Memorandum

To: Darryn Shepherd; Martin Pinkham

From: Don Macfarlane

Date: 11 May 2022

Woodstock Quarry Landfill Stability Analysis

This memorandum presents the results of geotechnical stability analyses of the landfill materials that are proposed to be used for backfill of Woodstock Quarry.

The analyses were carried out for one final cross section geometry (Section Ch250 on Drawing B5) and one intermediate profile (from Drawing B4). The stability of the landfill has been modelled with the full design height because this is the critical design case. The intermediate profile (slope angle) was varied to help determine construction constraints.

1. Landfill Design

The design of the landfill is detailed in the *Engineering Report*. In summary the final landfill will comprise approximately 4.35Mm^3 - 4.15 Mm^3 of waste, daily cover, and intermediate cover, and 0.2 Mm^3 of capping. It is proposed to place the refuse material to form final profiles with a maximum slope of 3H:1V and minimum slope of 20H:1V after settlement.

It is also proposed to construct a toe bund at the toe of the landfill to act as a buttress for the landfill refuse during operations where in situ rock cannot provide such support. The bund is proposed to be a minimum of 6 m high, 10 m wide at the top and sloping at 3H:1V on either side of the bund[1].

2. Geotechnical Design Parameters

The following parameters have been used in the stability analysis.

Fill materials

The geotechnical properties of the fill materials that have been used in the stability analyses are summarised in Table 1 below.

Table 1. Geotechnical properties of placed landfill materials

Material	Unit Weight (kN/m^3)	Cohesion c' (kPa)	Friction Angle ϕ' (degrees)
Refuse (final)	12	5	30
Refuse (temporary slopes)	9	5	30
Capping	Not treated separately - included within refuse		
Toe Bund	20	5	30
Liner interface - peak	17	0	25

[1] The final bund will vary in height along its length. The size of the bund has been developed interactively during this stability analysis. Bund heights varying between 2.5m and 15m at Ch250 were considered.

Bedrock

As detailed in the *Engineering Report*, the landfill is to be progressively constructed as backfill into worked out sections of the quarry. The design of the quarry pit slopes has not been considered in this analysis of the landfill stability as the pit slopes will be fully supported by the completed landfill[2].

The parameters given in Table 2 were used for the bedrock beneath the fill in the stability analyses.

Table 2. Geotechnical properties of bedrock materials

Material	Unit Weight (kN/m3)	Cohesion c' (kPa)	Friction Angle ϕ' (degrees)
Moderately to Highly Weathered	20	5	30
Unweathered to Slightly Weathered	27	40	40

Groundwater (leachate) conditions

Two scenarios for groundwater (leachate) within the landfill (above the liner) were modelled:

1. A 300mm depth over the entire base of the fill
2. 2.5m depth at the toe bund, transitioning to zero into the fill

Seismic criteria

So far as we are aware, currently there are no New Zealand standards or guidance documents that specify the earthquake return periods that need to be considered for a seismic hazard assessment of a landfill.

For this analysis, we have assessed the landfill to meet the criteria of Importance Level (IL) 3 as defined in NZS1170.5 Table 3.2 as the refuse that will be accepted at the site is not highly hazardous. We have assumed that the period over which the components of the landfill are required to be operational (including aftercare, by the end of which the environmental consequence of an event will have greatly reduced due to drying and consolidation of the waste) to be at least 100 years.

Two basic limit states are defined by NZS 1170:

1. The **Serviceability limit state (SLS)** represents a level of stress or strain within the structure below which there is a high expectation the structure can continue to be used without repair. This is a state that is likely to occur during construction of the landfill. We have equated this with the Operating Basis Earthquake (OBE) for a dam and adopted a design return period of 150 years for the SLS, based on NZSOLD (2015)[3] criteria.

[2] The design of the rock slopes is described in the *Geology* responses to the RFI's.

[3] NZSOLD (2015). NZ Dam Safety Guidelines

2. The **Ultimate limit state (ULS)** is primarily associated with complete structural failure in large (severe), relatively rare events. NZS1170.0:2002 Table 3.3 indicates that for a structure with a design life of more than 100 years the AEP for ULS is 1/2500[4].

For the Woodstock Quarry site we have adopted design seismic return periods for SLS and ULS (calculated in accordance with the Bridge Manual) as follows assuming IL3 and a 150-year return period for the SLS event[5] but also checked the stability in a 500-year return period event, which we have informally termed SLS(a):

- SLS – approximate return period of 150 years (0.22g at the site)
- SLS(a) – approximate return period of 500 years (0.35g at the site)
- ULS – approximate return period of 2500 years (0.63g at the site)

We note that an Alpine fault event is expected to generate horizontal PGA's in the order of 0.2g at the site (MM6 to MM7 intensity shaking) based on Bradley et al (2017)[6] and *ShakeMap* correlations between MMI and PGA given by Worden et al (2012)[7]. This is essentially the same as the 150-year return period PGA calculated as per the *Bridge Manual*.

3. Stability Analysis

Methodology

Landfill slope stability analyses have been undertaken on two engineering cross sections (Ch 250 shown on Drawing B5 and a temporary fill profile shown on Drawing B4) using proprietary Slope/W limit equilibrium software with the input values described above.

The analyses were run using an entry-exit failure method and all results reported are optimised for the critical failure surface identified by the software.

The analysis considered the following slope stability design cases:

- Static (long term stability of the landfill refuse, using effective stress parameters);
- Static (short term stability of the toe bund and temporary slopes of landfill refuse);
- Static stability of the landfill refuse with elevated groundwater conditions;
- Seismic Ultimate Limit State - ULS earthquake loading; and
- Seismic Serviceability Limit State - SLS earthquake loading – both 150 year (SLS) and 500 year (SLS(a)) seismic loads.

Elevated groundwater conditions were not included in the seismic stability analyses nor in the temporary static analyses.

---

[4] The *Bridge Manual* indicates that the lower bound ULS effects to be designed for *shall not be taken to be less than those due to a 6.5 magnitude earthquake at 20km distance*, for which the peak ground acceleration coefficient for a Class A/B rock site is 0.14g (from table 6.3 of the Bridge Manual). We adopted the guidance of NZS1170.0 for ULS.

[5] NZS1170 (Table 3.3) identifies 1 in 25 years for IL2 structures and 1 in 500 for IL4 structures. As we are taking the landfill to be an IL3 structure a 1 in 150 year (which is consistent with the OBE used for dams) is judged to be appropriate.

[6] Brendon A. Bradley, Sung E. Bae, Viktor Polak, Robin L. Lee, Ethan M. Thomson & Karim Tarbali (2017). Ground motion simulations of great earthquakes on the Alpine Fault: effect of hypocentre location and comparison with empirical modelling. *New Zealand Journal of Geology and Geophysics, 60:3*, 188-198, DOI: 10.1080/00288306.2017.1297313

[7] Worden, C.B.; Gerstenberger, M.C.; Rhoades, D.A.; Wald, D.J. (2012). Probabilistic relationships between ground-motion parameters and modified Mercalli intensity in California. *Bull Seismol. Soc Am 102*, p204–221.

Analysis Results

The results of the slope stability assessments are summarised in Tables 3 to 6 below. The Slope/W output plots are included as Attachment A, Figures 1 to 54.

It was initially assumed that the landfill and toe bund will be constructed fully on unweathered rock as the detailed distribution of the weathered rock in relation to the bund is not well known and the critical failure surfaces generated by Slope/W mostly fall within the refuse. Check modelling showed that the weathering in the rock did not significantly affect the FOS of the toe bund. This appears to be because the critical failure surface lies within the bund.

4. Assessment

Static stability

The final bund will vary in height along its length and where practical *in situ* rock will be used to provide toe support.

The stability assessments indicate that the critical failure surface breaks out above the toe bund and that a toe bund provides satisfactory support to the compacted refuse material upslope regardless of the bund height, provided that the front face of the landfill is sloped at 1V:3H (or flatter).

The analysis also shows that the static short term stability of temporary slopes within the landfill refuse is satisfactory provided that these slopes are no steeper than about 1V:2H.

Seismic stability

SLS: The stability assessments indicate that a toe bund mitigates the potential for slope failure in 1:3 slopes within the refuse under seismic conditions for a 150-year return period event but does not meet FOS requirements for a 500-year return period seismic load.

The stability analysis also shows that temporary slopes in the refuse will be stable in a 1/150 seismic event in slopes flatter than 1V:2H. A larger (500-year) event is likely to cause surface cracking and minor slumping of fill slopes.

ULS: None of the stability assessments indicate stability under 1/2500 seismic loads. The FOS was generally determined to be about 0.6 for circular failure and about 0.8 for sliding failure. These values are considered consistent with the definition of a ULS earthquake as an event that will cause damage requiring repair to a structure.

Using the Jibson (2007)[8] method, we estimate that displacements of up to 2 m might affect the landfill slopes in the event of ULS ground shaking. Although this displacement estimate is indicative only, it is anticipated that such displacements would cause damage that would be able to be repaired.

One option (2A) considered the capping being constructed over the top of the toe bund, for comparative purposes only, but was not considered as a practical option.

[8] Spreadsheet based on Jibson, R.W. (2007). *Regression models for estimating coseismic landslide displacement*. Engineering Geology 91, pp209-218

Table 3. Slope/W analysis results, N-S cross section at Ch250

Analysis	Front slope	Target FOS	Calculated FOS	Comments
Static long term	1V:3H	1.5	2.4	
Static short term (bund)	1V:3H	1.5	2.1	
Elevated groundwater	1V:3H	1.2	2.4	
Seismic SLS	1V:3H	1.0	1.3	1/150 AEP
Seismic SLS(a)	1V:3H	1.0	1.1	1/500 AEP
Seismic ULS (circular)	1V:3H	1.0	0.7	1/2500 AEP
Seismic ULS (sliding)	1V:3H	1.0	0.9	1/2500 AEP

Table 4. Slope/W analysis results, temporary E-W cross section

Analysis	Fill slope	Target FOS	Calculated FOS	Comments
Static short term (refuse)	1V:1H	1.5	0.9	Not acceptable
Static short term (refuse)	1V:1.5H	1.5	1.14	Not acceptable
Static short term (refuse)	1V:2H	1.5	1.43	
Static short term (refuse)	1V:2.5H	1.5	1.74	
Seismic SLS	1V:1H	1.0	-	Not modelled
Seismic SLS	1V:1.5H	1.0	0.76	1/150 AEP
Seismic SLS	1V:2H	1.0	0.91	1/150 AEP
Seismic SLS	1V:2.5H	1.0	1.05	1/150 AEP

Table 5a. Factor of safety (FOS) against failure of landfill refuse with toe bunds

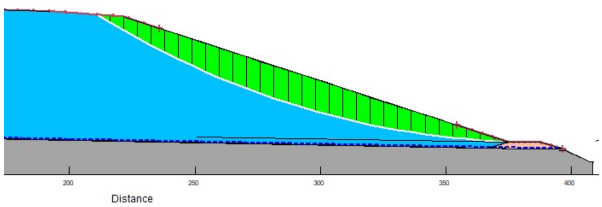
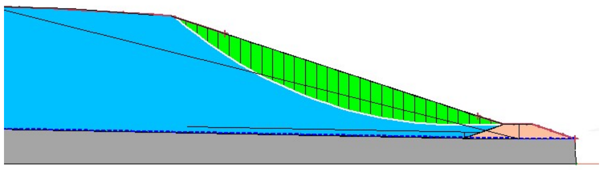
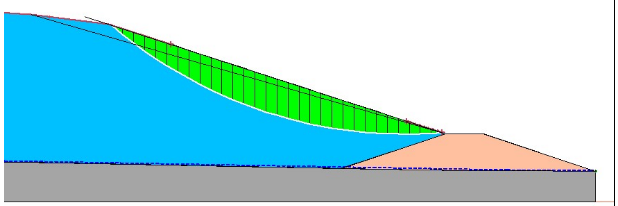
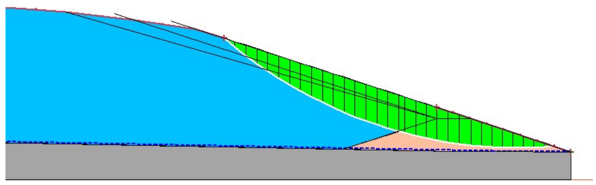
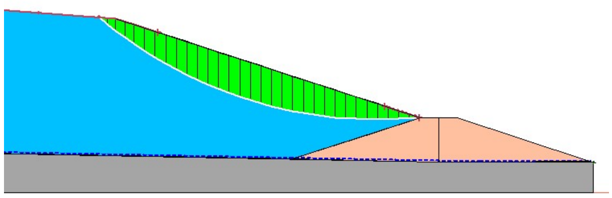
Toe Model See Figures 1 to 21 and 27 to 31 in Attachment A	Static with GW at 0.3m above excavation surface	Elevated GW	SLS 150-yr PGA (0.22g)	SLS(a) 500-yr PGA (0.35g)	ULS 2500-yr PGA (0.63g)
Target Factor of Safety (FOS)	1.5	1.2	1.0	1.0	1.0
2.5m high bund, 1:3 slope 	2.02	1.98	1.13	0.88	0.57
6m high bund, 1:3 slope 	2.07	2.07	1.16	0.91	0.60
12m high bund, 1:3 slope (Option 1) 	2.08	2.08	1.17	0.92	0.61
12m high bund, 1:3 slope (Option 2) 	2.13	2.13	1.20	0.93	0.60
15m high bund, 1:3 slope (Option 1) 	2.11	2.11	1.19	0.93	0.62

Table 5b. Factor of safety (FOS) against failure of toe bund

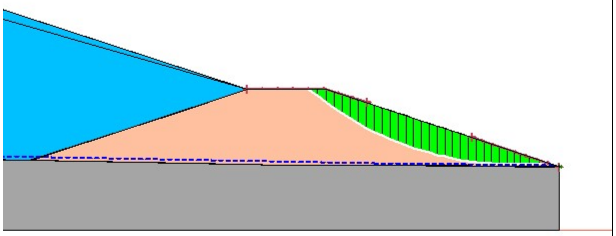
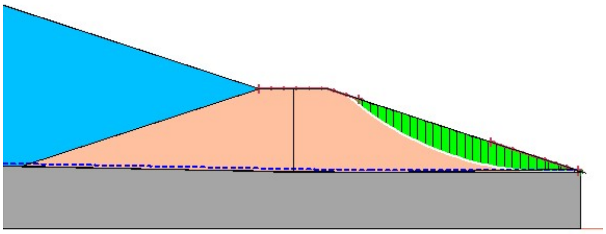
Toe Bund See Figures 22 to 26 and 36 to 45, Attachment A	Static with GW at 0.3m above excavation surface	Elevated GW	SLS 150-yr PGA (0.22g)	SLS(a) 500-yr PGA (0.35g)	ULS 2500-yr PGA (0.63g)
Target Factor of Safety (FOS)	1.5	1.2	1.0	1.0	1.0
Toe bund (12m high) 	2.22	2.04	1.25	0.98	0.65
Toe bund (15m high) 	2.14	1.99	1.20	0.94	0.62

