

APPENDIX A - Geotechnical Report



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July 5, 2018

Christopher Magdosku, P.E.
City Engineer
City of Encinitas
505 South Vulcan Avenue
Encinitas, California 92024

Subject: **COASTAL BLUFF AND LANDSLIDE STABILITY
BEACON'S BEACH ACCESS RECONSTRUCTION PROJECT
ENCINITAS, CALIFORNIA
AECOM Project No. 60539890**

Dear Mr. Magdosku:

As requested, this report provides AECOM Technical Services, Inc.'s (AECOM's) summary assessment of the existing landslide at Beacon's Beach. Recognizing the hazard posed by the existing landslide conditions, we understand the City of Encinitas (City) desires to go forward with the proposed beach access reconstruction project as soon as possible. Therefore the City is considering an emergency CEQA exemption per *CEQA 15269 (c)*. According to the City, a primary issue for the CEQA emergency exemption is whether the landslide presents a "*clear and imminent danger demanding immediate action.*"

Our supplemental geotechnical report (dated May 30, 2018) provides additional information for the current site conditions with updated geologic assessments and geotechnical evaluations of the coastal bluff and landslide. Based on our updated stability analyses, the landslide and upper bluff are only marginally stable, i.e., the site factors of safety are low; this condition has been apparent for some time as previously reported (URS, 2003). However, the current site conditions have become increasingly more precarious with further decreased geologic stability as a result of several decades of erosion and landslide movements. It should be recognized that natural, ongoing coastal erosion and the seismic setting of the site present risks that could trigger instability in the short term. Therefore, in our opinion, the CEQA exemption conditions are valid and appropriate, as summarized below.

1) The collapse of the bluff could cause damage to life, health, or property.

A potentially deep landslide as a result of renewed movement of the existing landslide, or slumping of the upper bluff could encroach into the westerly portion of the parking lot. The top section of the trail presents a safety hazard due to slumping that could occur in the oversteepened upper bluff. Landslide movements or slumping of the upper bluff could cause damage to vehicles or harm to people occupying the western edge of the parking lot and cause bluff materials to topple onto people using the access trail.

2) The existing conditions on the project site involve a clear and imminent danger that demands immediate action to prevent or mitigate the loss of, or damage to life, health, property, or essential public services.

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Two events are potentially hazardous: namely: 1) minor earthquake shaking and 2) continued upper bluff erosion. These events present the risk of renewed landslide movement and instability of the upper bluff that could occur in the short term, as described below.

Renewed Landslide Movement

Based on engineering analyses and monitoring of the landslide over the years, earthquake shaking is believed to be a likely landslide failure trigger. Slope stability analyses were performed on the same cross sections provided previously (URS, 2003) using updated topography; locations of the sections are shown on Figure 1¹. Factors of safety were analyzed for potential deep landsliding and for upper bluff instability.

The analyses indicate the upper bluff is only marginally stable (factor of safety at or less than 1.1) for “static” (without seismic shaking) conditions with potential failures extending to the top of the bluff². The potential deep landslide (i.e., landslide movement involving a deeper portion of the bluff beyond the active landslide) is also marginally stable, with factors of safety ranging between 1.04 (at Section D-D’) and 1.25 (Section C-C’, where the existing landslide is deeper). Table 1 summarizes the stability analyses.

Table 1. Summary of Stability Analyses

Cross-Section	Analysis Conditions	Factor of Safety, F.S.	
		Static	Pseudo-static $K_h^a=0.18g$
D-D’	Existing conditions, upper bluff stability	1.05	0.77
D-D’	Existing conditions with a B.P.S. failure	1.04	0.74
C-C’	Existing conditions, upper bluff stability	1.10	0.80
C-C’	Existing conditions with a B.P.S. failure	1.25	0.90
B-B’	Existing conditions, upper bluff stability	1.10	0.81
B-B’	Existing conditions with a B.P.S. failure	1.10	0.79
A-A’	Existing conditions, upper bluff stability	0.99	Not analyzed
A-A’	Existing conditions with a B.P.S. failure	1.24	0.99
Notes:			
a. A seismic coefficient of $K_h = 0.18g$ (1/2 of the design earthquake peak ground acceleration) was selected for pseudo-static analyses according to procedures outlined by the U.S. Department of Transportation Federal Highway Administration (FHWA, 2011) using the maximum probable earthquake.			
b. “B.P.S.” refers to “bedding plane shear” the same failure plane as at the Beacon’s Landslide and landslides just south of Beacon’s. (URS, 2003).			

¹ Graphic depictions of the slope stability models, including subsurface geology, groundwater and material properties are shown on Figures A-1 through A-15 in Attachment A. The background for development of the stability sections is provided in AECOM’s 2018 updated geotechnical report.

² A factor of safety greater than one generally implies a stable slope, failure of which should not occur assuming the slope is undisturbed. A factor of safety of 1.5 for static conditions is commonly used in practice.



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Pseudo-static stability analyses (i.e., analyses considering seismic shaking) were performed to evaluate the effects of potential seismic shaking. The previous seismic hazard assessment (URS, 2003) indicated the expected level of peak ground acceleration associated with about a 10 percent probability of being exceeded in a 50-year period is estimated to be $0.36g^3$. As shown on Table 1, using this approach, all of the factors of safety for the maximum probable earthquake are well below 1.0.

Seismic shaking at relatively low levels (i.e., lower than the maximum probable earthquake) could also create instability. Additional pseudo-static stability analyses were also performed to estimate the minimum “threshold” level of seismic shaking that would trigger instability. Those analyses indicate that relatively low seismic shaking as low as $0.24g$ or less would produce a factor of safety of 1.0 (indicating incipient failure). Seismic shaking at relatively low levels could originate from moderate earthquakes on nearby faults, or a more distant large earthquake. Moderate earthquakes occur more frequently than large earthquakes.

The system of active faults comprising the continental border land offshore from Beacon’s Beach is an active tectonic setting capable of moderate to large earthquakes. The 1986 “Oceanside” earthquake (M5.5) was felt strongly along the North County coastline, but the earthquake epicenter was far enough offshore to not cause significant damage along the coast. Given the site seismic setting, earthquake shaking could occur at any time. Relatively low seismic shaking levels could cause the landslide to be reactivated, or the upper bluff to fail

Upper Bluff Instability

The upper bluff at Beacon’s Beach is a landslide headscarp that will erode and flatten with time and could slump even without renewed movement of the deeper landslide. Due to the headscarp’s very steep inclination, upper bluff instability poses a hazard to persons using the existing beach access trail. Upper bluff instability could also damage the parking lot, vehicles in the lot, and harm people in the lot.

To help evaluate the risk of instability due to erosion, site topographic data bases were compiled from surveys in 2002 and repeated in 2017. Figure 2 is a comparison of the 2002 and 2017 topography for the site with the data sets compiled as overlays. The topographic analysis indicates negative changes in ground elevations (i.e., the ground surface has lowered; representing erosion), shown as varying shades of red. Areas of with positive elevation change (the ground surface has gone up) have received subaerial eroded sediment derived from the headscarp (shown in blue). Areas with only small topographic changes, estimated at less than 0.5 feet are shown in green. Labels are shown on the figure for increased clarity.

The topographic analysis indicates, over the past 15 years the upper bluff slope, i.e., the landslide headscarp, has eroded landward between 4 and 5 feet above and below the beach access trail, and more than 10 feet below the north portion of the parking lot⁴. The subaerial (non-marine) erosion rate of the terrace deposits (which underlie and form the oversteepened head scarp slope) ranges

³ A 10 percent probability of being exceeded in a 50-year period is a typical seismic design consideration in building codes, in this case the seismic shaking level is also considered the “maximum probable earthquake”.

⁴ The erosion indicated for the past 15 years is a minimum amount inasmuch as detailed site topography is not available for the time frame prior to 2002 (the landslide occurred in 1982/83).



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between 0.3 feet per year (about 4-inches per year) and more than 1-foot per year near the upper northerly switch back of the beach access trail. The landslide materials have accumulated a several foot thickness of loose eroded/sloughed sandy material derived from the landslide head scarp.

Some amount of elevation change is due to regrading to maintain the trail. According to the City, minor sloughing of the slope just below the top switchback has temporarily closed the trail and required the path to be regraded (notched) several feet landward. The uppermost portion of the trail (just below the highest switch back) has been built up several feet with fill soil to create a relatively uniform grade (indicated by blue contours, Figure 2). In effect, the upper trail is maintained with a thin fill slope placed along the edge of the naturally eroded, partially man-made cut made along the over steepened landslide head scarp (see photo at right).

It will be difficult to keep the trail open at the top section with continuing natural erosion and slope sloughing (URS letter to CCC dated February 16, 2016). Sections of the trail are also becoming increasingly unstable due to the increased accumulation of loose, sloughed material upslope of the trail. Tension cracks have been recently observed within these materials after rain (AECOM, 2017).



The average erosion rate measured at the site over the past 15 years is likely to continue in the short term. Above average weather and/or wave conditions could easily accelerate the average erosion rate. The upper bluff slope can only accommodate minor additional erosion induced steepening until either: 1) the currently over steepened landslide headscarp (below the trail) becomes vertical and collapses, 2) slumping occurs along the crest of the headscarp (above the trail), or 3) the terrace deposits supporting the trail erode and the trail becomes impassable. In each case, the top section of the trail currently presents a safety hazard where it traverses the oversteepened landslide headscarp.

The current landslide conditions and over steepened upper bluff present a clear and imminent danger that demands immediate action to prevent loss of, or damage to life, health, property, or essential public services, i.e., public beach access.



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3) The project would mitigate an emergency situation that has a high probability of occurring in the short-term.

The existing Beacon's Landslide was an emergency situation creating an unstable geologic landform that was never mitigated for public beach access. The current site conditions at Beacon's have become increasingly more precarious with further decreased geologic stability as a result of erosion and landslide movements over the past 35 years. The marginally stable site conditions have worsened from the site instability initiated by the unexpected landslide movement in the early 1980's. Ongoing coastal bluff erosion and instability at Beacon's Beach, like similar coastal settings tend to be episodic and can occur in response to waves, rainfall, and/or progressive weathering with steepening of the slope. These naturally recurring conditions are almost certain to happen in the short term. Based on over 15 years of site monitoring, continued average erosion that will further degrade the upper bluff has a high probability of occurring in the short term.

Landslide movements and bluff instability can occur in the short term and are difficult to monitor and predict in the coastal setting. The proposed beach access reconstruction project will increase the parking lot-bluff setback distance, avoid the over steepened landslide headscarp and will stabilize a small portion of the existing landslide. Therefore the project will mitigate an emergency situation that has a high probability of occurring in the short-term.

We appreciate providing this assessment of the existing landslide at Beacon's Beach.

Sincerely,

AECOM Technical Services, Inc.

David L. Schug, C.E.G. 1212
Senior Principal Engineering Geologist

Steven M. Fitzwilliam, G.E. 2501
Principal Geotechnical Engineer

Attachments

Figure 1 Site Plan and Geologic Map
Figure 2 Erosion Assessment (2002-2017)
Attachment A- Stability Sections

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References

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AECOM 2018, Supplemental Geotechnical Report, Beacon's Beach Access Reconstruction Project, Encinitas, CA, prepared for City of Encinitas, AECOM Project No. 60539890, dated May 30, 2018.

