TECHNICAL MEMORANDUM

DATE 9 December 2016 **REFERENCE No.** 1528407-057-M-Rev0

TO EPA Victoria

CC

FROM Golder Associates Pty Ltd **EMAIL**

FURTHER INFORMATION RE SECTION 22 NOTICE, MELBOURNE REGIONAL LANDFILL (MRL) EXTENSION

This Technical Memorandum provides further information to support the Works Approval Application for the proposed Melbourne Regional Landfill (MRL) Extension. In particular, we respond to the email from EPA titled *'Melbourne Regional Landfill Section 22 Notice Outstanding Items*'.

Further clarification is provided on a) contingency measures in the event of high groundwater levels; and b) the geotechnical stability of the side wall liner of the landfill, in particular where the landfill does not adjoin the quarry batter.

1.0 STABILITY ASSESSMENT

1.1 EPA Request

EPA Query 1 – EPA requests the following.

> *"The following requests are made:*
>
> 1. *Provide an assessment and measures on the geotechnical stability of the side wall and the side wall liners of the landfill, in particular where the landfill does not adjoin the quarry batter. Details are requested of the measures that will be installed to ensure that the geotechnical stability of side walls and the side wall liner will be maintained*."

1.2 Modelling

The landfill shape, general arrangement, floor liner and cap liner are presented in the Works Approval Application (WAA) documentation, and in particular we draw your attention to Appendix B – Figures, of the WAA. The side wall is supported by an Engineered Compacted Soil Bundwall as shown on the 'Typical Quarry Floor Detail' on Figure 27 – Typical Detail Sheet 1, reproduced as Plate 1 below.

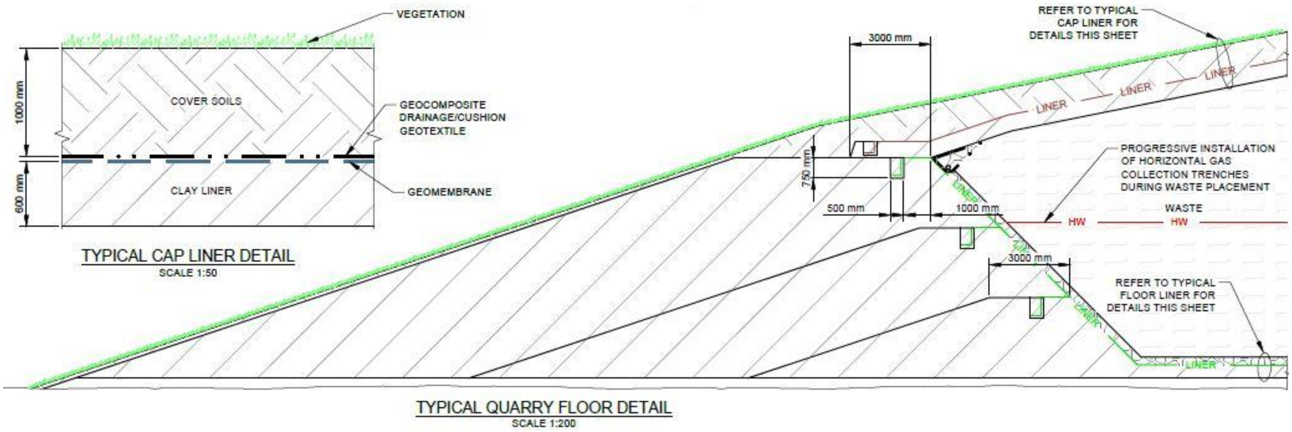

Plate 1: Typical Quarry Floor Detail, extract from Figure 27

The floor liner is shown on the 'Typical Floor Liner Detail' on Figure 27, reproduced as Plate 2 below.

