CARTLEDGE
MINING AND GEOTECHNICS

Millennium Mine

Geotechnical Assessment for PRCP

2023 Report

Report No.: CMG-MMI-RPT-010005

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MILLENNIUM MINE

GEOTECHNICAL ASSESSMENT FOR 2023 PRCP

REPORT

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1	12/12/23	L. Tian	25232	K. Mandisodza	24501	Final

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Executive summary

As part of the development of a Progressive Rehabilitation and Closure Plan (PRCP) under the transition notice issued under section 754 of the EA Act on 14th March 2022 to MetRes Pty Ltd, Cartledge Mining and Geotechnics (CM&G) have been engaged to undertake geotechnical assessments per the requirements of the General Rehabilitation Practices under Section 3.6.1 of the Guideline - PRC Plan. To enable these geotechnical assessments, CM&G collaborated with other Consulting firms that undertook other studies per the PRC plan requirements. Results from associated studies such as hydrogeology and landform design were provided and integrated into geotechnical models to assess the long-term stability of the final landform and associated interaction with underground voids per Section 3.6.3 of the Guideline – PRC Plan ESR/2019/4964 Version 3.00. The geotechnical assessments were also used to frame the proposed final landform's overarching stability risk assessment.

Millennium Mine is approximately 15 km east-southeast of Moranbah and operates two open cuts, including A, B, M, D, and E pits. E pit highwalls contain the portal for underground mining. The historic C pit has since been backfilled and rehabilitated. Mining operations are done through conventional open-cut mining and hauling, and the Site is characterised by complex geology and structural networks. CM&G undertook stability and deformation assessments of the final landform as part of the geotechnical study for PRCP requirements. The deformation analysis assessed long-term ground settlement and potential subsidence from highwall-underground void interactions. This assessment assumed that the underground portals will be sealed at closure. The landform stability analysis also considered the storage of coarse reject and dried tailings within M and D pits for inclusion in the final landform.

Stability and deformation analyses were conducted in consideration of the below assumptions:

- Model input parameters were obtained from historical data, literature review and slope displacement back analyses for long-term deformation trends. Iterations for models to simulate the recorded monitoring radar long-term displacements were conducted.
- Fault structures were modelled as persistent structures with a 1m thickness, per the provided structural model.
- The final landforms provided by the client were used in the stability and deformation analysis. The landforms were modelled to account for long-term degradation due to erosional processes.
- Portals were assumed to be sealed at Mine closure.

In our analysis, a complex model was constructed to simulate the site-specific conditions, encompassing relevant input parameters and utilising Rocscience's software - Slide 3 for limiting equilibrium stability analysis and RS3 for numerical analysis of the landform's deformational characteristics. The study encompassed stability analyses for the highwall and the final landform backfill material. For the final landform, simulations were conducted under static and pseudo-static (seismic) conditions, targeting a long-term stability factor of safety of 1.5 under static conditions and 1.1 for pseudo-static conditions.

The highwall analysis revealed a local minimum Factor of Safety (FoS) of 1.3 for both E and B Pits, localised in the residual material. While recorded in specific areas, these results were deemed non-influential to the overall slope stability. Similar results were observed in the backfill landform analysis, with localised lower safety factors recorded in M Pit. Despite these localised lower FoS in the mentioned location, it is important to emphasise that these areas still exhibit adequate stability.

Acknowledging the localised lower safety factors, it is crucial to highlight that all other Pits demonstrated favourable outcomes, meeting the long-term stability requirement with a safety factor greater than 1.5. In the analysis of pseudo-static conditions, all assessed Pits also met the stability requirement, exhibiting a factor of safety greater than 1.1.

Deformation analysis assessed long-term settlement and potential subsidence from highwall-void interactions and landform stability settlement. Analysis results indicated a deformation range between 140 mm to 350 mm settlement across the pits, with the highest settlement recorded in A-Pit and the lowest in M-Pit. The deformation analyses also considered the effects of time-dependent rockmass deterioration, which can manifest as highwall cracking or dilation of exposed discontinuities. Long-term radar monitoring trends were analysed, and results were adopted to account for time-dependent effects on stability.