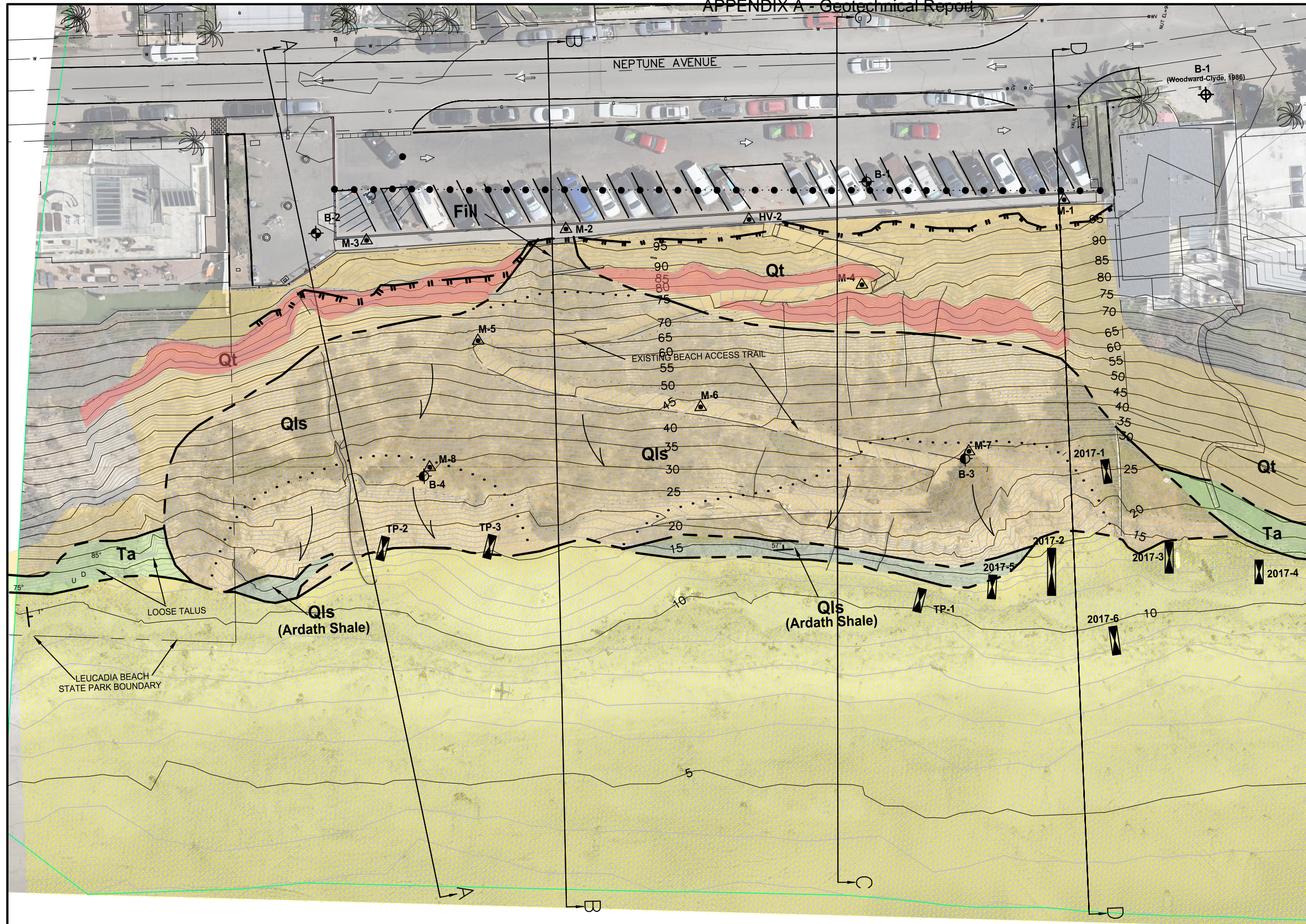
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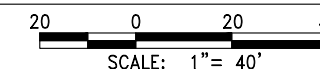
LEGEND

- INDICATES APPROXIMATE LOCATION OF TEST BORING (URS, 2003)
- INDICATES APPROXIMATE LOCATION OF TEST BORING WITH INCLINOMETER AND PIEZOMETER (URS, 2003)
- INDICATES APPROXIMATE LOCATION OF MONITORING WELL (URS, 2003)
- INDICATES APPROXIMATE LOCATION OF SLOPE MONITORING POINT (URS, 2003)
- INDICATES APPROXIMATE LOCATION OF TEST PIT
- INDICATES APPROXIMATE LOCATION OF PREVIOUS TEST BORING (WCC, 1986)
- INDICATES APPROXIMATE LOCATION OF GEOLOGIC CROSS SECTION (URS, 2003)
- INDICATES BEDDING STRIKE AND DIP
- INDICATES APPROXIMATE LOCATION OF BLUFF EDGE
- INDICATES GEOLOGIC CONTACT
- APPROXIMATE BOUNDARY OF LANDSLIDE LOBE
- APPROXIMATE LIMITS, BEACH SAND
- APPROXIMATE LIMITS, ACTIVE LANDSLIDE
- INDICATES QUATERNARY TERRACE DEPOSITS
- INDICATES TERTIARY ARDATH SHALE
- OVERSTEEPENED NEAR VERTICAL HEADSCARP
- BLUFF TOP SETBACK

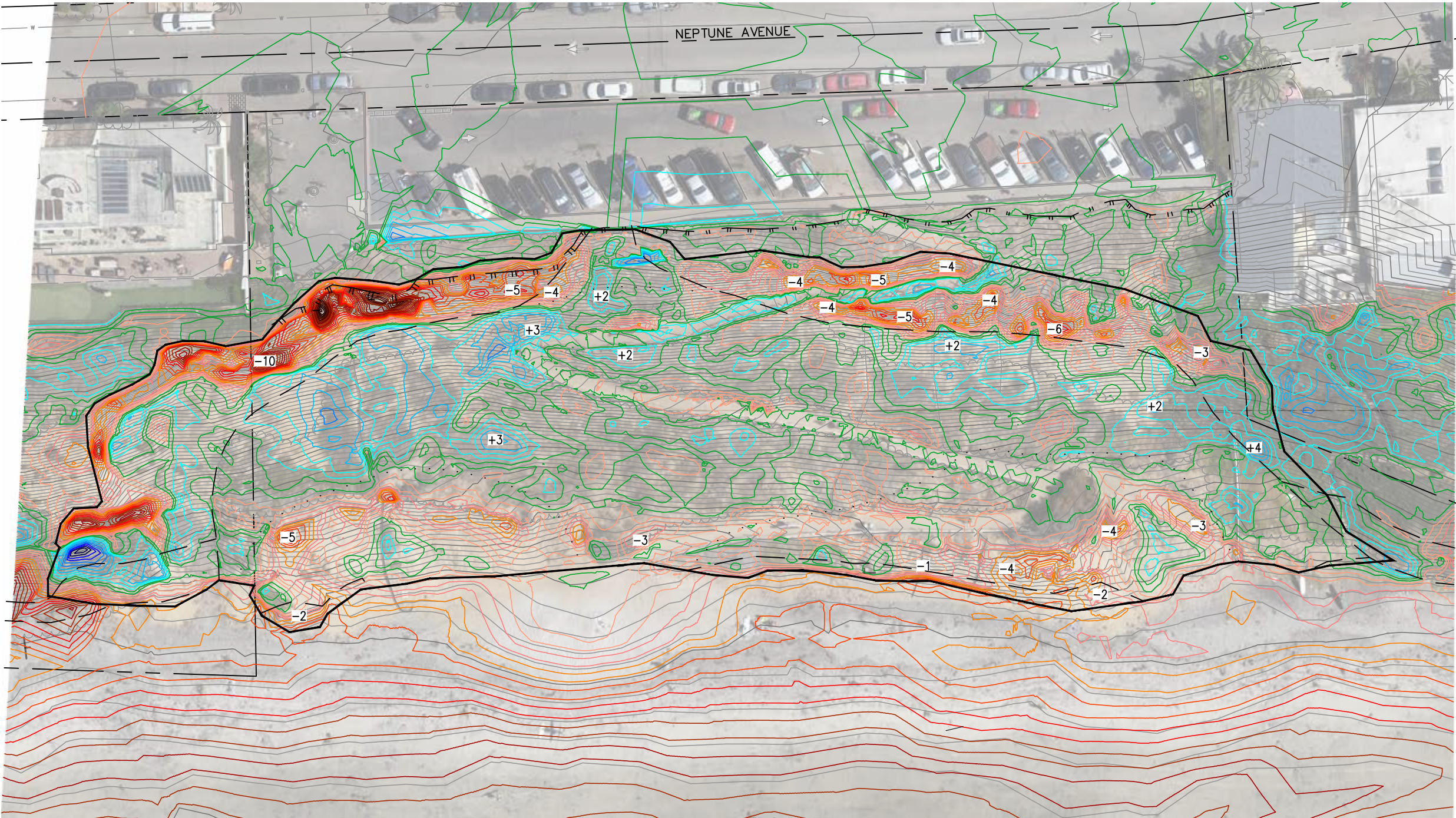
TOPOGRAPHIC MAP SOURCE: Right-Of-Way Engineering, 2017.

**SITE PLAN AND GEOLOGIC MAP
BEACON'S BEACH ACCESS RECONSTRUCTION PROJECT
ENCINITAS, CALIFORNIA**

AECOM



CHECKED BY: DLS	DATE: 3-21-2018	FIG. NO: 1
PM: DLS	PROJ. NO: 60539890	



Contours Table (feet)			
Number	Minimum Elevation	Maximum Elevation	Color
1	-14.231	-12.500	
2	-12.500	-11.500	
3	-11.500	-10.500	
4	-10.500	-9.500	
5	-9.500	-8.500	
6	-8.500	-7.500	
7	-7.500	-6.500	
8	-6.500	-5.500	
9	-5.500	-4.500	
10	-4.500	-3.500	
11	-3.500	-2.500	
12	-2.500	-1.500	
13	-1.500	-0.500	
14	-0.500	0.500	
15	0.500	1.500	
16	1.500	2.500	
17	2.500	3.500	
18	3.500	4.500	
19	4.500	5.500	
20	5.500	6.113	

TOPOGRAPHIC MAP SOURCE: Right-Of-Way Engineering, 2017.