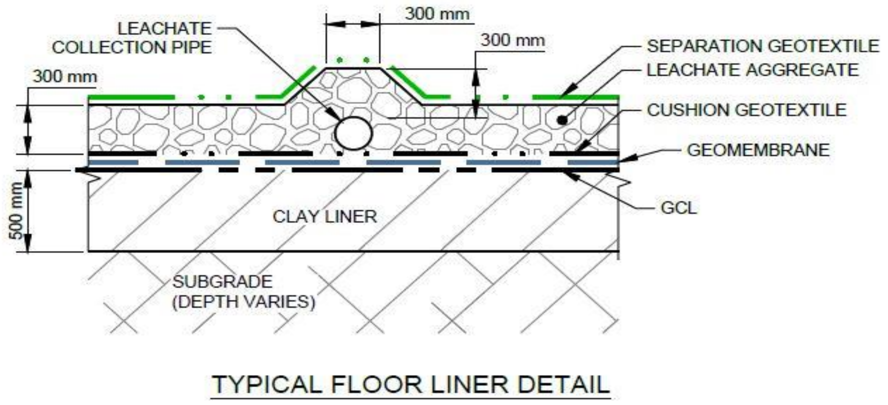

Plate 2: Typical Floor Liner Detail, extract from Figure 27

A typical cross section of the proposed landfill has been selected from the South Portion where the landfill does not adjoin the quarry batter, which is equivalent to Section C on Figure 25 (refer Plate 3) and is located as shown on Figure 20 (Refer Plate 4).

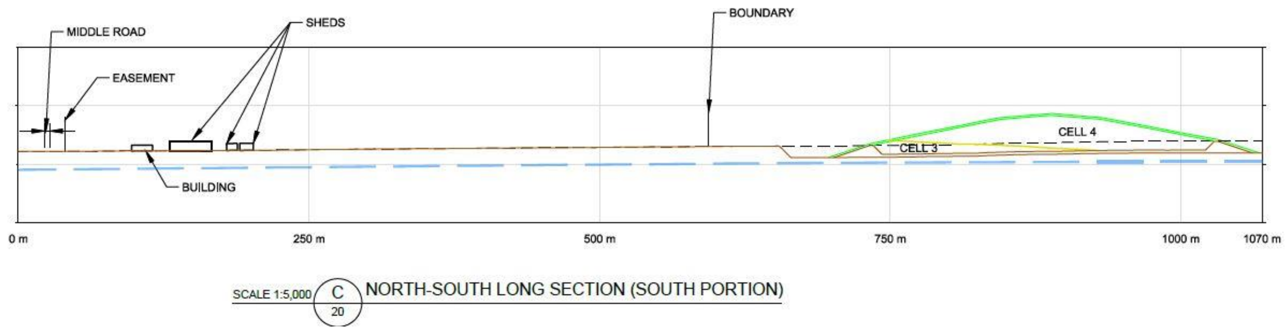

Plate 3: Section C extract from Figure 25

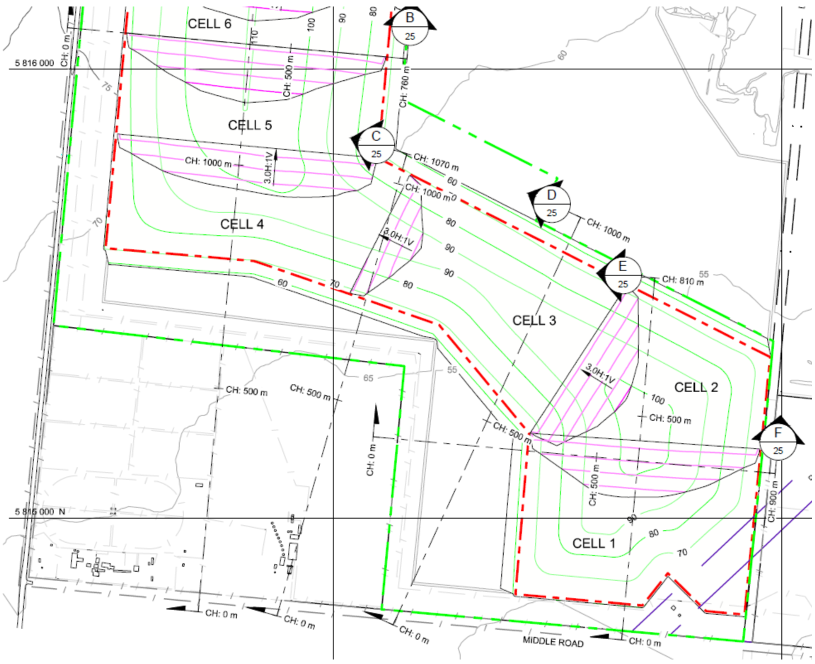

Plate 4: Location of Cross Section C Extract from WAA Figure 20

1.3 Stability Assessment

A stability assessment has been undertaken using the SLOPE W model. We analysed Cross Section C in the model and applied typical parameters for the engineered soil bundwall, geosynthetic liner materials and waste.