Based on the above methodology and assessments, it can be concluded that the geotechnical analysis approach considered in the analysis of the Millennium Mine addressed Sections 3.6.2, 3.6.3, and 3.6.4 of the Guideline - PRC Plan. The analysis results indicated long-term stability conditions for the final landform and the exposed highwalls. With the final landform modelled integrating long-term degradation/erosion and predisposition to ongoing stability issues as well as associated groundwater changes, the stability and deformation models simulate expected stability conditions for the proposed final landform and provide a basis to conclude that the proposed final landform will be a geostable landform.

1 Introduction

The Millennium Coal Mine is approximately 15 km east-southeast of Moranbah, 3 km north of the Isaac River, and 2 km south of the Peak Downs Highway in central Queensland.

The mine consists of two open cuts: Millennium Pit and Mavis Pit. Millennium Pit includes the pit voids south of the Daunia Access Road: A Pit, B Pit, the backfilled and rehabilitated C Pit, and the associated out-of-pit dumps. Mavis Pit includes the pit voids north of the Daunia Access Road: D Pit, E Pit, M Pit, the backfilled and rehabilitated northern portion of E Pit, and the associated out-of-pit dumps. Mining operations at the mine involve conventional open-cut coal and waste hauling using haul trucks, excavators, and loaders. Augering of final highwalls and endwalls is also conducted where suitable. Underground bord and pillar mining operations are also undertaken with access to workings via the portals located in E Pit highwall.

The structural geology at Millennium Mine is complex. Figure 1 provides a layout of the mine for the Millennium Mine operation, and Figures 2-8 show the current conditions of each pit. The mine is undergoing closure and rehabilitation, backfilling the M trench and the E Pit using mine spoil. To ensure compliance with the conditions specified in the PRCP Guideline for the planned post-closure pit design, M Mining has commissioned CM&G to assess the geotechnical stability and deformation of the proposed PRC plan.

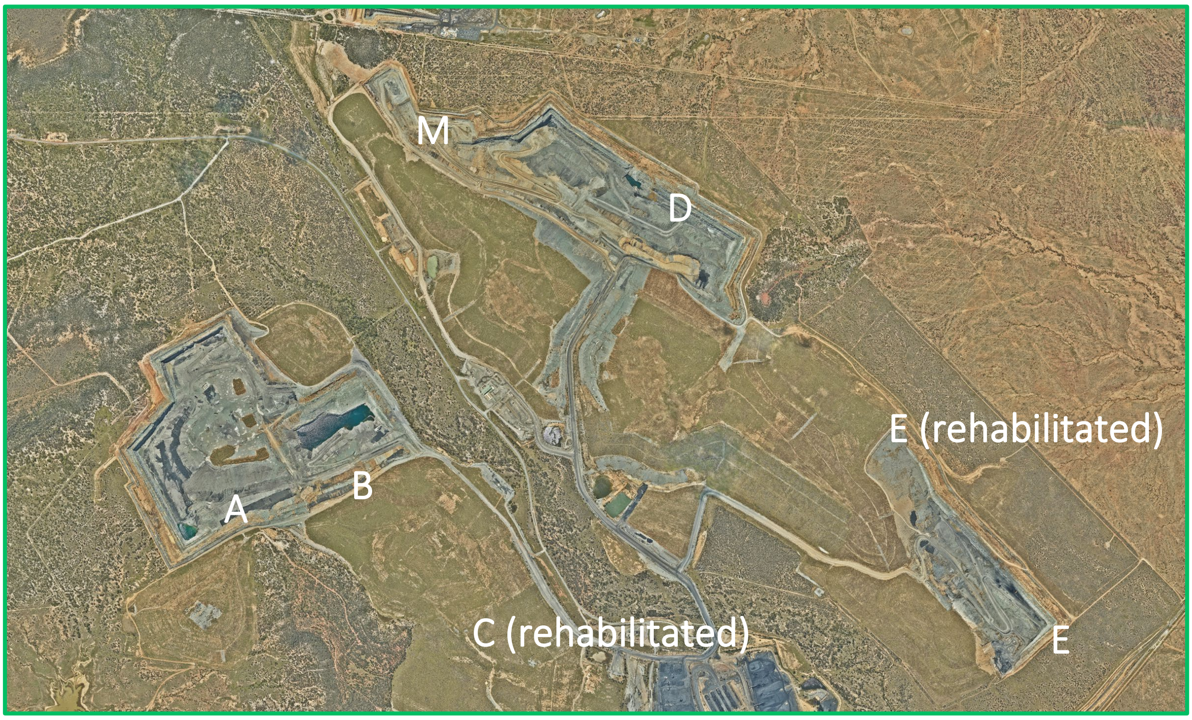

Figure 1: Millennium Mine Pit Layout

- A Pit

Located south of the mine layout, production was completed by mining up-thrown coal below the high wall. Production drilling was underway along the western end of the strip.