LEGEND

- EROSION BOUNDARY
- LANDSLIDE LIMITS
- BLUFF EDGE (2002)



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EROSION ASSESSMENT (2002-2017)
BEACON'S BEACH ACCESS RECONSTRUCTION PROJECT
ENCINITAS, CALIFORNIA

20 0 20 40 FT
SCALE: 1"= 40'

CHECKED BY: DS
PM: DL

DATE: 05-15-2018
PROJ. NO: 60539890

FIG. NO:
2

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Attachment A- Stability Sections

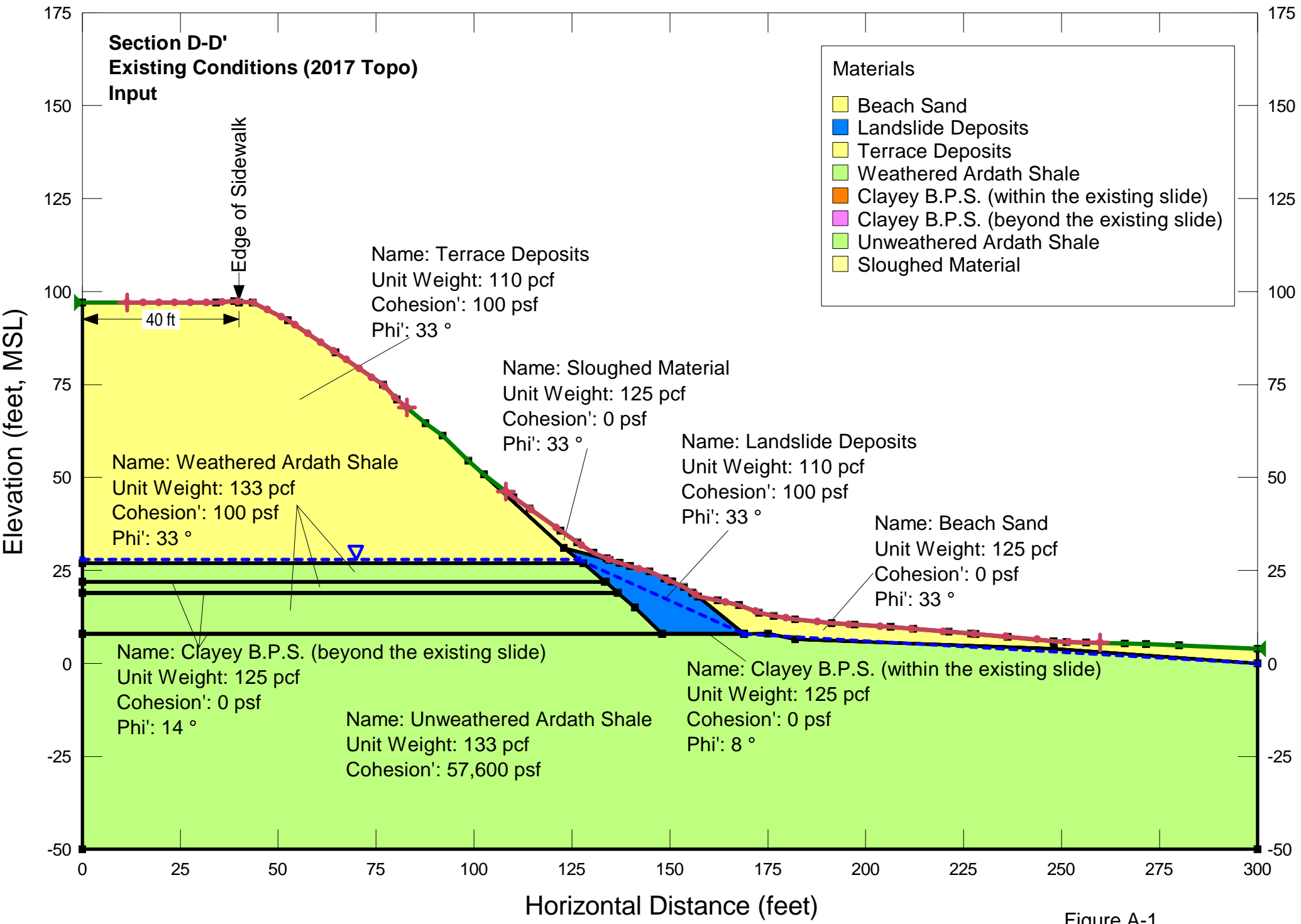