We assumed the following:

a) Engineered compacted soil fill underlying the floor liner. A High Density Polyethylene geomembrane floor and side wall liner, analysing for smooth geomembrane. A typical Geosynthetic Clay Liner (GCL) with non-woven geotextile on the outer surface.

b) We modelled the geosynthetic layers on the floor of the landfill using the lowest strength layer in terms of interface friction being the interface between the non-woven geotextile (cushion geotextile) and the top of a smooth geomembrane liner.

c) A liquid level on the floor of the landfill cell of 300mm to simulate the maximum leachate level.

The slope stability assessment for peak interface strengths is presented in the attached Appendix A and indicates the factor of safety for the waste slopes are within normally adopted ranges for permanent slopes in accordance with the assumed loading conditions.

We have based the stability assessment on the assumption of leachate levels being maintained within the leachate collection system.

We have also assessed the factor of safety for the dynamic earthquake loading conditions. The seismic analysis is based on earthquake acceleration coefficient adopted from the Earthquake Hazard Map of New South Wales, Victoria and Tasmania – 2003, AS1170.4-2007. The map presents the Peak Ground Acceleration (PGA) for the earthquake approximating the 1 in 475 year return period event. The acceleration coefficient for the Melbourne area is 0.08g.

Based on EPA criteria our target Factor of Safety is greater than or equal to 1.5 for static conditions and greater than or equal to 1.1 for dynamic (seismic) loading conditions.

Cases were analysed for Section C in the South Portion with various scenarios summarised as follows:

i) Case 1 – Deep Seated Analysis assessing the Bundwall - assumes a 3H:1V external batter on the Engineered Soil Bundwall with a 5H:1V waste slope grading to a 12H:1V waste slope near the crest, as per Section C, under peak (static) conditions with a leachate head of 300mm above the floor liner. Material properties assumed for the waste, engineered compacted soils and the geosynthetic liner materials are presented on Figure 1. We estimate a Factor of Safety of 2.1 for this case.

ii) Case 2 – Assessment of Liner Interface - the same parameters as Case 1 analysed to assess conditions along the geosynthetic layers on the floor and side wall liner, as presented on Figure 2. We estimate a Factor of Safety against sliding of 1.8 for this case using a smooth geomembrane liner.

iii) Case 3 – Seismic - the same parameters as Case 2 except with seismic loading, per Figure 3. We estimate a Factor of Safety against sliding of 1.2 for this case using a smooth geomembrane liner.

Cases were also analysed for Section H in the North Portion (equivalent to Section H, Figure 26 of the Works Approval Application) with various scenarios summarised as follows:

iv) Case 4 – Deep Seated Analysis - assumes a 3H:1V external batter on the Engineered Soil Bundwall with a waste slope grading as per Section H, under peak (static) conditions with a leachate head of 300mm above the floor liner. Material properties assumed for the waste, engineered compacted soils and the geosynthetic liner materials are presented on Figure 4. We estimate a Factor of Safety of 1.9 for this case.

v) Case 5 – Assessment of Bundwall and Liner Interface - the same parameters as Case 1 analysed to assess conditions along the geosynthetic layers on the floor and side wall liner and the bundwall, as presented on Figure 5. We estimate a Factor of Safety of 2.7 for this case.

vi) Case 6 – the same parameters as Case 4 except with seismic loading, as presented on Figure 6. We estimate a Factor of Safety against sliding of 1.2 for this case using a smooth geomembrane liner.

All cases satisfy the adopted Factor of Safety criteria for static and dynamic (seismic) conditions.

2.0 ADDITIONAL CONTINGENCY MEASURES FOR GROUNDWATER LEVELS

2.1 EPA Request

EPA Query 1 – EPA requests the following.