Figure 2: View of coal exposure and structures exposed in the highwall in A South.

- M Pit

Mining in M pit was completed.

Figure 3: Highwall mining in M pit before backfilling

Backfilling of M Pit is underway, with rejects being pushed into the remaining M Pit void.

Figure 4: Reject dump in M Pit.

Figure 5: Drone view of recent backfilling in M Pit.

- D Pit

D Pit South is currently used for water storage, while tailings are being dumped in the northern half of D Pit.

Figure 6: Water being stored in D Pit North.

- B Pit

Weathered spoil material from the A Pit South mining area has been dumped onto a bench within B Pit; see.

Figure 7: View of the B Pit low wall dump, looking southeast.

- E Pit

E pit is currently undermining.

Figure 8: E-Pit showing current highwall and low wall.

2 Scope of Work

The Scope of Work included the following items:

- Review and incorporate results from other relevant work completed by other consulting parties.
- Geotechnical modelling predicting long-term stability* (factor of safety, etc.) of M, D, E, A, and B pits, including mining voids, designed landforms, and geologic structures**.
- Information about the pit wall geotechnical stability and deformation.
- B pit landform levee stability assessment
- Address the PRCP Guideline requirements:
  i. Assess each final void's landform design** Consider the effects of significant groundwater level variation after mine closure.
  ii. Predict the long-term pit walls' geotechnical stability considering the effects of recovered groundwater levels.
  iii. Geotechnical assessments of the impact of the underground openings, i.e., augers, HW Miners, and board pillars, on the stability and deformation of pit walls.

The typical section of every pit is shown in Figures 9-14.