Figure A-1

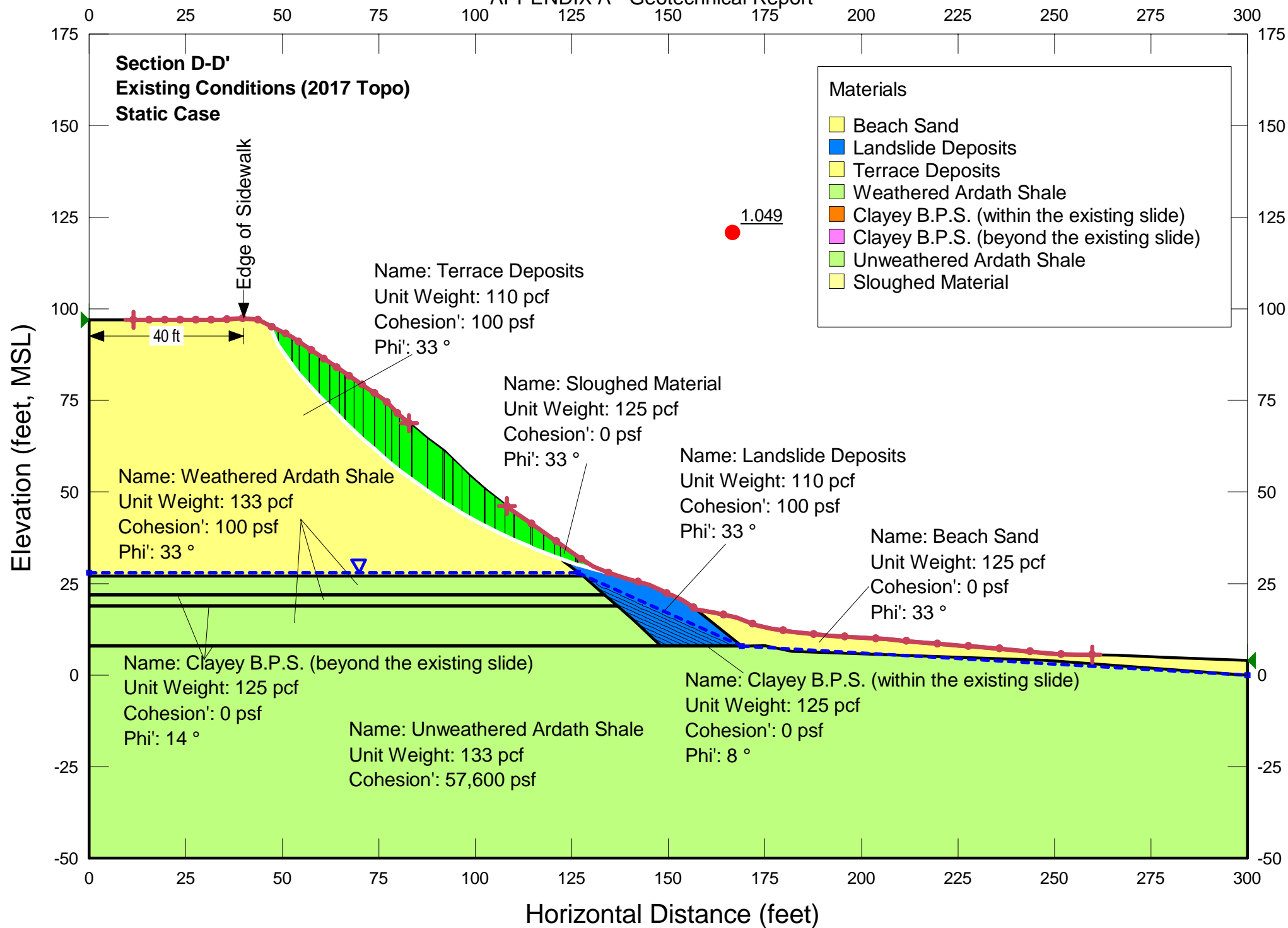


Figure A-2

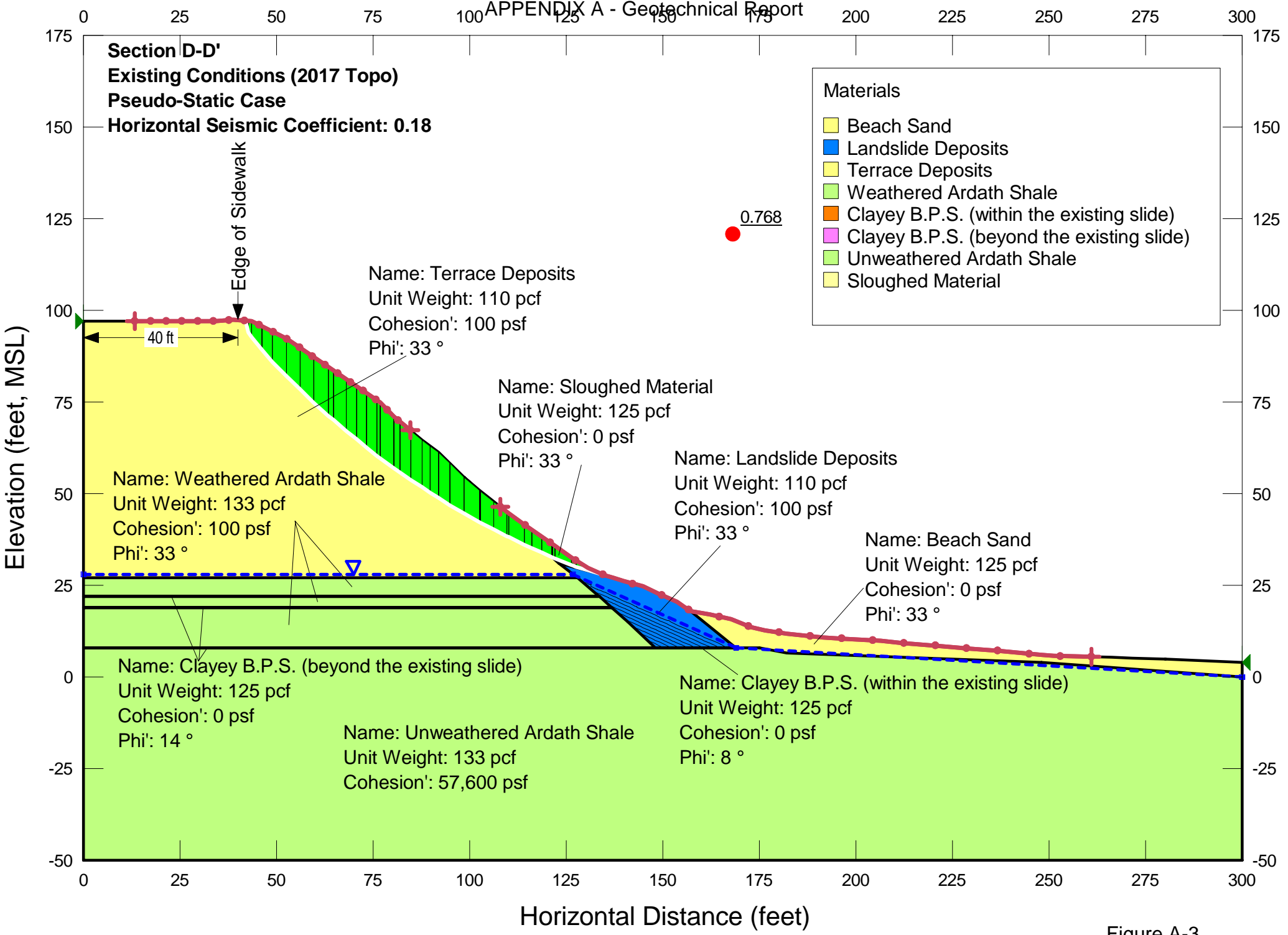


Figure A-3

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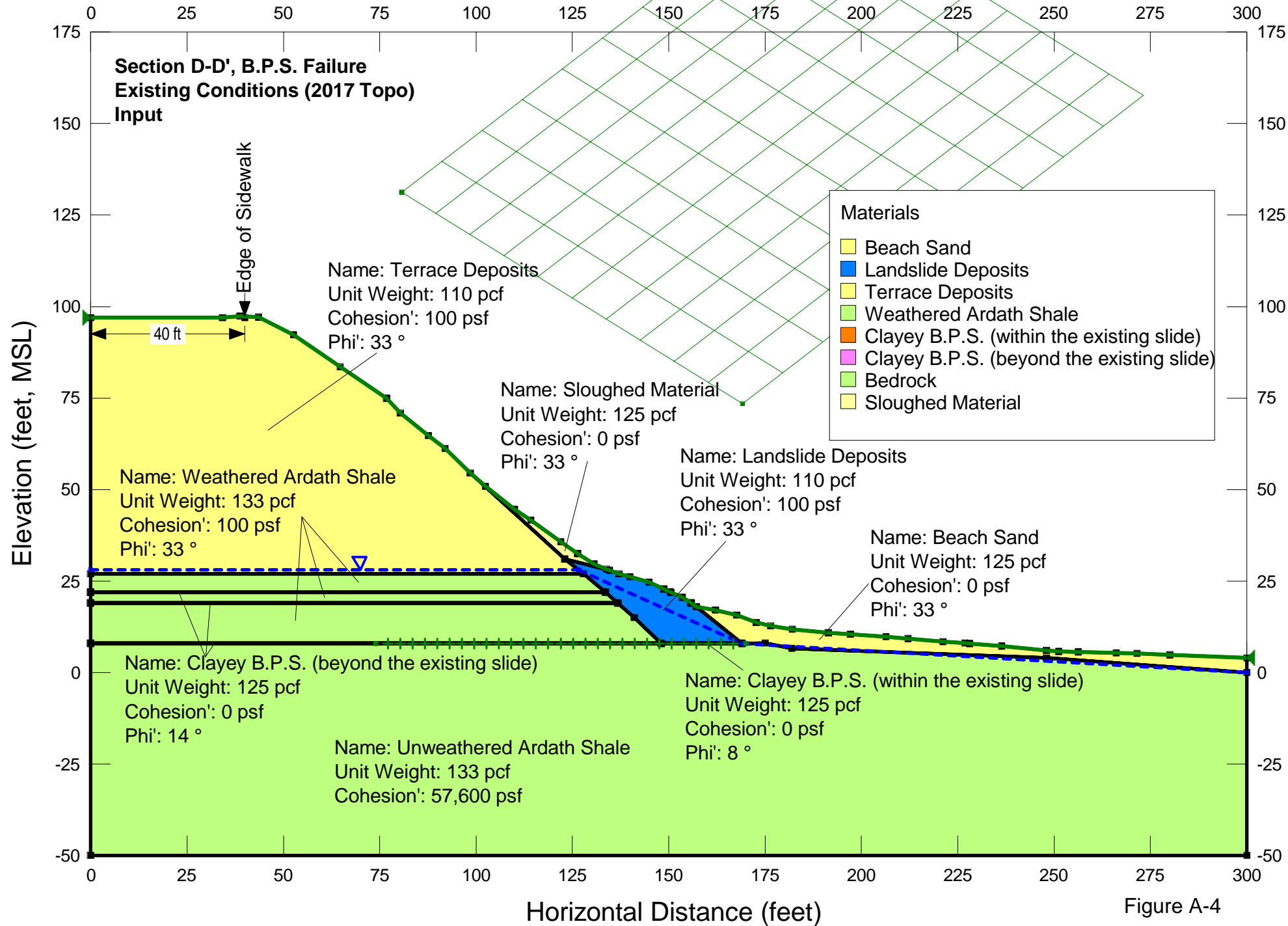


Figure A-4

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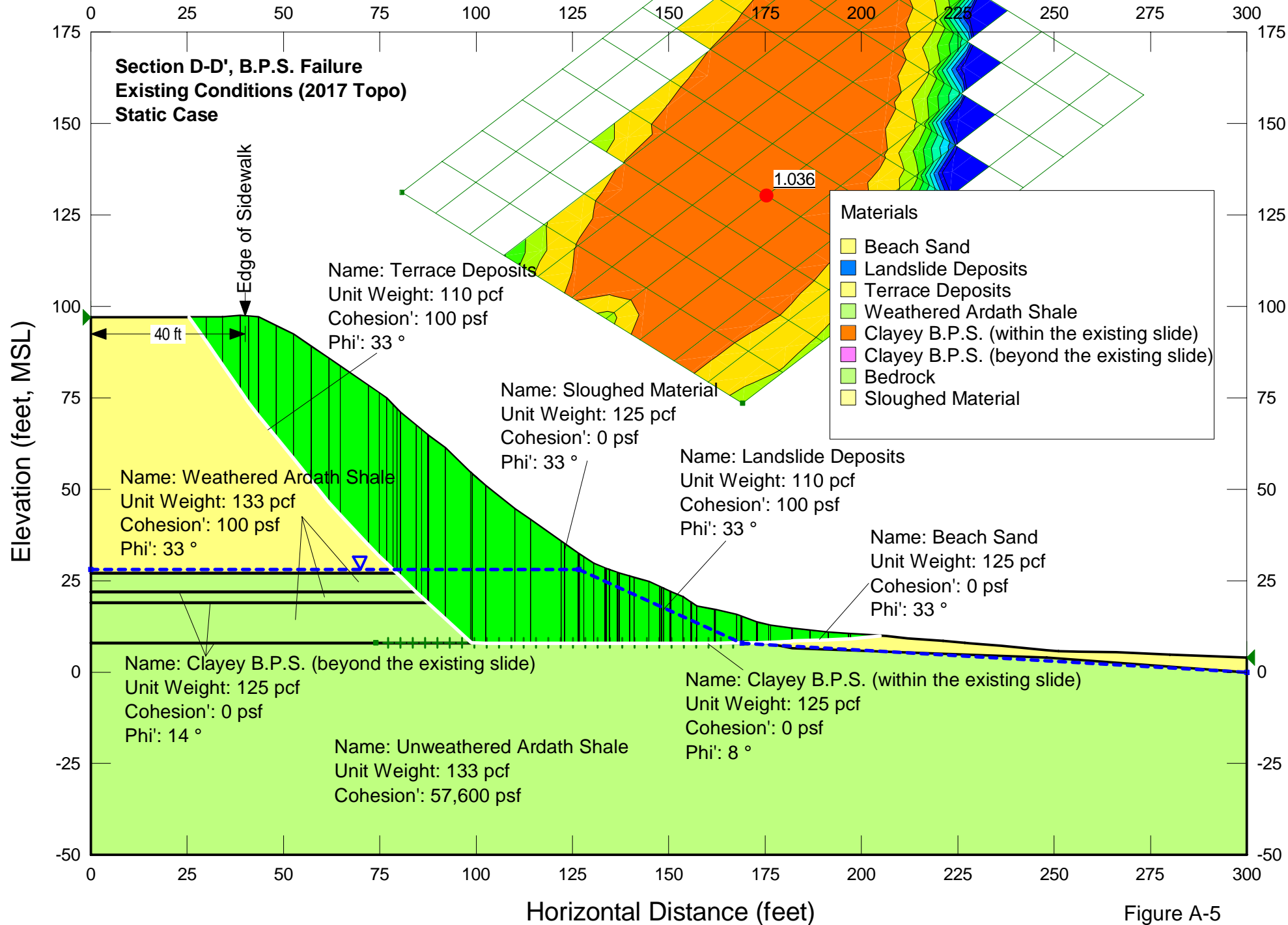


Figure A-5

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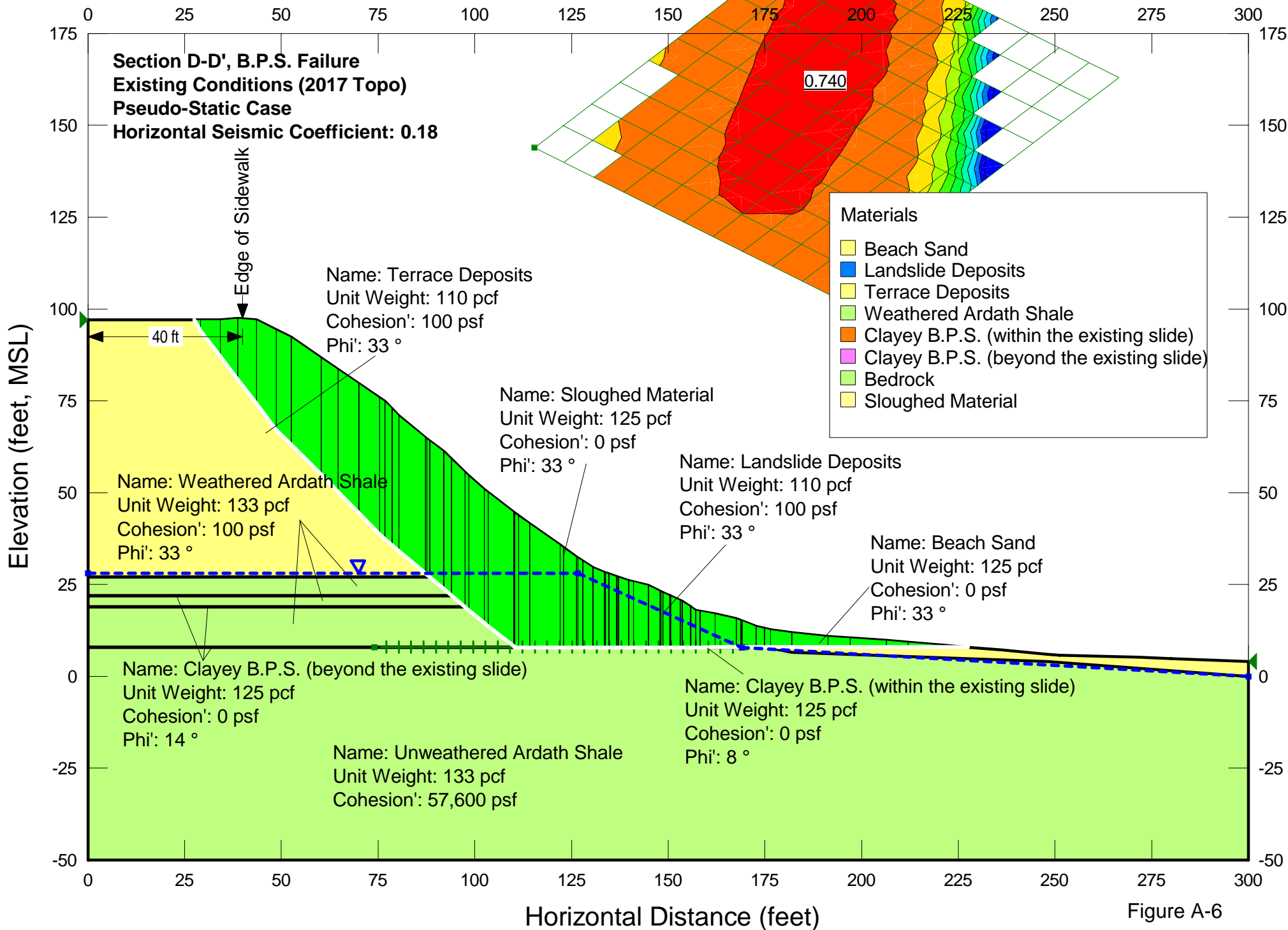