> "*The following requirements are made with regard to:*
>
> 1. *Additional design and management measures. If the information provided in response to (1) Understanding the Baseline Environment above indicates that a 2m separation between waste and the long term undisturbed depth to groundwater is not achieved (for any area within the landfill), please provide additional design and management practices that would be adopted to show compliance of clause 16(2) of the WMP. Note that those measures must be acceptable to the Authority."*

2.2 Works Approval Application

The Works Approval Application includes several sections related to groundwater management. In particular, groundwater levels due to the proposed landfill extension are addressed in a report prepared by AECOM, *Hydrogeological Assessment, Melbourne Regional Landfill,* included as Appendix D to the WAA, which concludes that:

> *"The proposed design of the Extension provides for 2 m vertical separation between the landfill cell liners and the natural water table across the site, in accordance with BPEM requirements for a Type 2 landfill."*

A proposed base liner design is provided in the Works Approval Application (WAA), presented as Figure 27 in Appendix B. The base liner system comprises the following:

- Engineered compacted subgrade soils.
- Low- permeability layer of compacted clay liner (0.5 m thick)
- Geosynthetic clay liner (GCL)
- Geomembrane liner
- Cushion geotextile
- Leachate collection pipes on cell floor with a sump and leachate extraction sump riser pipe
- Leachate collection aggregate (0.3 m thick)
- Separation Geotextile

Discussion of groundwater management is included in Section 15.2 (Groundwater Management System) of the Works Approval Application which states that:

"The proposed MRL extension will implement the following control measures to protect groundwater quality and comply with BPEM requirements.

- *The landfill liner system design will be designed to minimise the migration of leachate and landfill gas into the groundwater system.*
- *The leachate management system is designed to control, contain and treat leachate to prevent discharge into groundwater.*
- *During construction, leachate will be segregated from stormwater drains and stormwater ponds will be tested for the presence of contaminants to detect the migration of leachate.*

- *Frequent monitoring of groundwater monitoring bores will be undertaken in accordance with the EPA criteria to assess on an ongoing basis any influence from the landfill.”*

2.3 Groundwater

It is our understanding that Boral has been extracting groundwater from onsite as part of the quarrying operations. EPA has requested consideration as a contingency measure of a condition where the long term groundwater level rises once extraction of groundwater is complete. In this theoretical scenario, the groundwater could rebound to the floor of the quarry. In order to maintain 2 m of vertical separation between the waste and the theoretical groundwater level we have assessed an additional contingency measure comprising the installation of a continuous groundwater collection gravel layer at a depth of 2m below the underside of waste with associated groundwater collection pipes.

2.4 Additional Design and Management Measures

With respect to the theoretical rebound of groundwater, a groundwater collection layer could be implemented in addition to the base liner design presented in the Works Approval Application, if considered necessary at the detailed design stage prior to licencing cells. The aim being to maintain the long term groundwater level 2m below the waste:

- Construct a groundwater collection layer to collect groundwater and to direct groundwater to groundwater collection sumps. Construct the engineered compacted subgrade soils between the groundwater collection layer and the compacted clay floor and side wall liner. This would achieve a 2 m separation between waste and the groundwater.
- Monitor the groundwater level and extract groundwater when required.

2.4.1 Groundwater Collection Layer

A groundwater collection layer would comprise of groundwater collection pipes surrounded by groundwater drainage aggregate, which is overlain by a layer of filter geotextile. The groundwater collection layer is to be constructed above the quarry floor within the engineered compacted subgrade soil, which is formed by clearing of the quarry floor followed by placement of an engineered compacted subgrade soil with various depths to shape the ground to promote drainage of groundwater. The spacing of the groundwater pipes would be determined at the detailed design stage prior to licencing the cells, taking account of groundwater conditions, inflow rates and the cell geometry.

Plate 5 presents details of the groundwater collection layer.