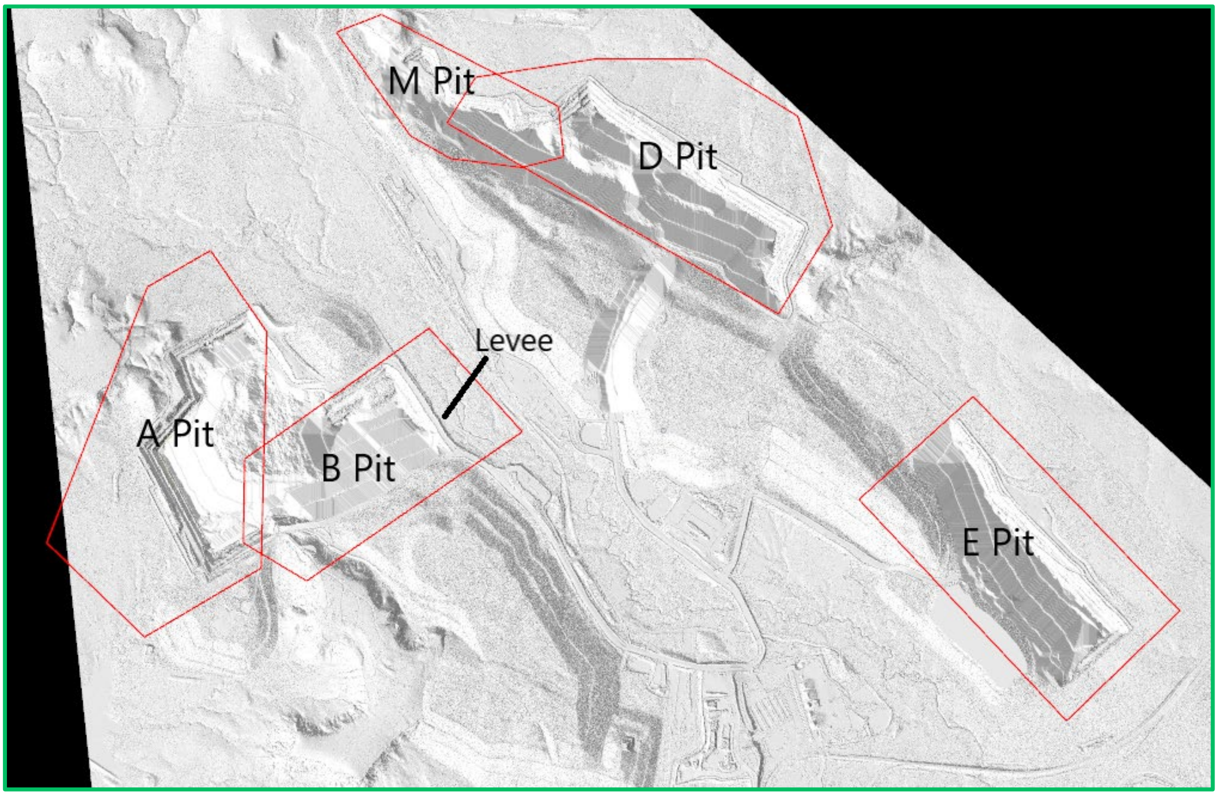

Figure 9: Plan view of the designed final landform and the locations of each pit

* This report focuses on landform stability in the Millennium Mine PRCP geotechnical assessment. For the underground mining considerations, including stability assessments, please refer to Gordon Geotechniques' comprehensive report. Their findings and recommendations regarding underground stability are integral to the overall geotechnical evaluation of the site.

**The designed landform is depicted in Figure 1 with the locations of each pit. The designed slope of the backfill landform is 25%. The slope of the designed highwall, as indicated in Figures 15 and 16, is 70°.

