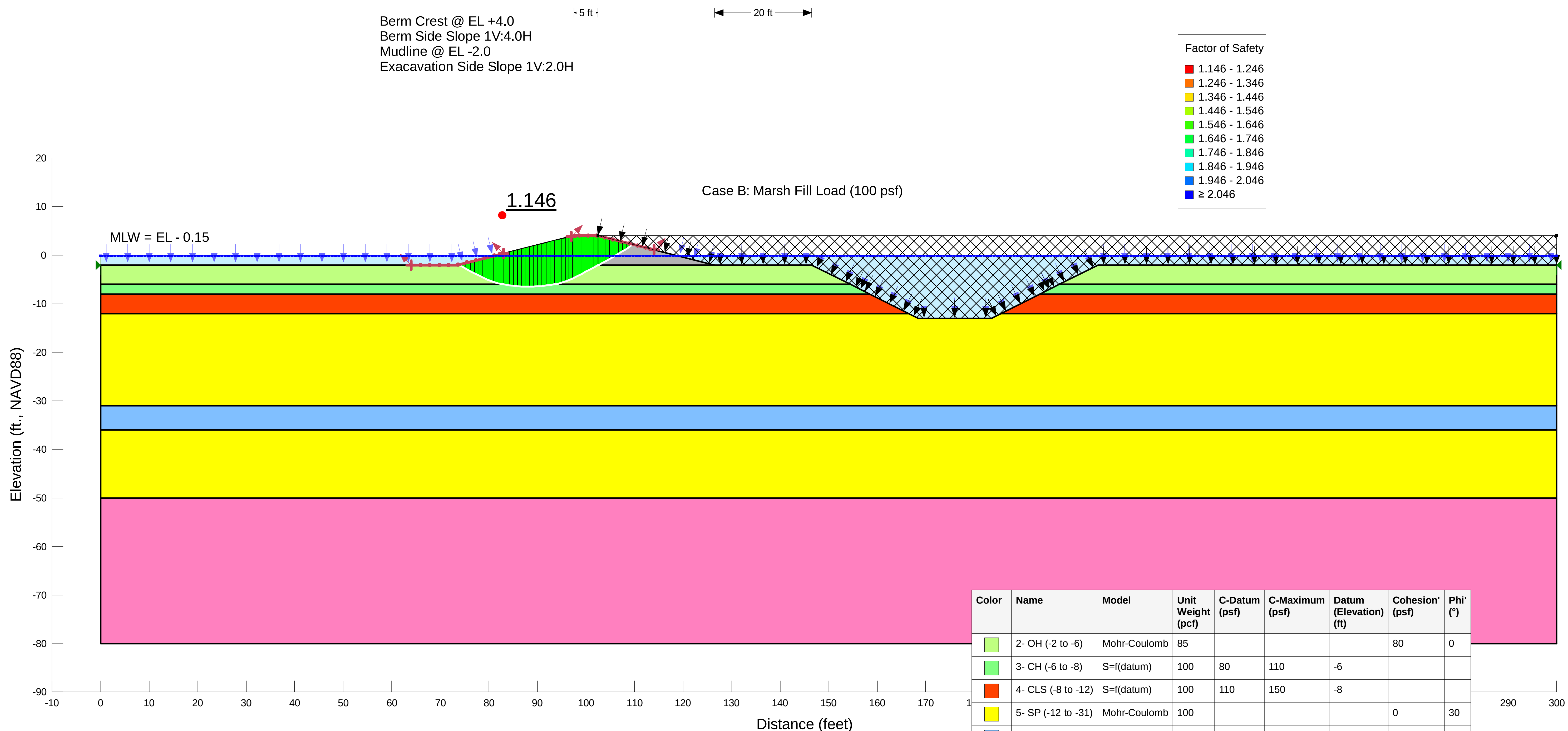
File Name: 17-2810 Reach 2 (TOB @ 4.0) SS 1V4-00H ML-2 (B=20) Borrow.gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.194

Ardaman & Associates, Inc.



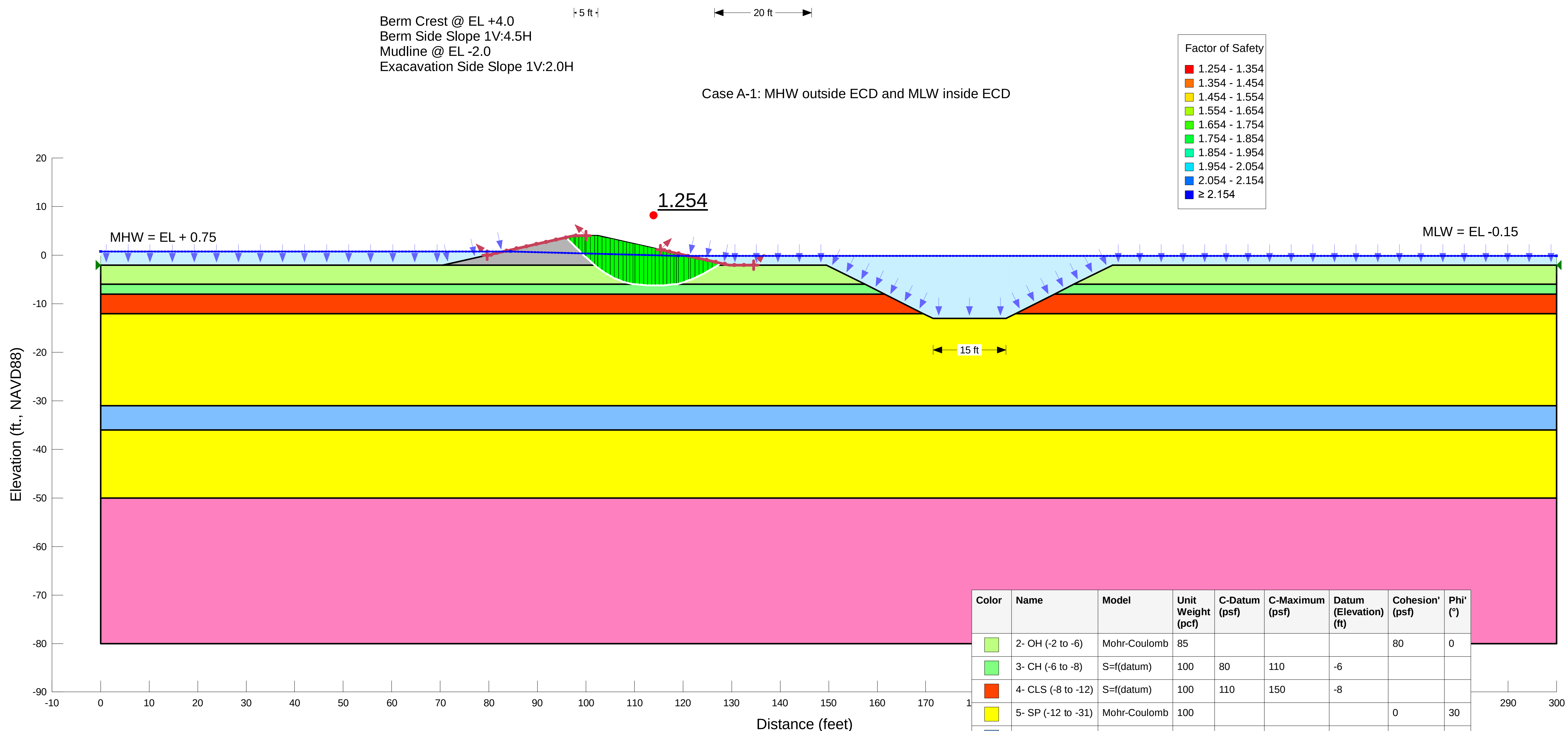
Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

File Name: 17-2810 Reach 2 (TOB @ 4.0) SS 1V4-00H ML-2 (B=20) Borrow.gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.286



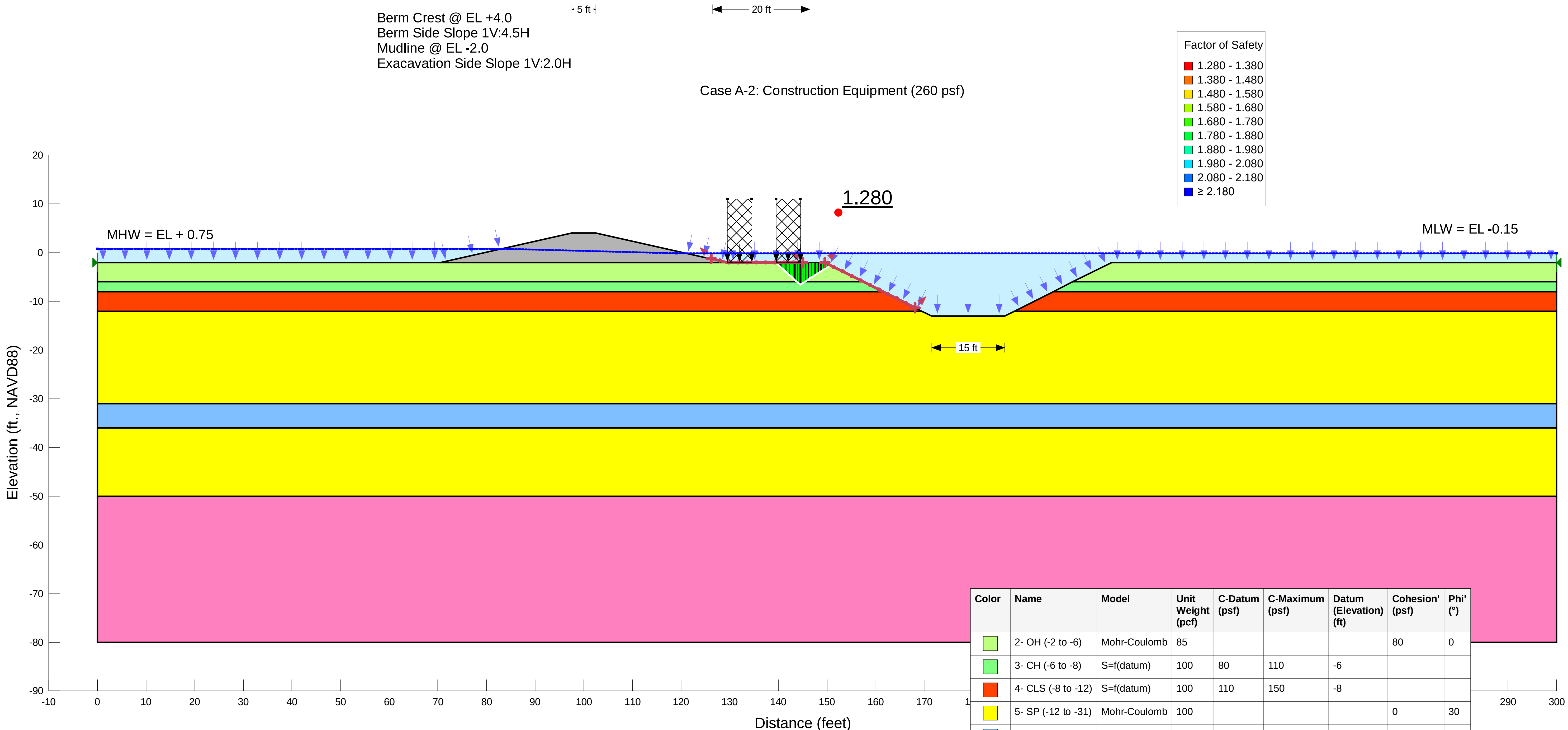
Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

File Name: 17-2810 Reach 2 (TOB @ 4.0) SS 1V4-00H ML-2 (B=20) Borrow.gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.146



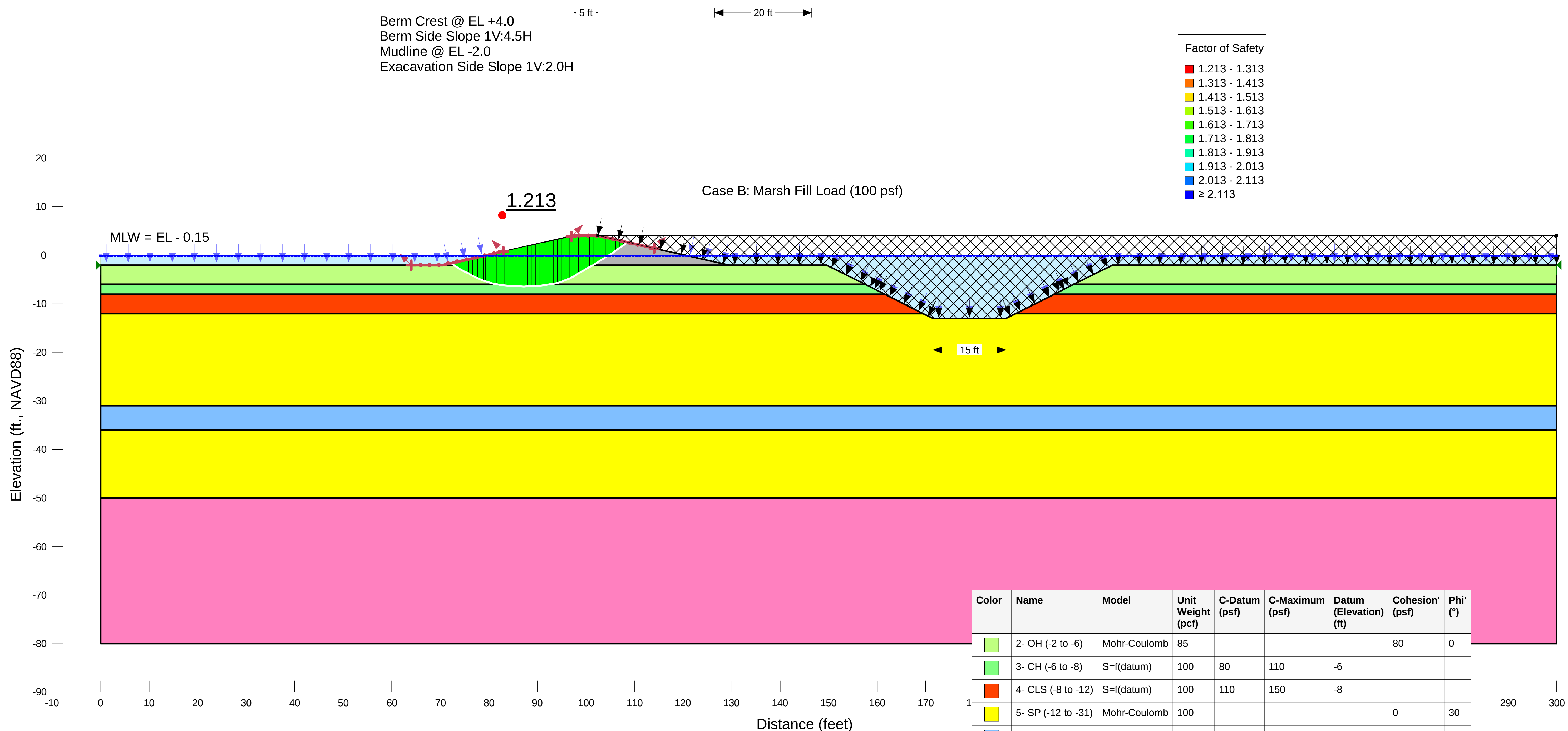
Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

File Name: 17-2810 Reach 2 (TOB @ 4.0) SS 1V4-50H ML-2 (B=20) Borrow.gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.254



Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

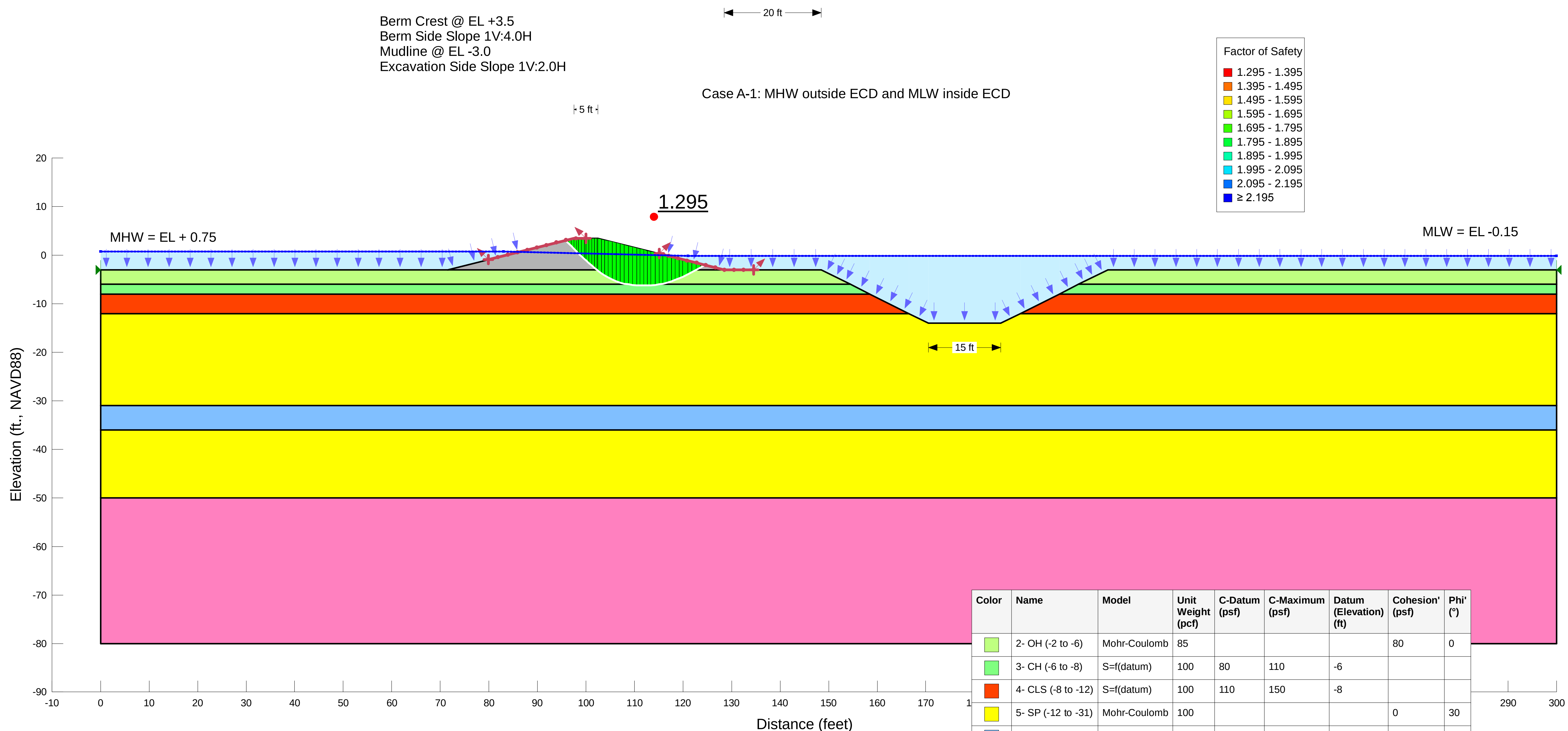
File Name: 17-2810 Reach 2 (TOB @ 4.0) SS 1V4-50H ML-2 (B=20) Borrow.gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.280



Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

File Name: 17-2810 Reach 2 (TOB @ 4.0) SS 1V4-50H ML-2 (B=20) Borrow.gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.213

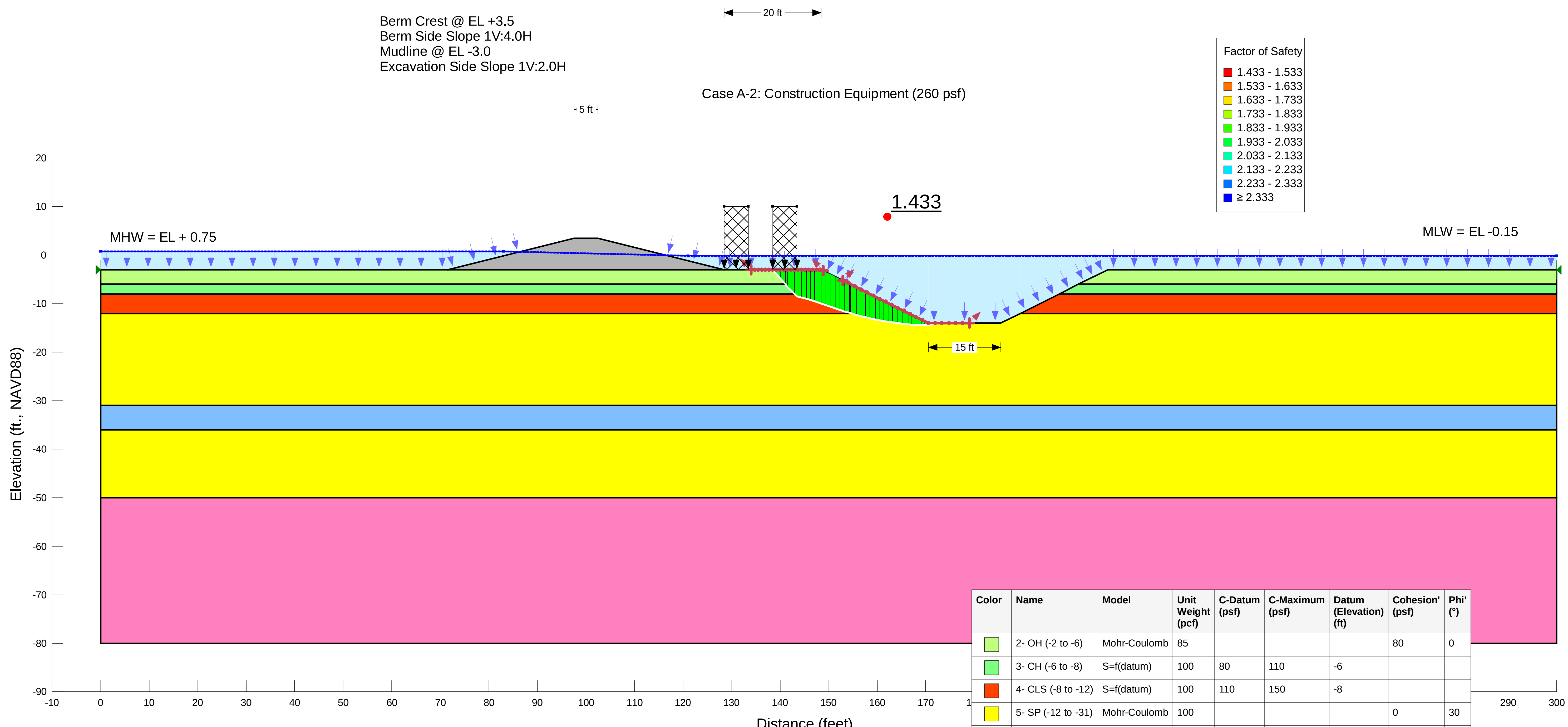
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

File Name: 17-2810 Reach 2 (TOB @ 3.5) SS 1V4-00H ML-3 (B=20) Borrow.gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.295

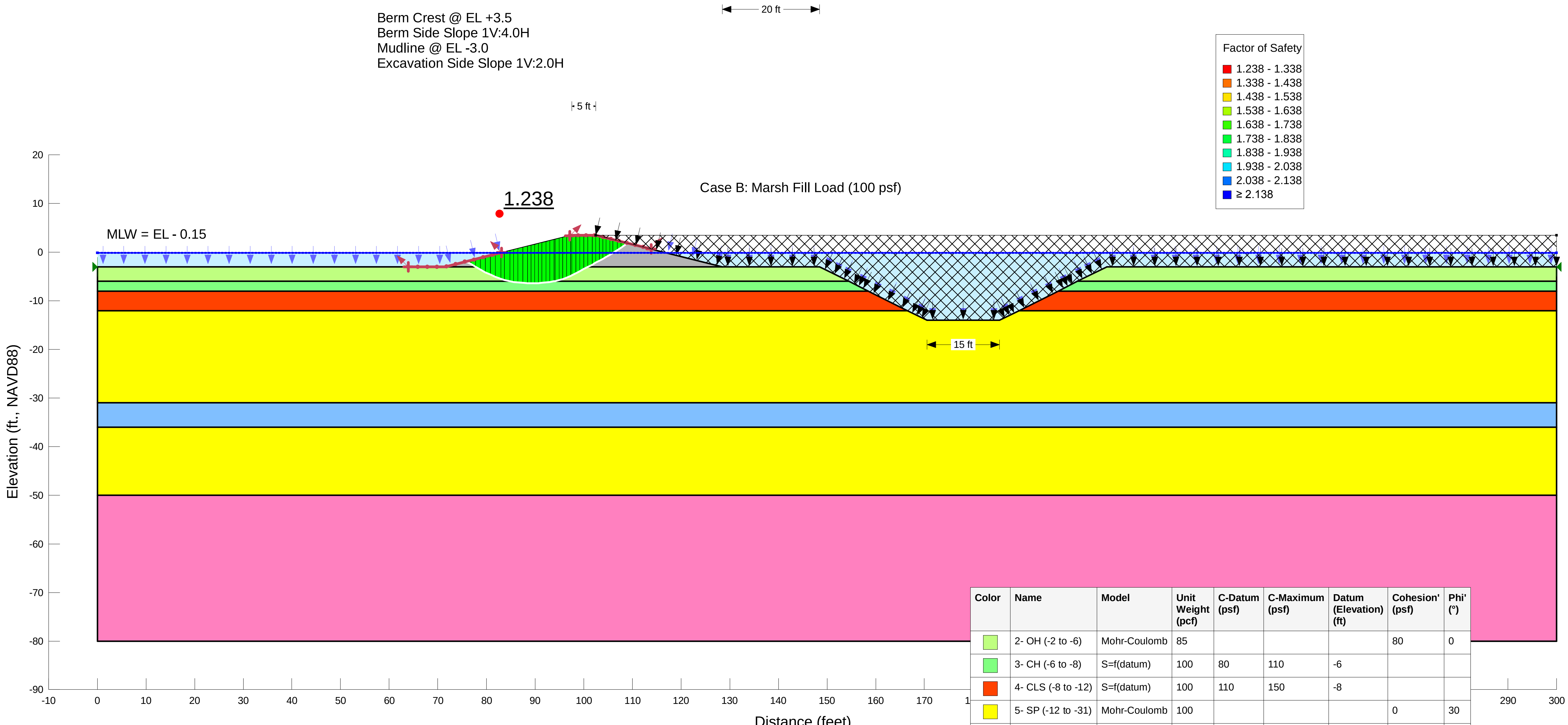
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

File Name: 17-2810 Reach 2 (TOB @ 3.5) SS 1V4-00H ML-3 (B=20) Borrow.gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.433

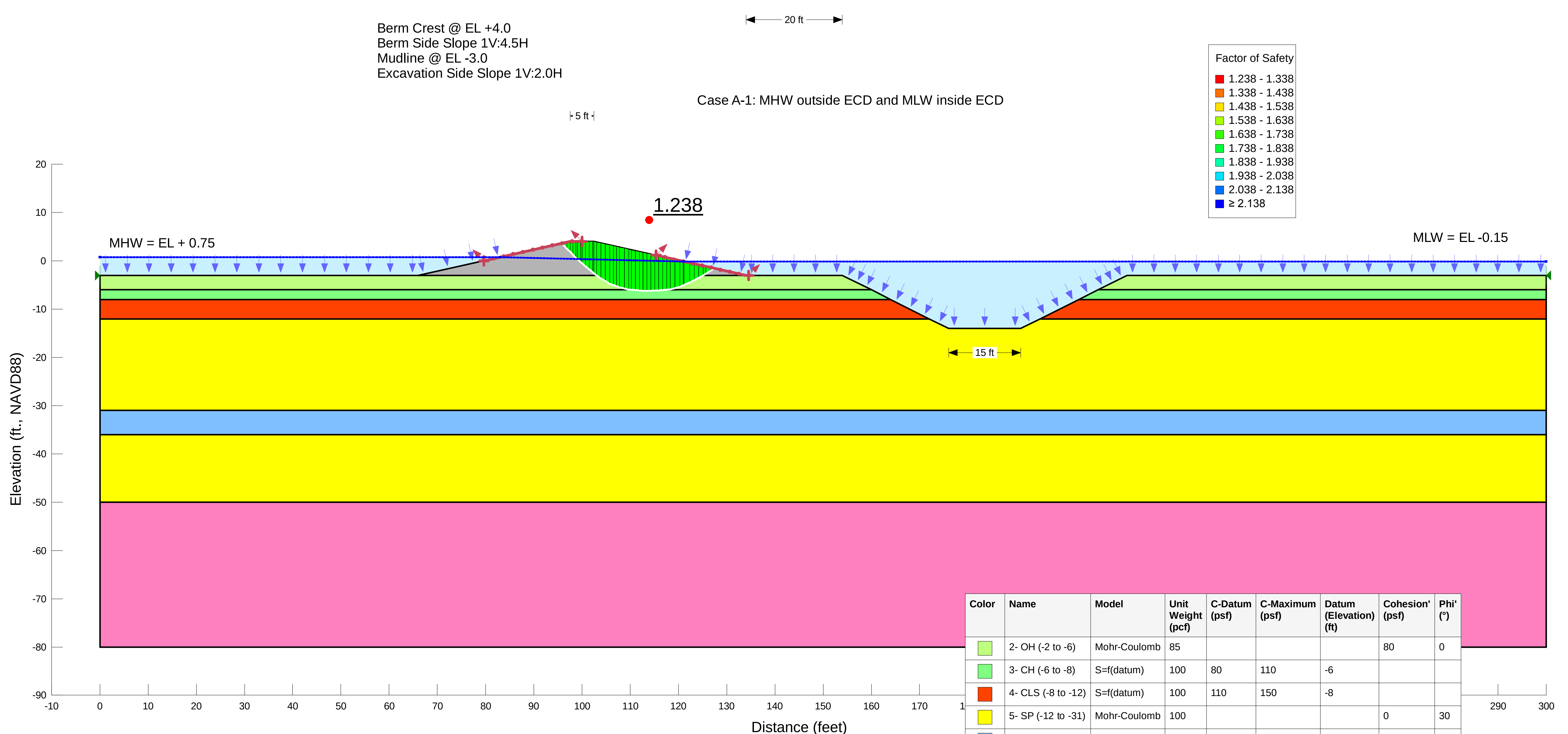
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

File Name: 17-2810 Reach 2 (TOB @ 3.5) SS 1V4-00H ML-3 (B=20) Borrow.gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.238

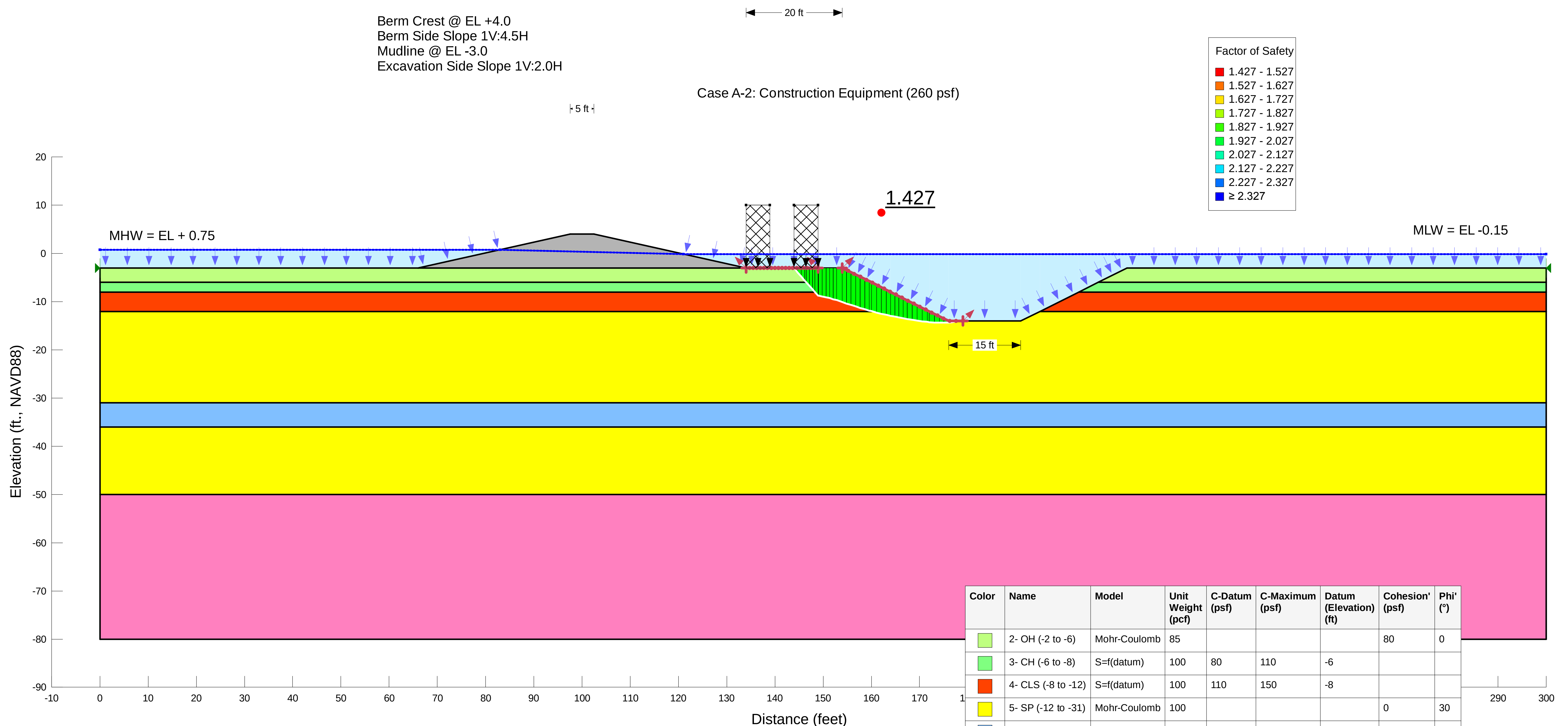
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

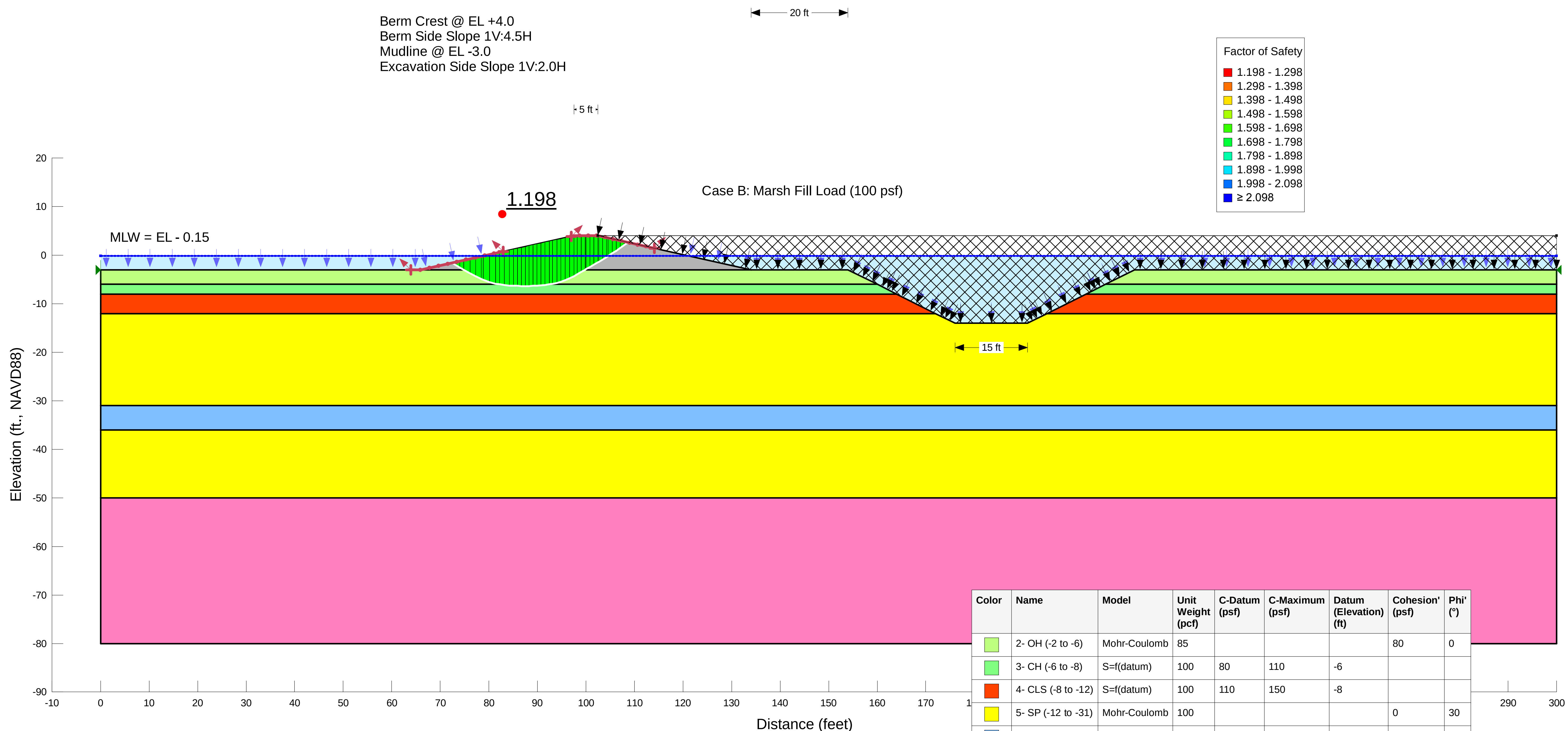
File Name: 17-2810 Reach 2 (TOB @ 4.0) SS 1V4-50H ML-3 (B=20) Borrow.gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.238

Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

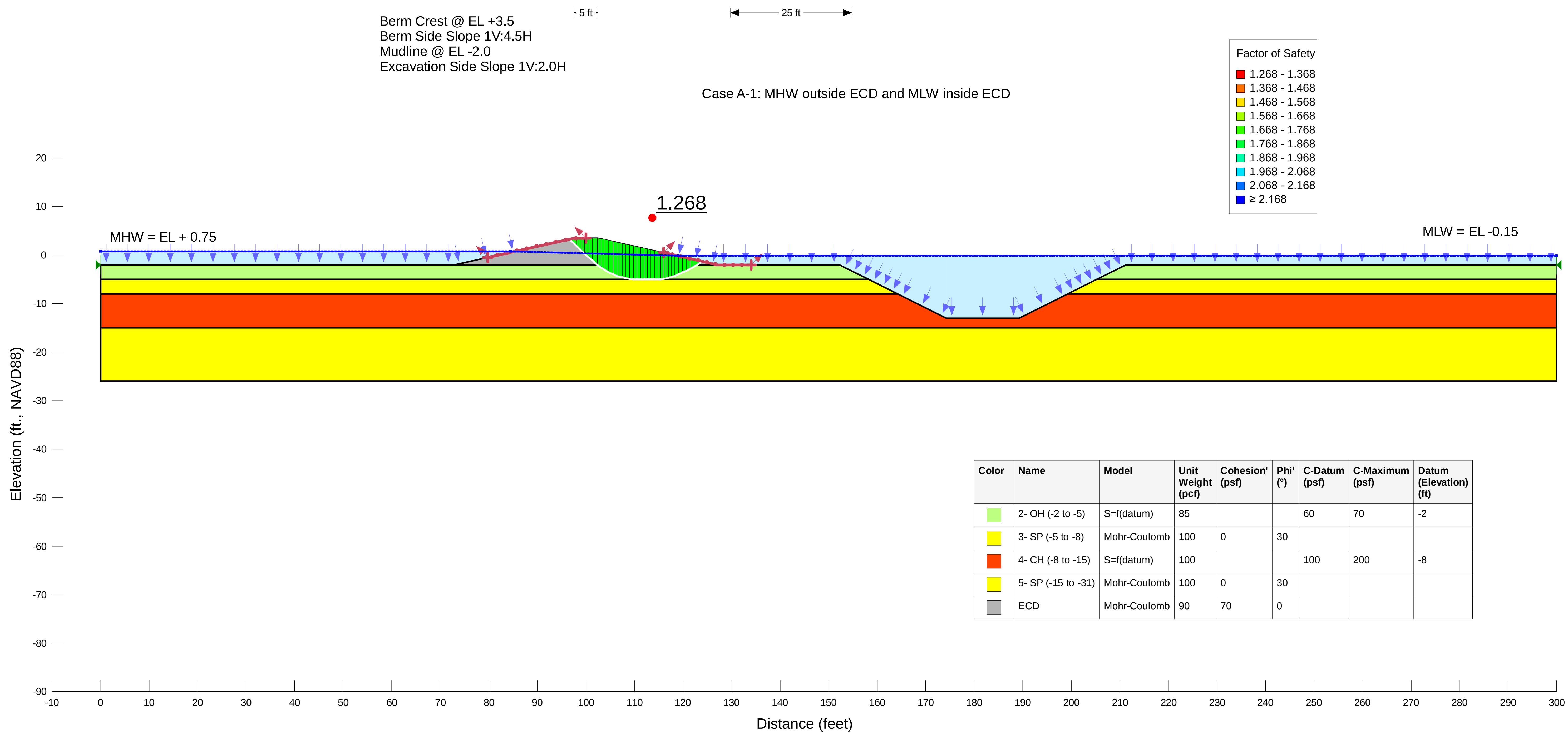
File Name: 17-2810 Reach 2 (TOB @ 4.0) SS 1V4-50H ML-3 (B=20) Borrow.gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.427



Color	Name	Model	Unit Weight (pcf)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)	Cohesion' (psf)	Phi' (°)
	2- OH (-2 to -6)	Mohr-Coulomb	85				80	0
	3- CH (-6 to -8)	S=f(datum)	100	80	110	-6		
	4- CLS (-8 to -12)	S=f(datum)	100	110	150	-8		
	5- SP (-12 to -31)	Mohr-Coulomb	100				0	30
	6- CH (-31 to -36)	S=f(datum)	100	300	340	-31		
	7- SP (-36 to -50)	Mohr-Coulomb	105				0	30
	8- CH (-50 to -80)	S=f(datum)	105	460	750	-50		
	ECD	Mohr-Coulomb	90				70	0

File Name: 17-2810 Reach 2 (TOB @ 4.0) SS 1V4-50H ML-3 (B=20) Borrow.gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.198

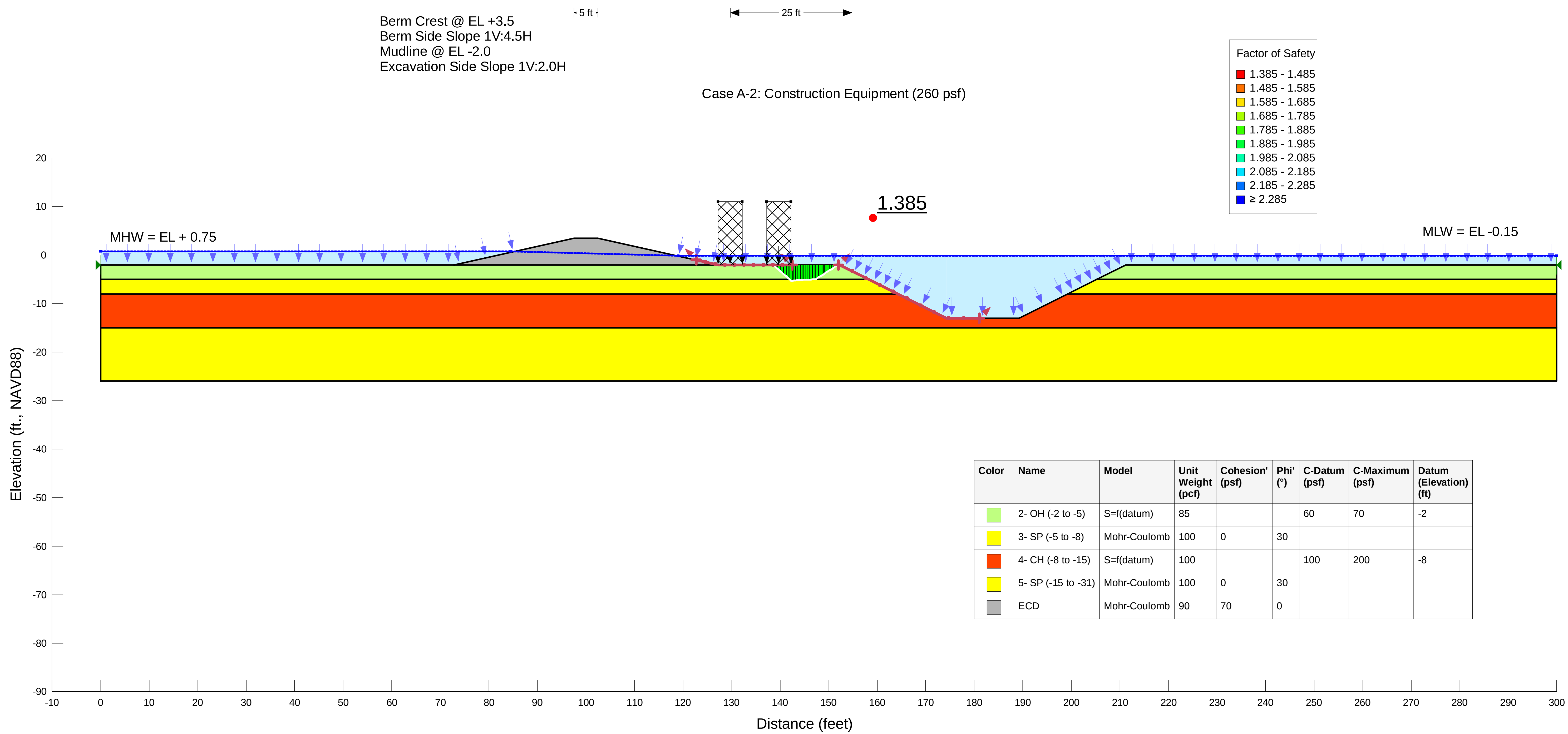
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 3 (TOB @ 3.5) SS 1V4-50H ML-2 (B=25).gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.268

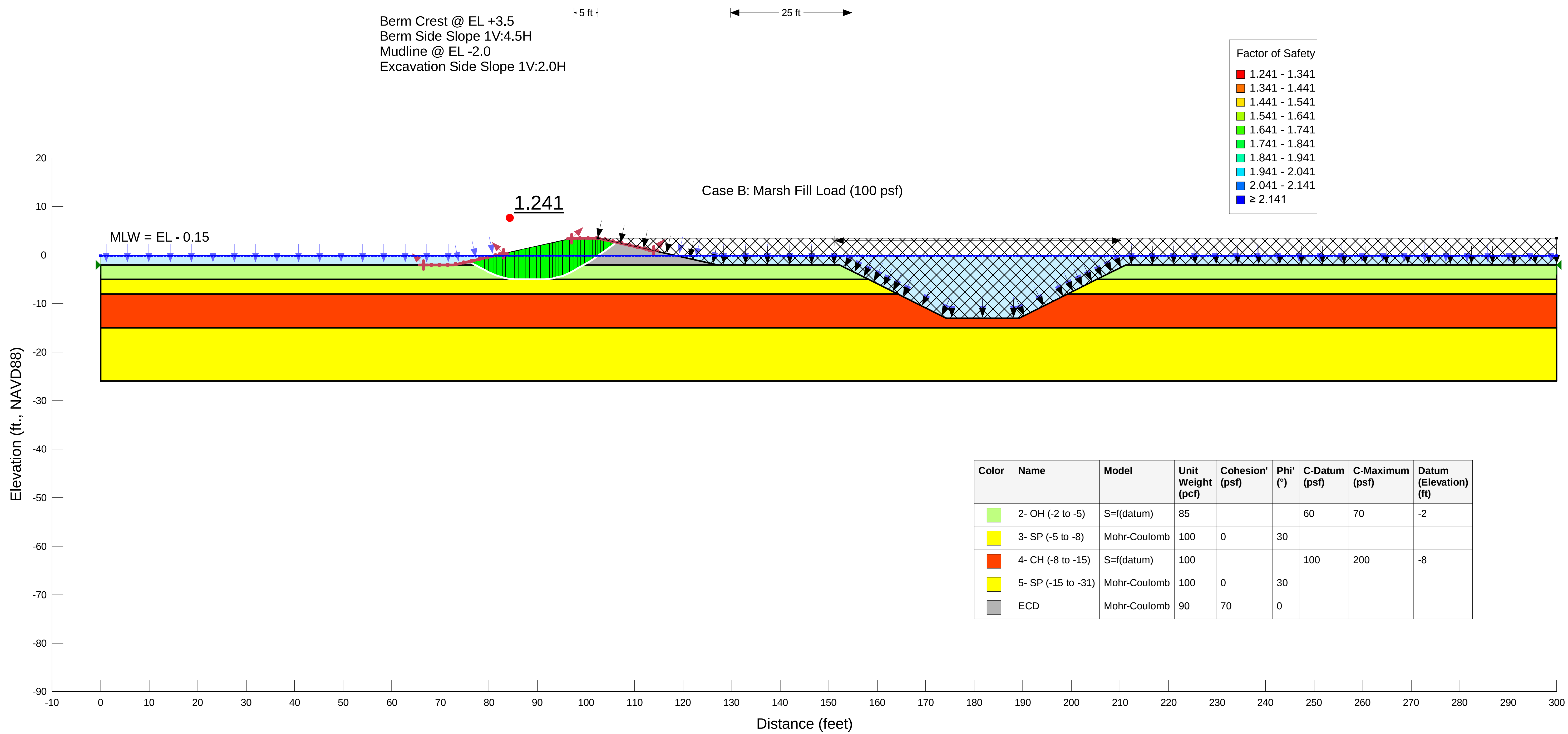
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 3 (TOB @ 3.5) SS 1V4-50H ML-2 (B=25).gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.385

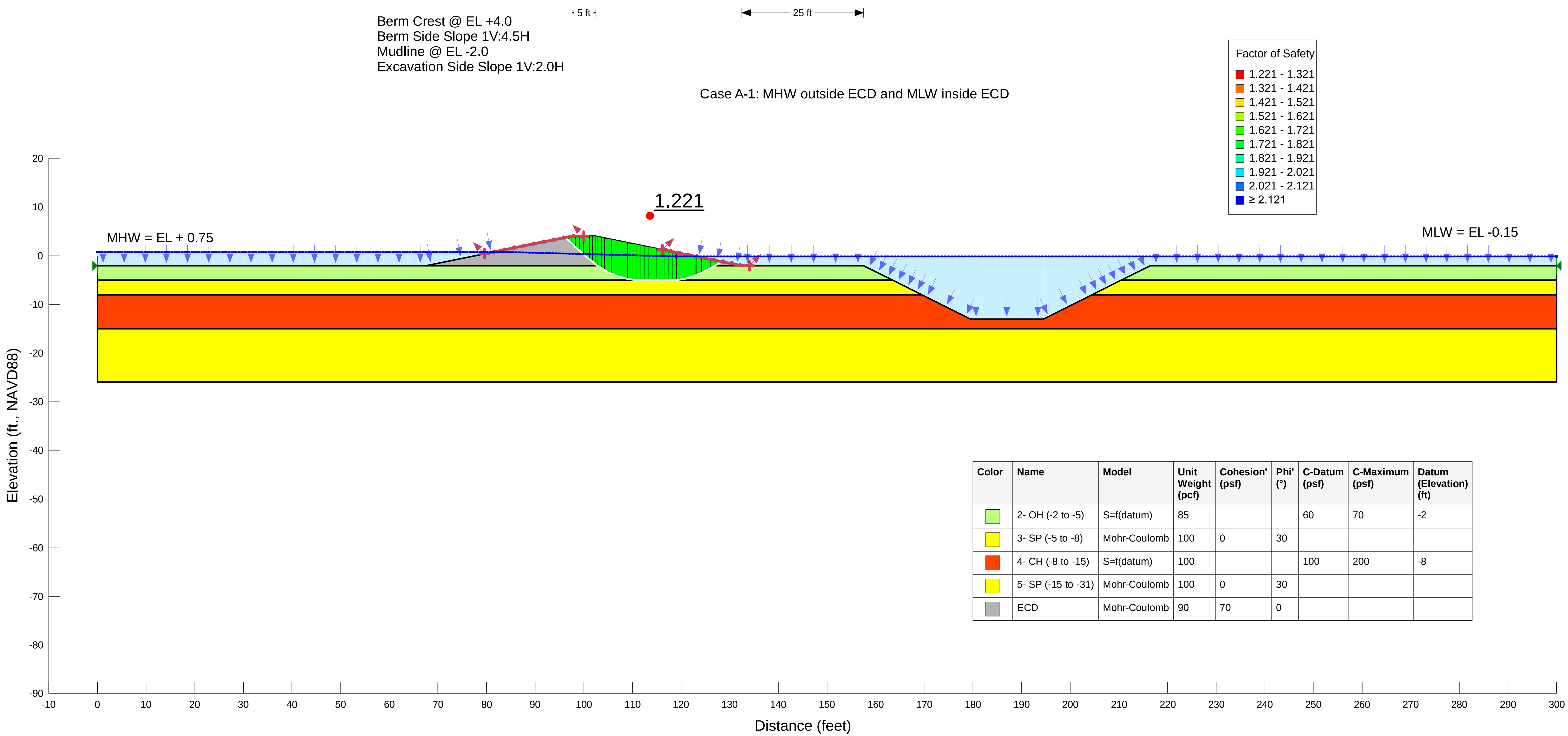
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	70	0			