Table 5c. Factor of safety (FOS) against sliding on liner

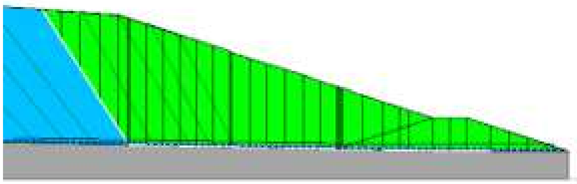
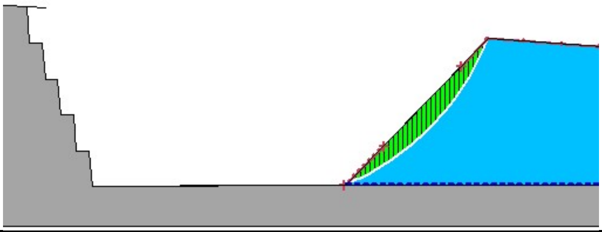
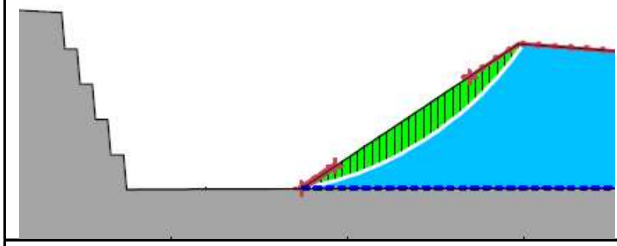
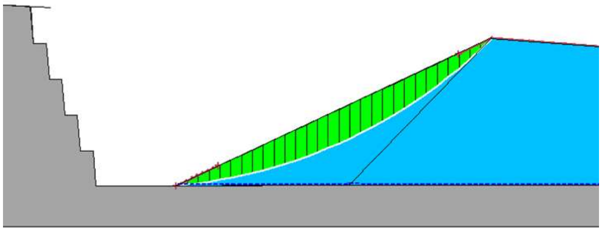
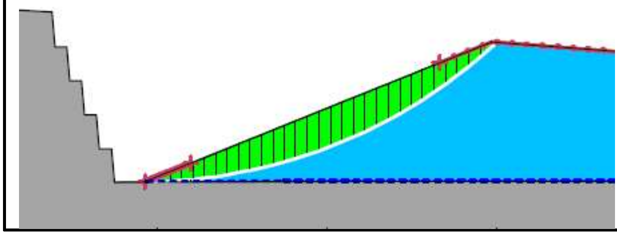
Sliding on liner See Figures 32 to 35 in Attachment A	Static with GW at 0.3m above excavation surface	Elevated GW	SLS 150-yr PGA (0.22g)	SLS(a) 500-yr PGA (0.35g)	ULS 2500-yr PGA (0.63g)
Target Factor of Safety (FOS)	1.5	1.2	1.0	1.0	1.0
	3.24	-	1.62	1.23	0.78

Table 6. Factor of safety against cross-slope failure (temporary slopes)

Temporary fill slopes See Figures 46 to 54 in Attachment A	Static with GW at 0.3m above excavation surface	Elevated GW	SLS 150-yr PGA (0.22g)	SLS(a) 500-yr PGA (0.35g)	ULS 2500-yr PGA (0.63g)
Target Factor of Safety (FOS)	1.5	1.2	1.0	1.0	1.0
1:1 slope 	0.92	Not Modelled			
1V:1.5H slope 	1.15	Not Modelled	0.77	0.63	Not Modelled
1V:2H slope 	1.43	Not Modelled	0.91	0.74	Not Modelled
1V:2.5H 	1.74	Not Modelled	1.05	0.83	Not Modelled

Attachment A

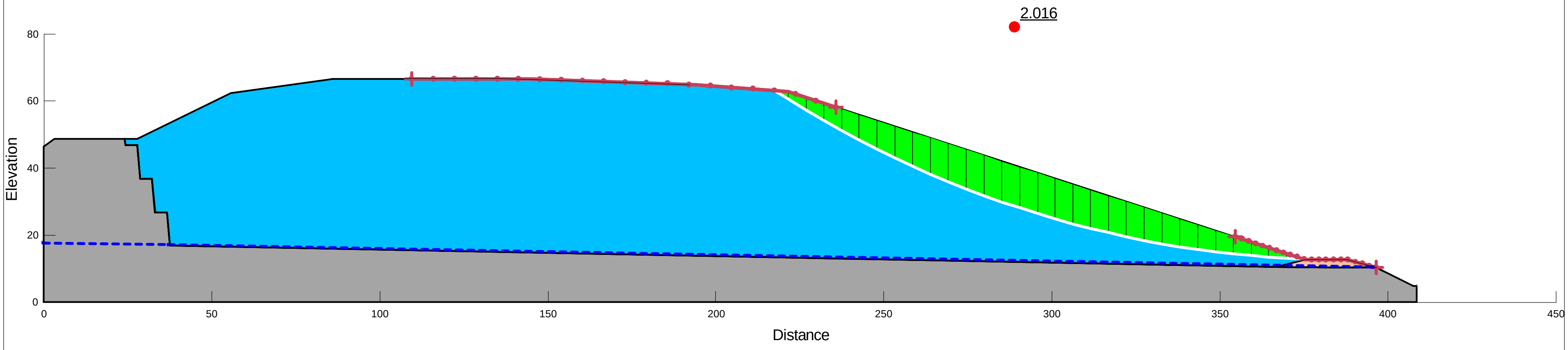
Stability Assessment Results

Woodstock Quarry Stability Assessment - Figure 1

Analysis: Static (landfill slope 1:3 with 2.5m bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

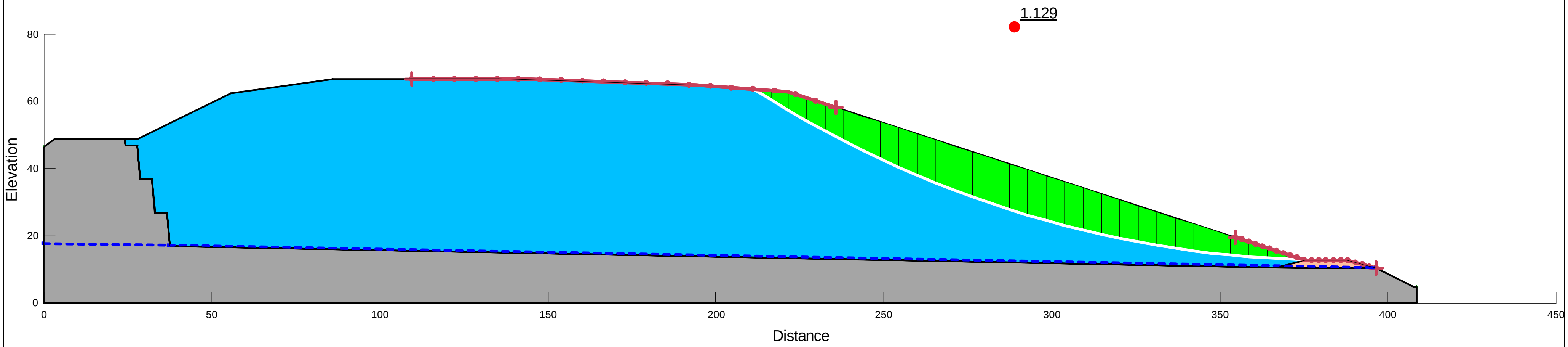


Woodstock Quarry Stability Assessment - Figure 2

Analysis: Seismic PGA 0.22g (landfill slope 1:3 with 2.5m bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

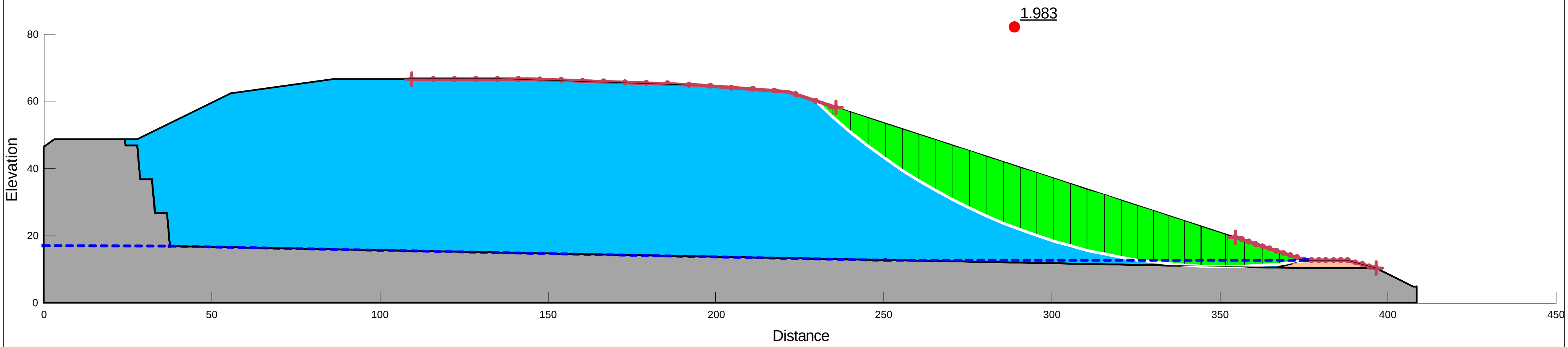


Woodstock Quarry Stability Assessment - Figure 3

Analysis: Elevated Groundwater (landfill slope 1:3 with 2.5m bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

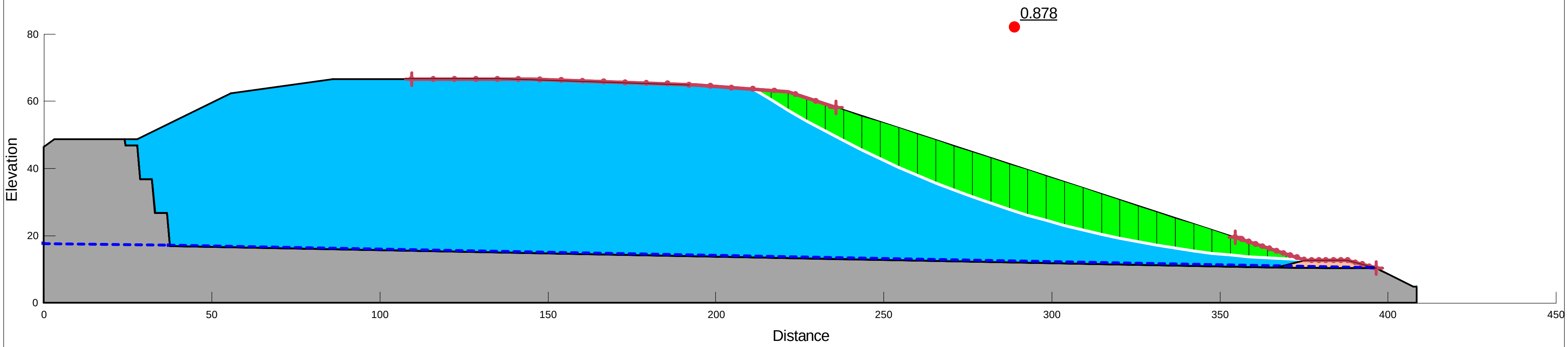


Woodstock Quarry Stability Assessment - Figure 4

Analysis: Seismic PGA 0.35g (landfill slope 1:3 with 2.5m bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

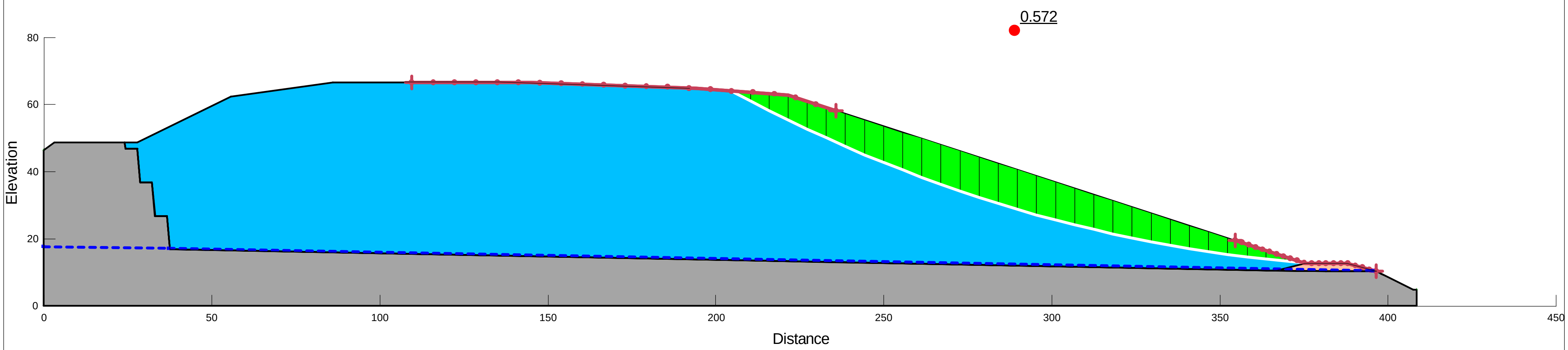


Woodstock Quarry Stability Assessment - Figure 5

Analysis: Seismic PGA 0.63g (landfill slope 1:3 with 2.5m bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

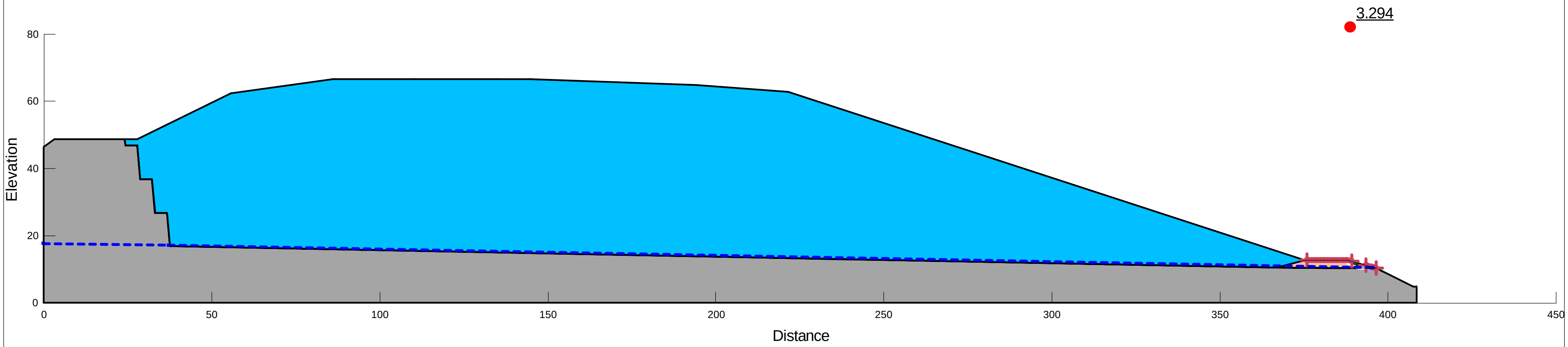


Woodstock Quarry Stability Assessment - Figure 6

Analysis: Static (2.5m toe bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

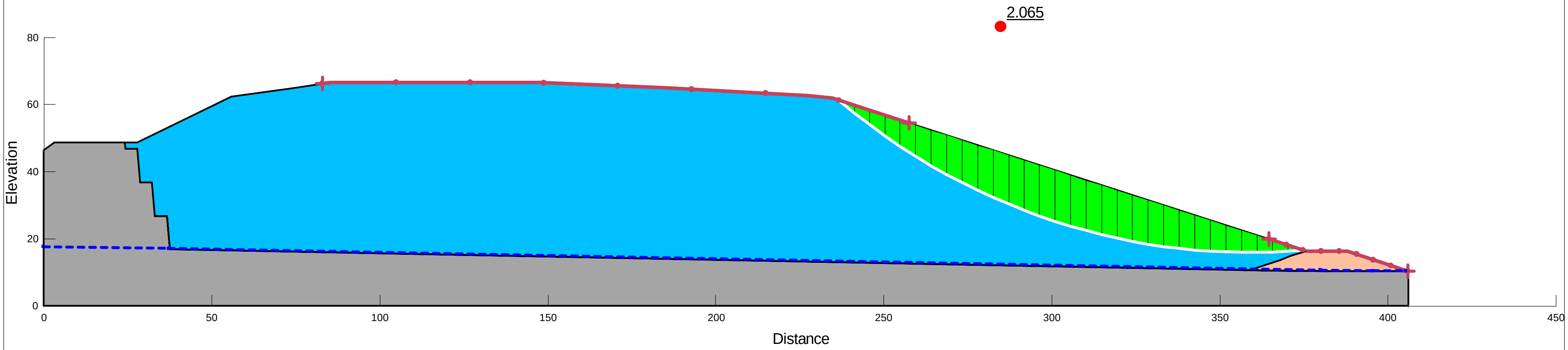


Woodstock Quarry Stability Assessment - Figure 7

Analysis: Static (landfill slope 1:3 with 6m bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