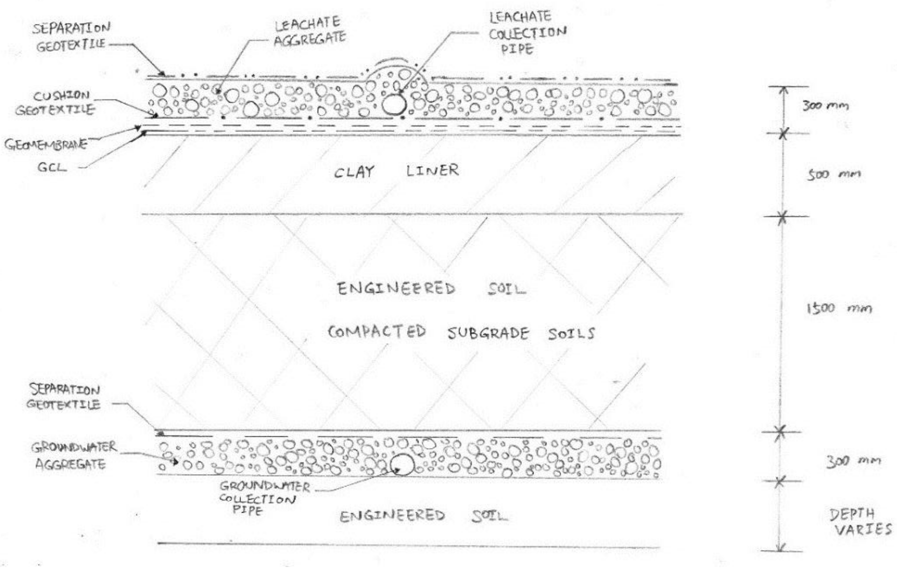

Plate 5: Proposed Groundwater Collection Layer

3.0 CLOSURE

If you have any further questions please contact us.

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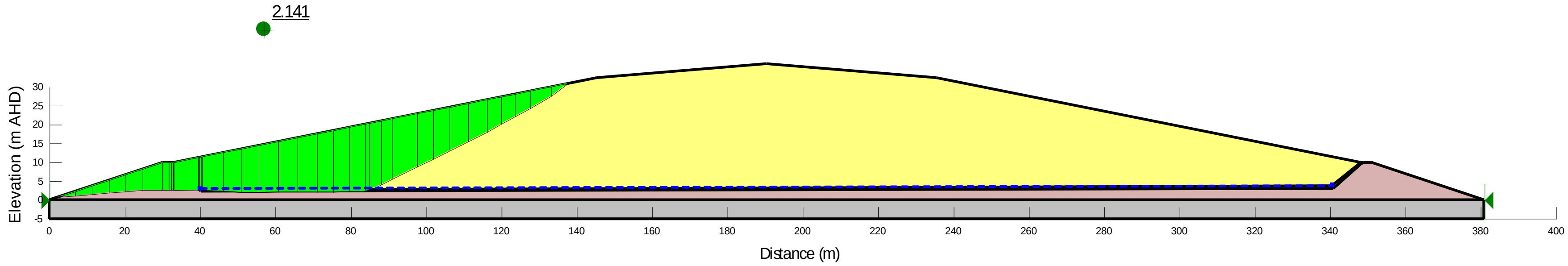
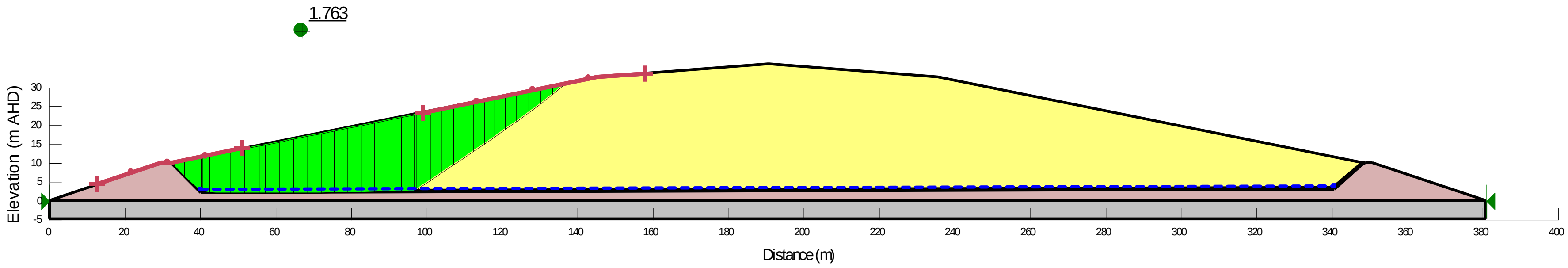