Figure A-6

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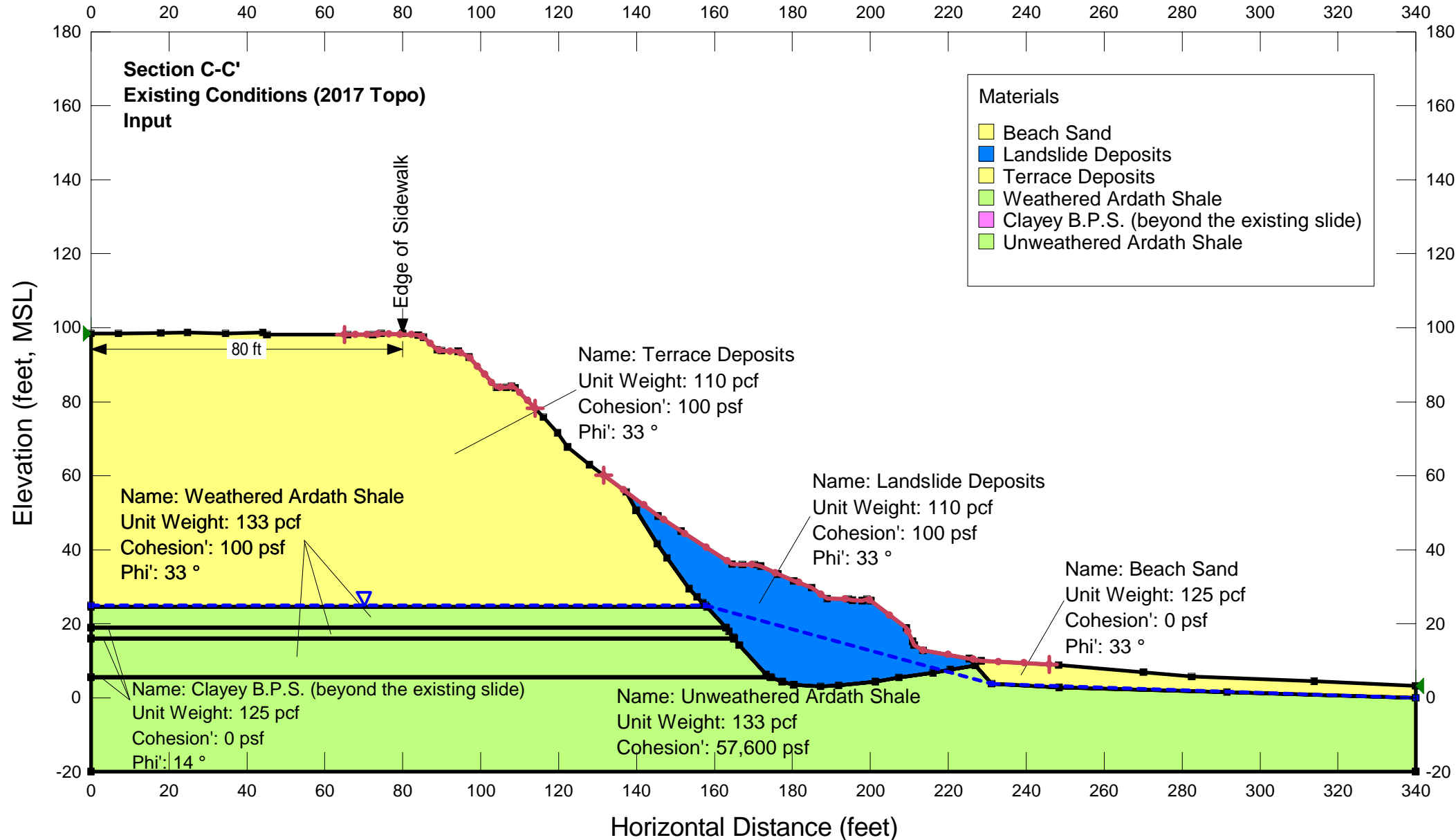


Figure A-7

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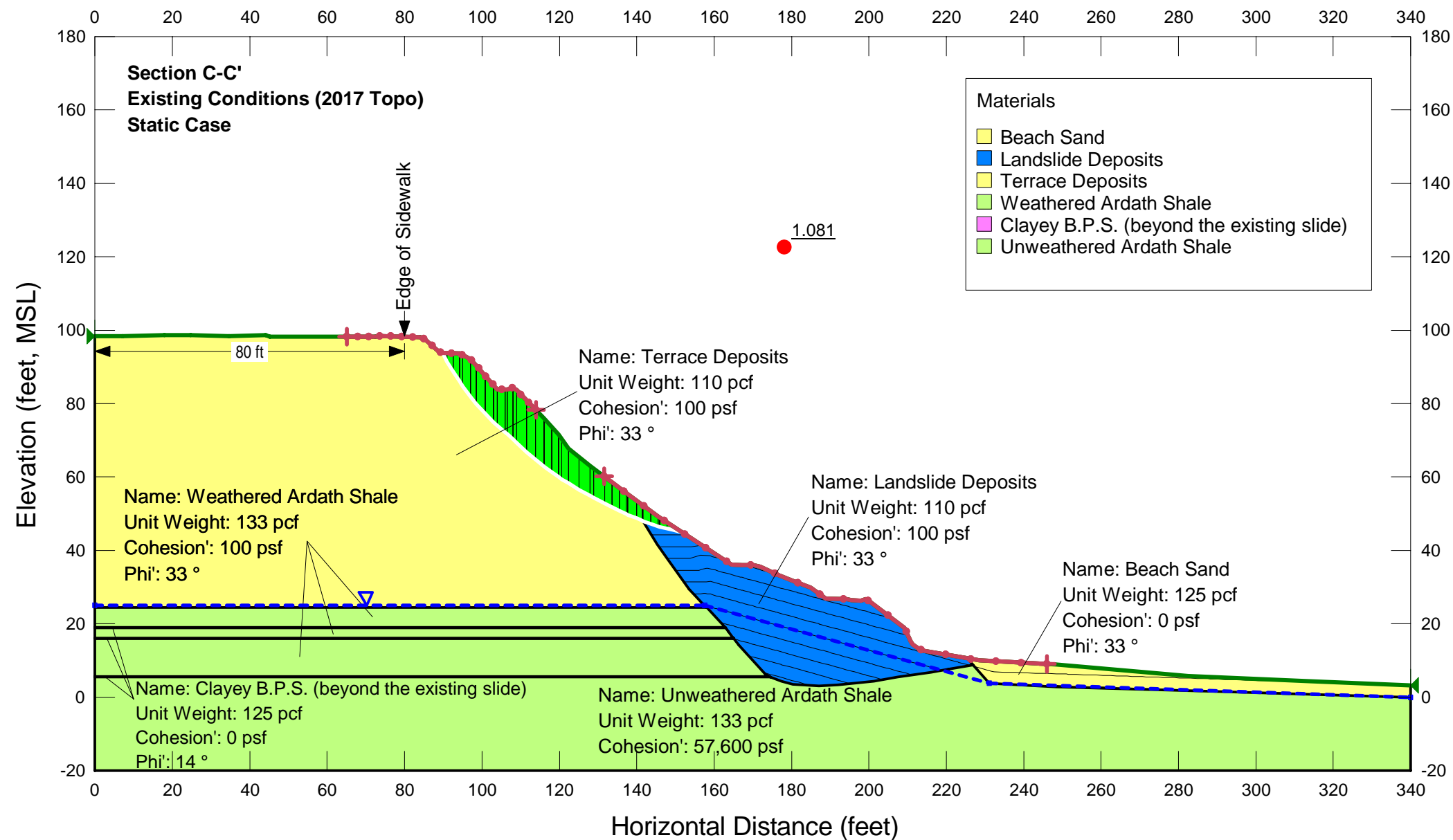


Figure A-8

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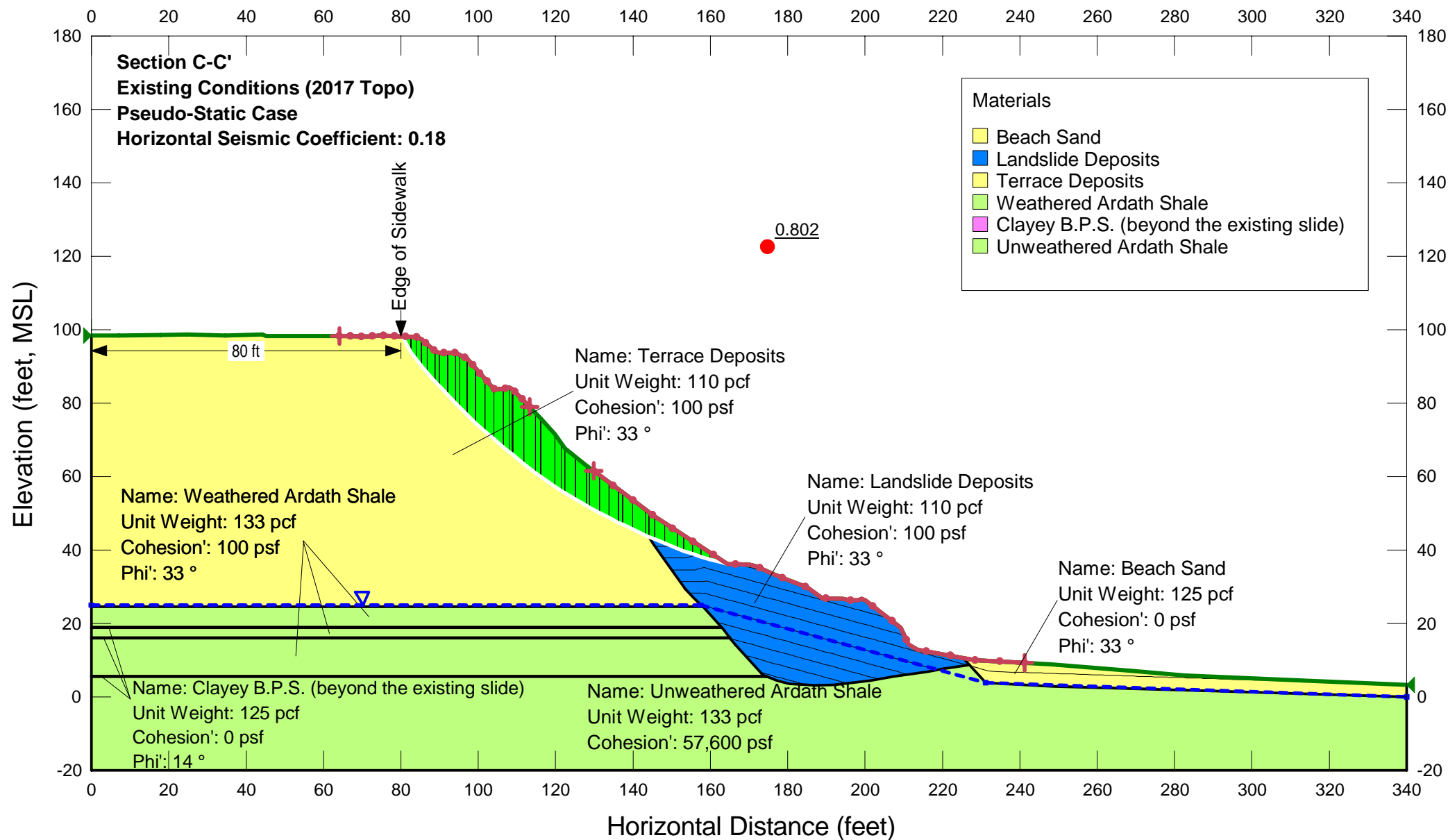