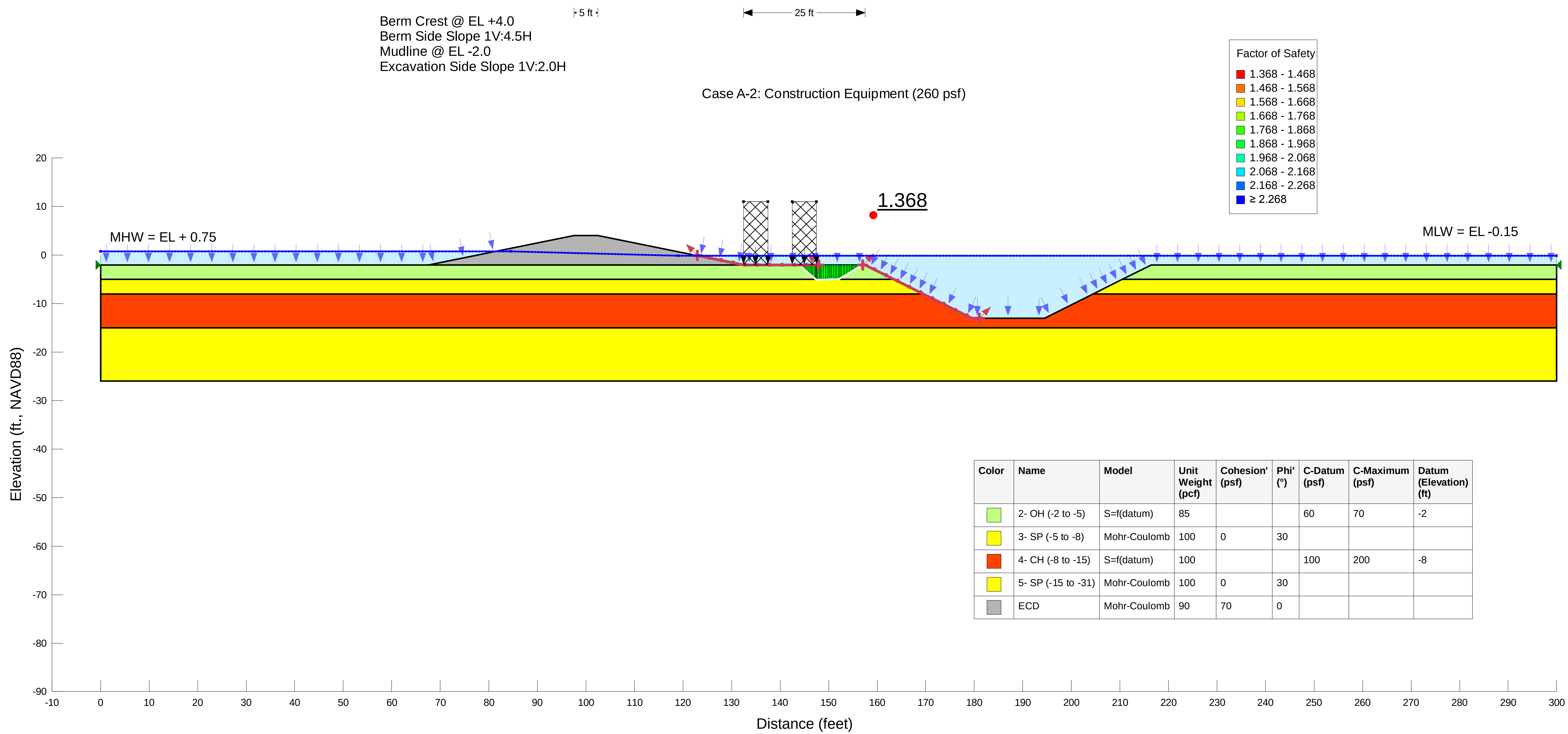
File Name: 17-2810 Reach 3 (TOB @ 3.5) SS 1V4-50H ML-2 (B=25).gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.241

Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	70	0			

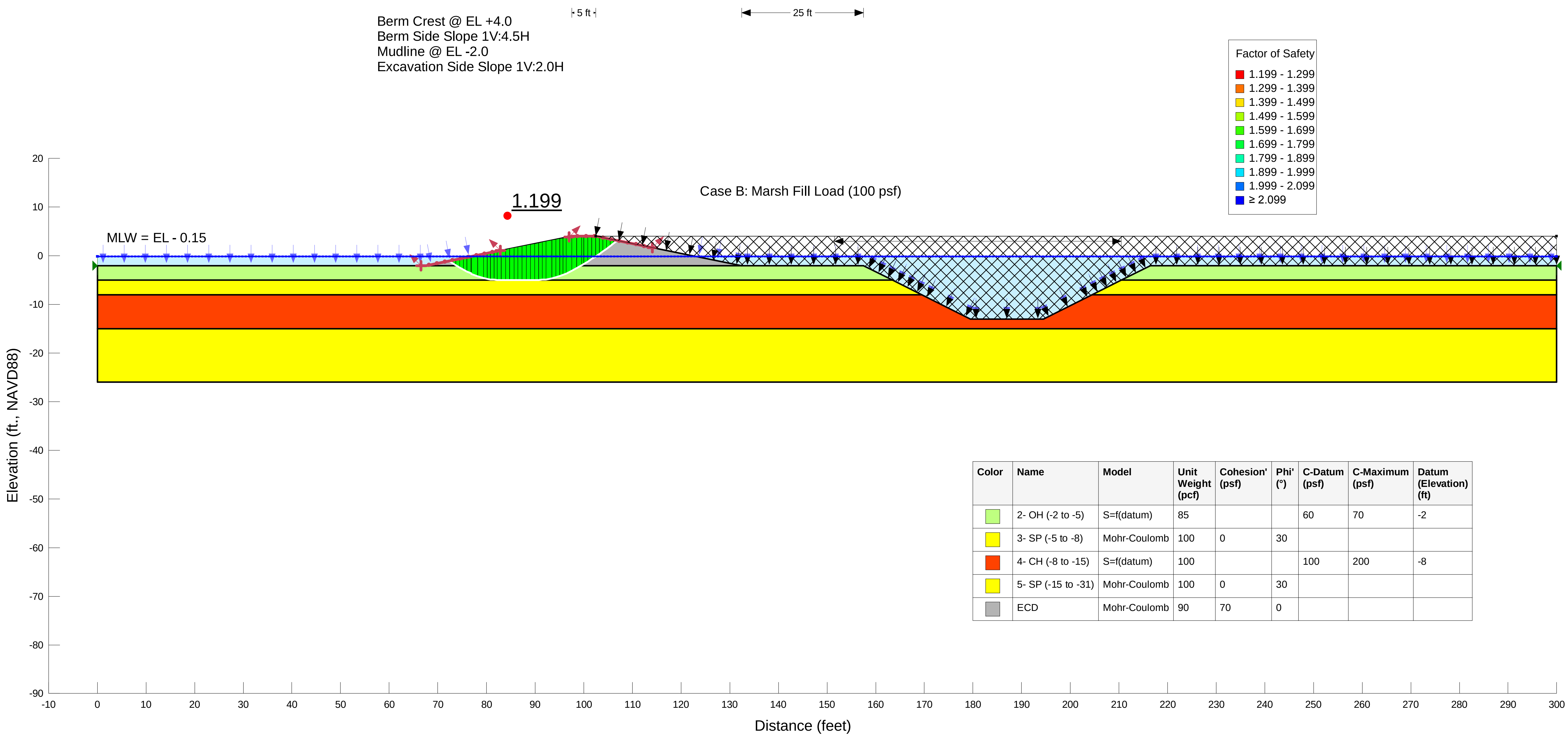
File Name: 17-2810 Reach 3 (TOB @ 4.0) SS 1V5-00H ML-2 (B=25).gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.221



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 3 (TOB @ 4.0) SS 1V5-00H ML-2 (B=25).gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.368

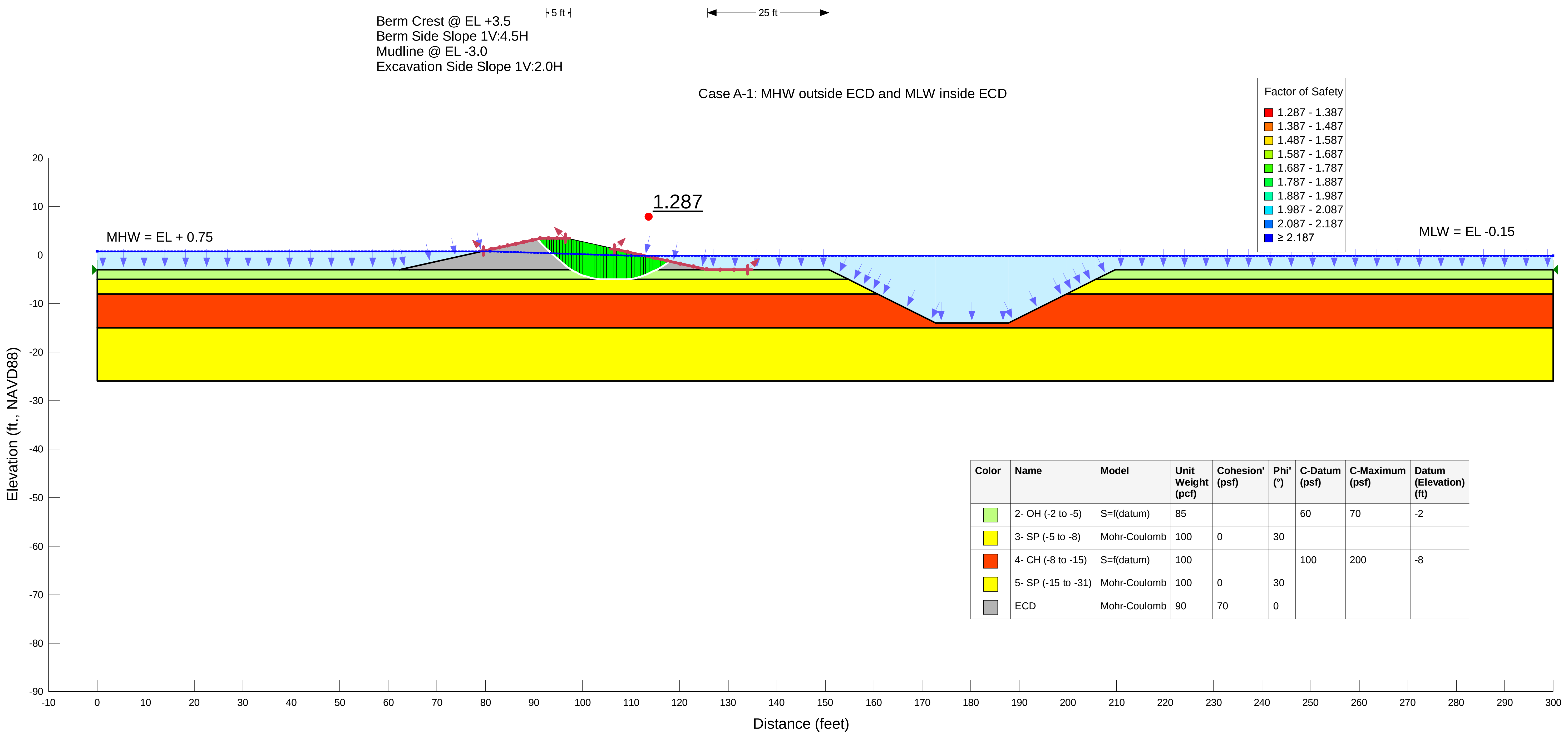
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 3 (TOB @ 4.0) SS 1V5-00H ML-2 (B=25).gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.199

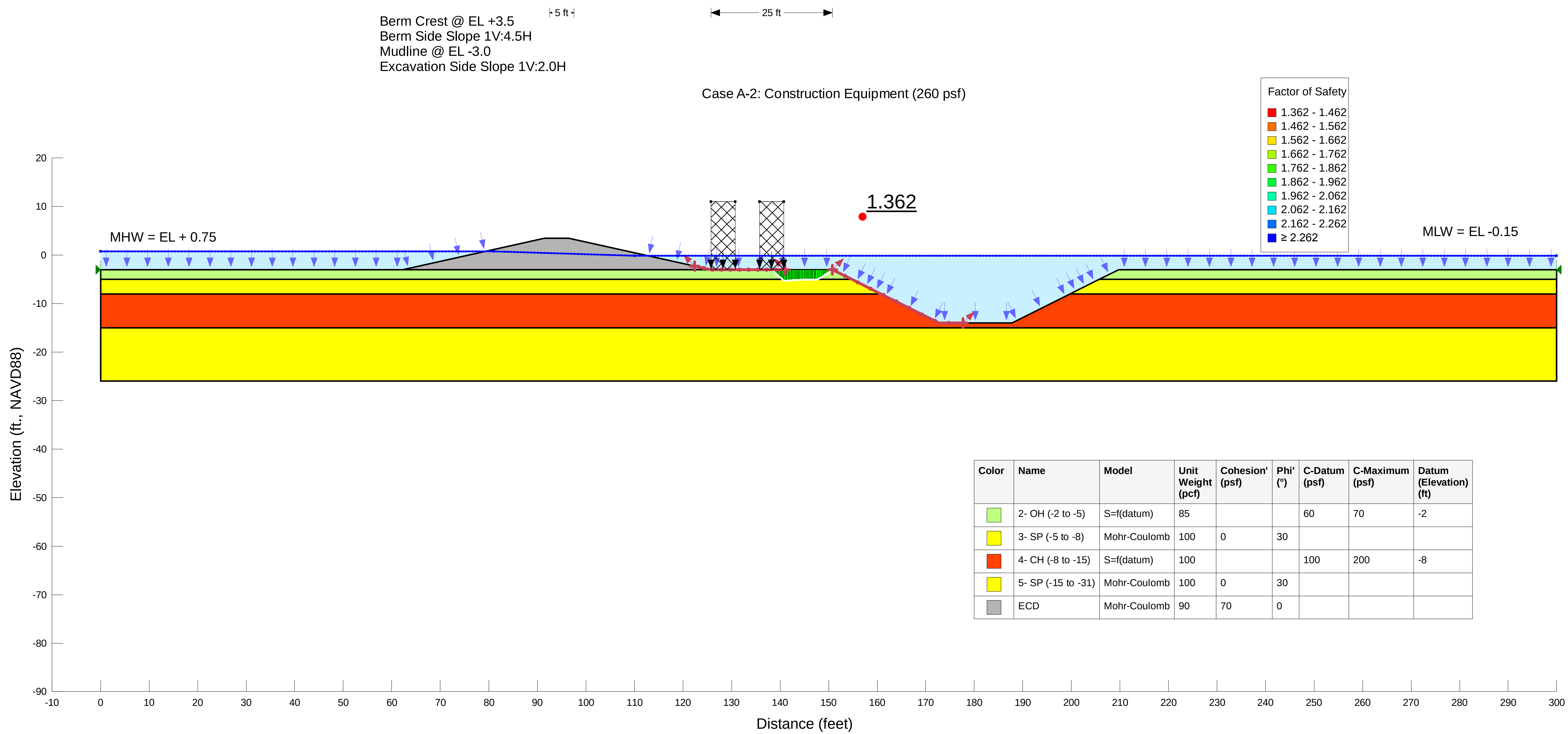
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	70	0			

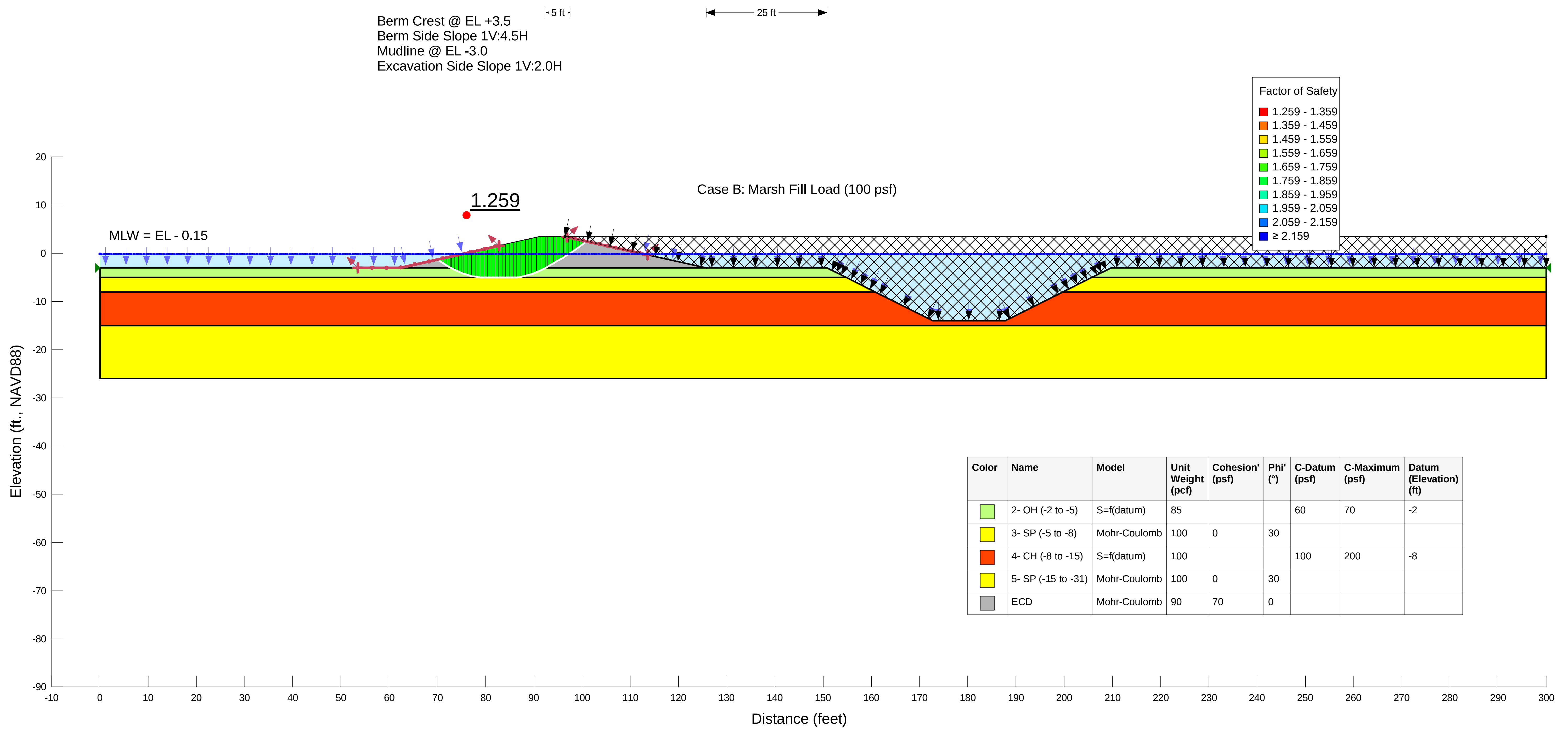
File Name: 17-2810 Reach 3 (TOB @ 3.5) SS 1V4-50H ML-3 (B=25).gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.287

Ardaman & Associates, Inc.