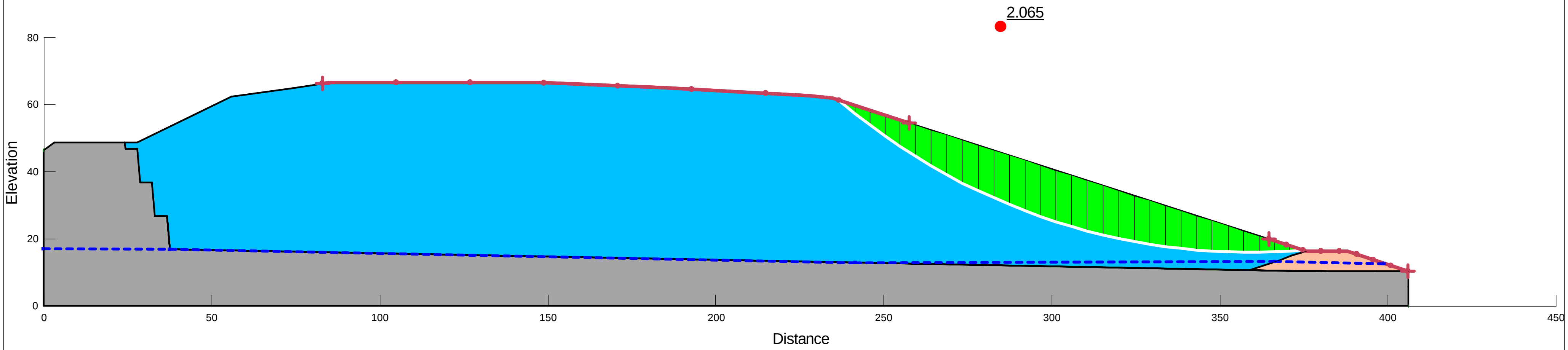


Woodstock Quarry Stability Assessment - Figure 8

Analysis: Elevated Groundwater (landfill slope 1:3 with 6m bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

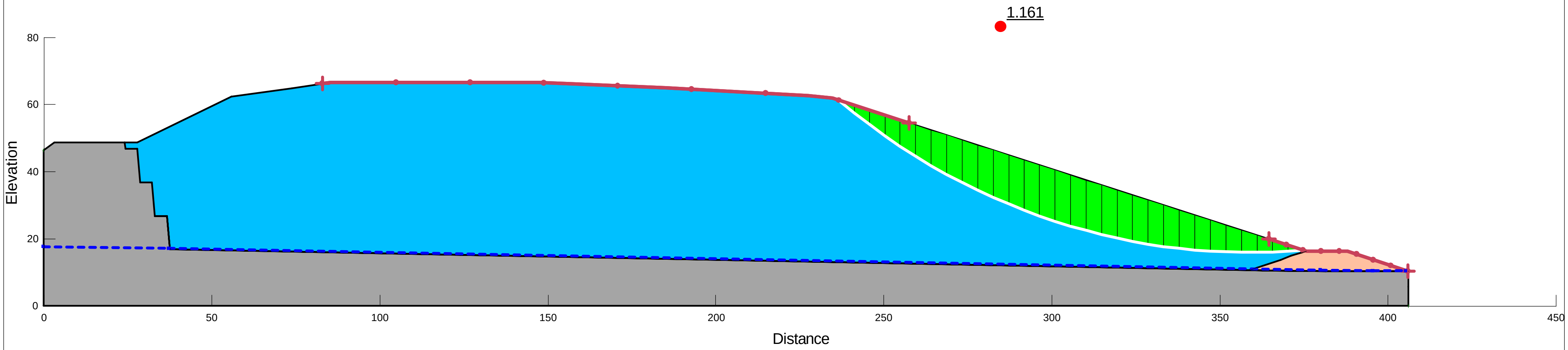


Woodstock Quarry Stability Assessment - Figure 9

Analysis: Seismic PGA 0.22g (landfill slope 1:3 with 6m bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

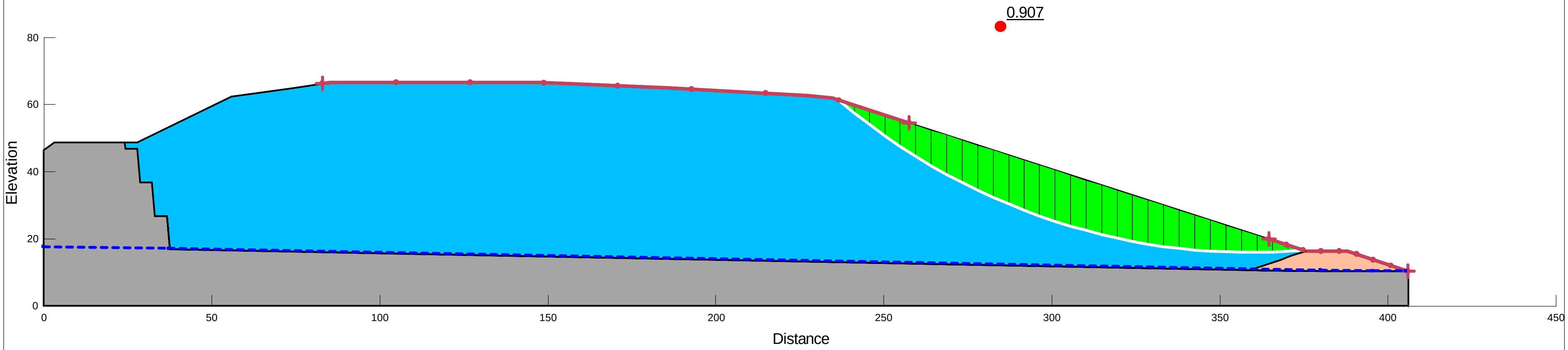


Woodstock Quarry Stability Assessment - Figure 10

Analysis: Seismic PGA 0.35g (landfill slope 1:3 with 6m bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

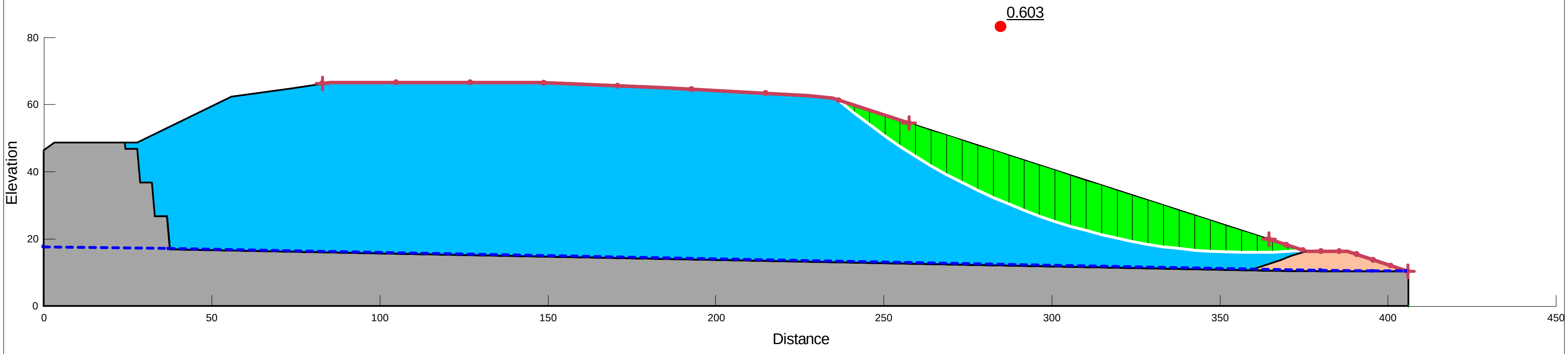


Woodstock Quarry Stability Assessment - Figure 11

Analysis: Seismic PGA 0.63g (landfill slope 1:3 with 6m bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

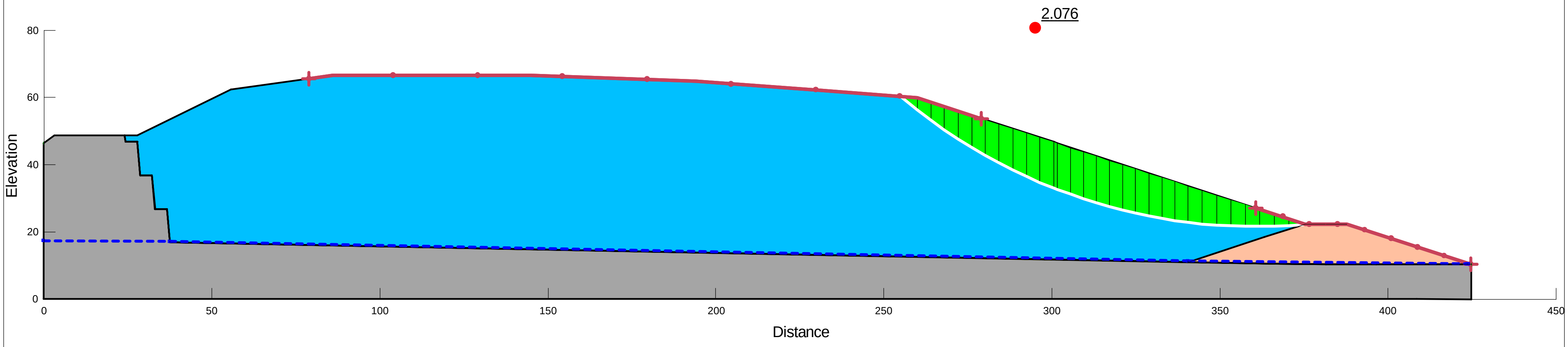


Woodstock Quarry Stability Assessment - Figure 12

Analysis: Static (landlfill slope 1:3 with 12m toe bund - option 1)

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

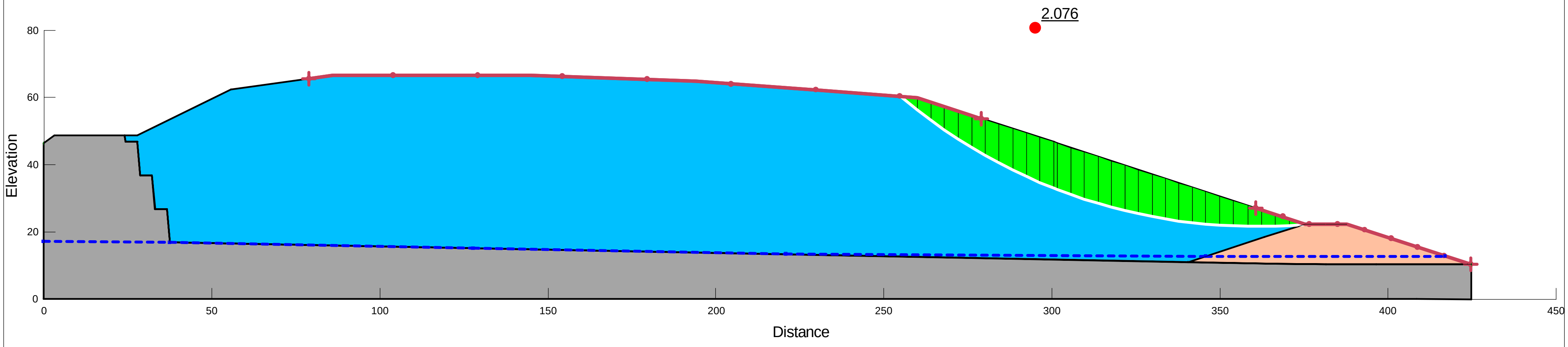


Woodstock Quarry Stability Assessment - Figure 13

Analysis: Elevated Groundwater (landfill slope 1:3 with 12m bund - option 1)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

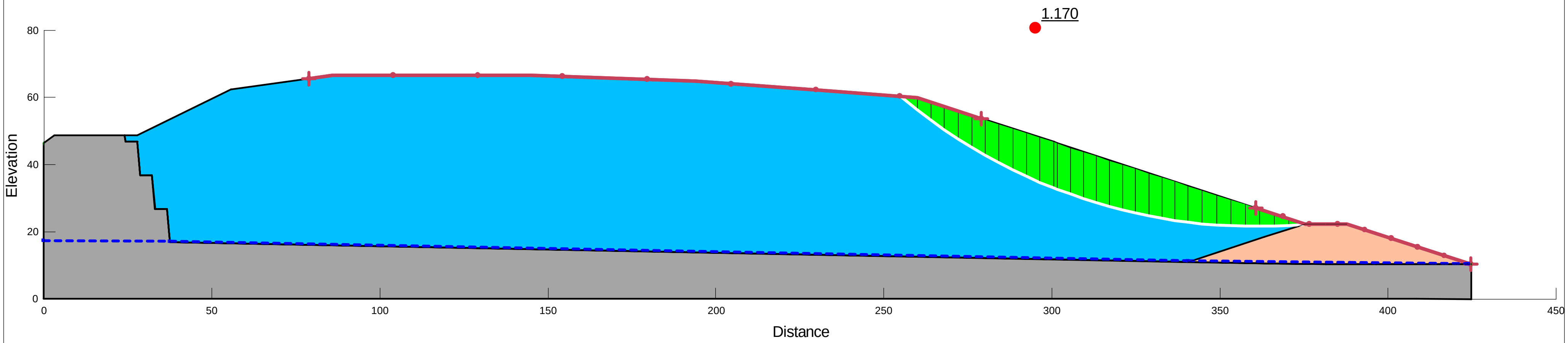


Woodstock Quarry Stability Assessment - Figure 14

Analysis: Seismic PGA 0.22g (landfill slope 1:3 with 12m bund - option 1)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

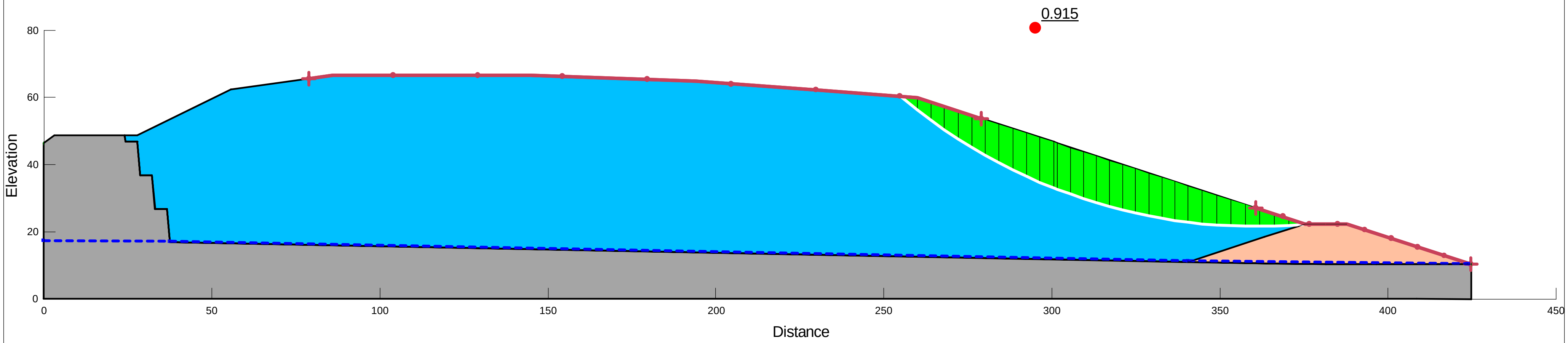


Woodstock Quarry Stability Assessment - Figure 15

Analysis: Seismic PGA 0.35g (landfill slope 1:3 with 12m bund - option 1)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