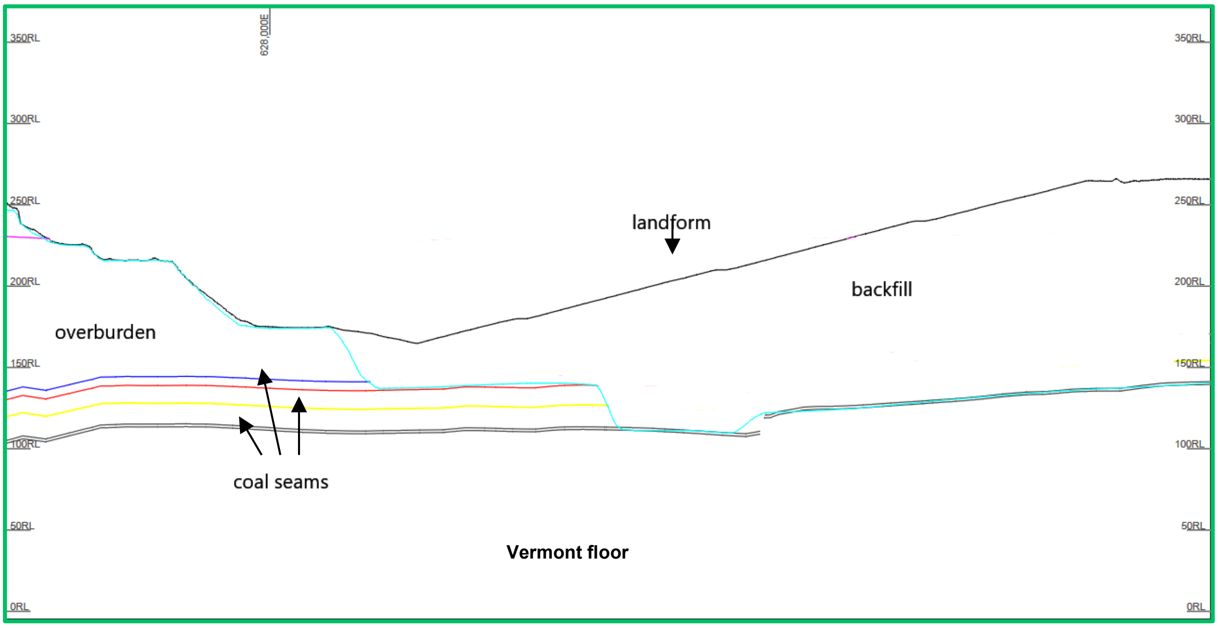

Figure 10: Typical section of A Pit

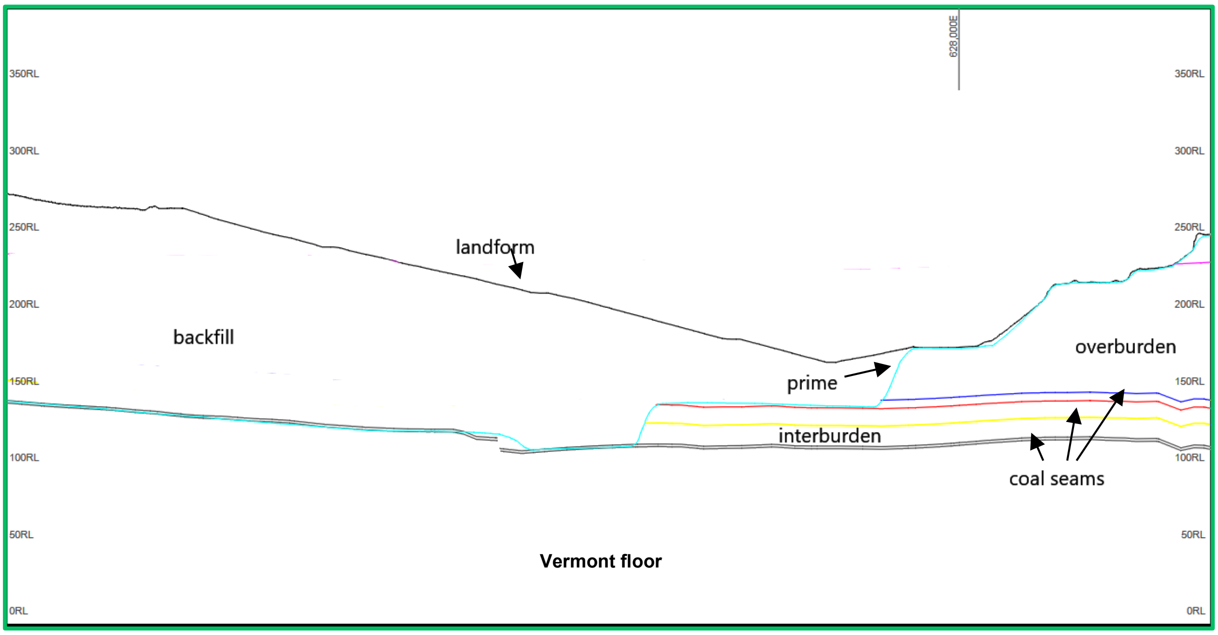

Figure 11: Typical section of B Pit

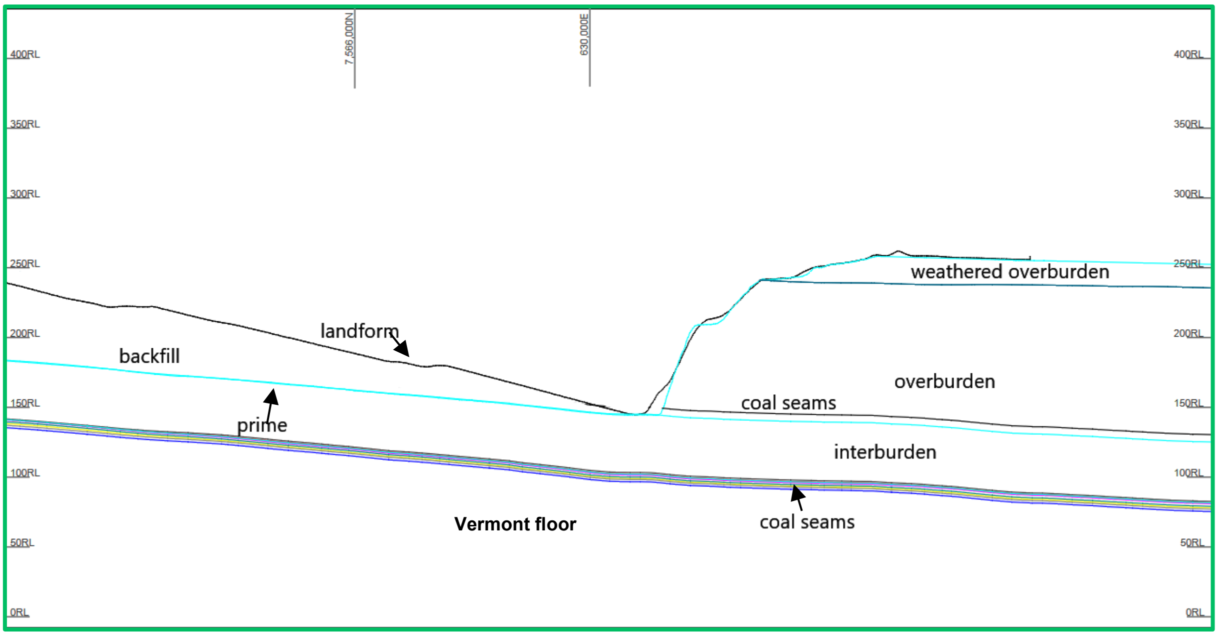

Figure 12: Typical section of D Pit

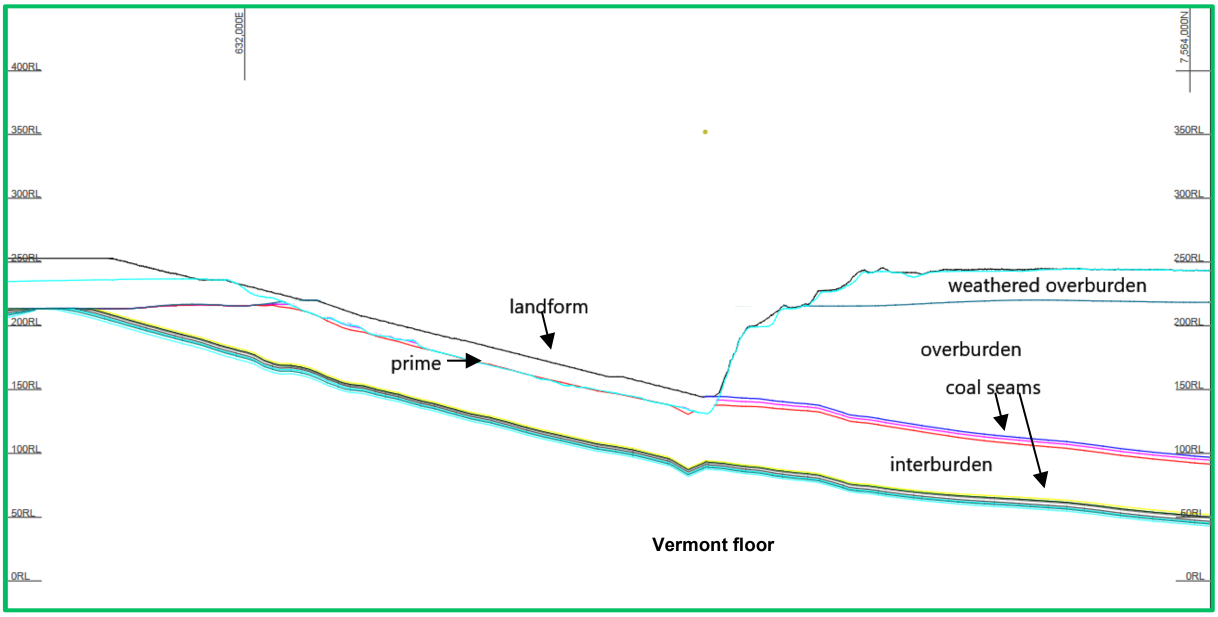

Figure 13: Typical section of E Pit

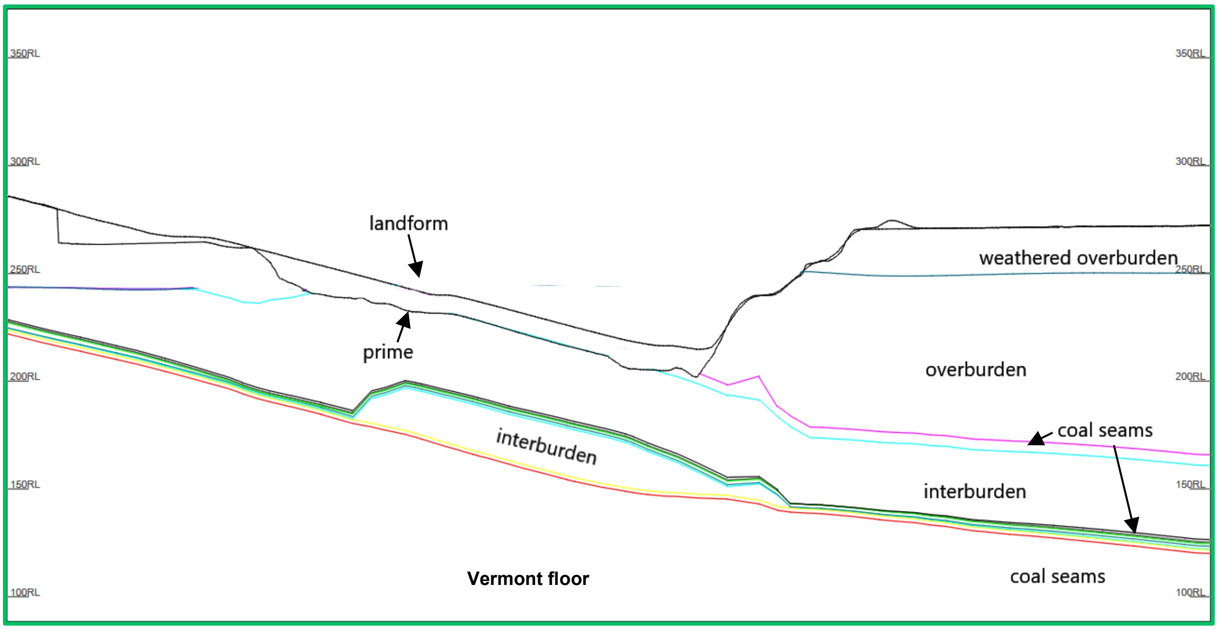

Figure 14: Typical section of M Pit

3 Background

3.1 Lithological Sequence and Geotechnical Domains

Table 1, Table 2, and Figure 2 summarise the lithological sequence of the Mine site.

Table 1: Typical Millennium Pit lithological sequence

Depth below Ground Surface (m)	Lithology
0 – 3 m	Clay and residual soil
3 – 15 m	Weathered sandstone and siltstone (base of weathering +/- 15 m)