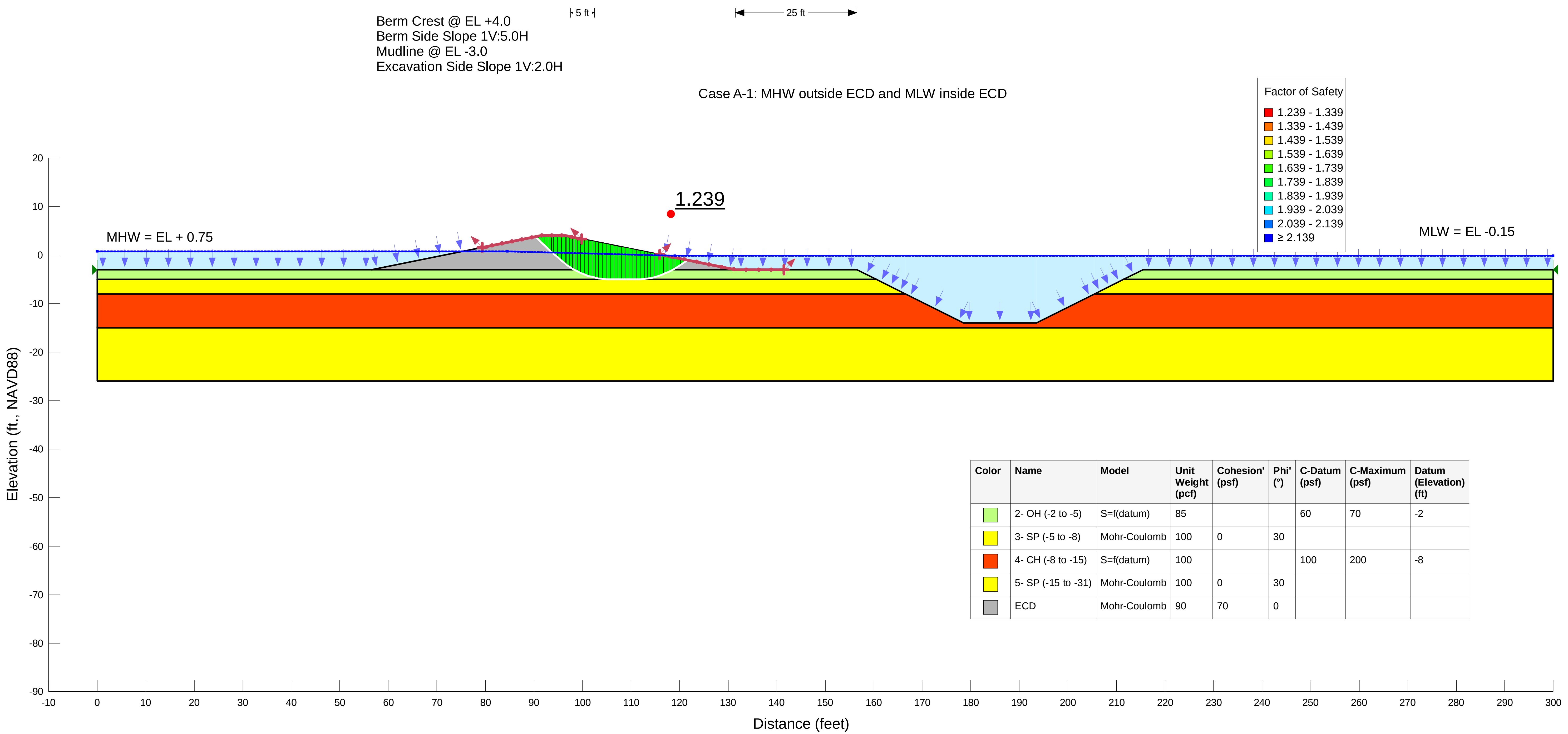
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 3 (TOB @ 3.5) SS 1V4-50H ML-3 (B=25).gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.362



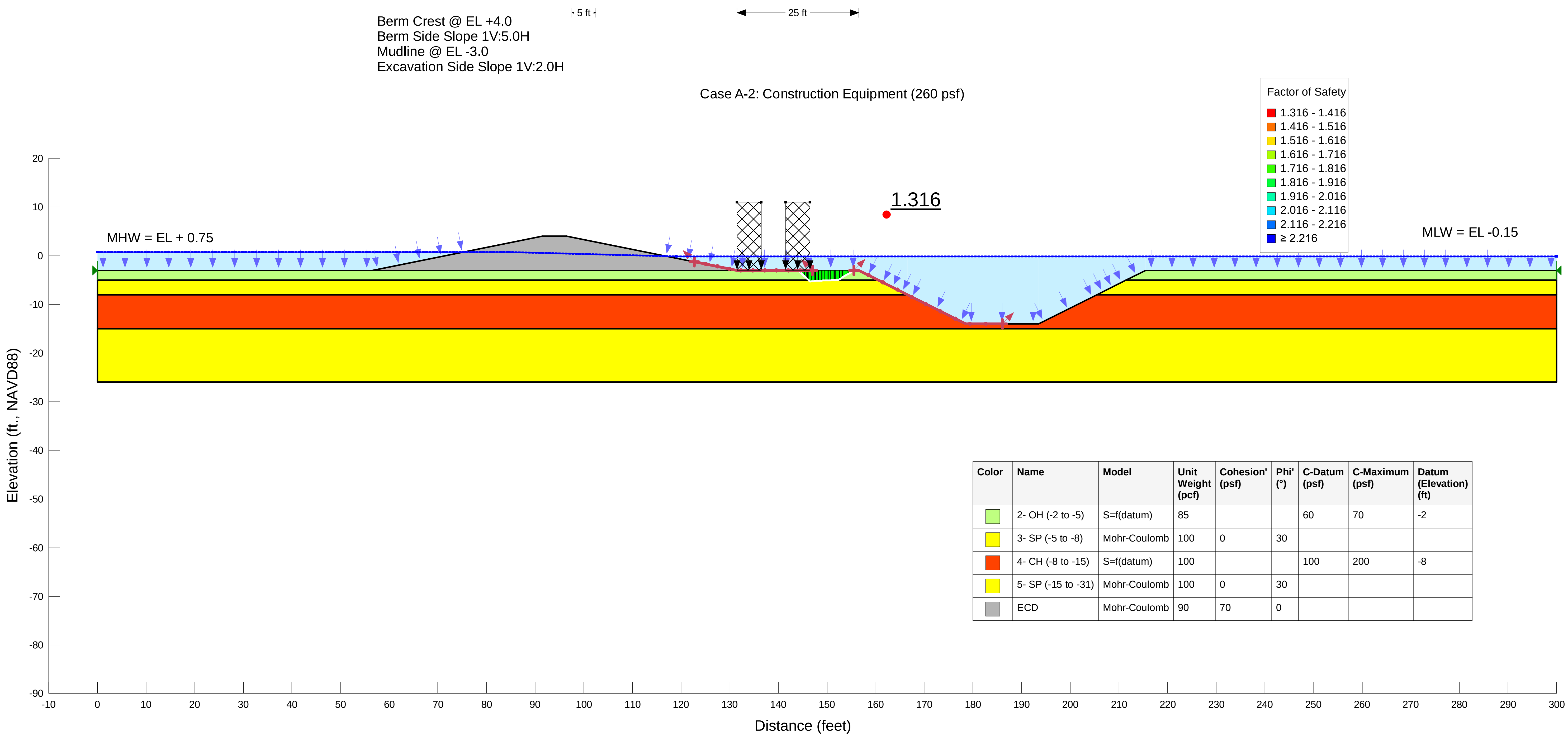
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 3 (TOB @ 3.5) SS 1V4-50H ML-3 (B=25).gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.259



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 3 (TOB @ 4.0) SS 1V5-00H ML-3 (B=25).gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.239



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	70	0			

File Name: 17-2810 Reach 3 (TOB @ 4.0) SS 1V5-00H ML-3 (B=25).gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.316

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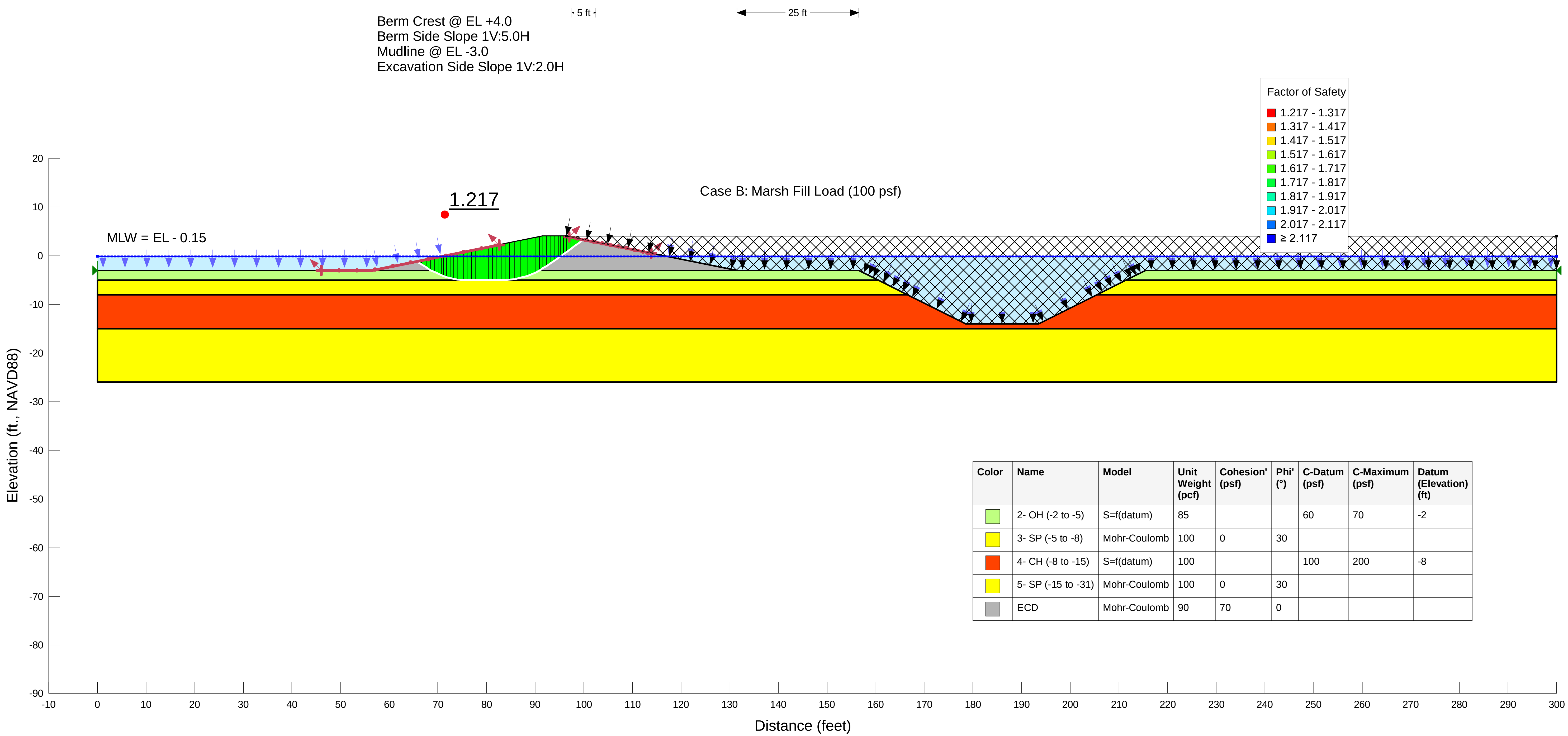
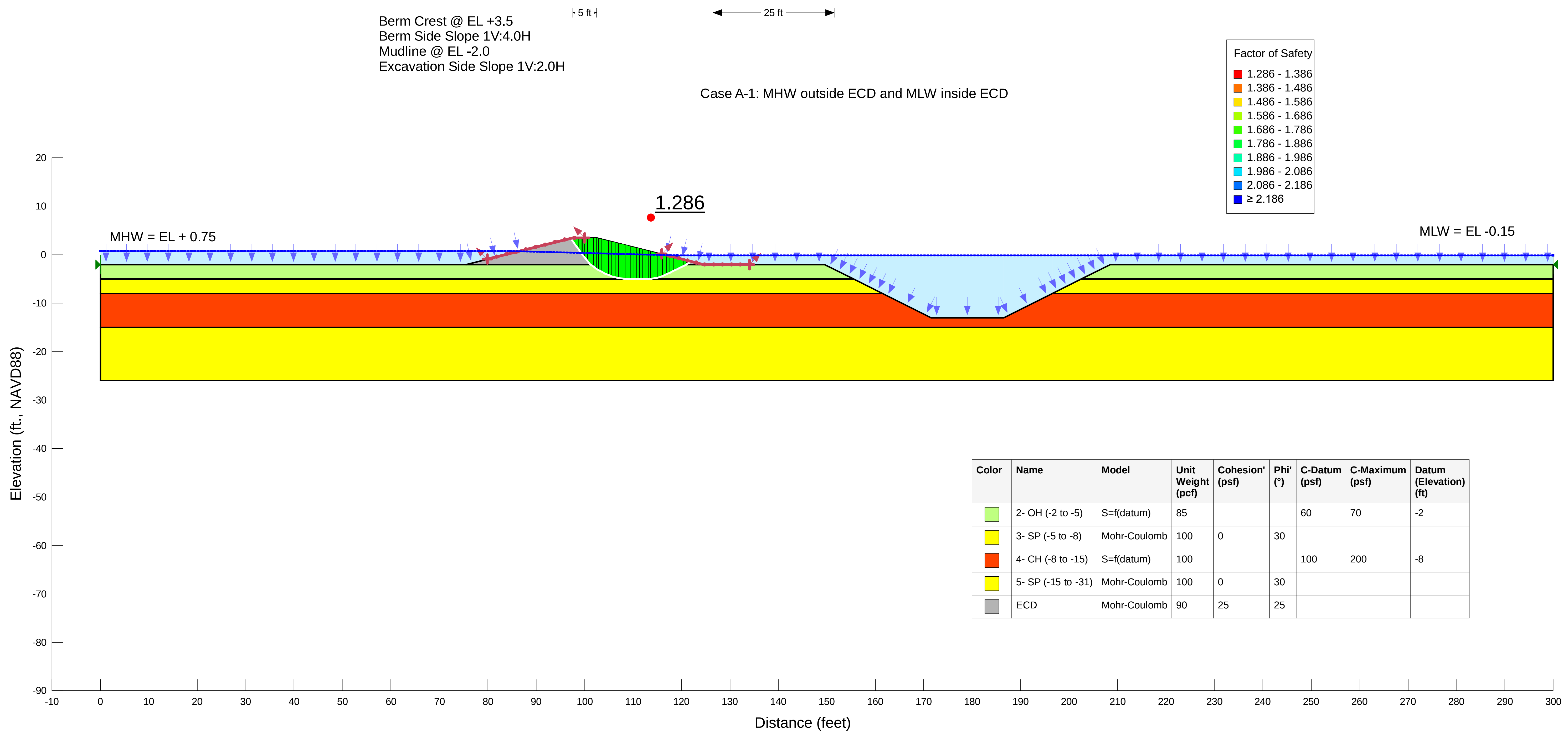


Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	70	0			

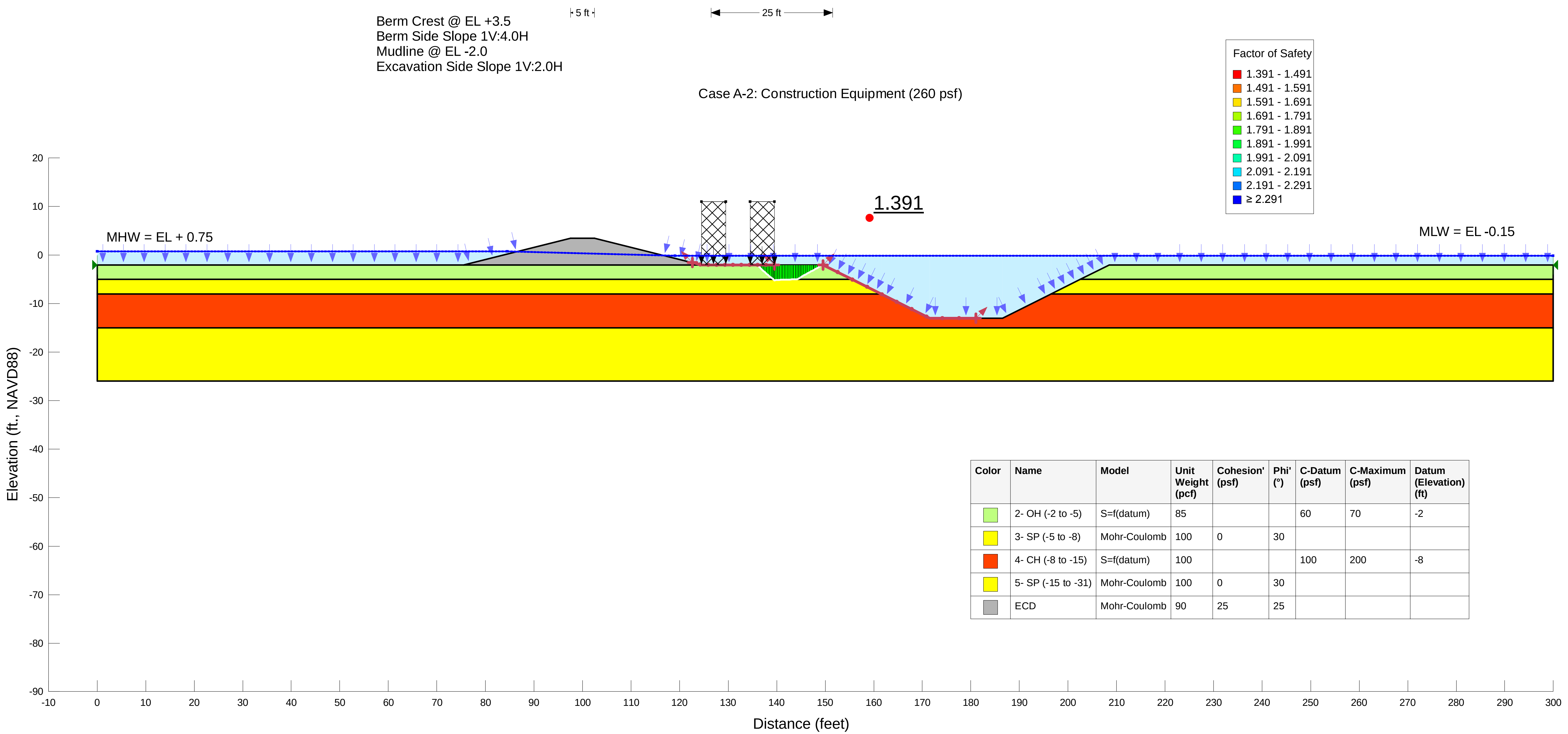
File Name: 17-2810 Reach 3 (TOB @ 4.0) SS 1V5-00H ML-3 (B=25).gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.217

Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	25	25			

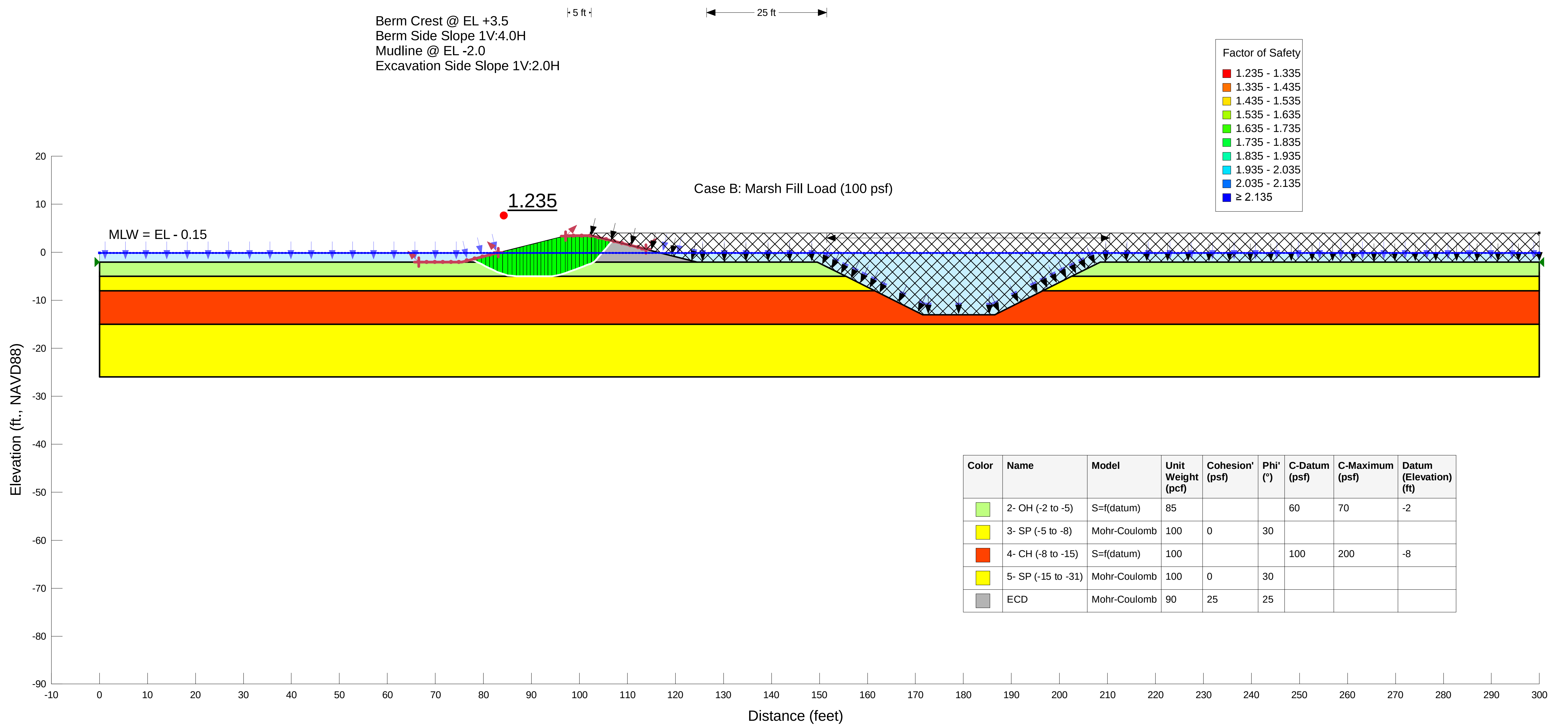
File Name: 17-2810 Reach 3 (TOB @ 3.5) SS 1V4-00H ML-2 (B=25) - Sand Case.gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.286



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	25	25			

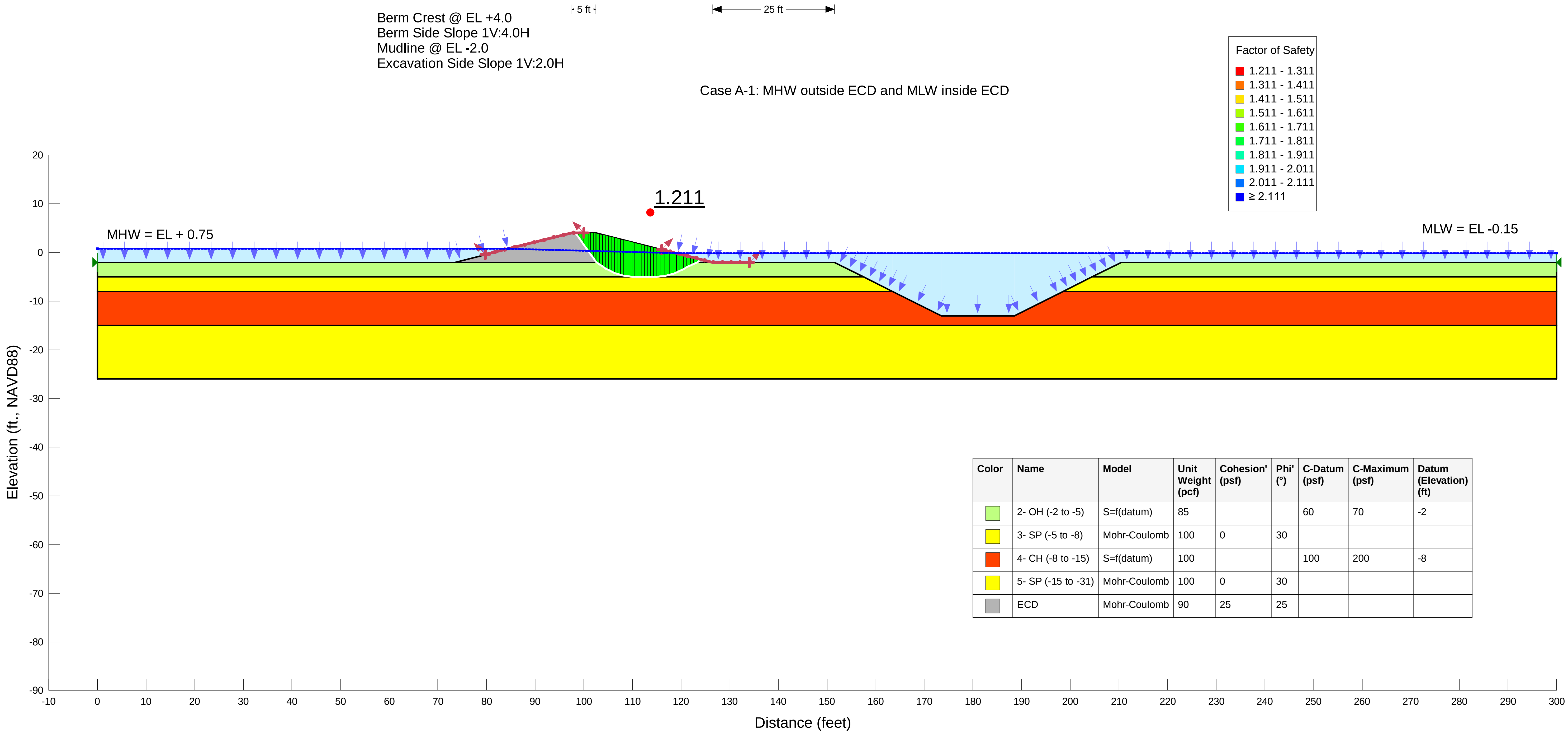
File Name: 17-2810 Reach 3 (TOB @ 3.5) SS 1V4-00H ML-2 (B=25) - Sand Case.gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.391

Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	25	25			

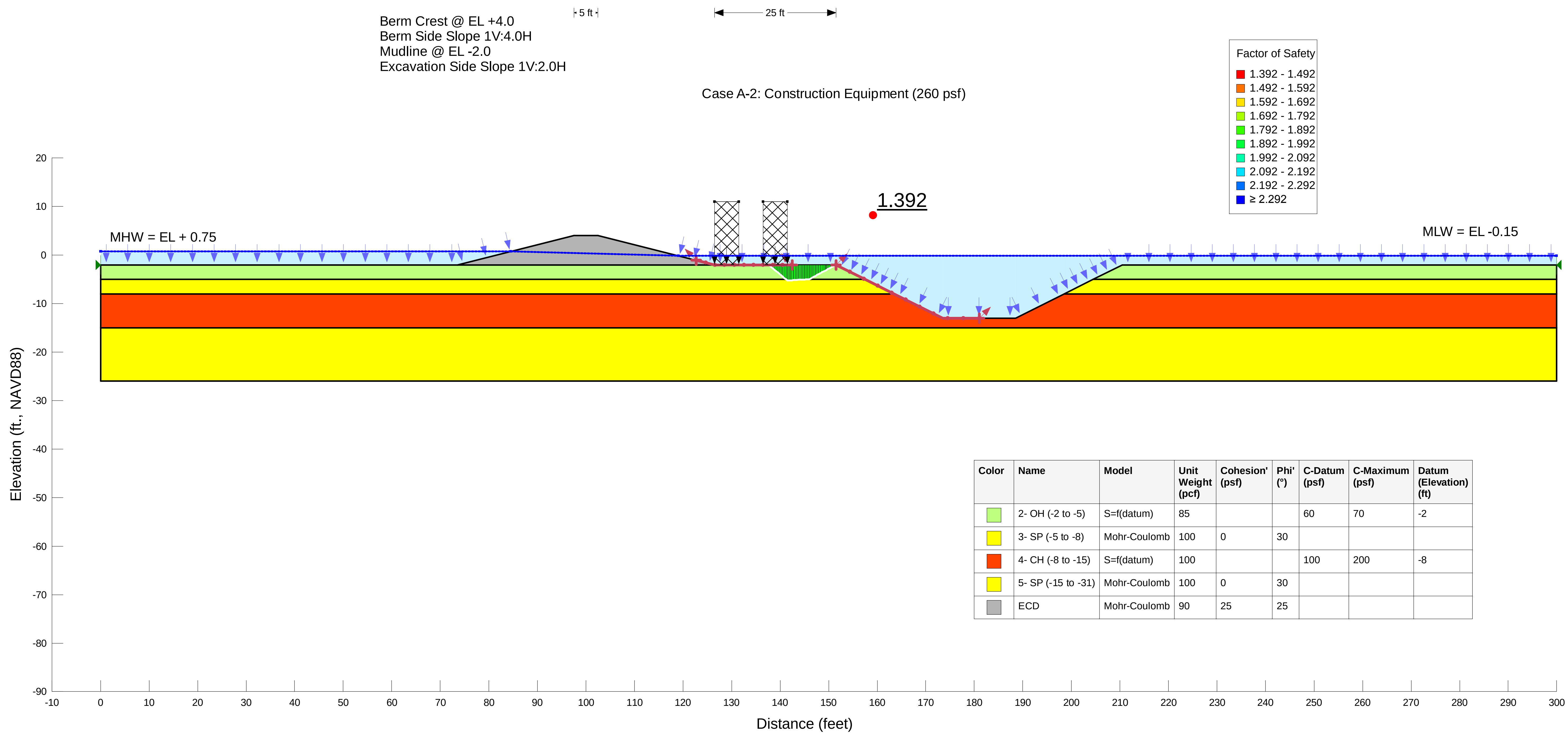
File Name: 17-2810 Reach 3 (TOB @ 3.5) SS 1V4-00H ML-2 (B=25) - Sand Case.gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.235



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	25	25			

File Name: 17-2810 Reach 3 (TOB @ 4.0) SS 1V4-00H ML-2 (B=25) - Sand Case.gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.211

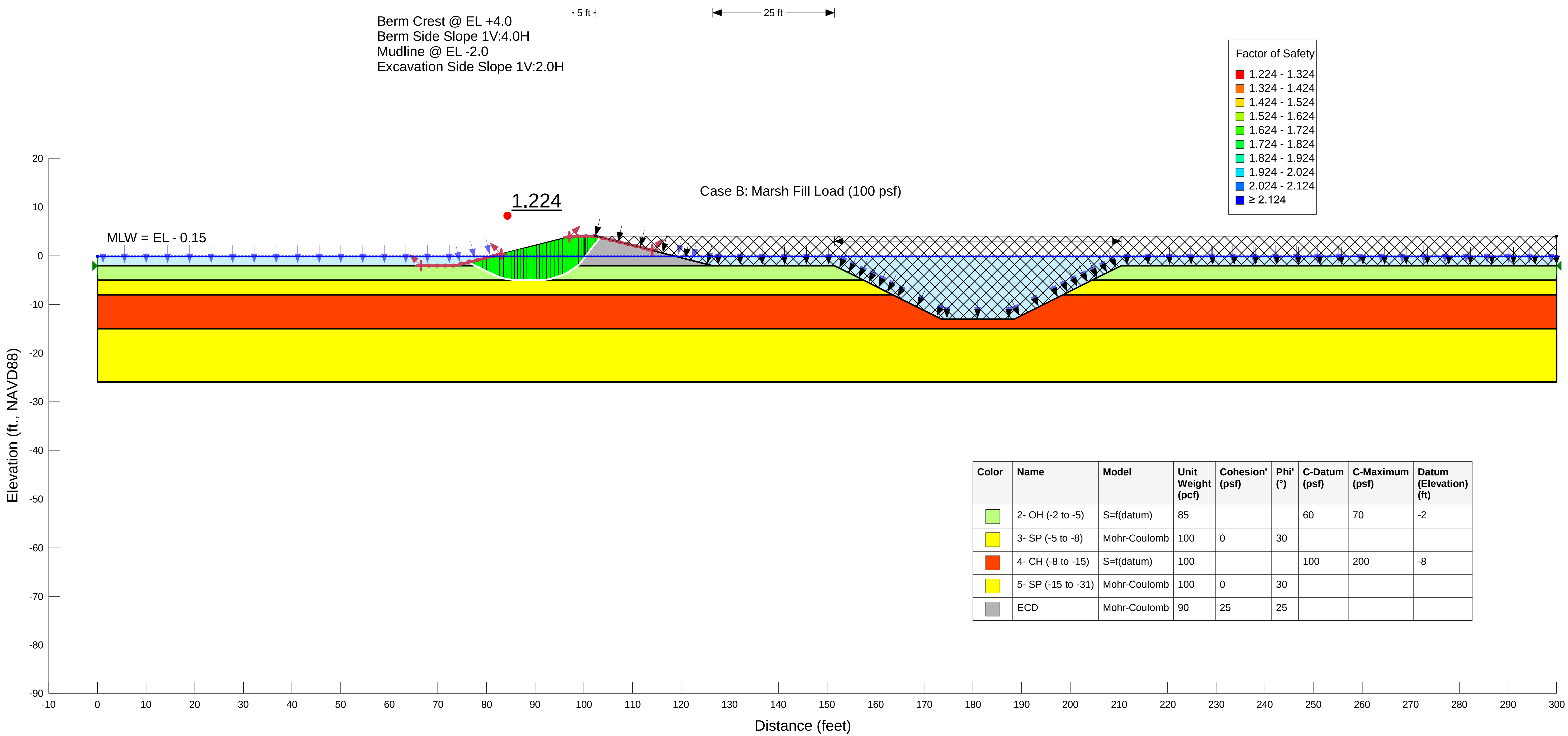
Ardaman & Associates, Inc.



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	25	25			

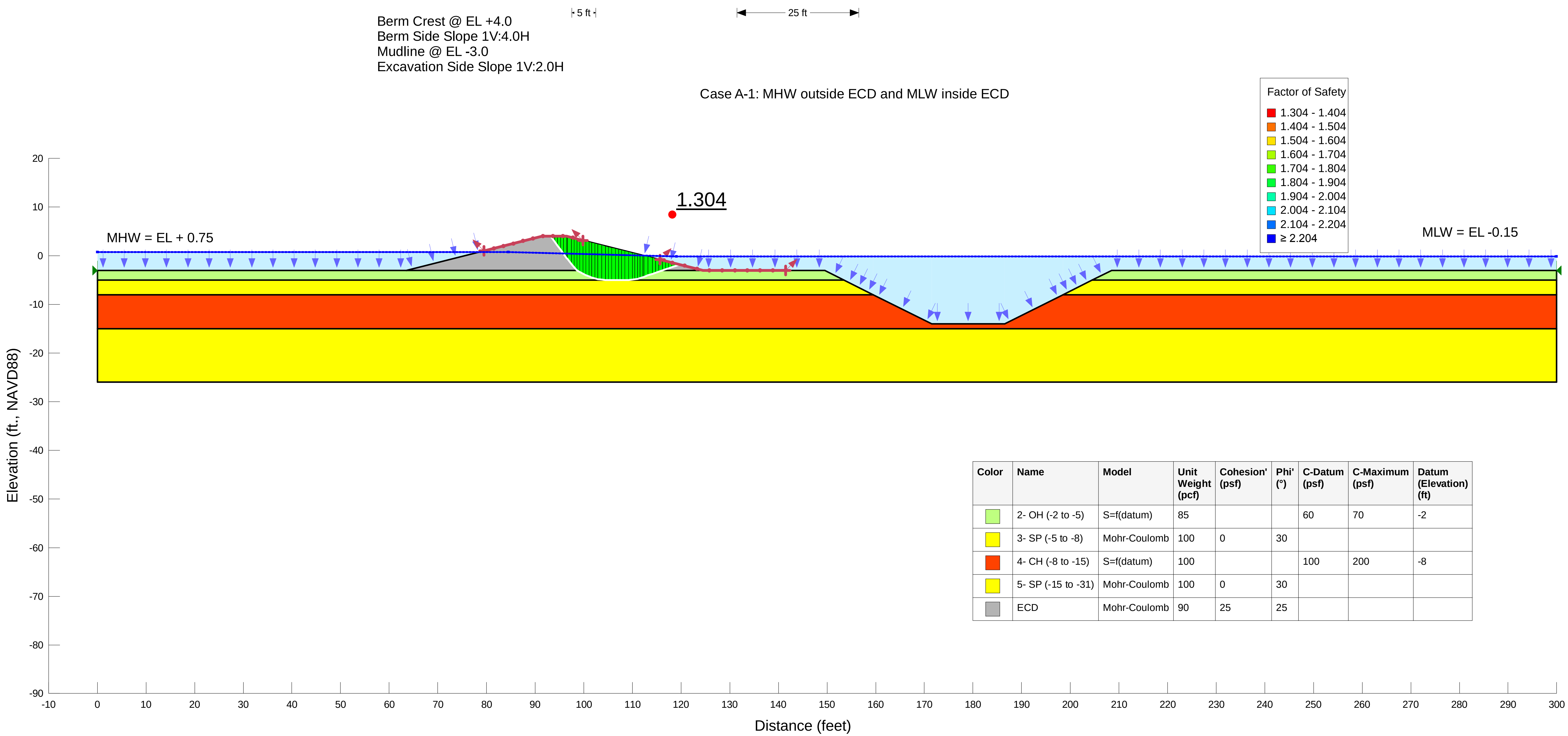
File Name: 17-2810 Reach 3 (TOB @ 4.0) SS 1V4-00H ML-2 (B=25) - Sand Case.gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.392

Ardaman & Associates, Inc.