Figure A-9

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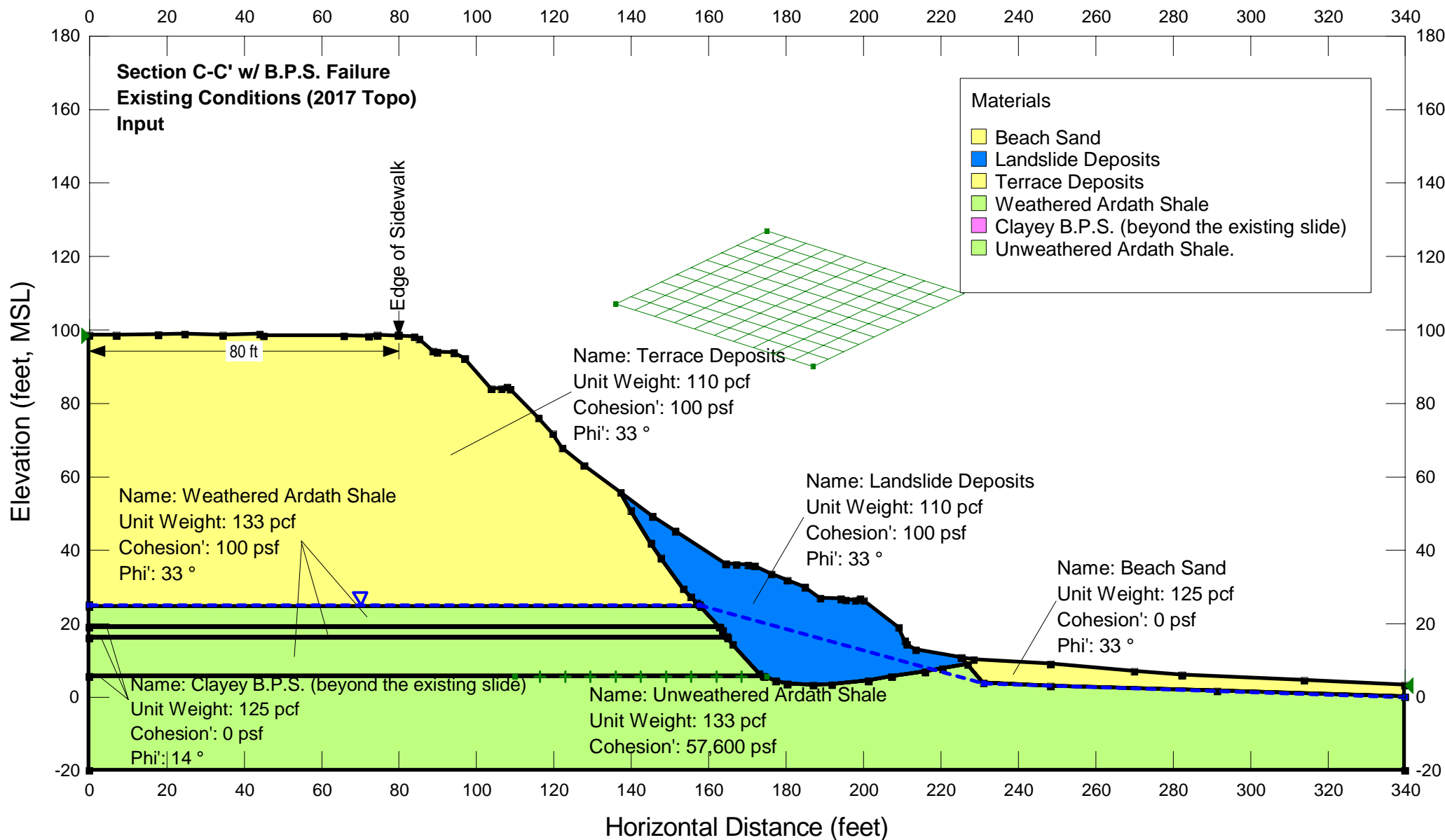


Figure A-10

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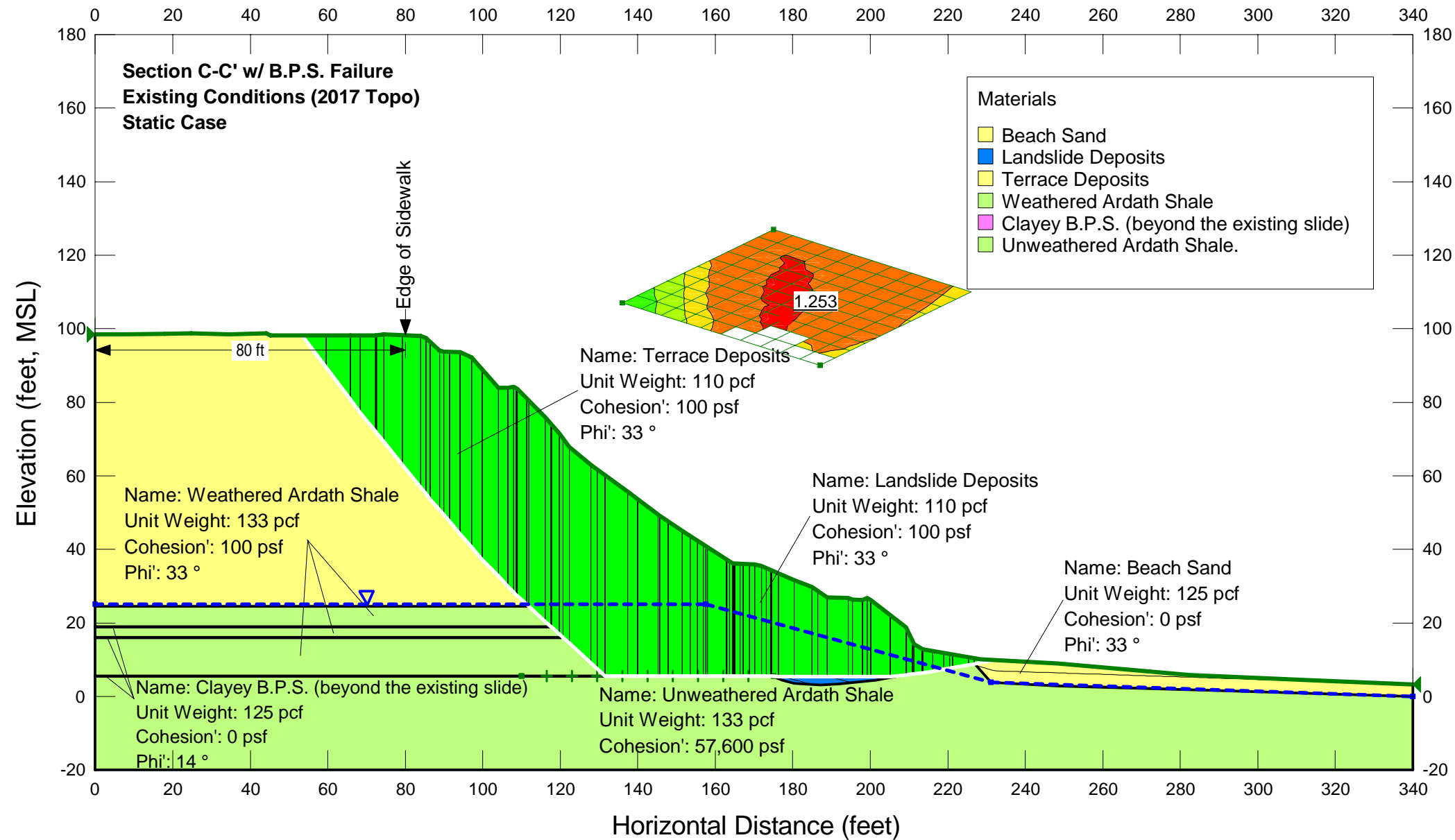