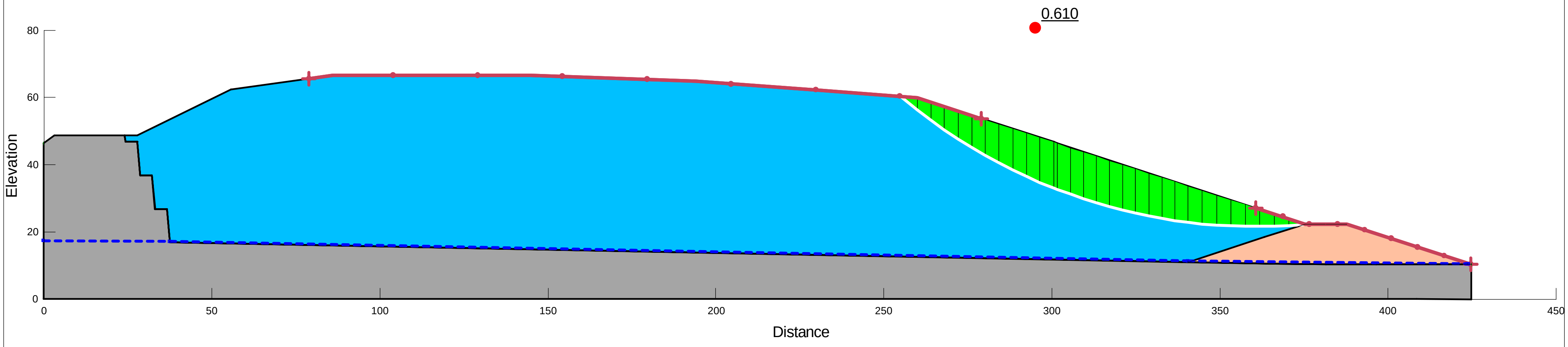


Woodstock Quarry Stability Assessment - Figure 16

Analysis: Seismic PGA 0.63g (landfill slope 1:3 with 12m toe bund - option 1)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

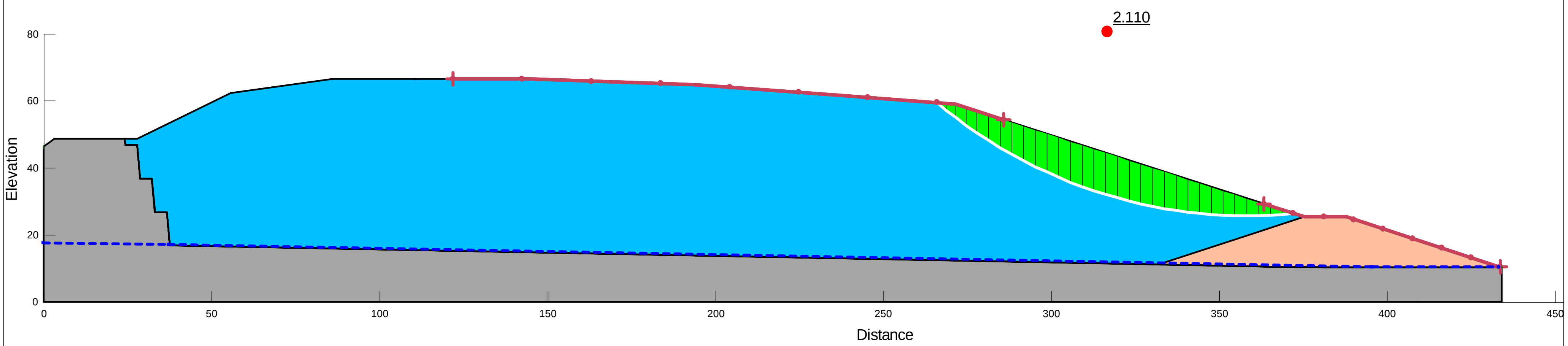


Woodstock Quarry Stability Assessment - Figure 17

Analysis: Static (landfill slope 1:3 with 15m bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

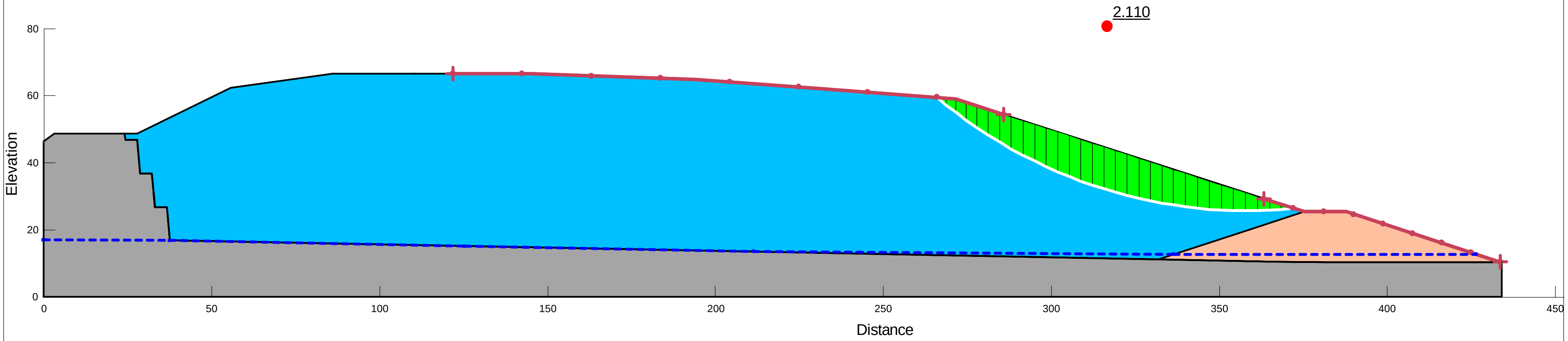


Woodstock Quarry Stability Assessment - Figure 18

Analysis: Elevated Groundwater (landfill slope 1:3 with 15m bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

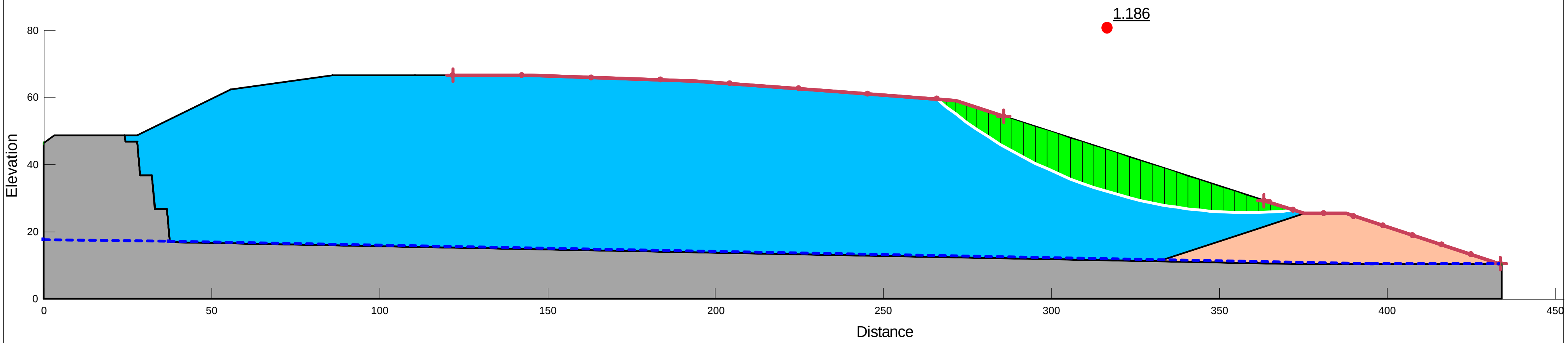


Woodstock Quarry Stability Assessment - Figure 19

Analysis: Seismic PGA 0.22g (landfill slope 1:3 with 15m toe bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

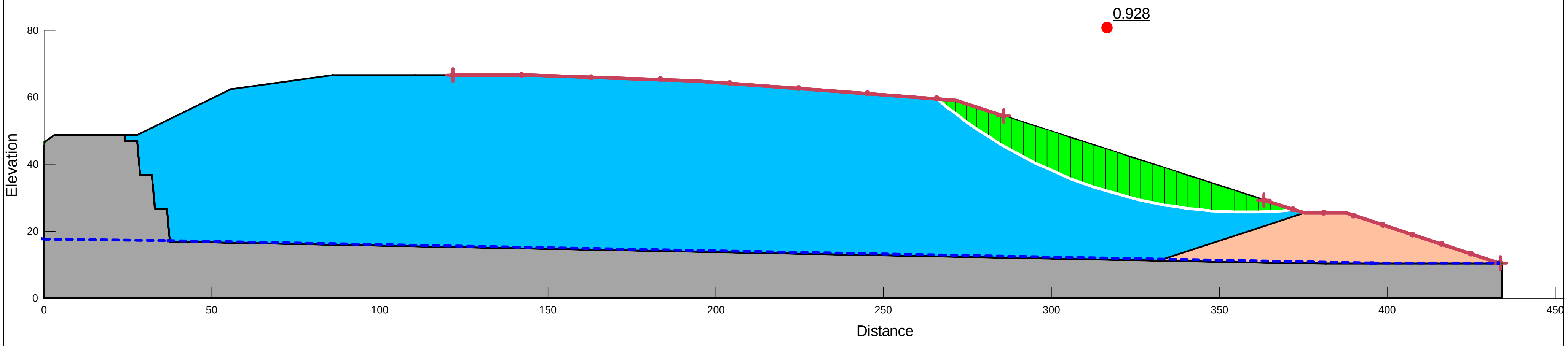


Woodstock Quarry Stability Assessment - Figure 20

Analysis: Seismic PGA 0.35g (landfill slope 1:3 with 15m toe bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

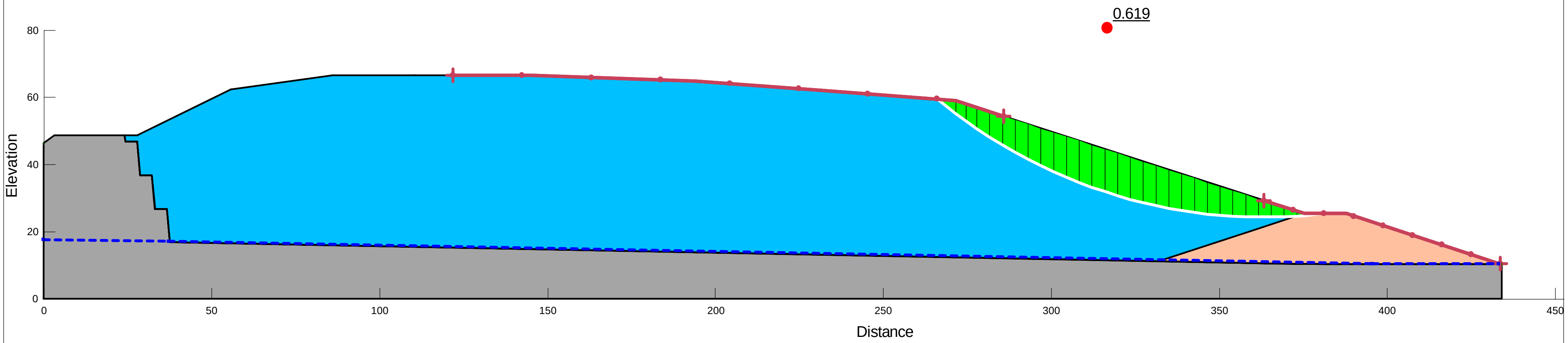


Woodstock Quarry Stability Assessment - Figure 21

Analysis: Seismic PGA 0.63g (landfill slope 1:3 with 15m toe bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

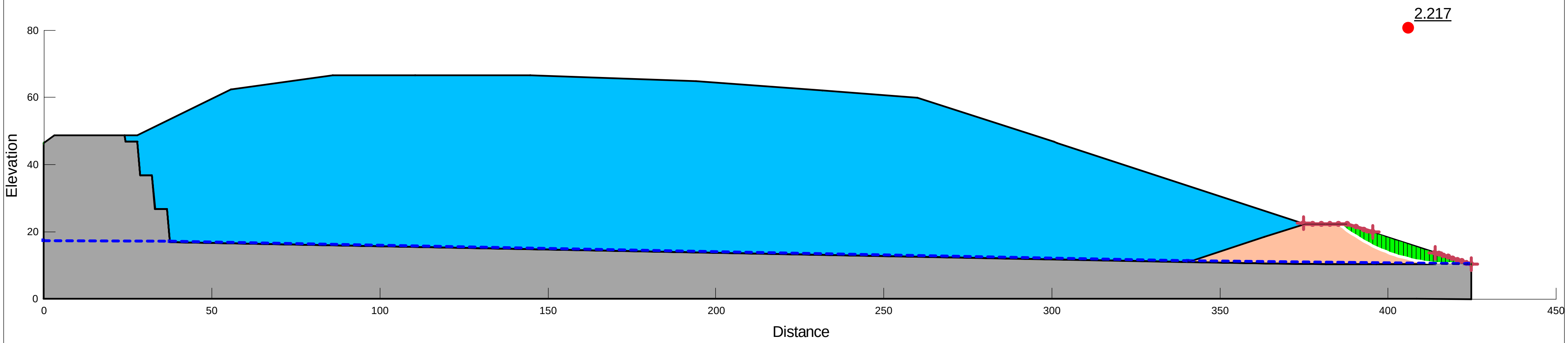


Woodstock Quarry Stability Assessment - Figure 22

Analysis: Static (12m toe bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

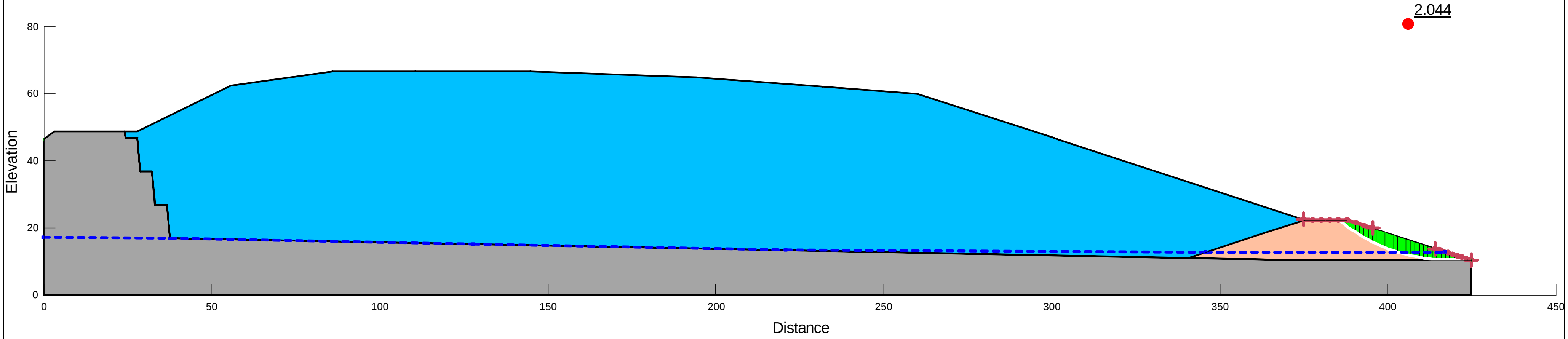


Woodstock Quarry Stability Assessment - Figure 23

Analysis: Elevated Groundwater (12m toe bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