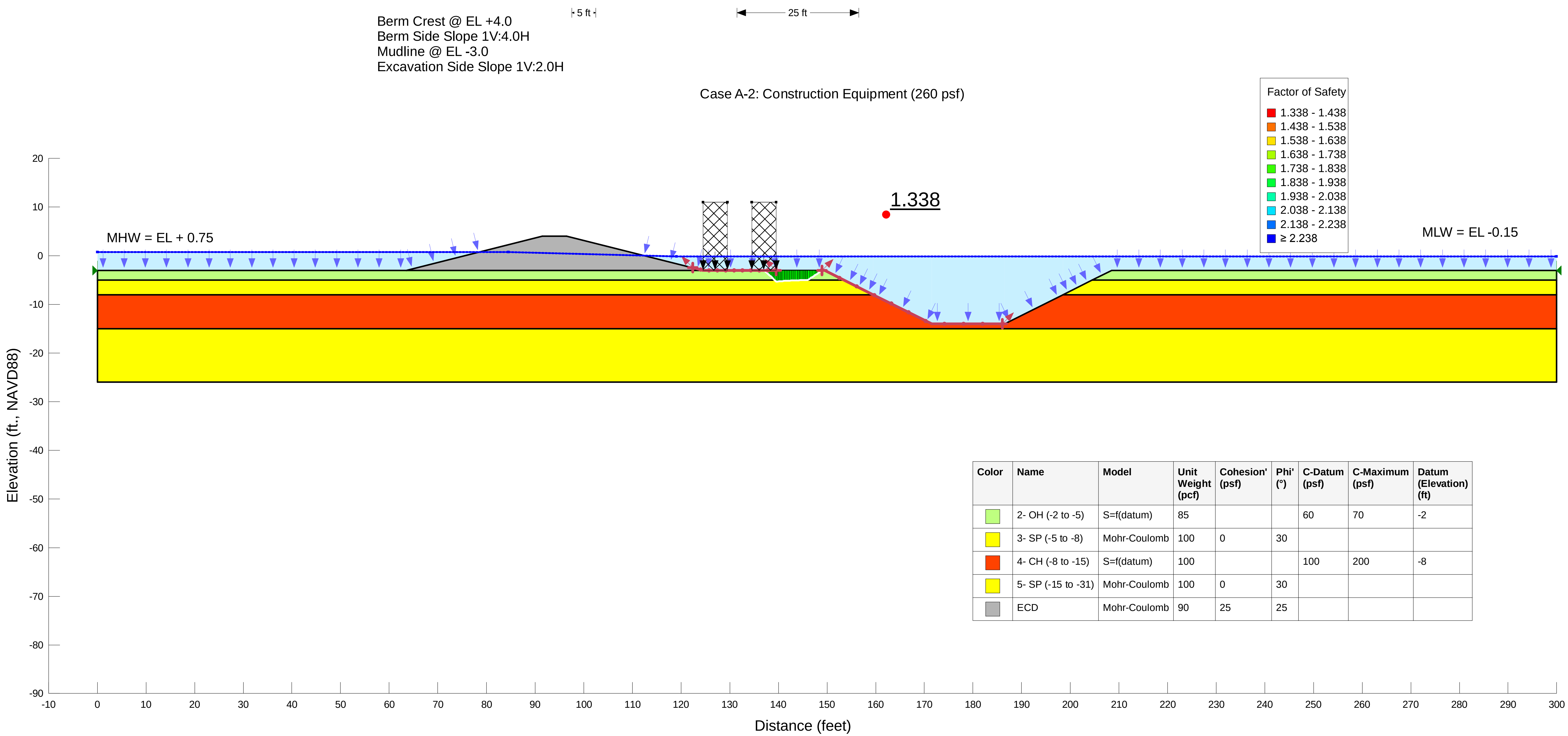
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	25	25			

File Name: 17-2810 Reach 3 (TOB @ 4.0) SS 1V4-00H ML-2 (B=25) - Sand Case.gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.224



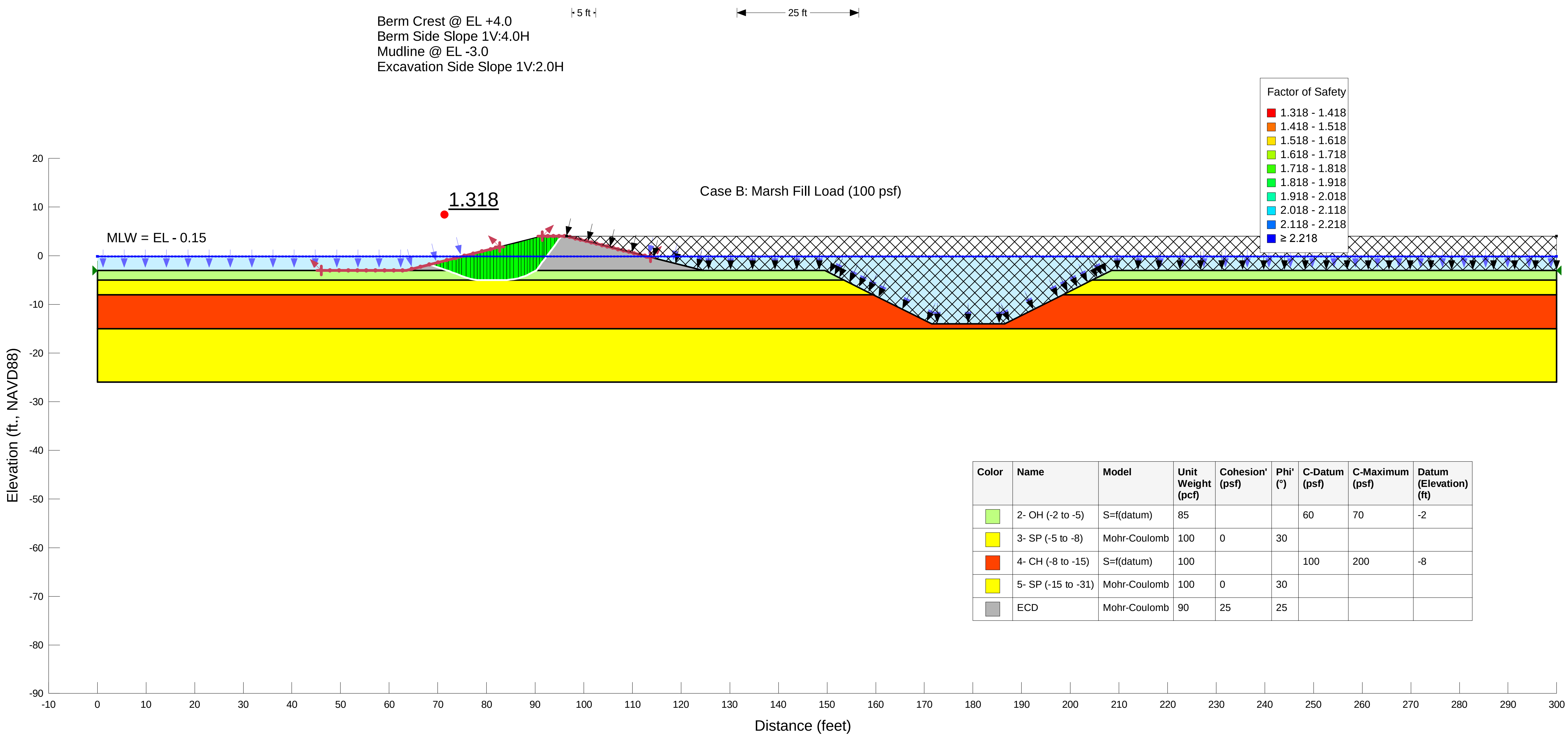
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	25	25			

File Name: 17-2810 Reach 3 (TOB @ 4.0) SS 1V4-00H ML-3 (B=25) - Sand Case.gsz - Name: Case A-1 - EE (45-deg) & opt - Factor of Safety: 1.304



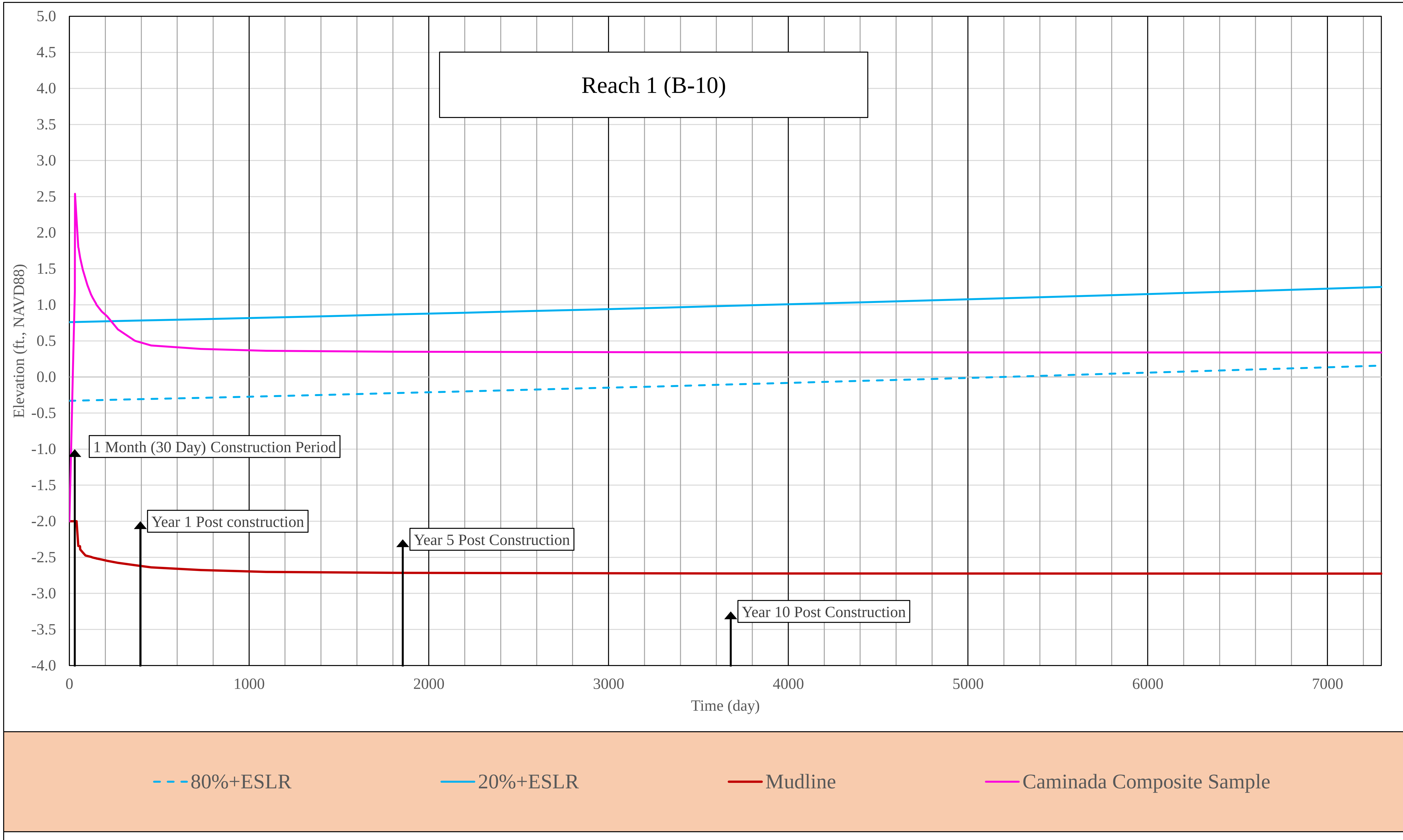
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	25	25			

File Name: 17-2810 Reach 3 (TOB @ 4.0) SS 1V4-00H ML-3 (B=25) - Sand Case.gsz - Name: Case A-2 - EE (45-deg) & opt - Factor of Safety: 1.338



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	C-Datum (psf)	C-Maximum (psf)	Datum (Elevation) (ft)
	2- OH (-2 to -5)	S=f(datum)	85			60	70	-2
	3- SP (-5 to -8)	Mohr-Coulomb	100	0	30			
	4- CH (-8 to -15)	S=f(datum)	100			100	200	-8
	5- SP (-15 to -31)	Mohr-Coulomb	100	0	30			
	ECD	Mohr-Coulomb	90	25	25			

File Name: 17-2810 Reach 3 (TOB @ 4.0) SS 1V4-00H ML-3 (B=25) - Sand Case.gsz - Name: Case B - EE (45-deg) & opt - Factor of Safety: 1.318



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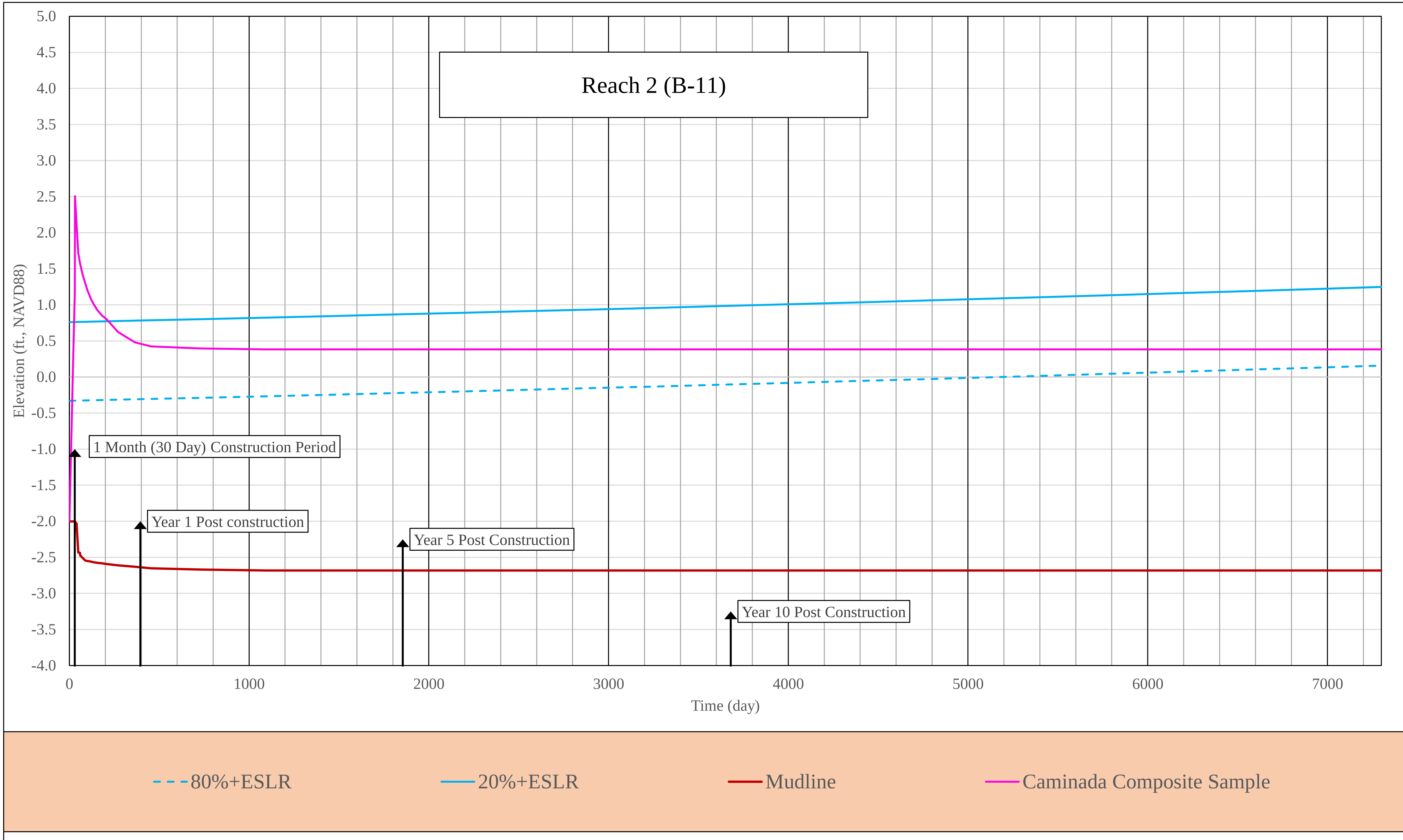