Figure A-11

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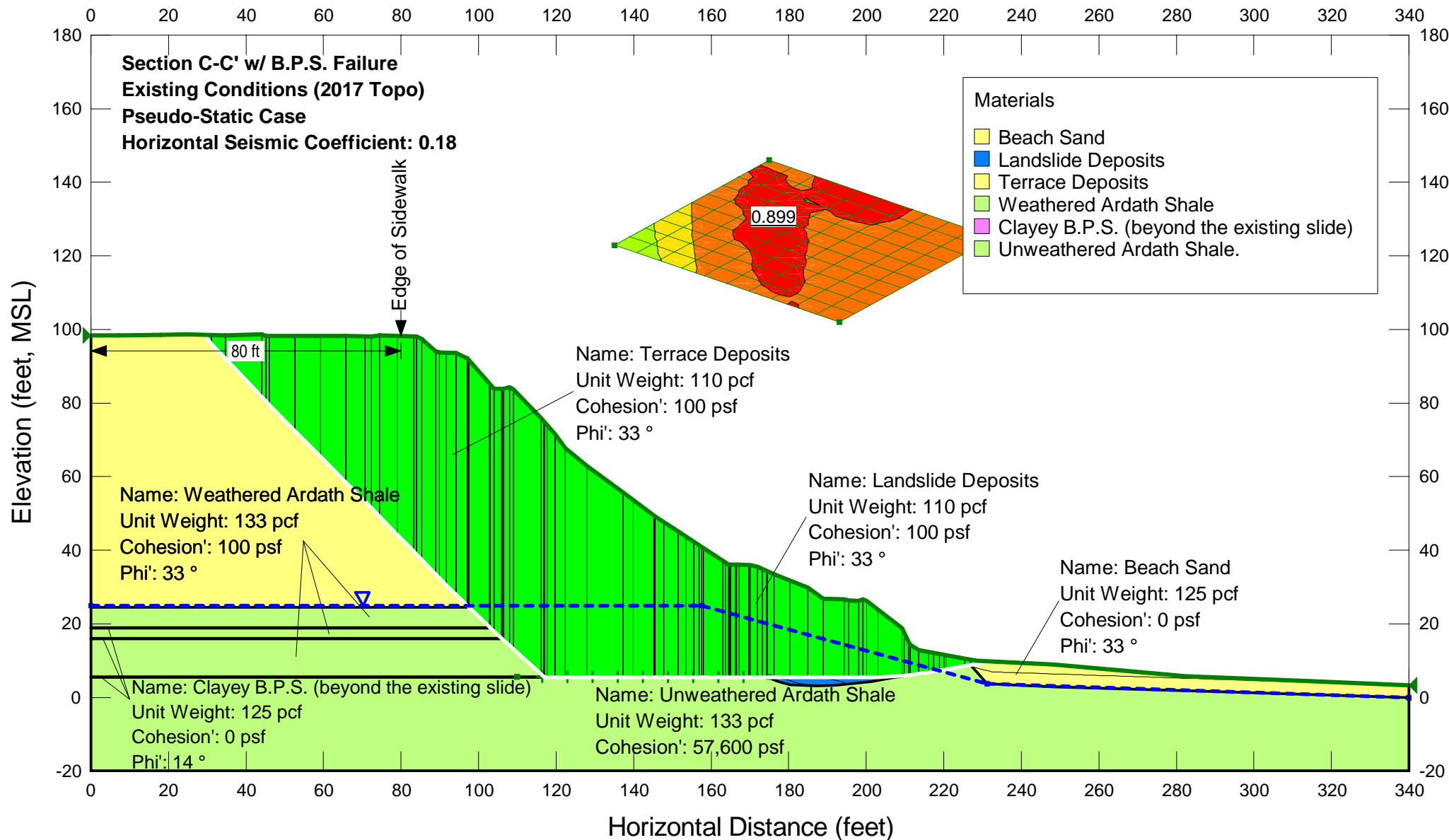
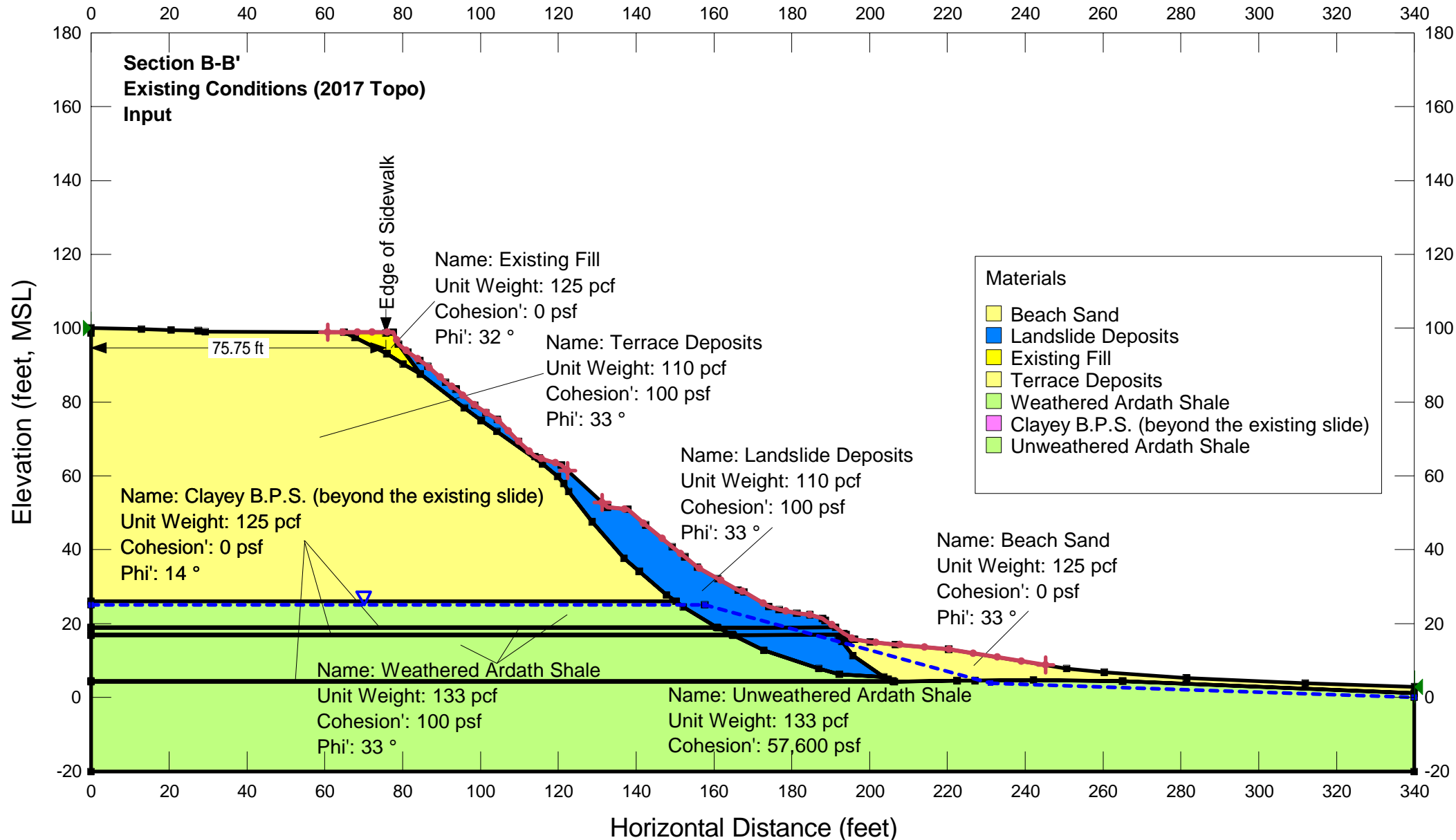
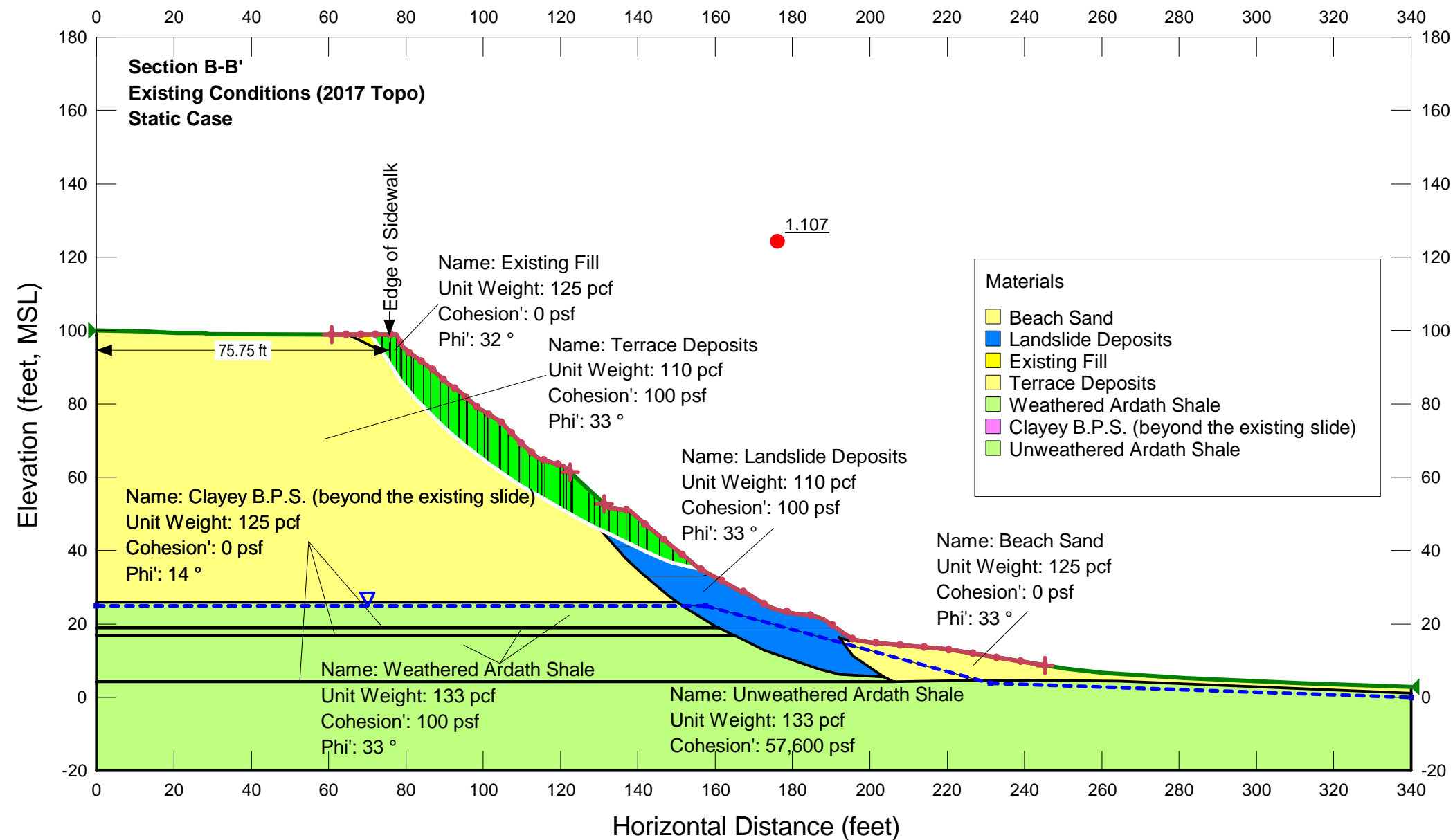


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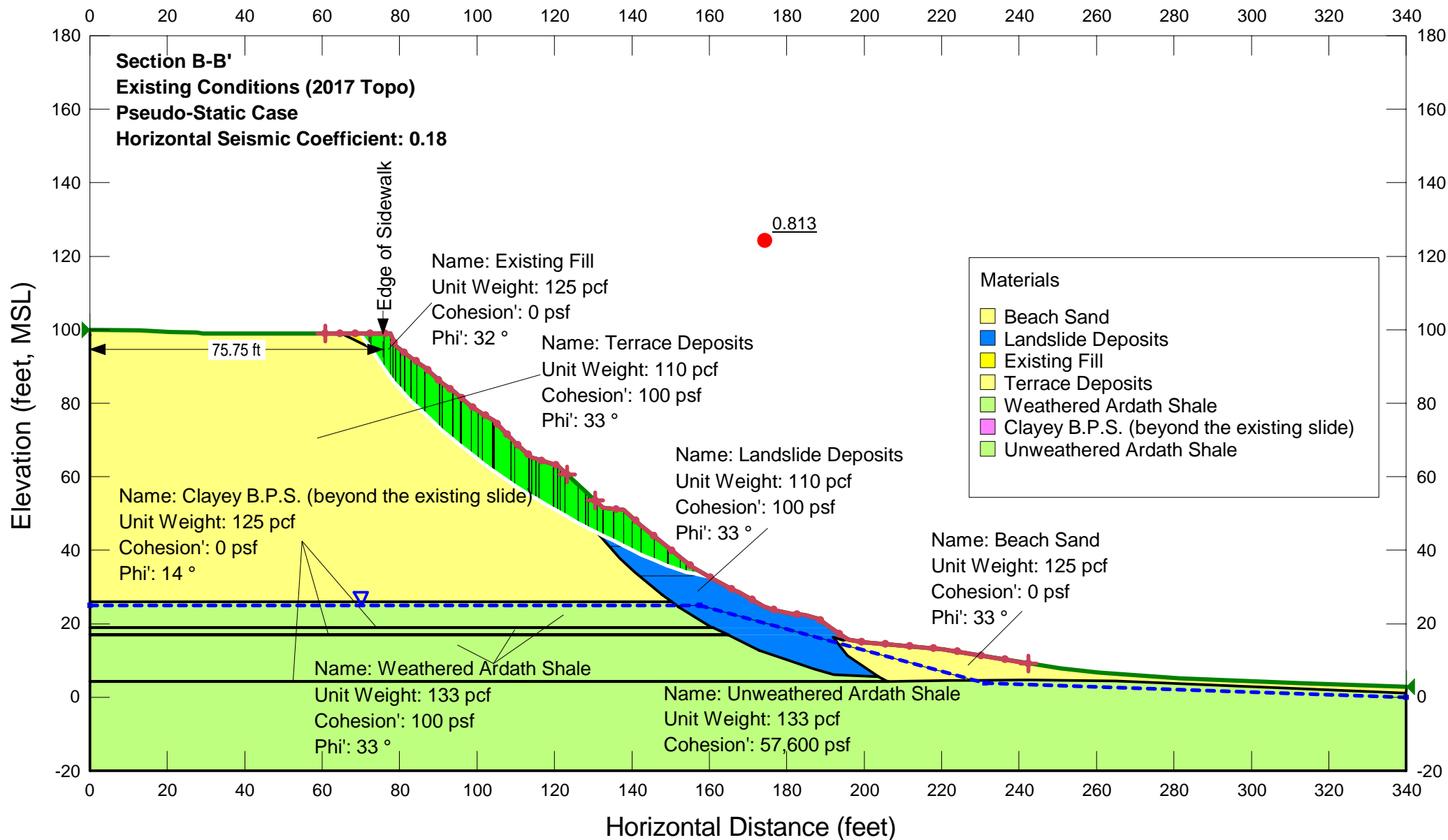
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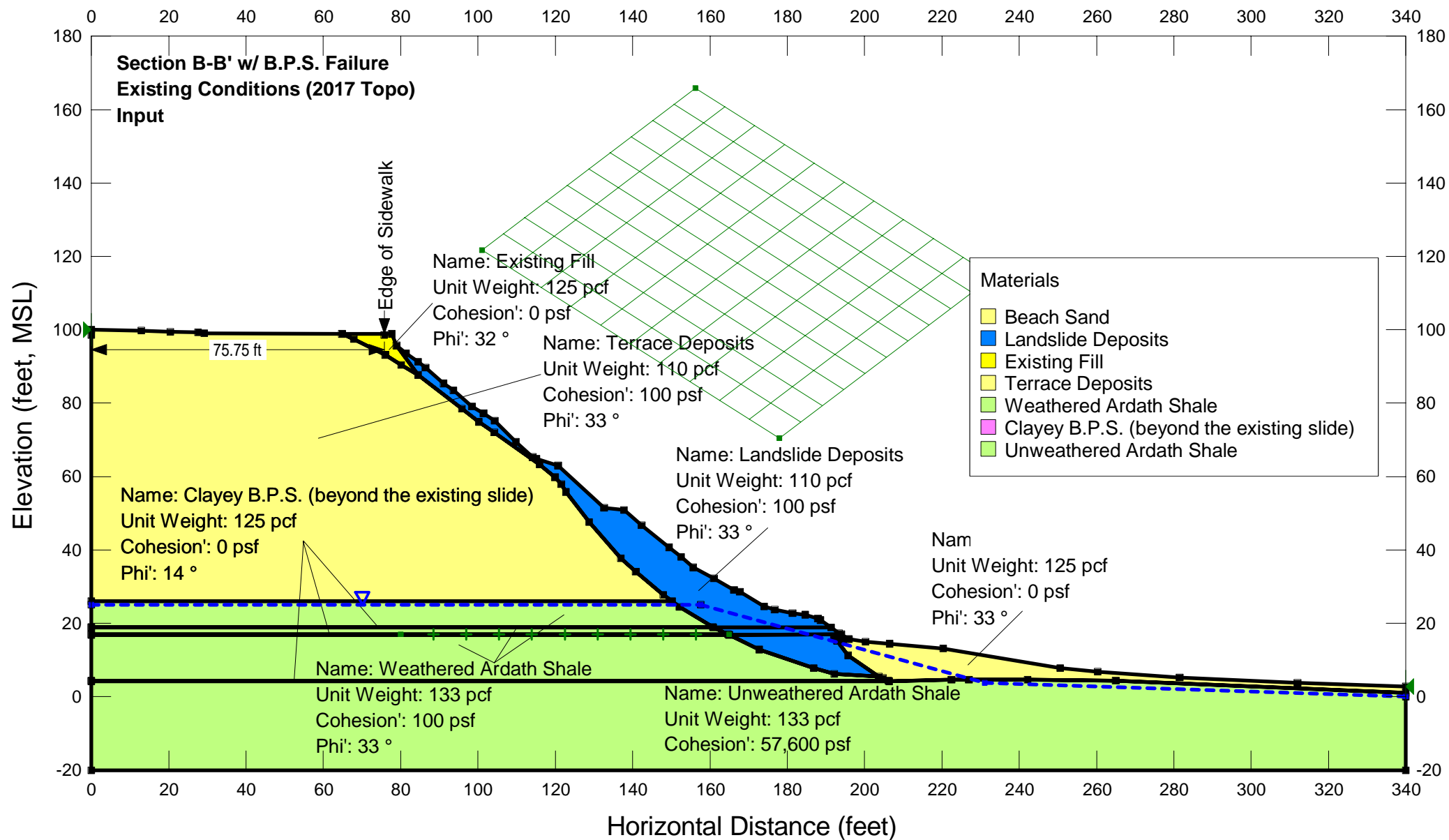