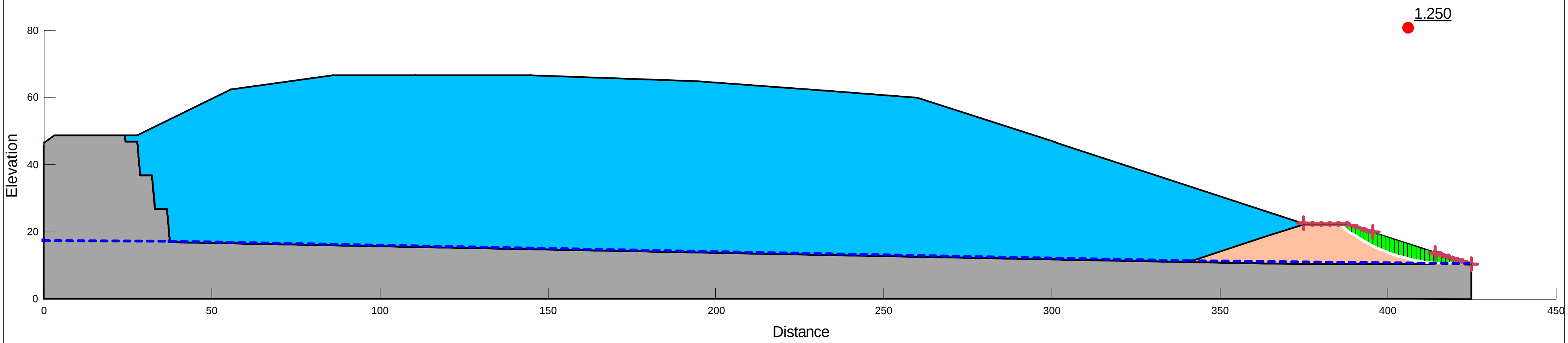


Woodstock Quarry Stability Assessment - Figure 24

Analysis: Seismic PGA 0.22g (12m toe bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

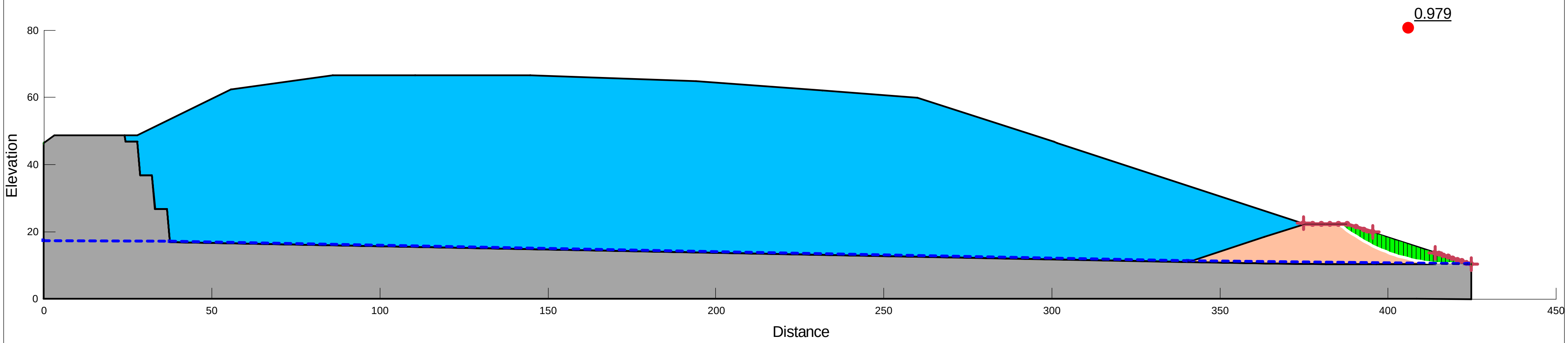


Woodstock Quarry Stability Assessment - Figure 25

Analysis: Seismic PGA 0.35g (12m toe bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

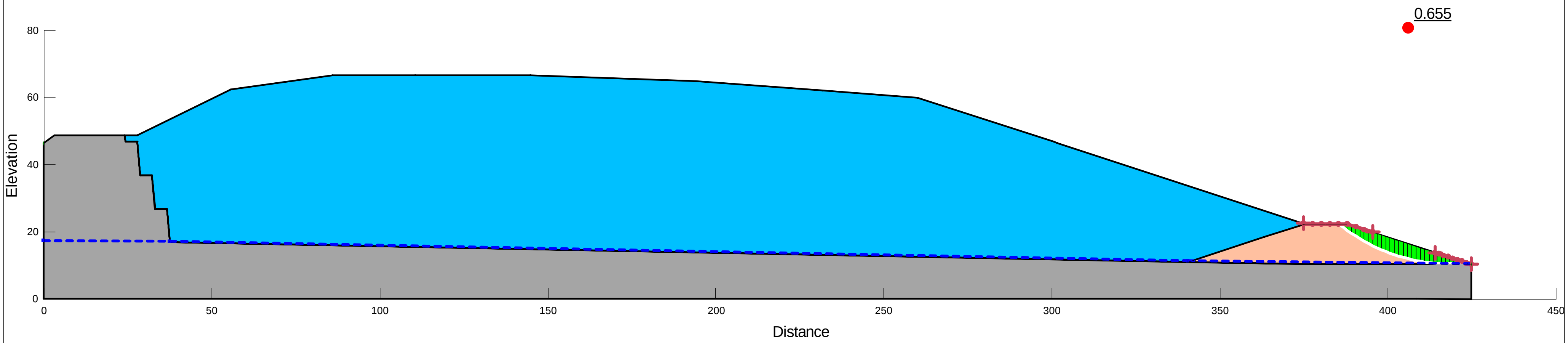


Woodstock Quarry Stability Assessment - Figure 26

Analysis: Seismic PGA 0.63g (12m toe bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

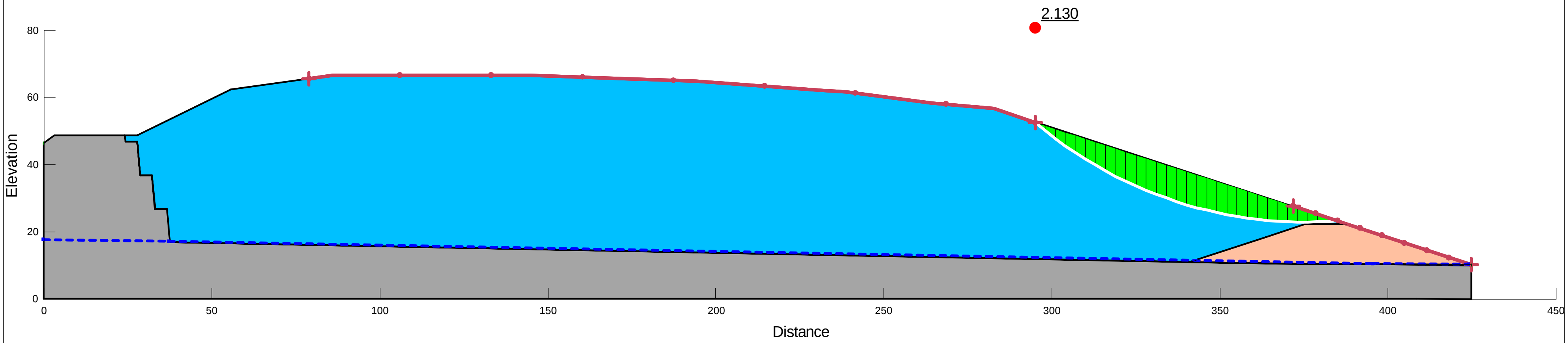


Woodstock Quarry Stability Assessment - Figure 27

Analysis: Static (landfill slope 1:3 slope with 12m bund - option 2)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

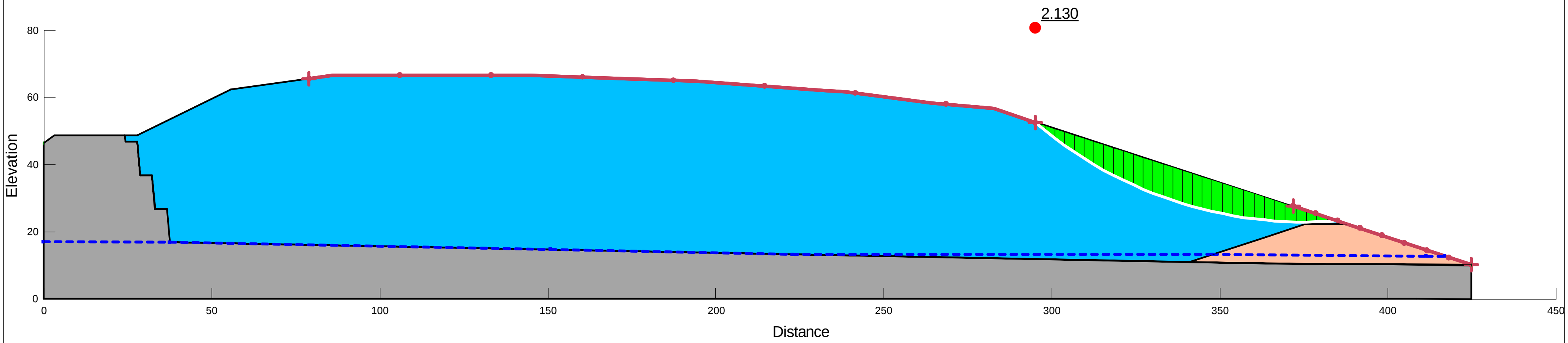


Woodstock Quarry Stability Assessment - Figure 28

Analysis: Elevated Groundwater (landfill slope 1:3 with 12m bund - option 2)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

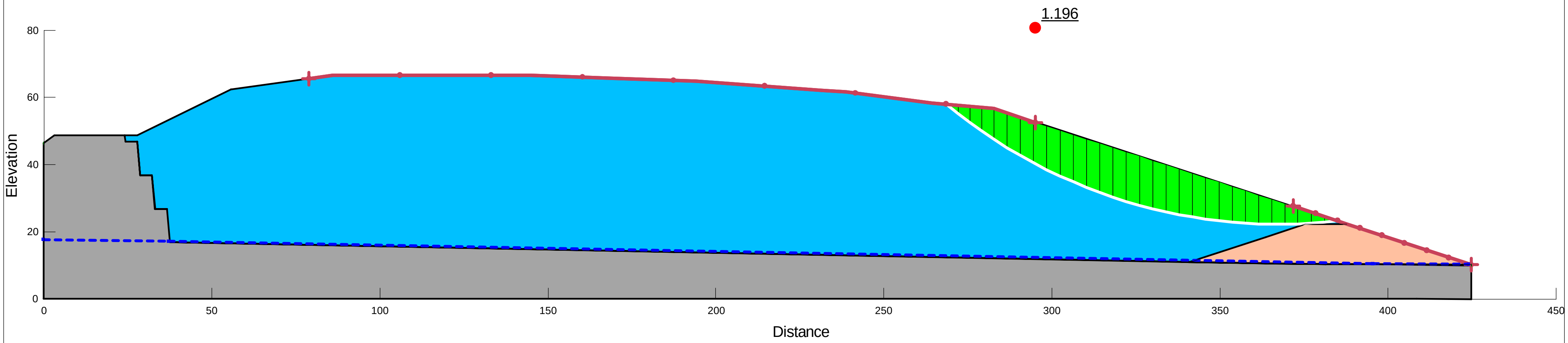


Woodstock Quarry Stability Assessment - Figure 29

Analysis: Seismic PGA 0.22g (landfill slope 1:3 with 12m bund - option 2)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

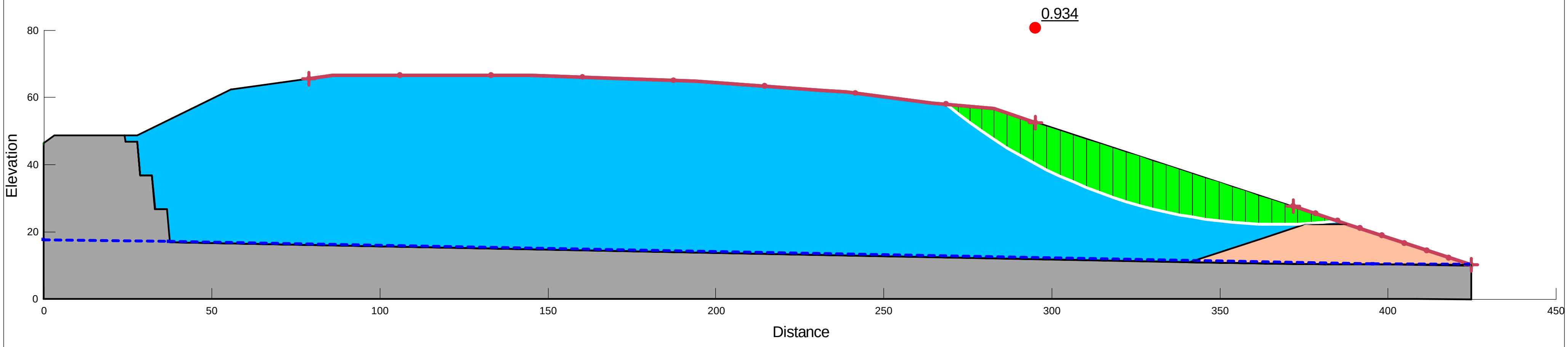


Woodstock Quarry Stability Assessment - Figure 30

Analysis: Seismic PGA 0.35g (landfill slope 1:3 with 12m bund - option 2)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

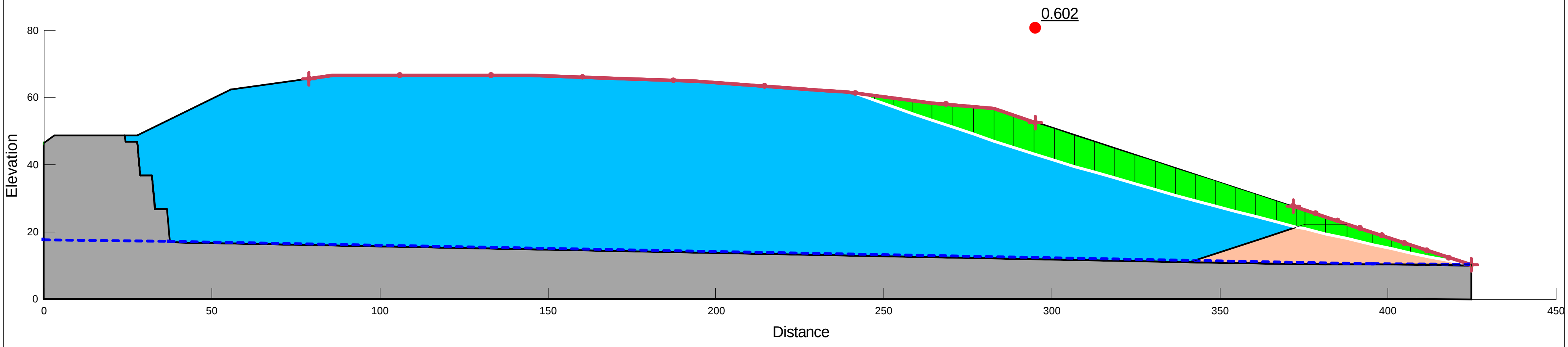


Woodstock Quarry Stability Assessment - Figure 31

Analysis: Seismic PGA 0.63g (landfill slope 1:3 with 12m bund - option 2)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