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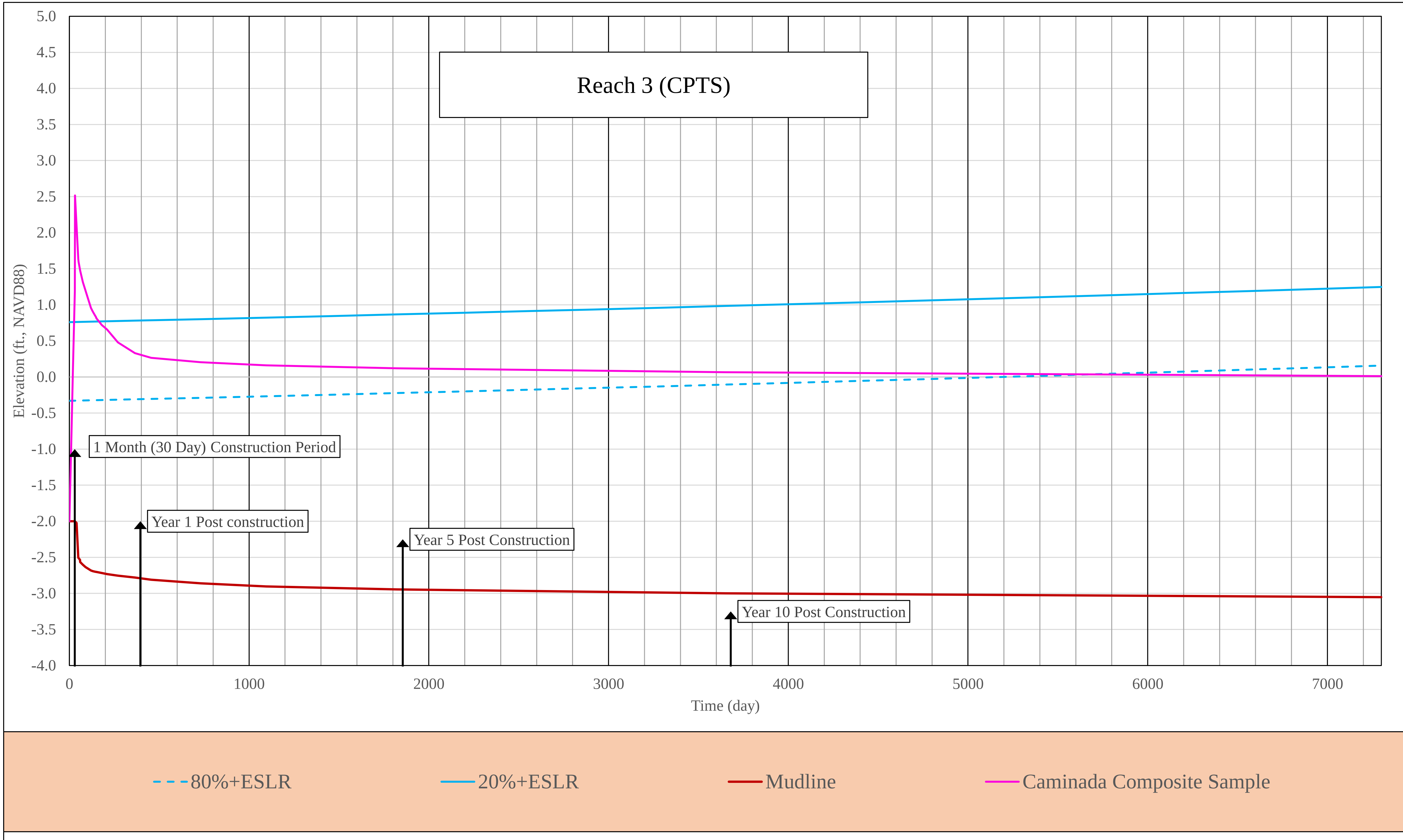
Reach 3 (CPTS)
Elevation (ft., NAVD88)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
1 Month (30 Day) Construction Period
Year 1 Post construction
Year 5 Post Construction
Year 10 Post Construction
0
1000
2000
3000
4000
5000
6000
7000
Time (day)
80%+ESLR
20%+ESLR
Mudline
Caminada Composite Sample

Ardaman & Associates, Inc.

Cut-to-Fill Calculations - Marsh Fill Offshore Borrow Area

Project Name: 17-2810
Project No.: (BA-193) Caminada Headlands Marsh Creation - Offshore Borrow Area

1) Determine volume required to fill the marsh to grade

Marsh Fill Area =	19,340,640	$ft.^2$	444.00	acre	
Req. Fill Thickness =	2.90	ft.			
Fill Volume =	56,087,856	$ft.^3$	2,077,328	CY.	
Volume created by the Containement Dike =	-	$ft.^3$	-	CY.	[Not Determined at this time]
Total Volume =	56,087,856	$ft.^3$	2,077,328	CY.	

2) Determine the equivalent volume of solids in the marsh fill

Avg. Void Ratio, e_0 =	2.25	(#)			[From PSDDF Output @ t=20yr]
Volume of Solids =	17,257,802	$ft.^3$	639,178	CY.	[Fill Volume / (1+e_0)]

3) Determine the total volume required in the borrow area

In-Situ Void Ratio, e_0 =	1.45	(#)			
Estimated Losses in Tranportation =	10%	(%)			
Total Volume + Losses=	46,509,776	$ft.^3$	1,722,584	CY.	[Volume of Solids * (1+e_0)]

Cut to Fill Ratio = 0.83 (#)

4) Determine if the borrow source is enough

Borrow Area =	7,000,000	$ft.^2$	160.70	acre	[From Furnished Shape File Area between V-2 and V-3]

Depth of Cut (ft.) =	2	Volume of Borrow =	14,000,000	$ft.^3$	518,519	CY.	not enough
Depth of Cut (ft.) =	3	Volume of Borrow =	21,000,000	$ft.^3$	777,778	CY.	not enough
Depth of Cut (ft.) =	4	Volume of Borrow =	28,000,000	$ft.^3$	1,037,037	CY.	not enough
Depth of Cut (ft.) =	5	Volume of Borrow =	35,000,000	$ft.^3$	1,296,296	CY.	not enough
Depth of Cut (ft.) =	6	Volume of Borrow =	42,000,000	$ft.^3$	1,555,556	CY.	not enough
Depth of Cut (ft.) =	7	Volume of Borrow =	49,000,000	$ft.^3$	1,814,815	CY.	OK
Depth of Cut (ft.) =	8	Volume of Borrow =	56,000,000	$ft.^3$	2,074,074	CY.	OK
Depth of Cut (ft.) =	9	Volume of Borrow =	63,000,000	$ft.^3$	2,333,333	CY.	OK
Depth of Cut (ft.) =	10	Volume of Borrow =	70,000,000	$ft.^3$	2,592,593	CY.	OK
Depth of Cut (ft.) =	11	Volume of Borrow =	77,000,000	$ft.^3$	2,851,852	CY.	OK
Depth of Cut (ft.) =	12	Volume of Borrow =	84,000,000	$ft.^3$	3,111,111	CY.	OK
Depth of Cut (ft.) =	13	Volume of Borrow =	91,000,000	$ft.^3$	3,370,370	CY.	OK
Depth of Cut (ft.) =	14	Volume of Borrow =	98,000,000	$ft.^3$	3,629,630	CY.	OK
Depth of Cut (ft.) =	15	Volume of Borrow =	105,000,000	$ft.^3$	3,888,889	CY.	OK

Ardaman & Associates, Inc.

Cut-to-Fill Calculations - Containment Dike

Project No. 17-2810
Project Name: (BA-193) Caminada Headlands Marsh Creation - Reach 1

1) Compute Total Volume of Embankment

Marsh Creation Area: Dikes

Average Ground Elevation:	-2	ft., NAVD88	(Furnished)		
Crown Width:	5	ft.			
Side Slopes	4	H:1V			
Crown Elevation:	4	ft., NAVD88			
Area:	174.0	$ft.^2$			
Length:	1	ft.	(Per 1 ft. into the page)		
Volume:	174	$ft.^3$		6.44	cu.yd.

Marsh Creation Area: Immediate Settlement beneath dikes

Immediate Settlement:	4.00	in.	0.333	$ft.^3$		
Equivalent Base Width (ft.):	29.00	ft.				
Total Base Width (ft.):	53.00	ft.				
Length of Dike:	1	ft.				
		Volume:	13.67	$ft.^3$	0.51	cu.yd.
		Total Volume + 10% Losses,Vc =	206.43	$ft.^3$	7.65	cu. Yd.
				use:	7.70	cu. Yd.

2) Compute the Weight of the Solids for the placed Embankment

γc dry:	56.7	pcf.	Dry Weight of Embankment
Mcv:	50.0	(%)	Moisture Content of compacted material
γc:	85.0	pcf.	Wet Weight of Material

Ws = 11,698 lbs.

3) Calculate the Required Volume of Borrow Material

γb dry:	58.8	pcf.	Dry weight of Borrow Material
Mcb:	70.0	(%)	Moisture Content of borrow material
γb:	100.0	pcf.	Wet Weight of Borrow

Total Volume of Borrow, Vb =	198.86	$ft.^3$	7.37	cu. Yd.
		use:	7.40	cu. Yd.

4) Determine % Shrink

% Shrink = -3.81% (Vb-Vc)/Vb

5) Determine Cut-to-Fill Ratio

Cut-to-Fill = 1.15 (Volume of Borrow / Neat Volume)

Ardaman & Associates, Inc.

Cut-to-Fill Calculations - Containment Dike

Project No. 17-2810
Project Name: (BA-193) Caminada Headlands Marsh Creation - Reach 2

1) Compute Total Volume of Embankment

Marsh Creation Area: Dikes

Average Ground Elevation:	-2	ft., NAVD88	(Furnished)
Crown Width:	5	ft.	
Side Slopes	4	H:1V	
Crown Elevation:	4	ft., NAVD88	
Area:	174.0	$ft.^2$	
Length:	1	ft.	(Per 1 ft. into the page)

Volume: 174 $ft.^3$ 6.44 cu.yd.

Marsh Creation Area: Immediate Settlement beneath dikes

Immediate Settlement:	7.00	in.	0.583	$ft.^3$
Equivalent Base Width (ft.):	29.00	ft.		
Total Base Width (ft.):	53.00	ft.		
Length of Dike:	1	ft.		

Volume: 23.92 $ft.^3$ 0.89 cu.yd.

Total Volume + 10% Losses,Vc = 217.71 $ft.^3$ 8.06 cu. Yd.

use: 8.10 cu. Yd.

2) Compute the Weight of the Solids for the placed Embankment

γc dry:	38.6	pcf.	Dry Weight of Embankment
Mcv:	120.0	(%)	Moisture Content of compacted material
γc:	85.0	pcf.	Wet Weight of Material

Ws = 8,411 lbs.

3) Calculate the Required Volume of Borrow Material

γb dry:	34.0	pcf.	Dry weight of Borrow Material
Mcb:	150.0	(%)	Moisture Content of borrow material
γb:	85.0	pcf.	Wet Weight of Borrow

Total Volume of Borrow, Vb = 247.40 $ft.^3$ 9.16 cu. Yd.

use: 9.20 cu. Yd.

4) Determine % Shrink

% Shrink = 12.00% (Vb-Vc)/Vb

5) Determine Cut-to-Fill Ratio

Cut-to-Fill = 1.43 (Volume of Borrow / Neat Volume)

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Cut-to-Fill Calculations - Containment Dike

Project No. 17-2810
Project Name: (BA-193) Caminada Headlands Marsh Creation - Reach 3

1) Compute Total Volume of Embankment

Marsh Creation Area: Dikes

Average Ground Elevation:	-2	ft., NAVD88	(Furnished)		
Crown Width:	5	ft.			
Side Slopes	4.5	H:1V			
Crown Elevation:	4	ft., NAVD88			
Area:	192.0	$ft.^2$			
Length:	1	ft.	(Per 1 ft. into the page)		
		Volume:	192	$ft.^3$	7.11 cu.yd.

Marsh Creation Area: Immediate Settlement beneath dikes

Immediate Settlement:	11.00	in.	0.917	$ft.^3$	
Equivalent Base Width (ft.):	32.00	ft.			
Total Base Width (ft.):	59.00	ft.			
Length of Dike:	1	ft.			
		Volume:	41.71	$ft.^3$	1.54 cu.yd.
		Total Volume + 10% Losses,Vc =	257.08	$ft.^3$	9.52 cu. Yd.
				use:	9.60 cu. Yd.

2) Compute the Weight of the Solids for the placed Embankment

γc dry:	50.0	pcf.	Dry Weight of Embankment
Mcv:	80.0	(%)	Moisture Content of compacted material
γc:	90.0	pcf.	Wet Weight of Material
		Ws =	12,854 lbs.

3) Calculate the Required Volume of Borrow Material

γb dry:	45.0	pcf.	Dry weight of Borrow Material		
Mcb:	100.0	(%)	Moisture Content of borrow material		
γb:	90.0	pcf.	Wet Weight of Borrow		
		Total Volume of Borrow, Vb =	285.64	$ft.^3$	10.58 cu. Yd.
				use:	10.60 cu. Yd.

4) Determine % Shrink

% Shrink = 10.00% (Vb-Vc)/Vb

5) Determine Cut-to-Fill Ratio

Cut-to-Fill = 1.49 (Volume of Borrow / Neat Volume)

Determination of Borrow Excavation Limits

1) *Neat Area Volume for Earthen Containment Dikes:*

Reach 1:

Mudline Elev. =	-2.00	ft., NAVD88	A_1 =	30.0	ft^2	(Rectangular Section)
ECD Crest Elev. =	4.00	ft., NAVD88	$A_2 = A_3$ =	72.0	ft^2	(Trapozoidal ection)
Crest Width =	5.00	ft.	A_{tot} =	174.0	ft^3 / ln. ft.	(Neat Area Volume)
Side Slopes =	4.00	H:1V	A_{tot} =	6.4	CY / ln. ft.	

Reach 2:

Mudline Elev. =	-2.00	ft., NAVD88	A_1 =	30.0	ft^2	(Rectangular Section)
ECD Crest Elev. =	4.00	ft., NAVD88	$A_2 = A_3$ =	72.0	ft^2	(Trapozoidal ection)
Crest Width =	5.00	ft.	A_{tot} =	174.0	ft^3 / ln. ft.	(Neat Area Volume)
Side Slopes =	4.00	H:1V	A_{tot} =	6.4	CY / ln. ft.	

Reach 3:

Mudline Elev. =	-2.00	ft., NAVD88	A_1 =	30.0	ft^2	(Rectangular Section)
ECD Crest Elev. =	4.00	ft., NAVD88	$A_2 = A_3$ =	81.0	ft^2	(Trapozoidal ection)
Crest Width =	5.00	ft.	A_{tot} =	192.0	ft^3 / ln. ft.	(Neat Area Volume)
Side Slopes =	4.50	H:1V	A_{tot} =	7.1	CY / ln. ft.	

2) *Determine Area of Immediate Undrained Deformations:*

Reach 1:

Undrained Deformations =	4.00	in.	0.3333 ft.	A_1 =	9.7	ft^2	(Rectangular Section)
Equivalent Base Width, B' =	29	ft.		$A_2 = A_3$ =	2.0	ft^2	(Trapozoidal ection)
Ttoal Base Width, B =	53	ft.		A_{tot} =	13.7	ft^3 / ln. ft.	(Volume)

Reach 2:

Undrained Deformations =	7.00	in.	0.5833 ft.	A_1 =	16.9	ft^2	(Rectangular Section)
Equivalent Base Width, B' =	29	ft.		$A_2 = A_3$ =	3.5	ft^2	(Trapozoidal ection)
Ttoal Base Width, B =	53	ft.		A_{tot} =	23.9	ft^3 / ln. ft.	(Volume)

Reach 2:

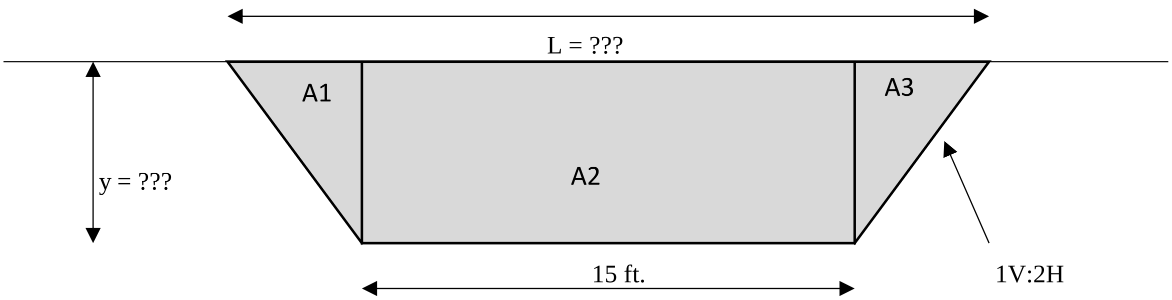
Undrained Deformations =	11.00	in.	0.9167 ft.	A_1 =	29.3	ft^2	(Rectangular Section)
Equivalent Base Width, B' =	32	ft.		$A_2 = A_3$ =	6.2	ft^2	(Trapozoidal ection)
Ttoal Base Width, B =	59	ft.		A_{tot} =	41.7	ft^3 / ln. ft.	(Volume)

3) *Total Volume:*

	Reach 1:		Reach 2:		Reach 3:	
Neat Area Volume =	174.0	ft^3 / ln. ft.	174.0	ft^3 / ln. ft.	192.0	ft^3 / ln. ft.
Undrained Deformation Volume =	13.7	ft^3 / ln. ft.	23.9	ft^3 / ln. ft.	41.7	ft^3 / ln. ft.
Total Volume =	187.7	ft^3 / ln. ft.	197.9	ft^3 / ln. ft.	233.7	ft^3 / ln. ft.
Losses / Drying / Compaction Use =	200.0	ft^3 / ln. ft.	200.0	ft^3 / ln. ft.	250.0	ft^3 / ln. ft.

3) *Determine Depth of Borrow Required:*

Borrow Excavation Schematic (Not to Scale): 15-ft. wide bottom and 1V:2H Side Slopes



$$Volume\ of\ Borrow = A1 + A2 + A3$$
$$A1 = A3 = 0.5 * (2y) * y$$
$$A2 = 15y$$

$(2y^2)$ + 15y - Volume of borrow = 0

$$y = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Reach 1:

Volume of Borrow =	200.0	ft^3 / ln. ft.	7.4	CY / ln. ft.			
a =	2.0	root y_1 =	6.93		use y =	6.93	ft.
b =	15.0	root y_2 =	-14.43		L =	42.72	ft.
c =	-200.0						

Reach 2:

Volume of Borrow =	200.0	ft^3 / ln. ft.	7.4	CY / ln. ft.			
a =	2.0	root y_1 =	6.93		use y =	6.93	ft.
b =	15.0	root y_2 =	-14.43		L =	42.72	ft.
c =	-200.0						

Reach 3:

Volume of Borrow =	250.0	ft^3 / ln. ft.	9.3	CY / ln. ft.			
a =	2.0	root y_1 =	8.04		use y =	8.04	ft.
b =	15.0	root y_2 =	-15.54		L =	47.17	ft.
c =	-250.0						