Figure 13

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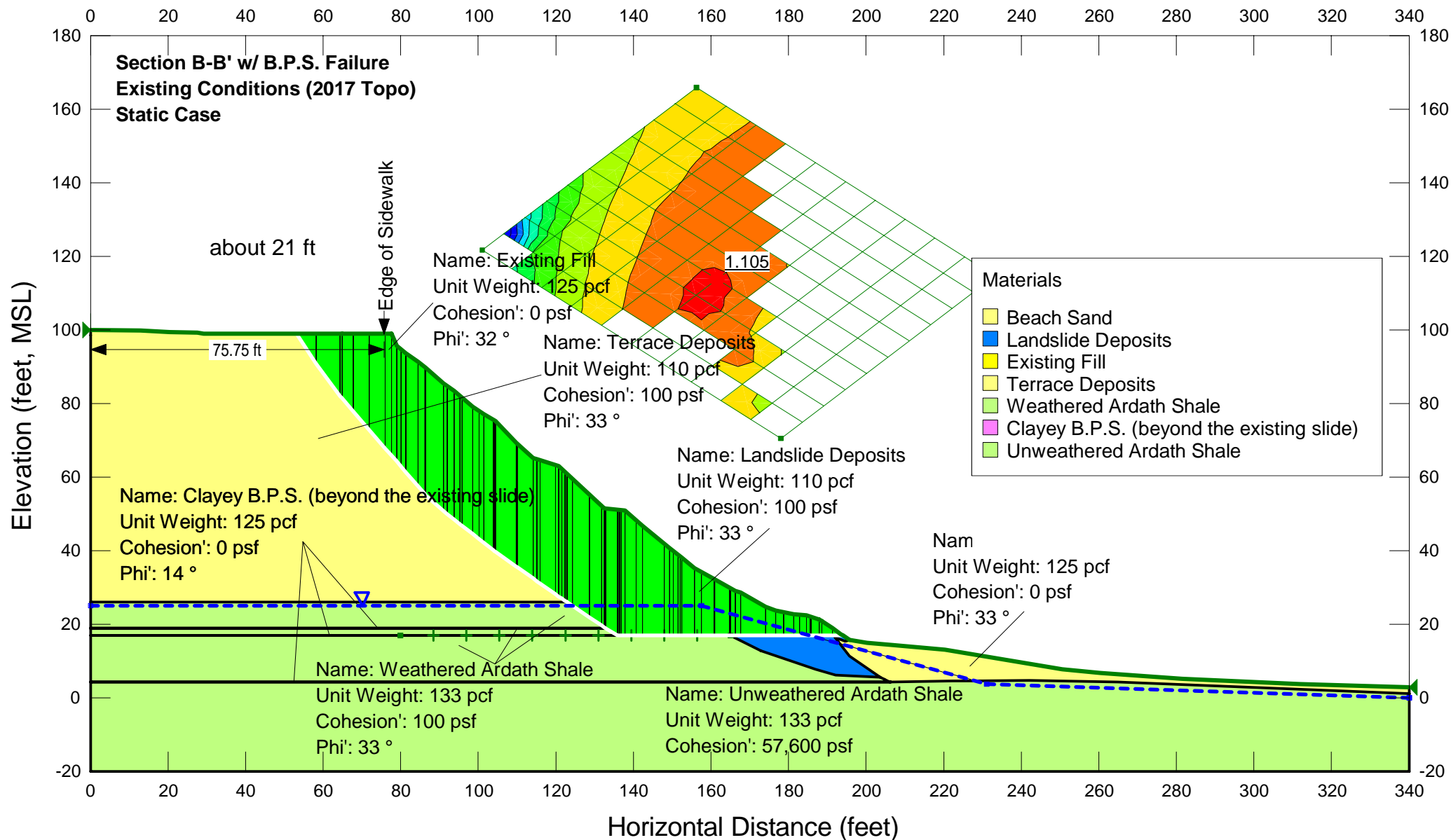


Figure 14

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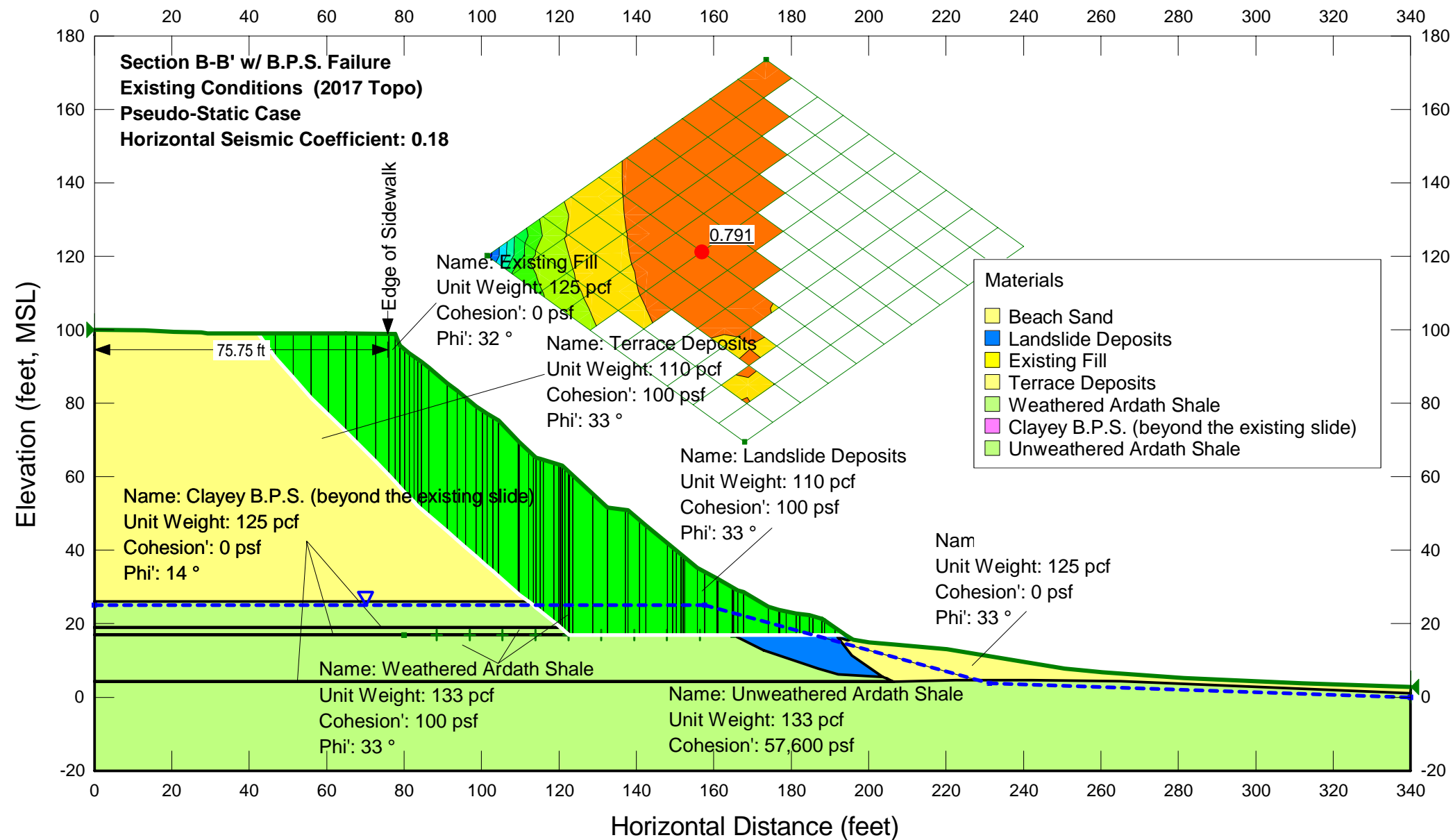


Figure 15