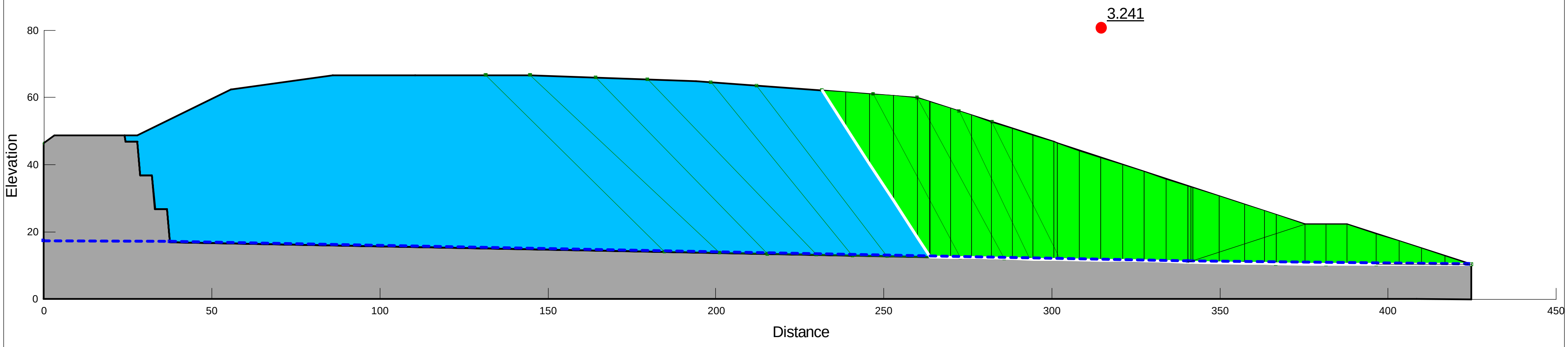


Woodstock Quarry Stability Assessment - Figure 32

Analysis: Static (sliding on liner)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Fully-Specified
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

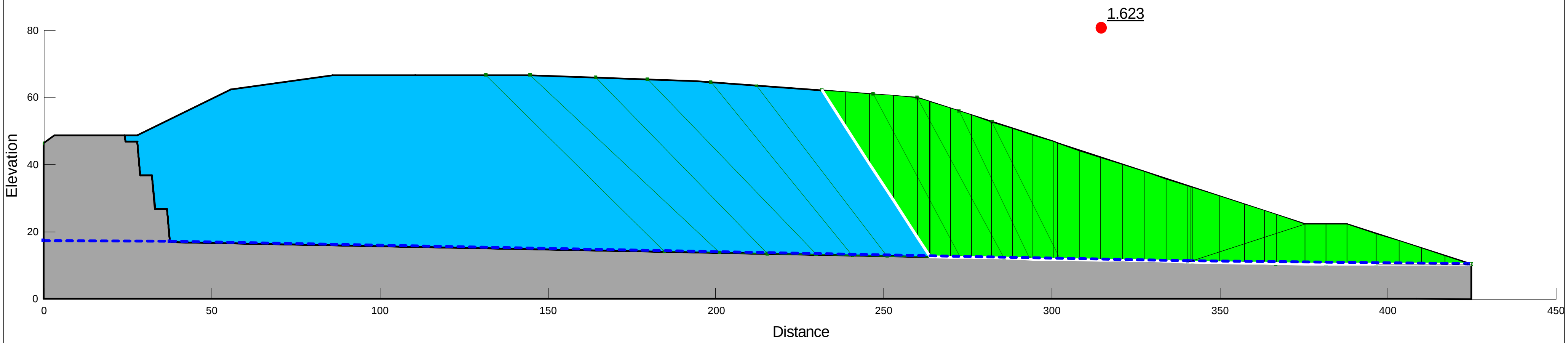


Woodstock Quarry Stability Assessment - Figure 33

Analysis: Seismic PGA 0.22g (sliding on liner)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Fully-Specified
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

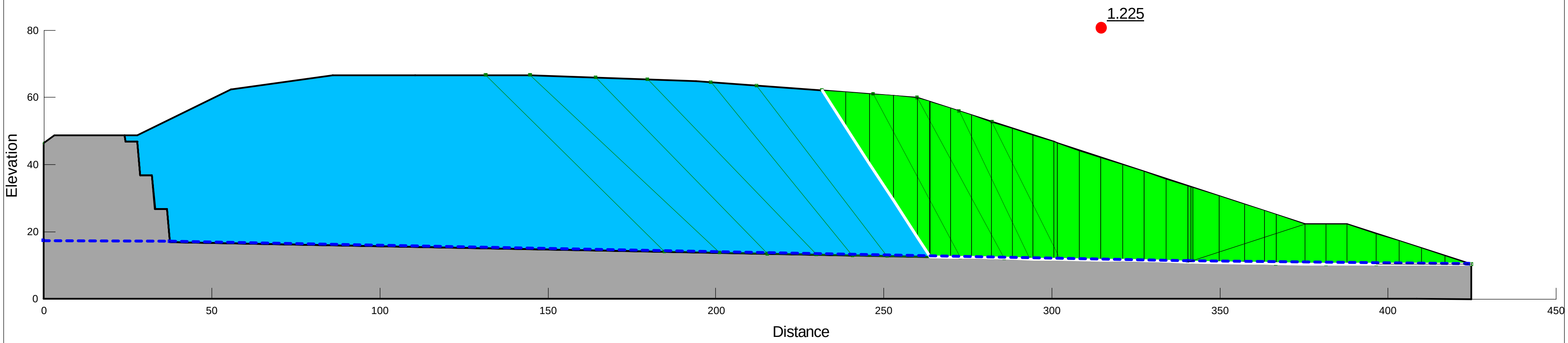


Woodstock Quarry Stability Assessment - Figure 34

Analysis: Seismic PGA 0.35g (sliding on liner)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Fully-Specified
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

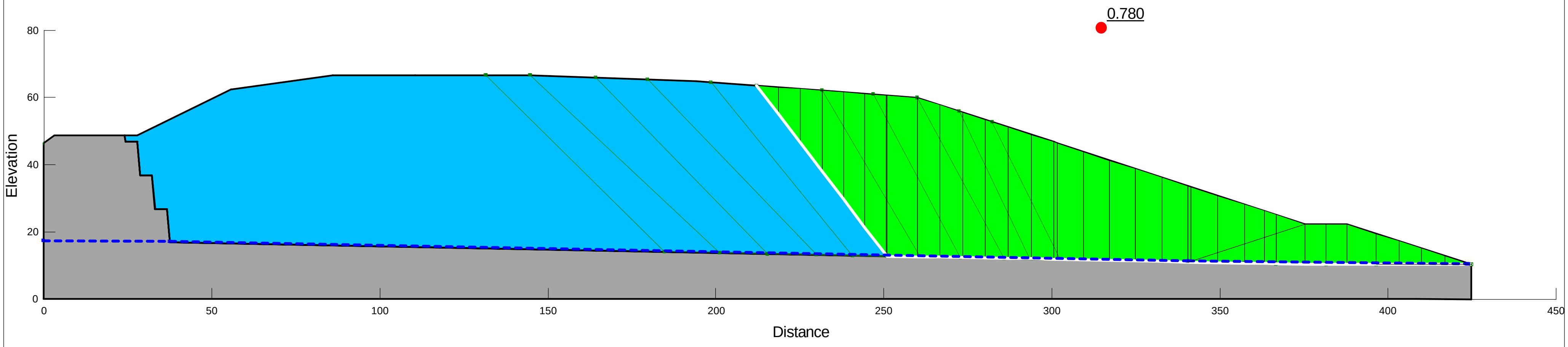


Woodstock Quarry Stability Assessment - Figure 35

Analysis: Seismic PGA 0.63g (sliding on liner)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Fully-Specified
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

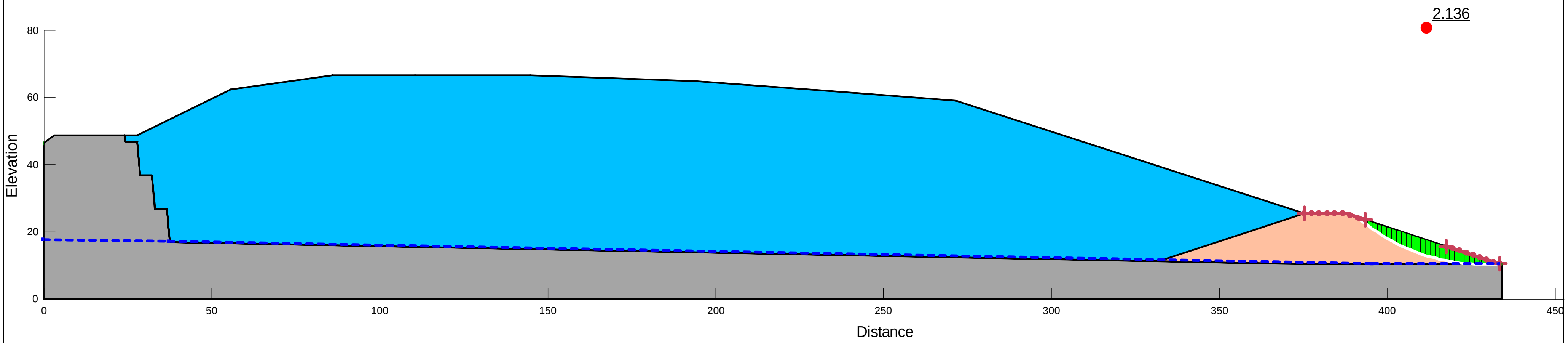


Woodstock Quarry Stability Assessment - Figure 36

Analysis: Static (15m toe bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

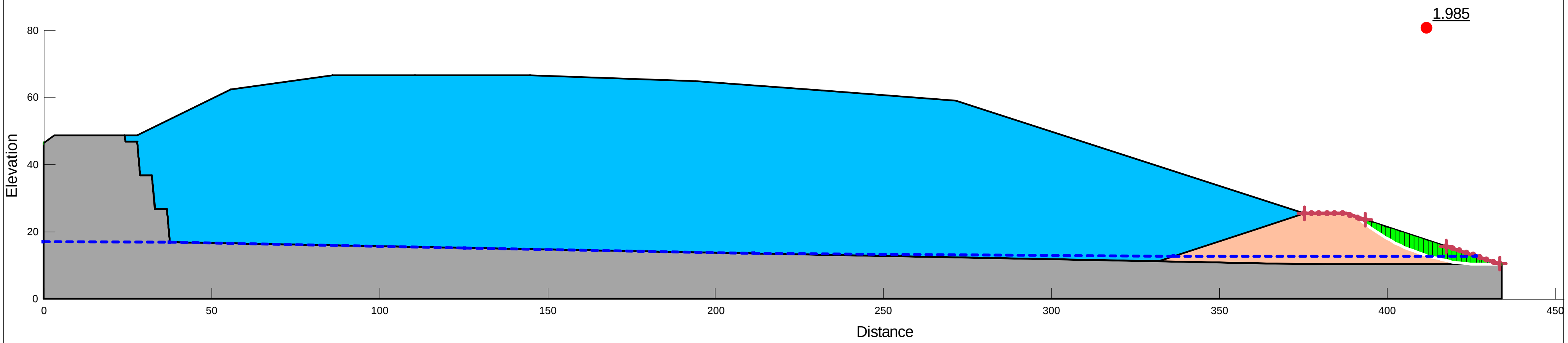


Woodstock Quarry Stability Assessment - Figure 37

Analysis: Elevated Groundwater (15m toe bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

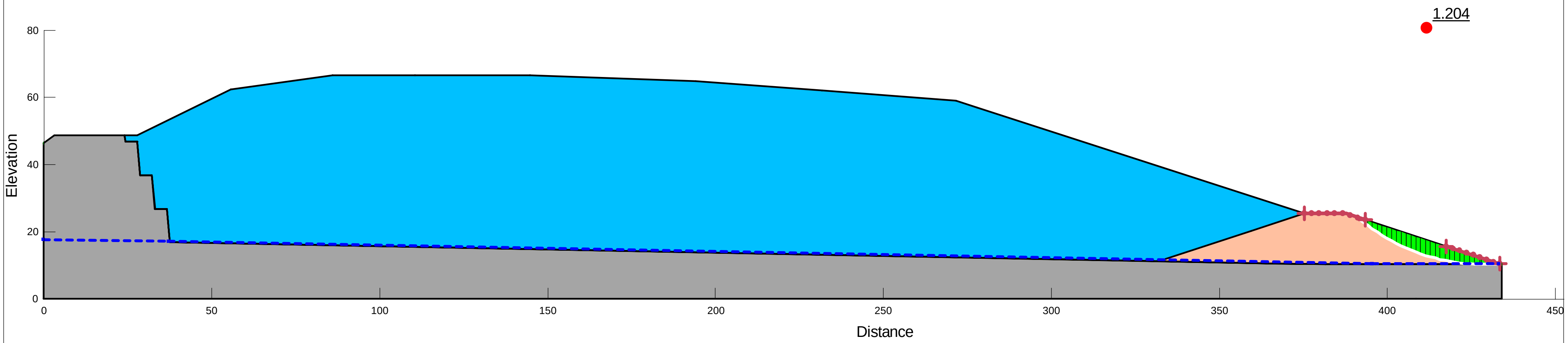


Woodstock Quarry Stability Assessment - Figure 38

Analysis: Seismic PGA 0.22g (15m toe bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

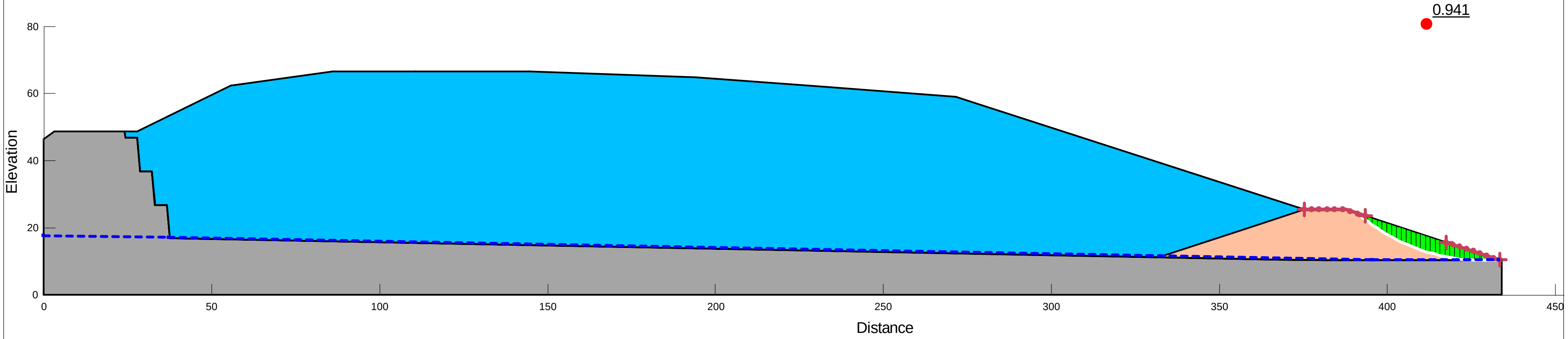


Woodstock Quarry Stability Assessment - Figure 39

Analysis: Seismic PGA 0.35g (15m toe bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