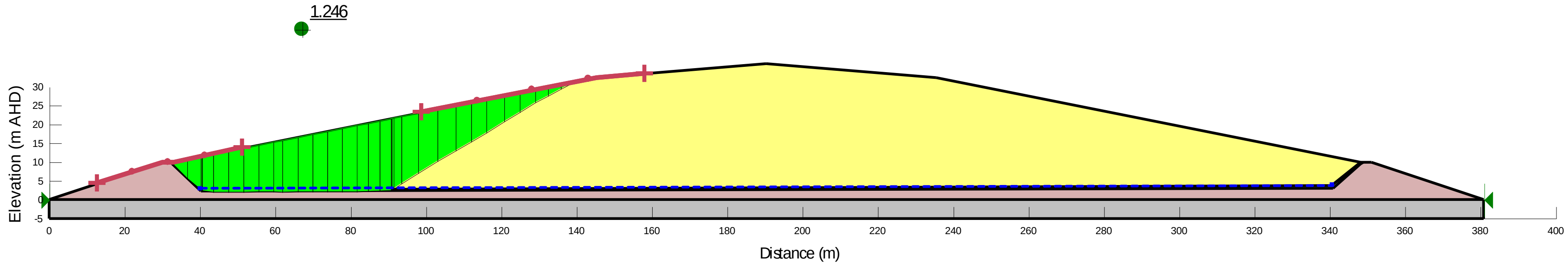
Name: Waste   Model: Mohr-Coulomb   Unit Weight: 12 kN/m³   Cohesion: 5 kPa   Phi: 25 °
Name: Liner System   Model: Mohr-Coulomb   Unit Weight: 10 kN/m³   Cohesion: 0 kPa   Phi: 11 °
Name: Engineered Fill   Model: Mohr-Coulomb   Unit Weight: 19 kN/m³   Cohesion: 5 kPa   Phi: 28 °
Name: Bedrock   Model: Bedrock (Impenetrable)

Figure 1: Case 1- Section C Stability Analysis - Bundwall



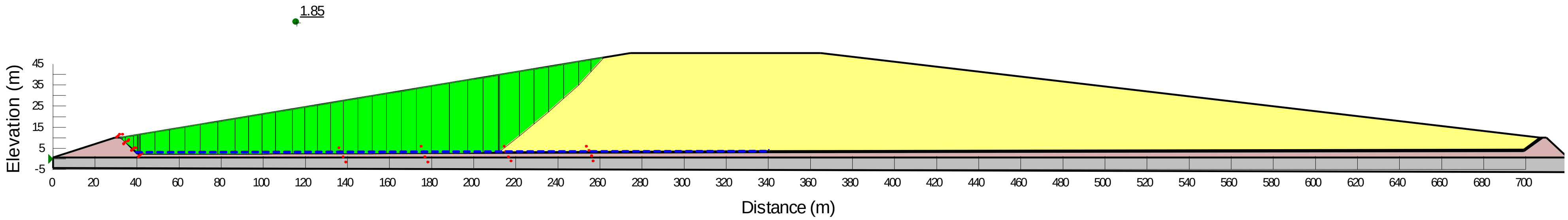
Name: Waste   Model: Mohr-Coulomb   Unit Weight: 12 kN/m³   Cohesion: 5 kPa   Phi: 25 °
Name: Liner System   Model: Mohr-Coulomb   Unit Weight: 10 kN/m³   Cohesion: 0 kPa   Phi: 11 °
Name: Engineered Fill   Model: Mohr-Coulomb   Unit Weight: 19 kN/m³   Cohesion: 5 kPa   Phi: 28 °
Name: Bedrock   Model: Bedrock (Impenetrable)