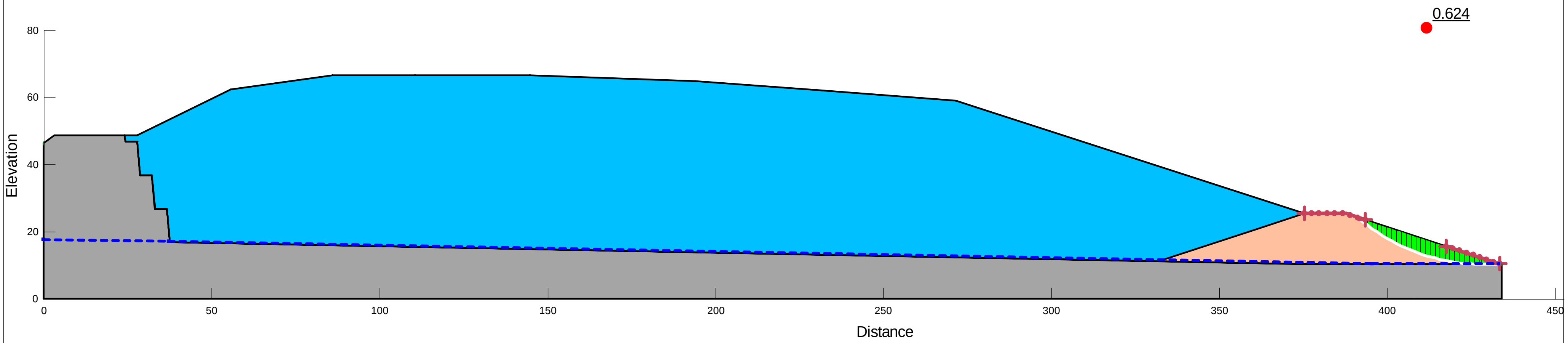


Woodstock Quarry Stability Assessment - Figure 40

Analysis: Seismic PGA 0.63g (15m toe bund)

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30
	UW Rock	Mohr-Coulomb	27	40	40

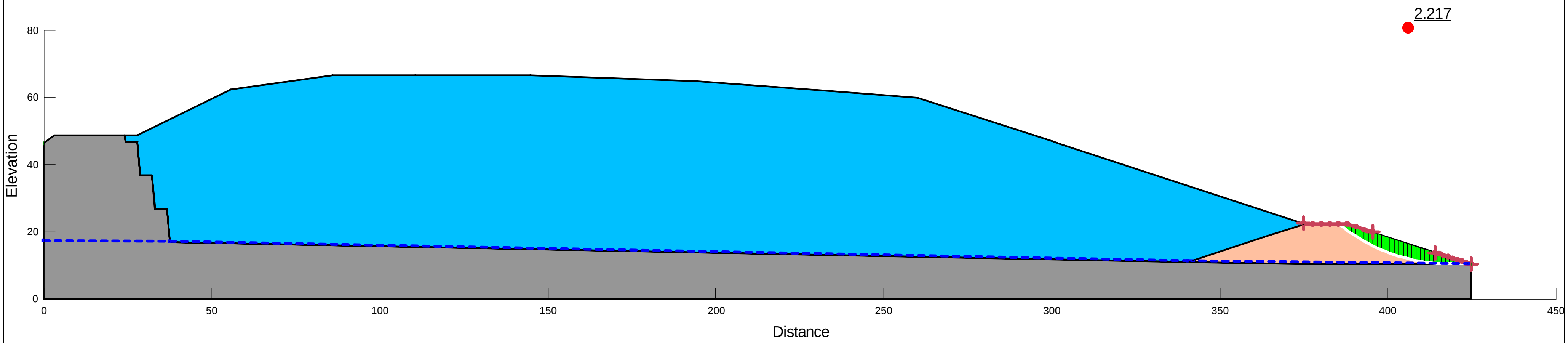


Woodstock Quarry Stability Assessment - Figure 41

Analysis: Static (12m toe bund) MW-HW rock

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	MW-HW Rock	Mohr-Coulomb	22	15	30
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30

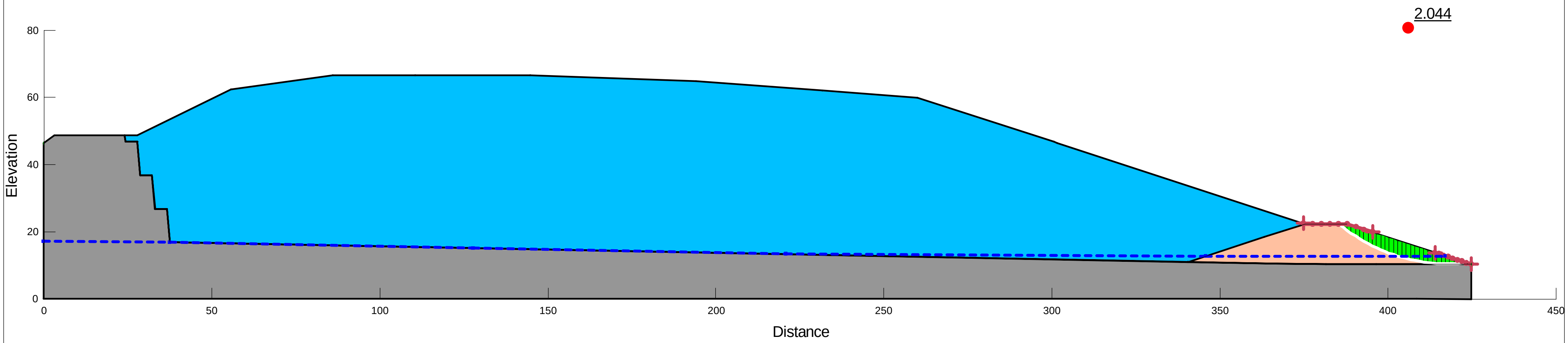


Woodstock Quarry Stability Assessment - Figure 42

Analysis: Elevated Groundwater (12m toe bund) MW-HW rock

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	MW-HW Rock	Mohr-Coulomb	22	15	30
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30

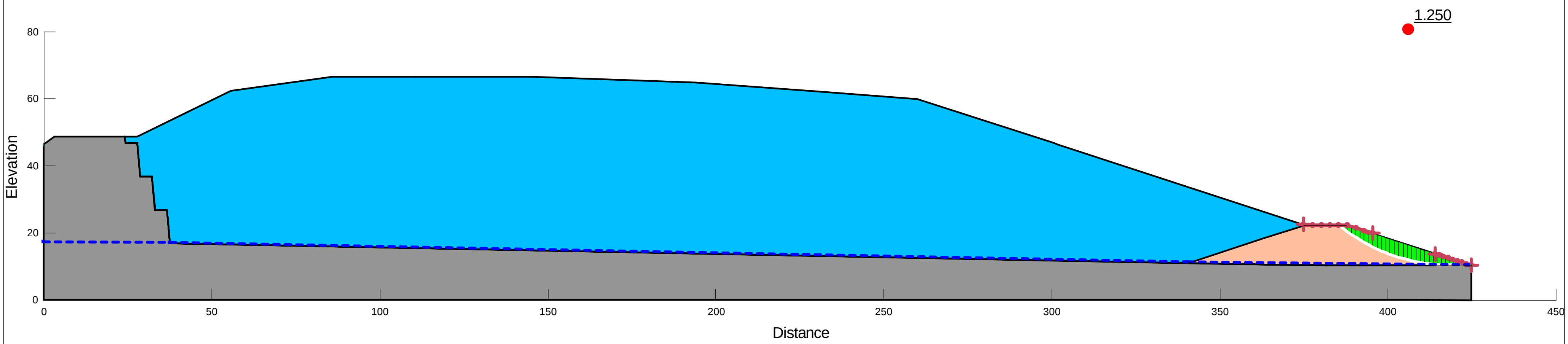


Woodstock Quarry Stability Assessment - Figure 43

Analysis: Seismic PGA 0.22g (12m toe bund) HW-MW rock

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	MW-HW Rock	Mohr-Coulomb	22	15	30
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30

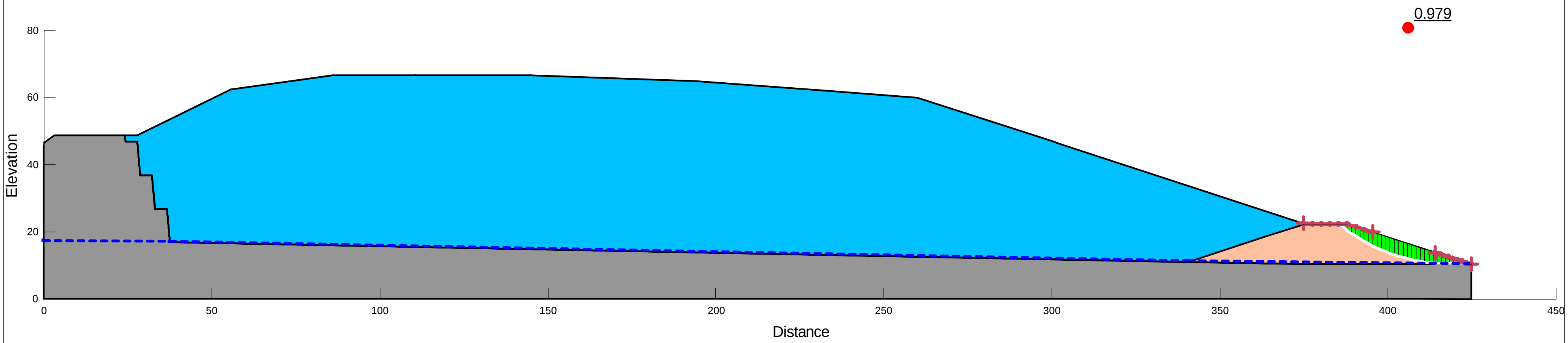


Woodstock Quarry Stability Assessment - Figure 44

Analysis: Seismic PGA 0.35g (12m toe bund) MW-HW rock

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	MW-HW Rock	Mohr-Coulomb	22	15	30
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30

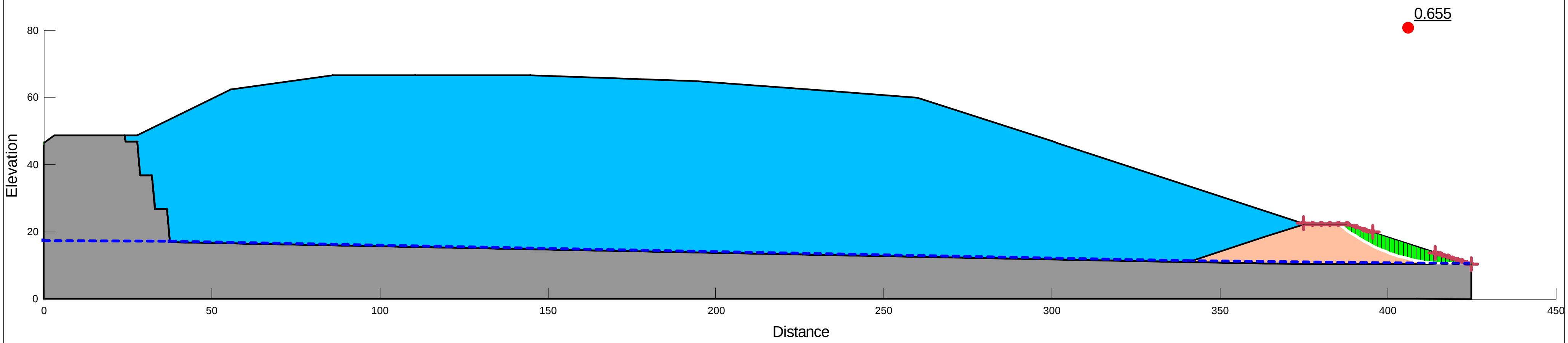


Woodstock Quarry Stability Assessment - Figure 45

Analysis: Seismic PGA 0.63g (12m toe bund) MW-HW

Analysis Type: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	MW-HW Rock	Mohr-Coulomb	22	15	30
	Refuse	Mohr-Coulomb	12	5	30
	Toe bund	Mohr-Coulomb	20	5	30

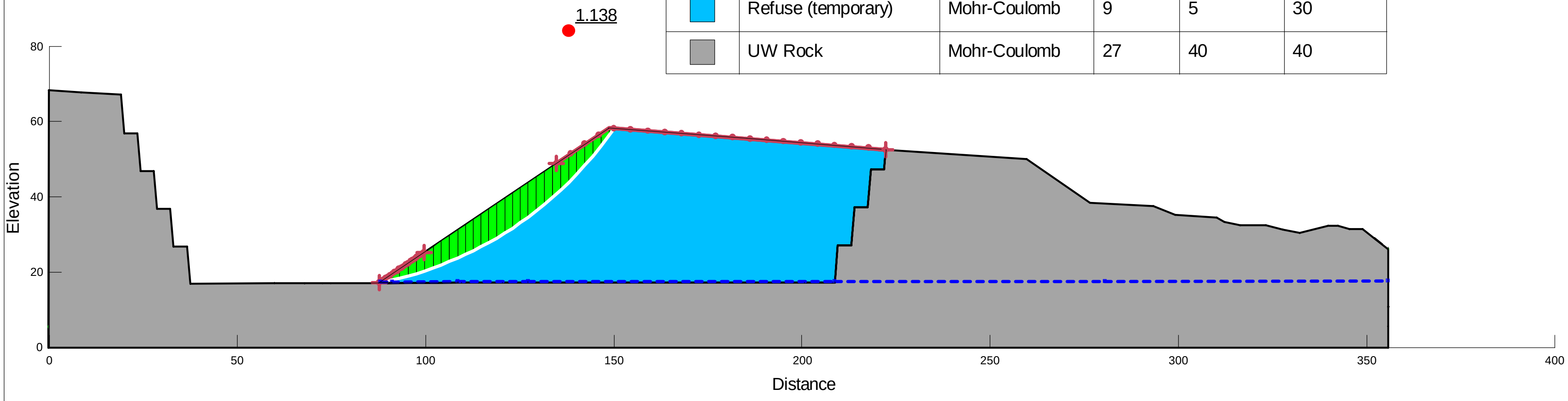


Woodstock Quarry Stability Assessment - Figure 46

Analysis: Static (Temporary Waste Pile 1:1.5 slope) with liner

Analysis Type: Morgenstern-Price
Direction of movement: Right to Left
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse (temporary)	Mohr-Coulomb	9	5	30
	UW Rock	Mohr-Coulomb	27	40	40

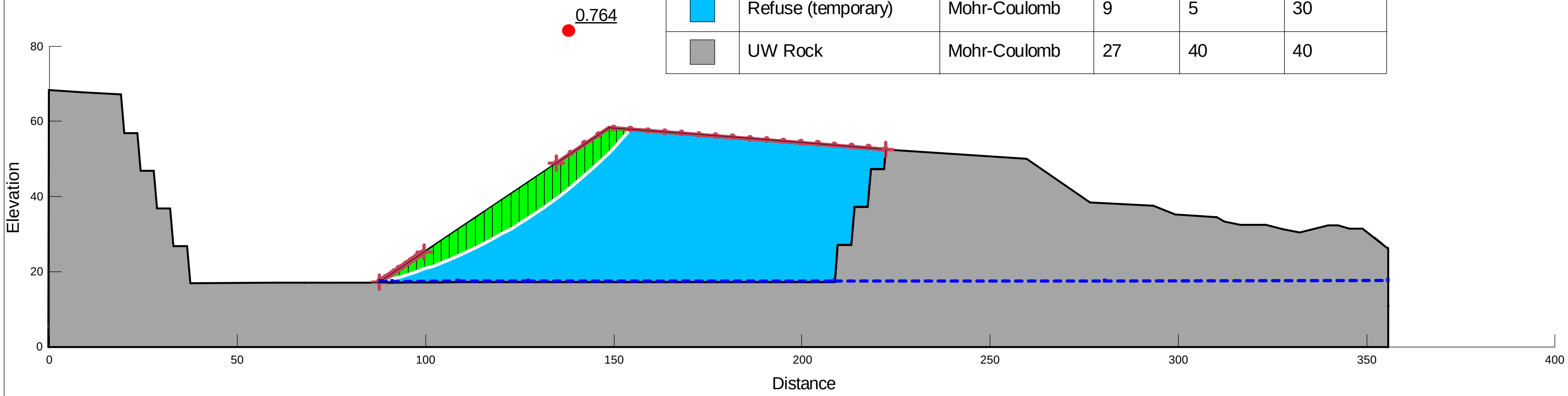


Woodstock Quarry Stability Assessment - Figure 47

Analysis: Seismic PGA 0.22g (Temporary Waste Pile 1:1.5 slope) with liner

Analysis Type: Morgenstern-Price
Direction of movement: Right to Left
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse (temporary)	Mohr-Coulomb	9	5	30
	UW Rock	Mohr-Coulomb	27	40	40

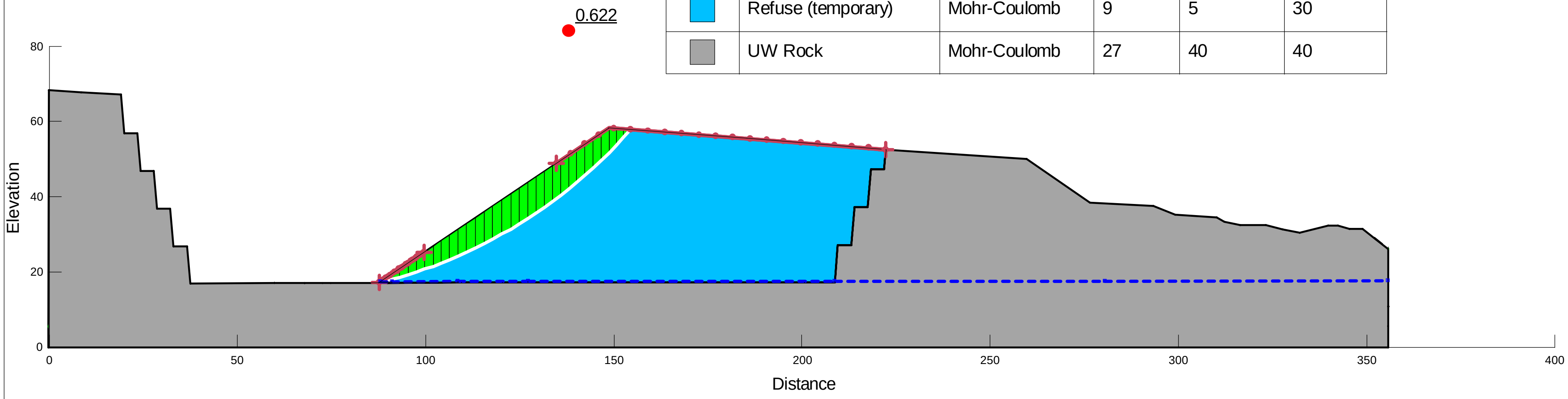


Woodstock Quarry Stability Assessment - Figure 48

Analysis: Seismic PGA 0.35g (Temporary Waste Pile 1:1.5 slope) with liner

Analysis Type: Morgenstern-Price
Direction of movement: Right to Left
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse (temporary)	Mohr-Coulomb	9	5	30
	UW Rock	Mohr-Coulomb	27	40	40

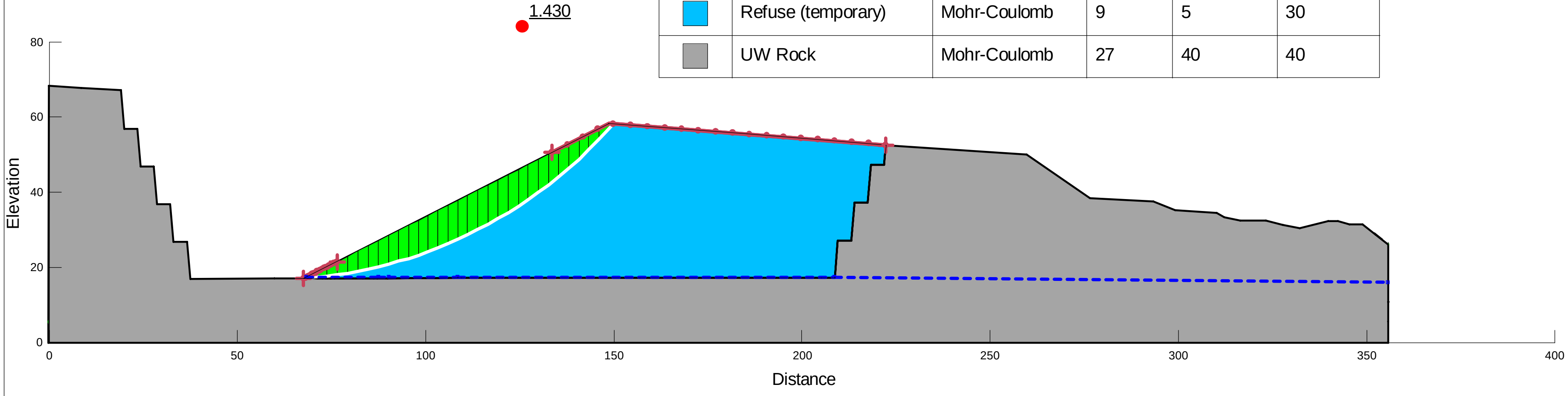


Woodstock Quarry Stability Assessment - Figure 49

Analysis: Static (Temporary Waste Pile 1:2 slope) with liner

Analysis Type: Morgenstern-Price
Direction of movement: Right to Left
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse (temporary)	Mohr-Coulomb	9	5	30
	UW Rock	Mohr-Coulomb	27	40	40

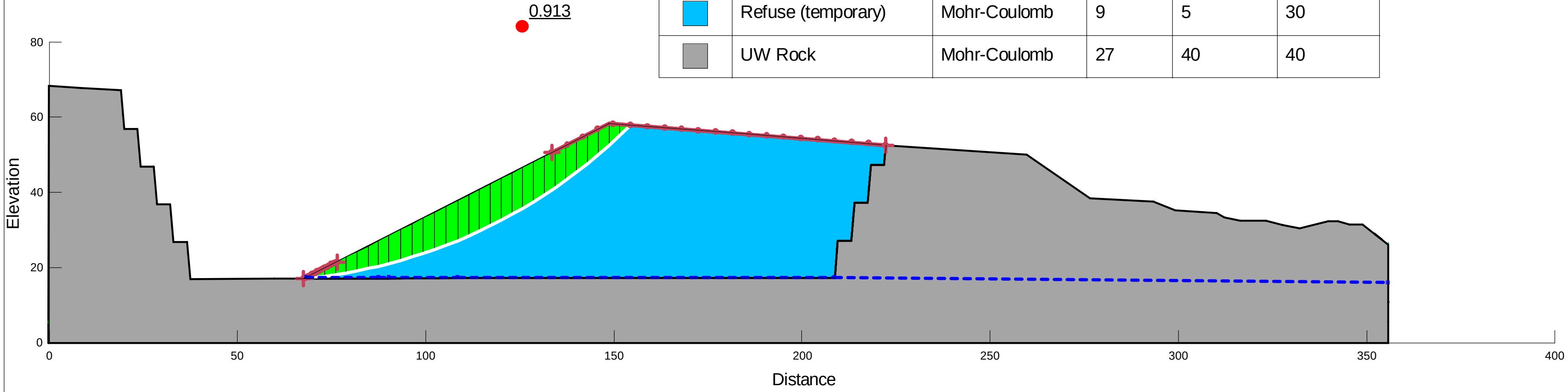


Woodstock Quarry Stability Assessment - Figure 50

Analysis: Seismic PGA 0.22g (Temporary Waste Pile 1:2 slope) with liner

Analysis Type: Morgenstern-Price
Direction of movement: Right to Left
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse (temporary)	Mohr-Coulomb	9	5	30
	UW Rock	Mohr-Coulomb	27	40	40

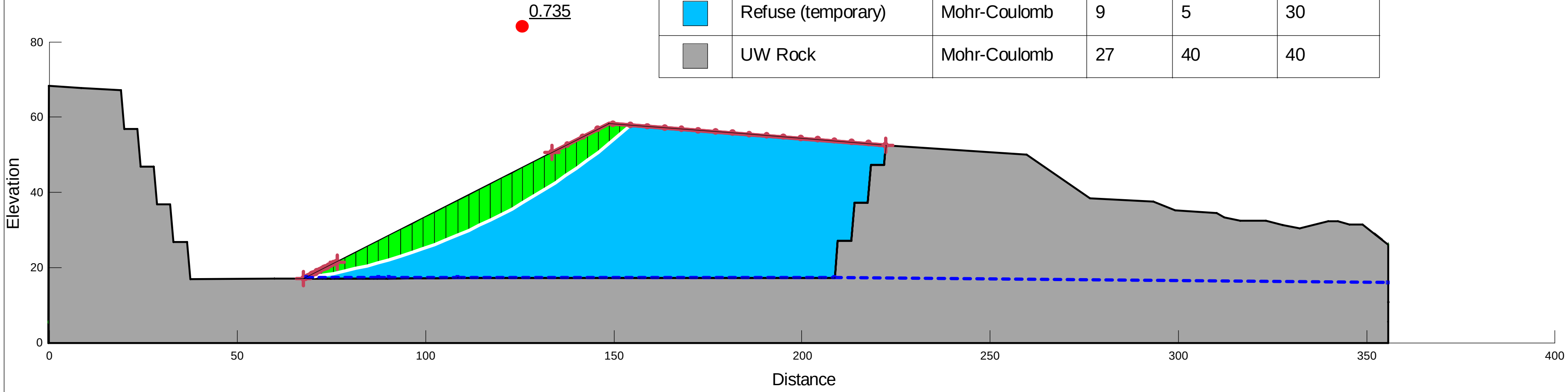


Woodstock Quarry Stability Assessment - Figure 51

Analysis: Seismic PGA 0.35g (Temporary Waste Pile 1:2 slope) with liner

Analysis Type: Morgenstern-Price
Direction of movement: Right to Left
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse (temporary)	Mohr-Coulomb	9	5	30
	UW Rock	Mohr-Coulomb	27	40	40

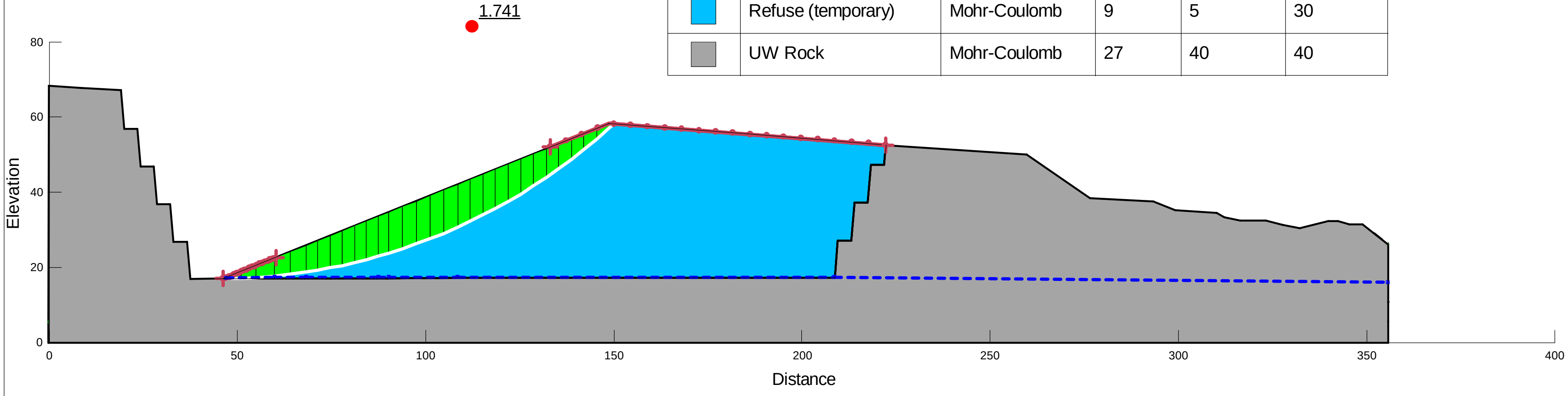


Woodstock Quarry Stability Assessment - Figure 52

Analysis: Static (Temporary Waste Pile 1:2.5 slope) with liner

Analysis Type: Morgenstern-Price
Direction of movement: Right to Left
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse (temporary)	Mohr-Coulomb	9	5	30
	UW Rock	Mohr-Coulomb	27	40	40

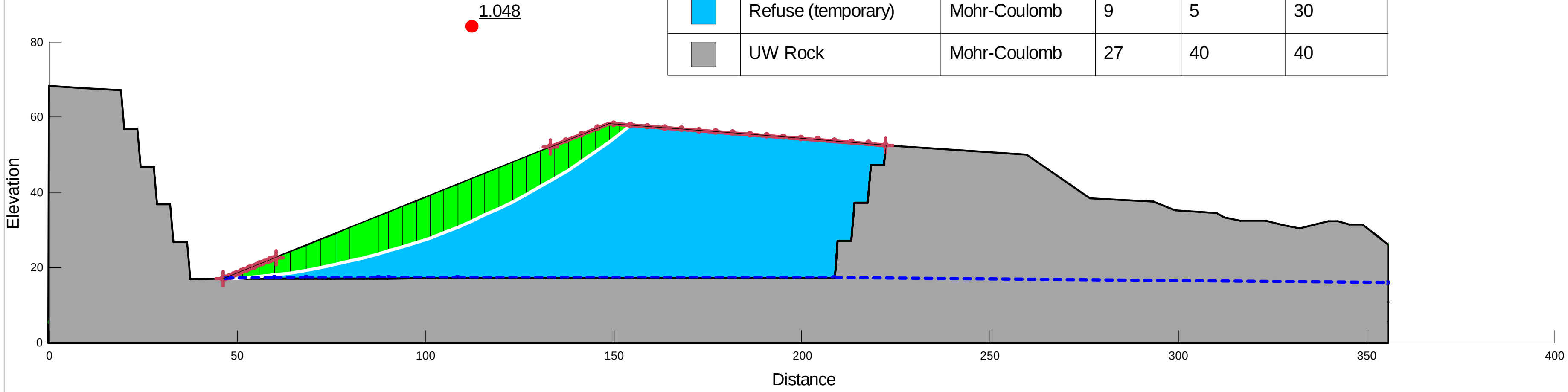


Woodstock Quarry Stability Assessment - Figure 53

Analysis: Seismic PGA 0.22g (Temporary Waste Pile 1:2.5 slope) with liner

Analysis Type: Morgenstern-Price
Direction of movement: Right to Left
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse (temporary)	Mohr-Coulomb	9	5	30
	UW Rock	Mohr-Coulomb	27	40	40



Woodstock Quarry Stability Assessment - Figure 54

Analysis: Seismic PGA 0.35g (Temporary Waste Pile 1:2.5 slope) with liner

Analysis Type: Morgenstern-Price
Direction of movement: Right to Left
Slip Surface Option: Entry and Exit
PWP Conditions from: Piezometric Line
F of S Calculation Option: Constant

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Liner Interface - Peak	Mohr-Coulomb	17	0	25
	Refuse (temporary)	Mohr-Coulomb	9	5	30
	UW Rock	Mohr-Coulomb	27	40	40