Figure 2: Case 2 - Section C Stability Analysis - Liner Interface



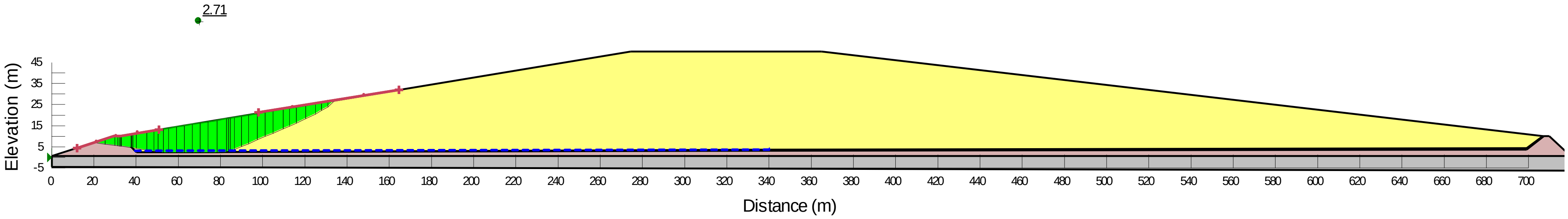
Name: Waste Model: Mohr-Coulomb Unit Weight: 12 kN/m³ Cohesion: 5 kPa Phi: 25 °
Name: Liner System Model: Mohr-Coulomb Unit Weight: 10 kN/m³ Cohesion: 0 kPa Phi: 11 °
Name: Engineered Fill Model: Mohr-Coulomb Unit Weight: 19 kN/m³ Cohesion: 5 kPa Phi: 28 °
Name: Bedrock Model: Bedrock (Impenetrable)

Figure 3: Case 3 – Section C Stability Analysis (seismic loading)



Name: Waste Model: Mohr-Coulomb Unit Weight: 12 kN/m³ Cohesion: 5 kPa Phi: 25 °
Name: Liner System Model: Mohr-Coulomb Unit Weight: 10 kN/m³ Cohesion: 0 kPa Phi: 11 °
Name: Engineered Fill Model: Mohr-Coulomb Unit Weight: 19 kN/m³ Cohesion: 5 kPa Phi: 28 °
Name: Bedrock Model: Bedrock (Impenetrable)

Figure 4: Case 4 - Section H Stability Analysis



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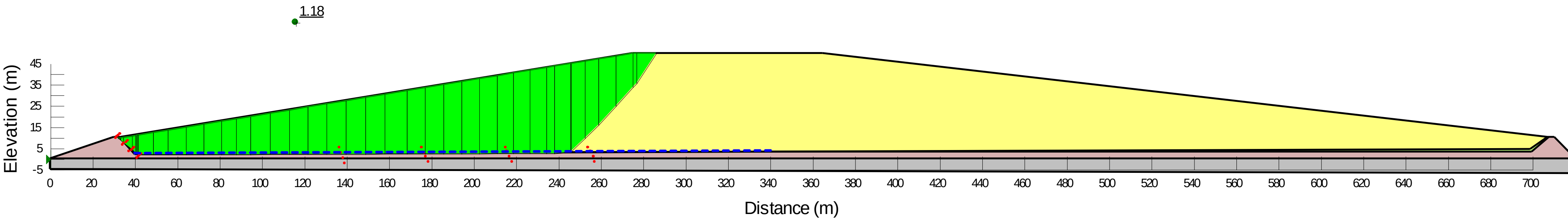
Name: Liner System Model: Mohr-Coulomb Unit Weight: 10 kN/m³ Cohesion: 0 kPa Phi: 11 °
Name: Engineered Fill Model: Mohr-Coulomb Unit Weight: 19 kN/m³ Cohesion: 5 kPa Phi: 28 °
Name: Bedrock Model: Bedrock (Impenetrable)

Figure 5: Case 5 - Section H Stability Assessment



Name: Waste Model: Mohr-Coulomb Unit Weight: 12 kN/m³ Cohesion: 5 kPa Phi: 25 °
Name: Liner System Model: Mohr-Coulomb Unit Weight: 10 kN/m³ Cohesion: 0 kPa Phi: 11 °
Name: Engineered Fill Model: Mohr-Coulomb Unit Weight: 19 kN/m³ Cohesion: 5 kPa Phi: 28 °
Name: Bedrock Model: Bedrock (Impenetrable)

Figure 6: Case 6 - Section H Stability Assessment (seismic loading)

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