15 – 65 m	Sandstone (30%), siltstone (65%) and mudstone (5% - above coal)
65 – 72 m	**Leichhardt Coal Seam (average thickness 4.5 m, range 4.0 m to 8.5 m)**
72 – 84 m	Siltstone (90%) and sandstone (10%)
84 – 85 m	**Millennium Coal Seam (average thickness 0.7m, range 0.5m to 0.9m)**
85 – 97 m	Siltstone (85%) and mudstone (15% - above coal)
97 – 99 m	**Vermont Upper Coal Seam (average thickness 2m)**
99 – 105 m	Mudstone (100%)
105 – 116 m	Siltstone (80%), sandstone (15%) and mudstone (5% - above the coal)
116 – 118 m	**Vermont Lower Coal Seam (average thickness 2m)**
118 – 120 m	Mudstone (100%)
120 – 126 m	Siltstone (100%)
126 – 158 m	Sandstone (100% - mainly clean sandstone)
158 – 180 m	**Girrah Coal Seam – coal (50%), carb, shale (15%), siltstone (35%)**

Table 2: Typical Mavis Pit lithological sequence

Unit	Description
Residual Soil	Clayey residual soil
Weathered Overburden	Weathered sandstone and laminated siltstone
Fresh Overburden	Interlaminated sandstone, siltstone, and mudstone
Leichardt Coal Measures	Leichardt coal seam measuring up to 5.5 m in thickness.
Leichardt – Millennium Interburden	Interlaminated sandstone, siltstone, and mudstone
Millennium Coal Seam	Millennium coal seam measuring up to 1.0 m in thickness.

Millennium – Vermont Interburden	Interlaminated sandstone, siltstone, and mudstone
Vermont Upper Coal Seam	Vermont Upper coal seam measuring up to 2.0 m in thickness
Vermont Upper – Vermont Lower Interburden	Interlaminated sandstone, siltstone, and mudstone
Vermont Lower Coal Seam	Vermont Lower coal seam
Vermont Floor	Interlaminated sandstone, siltstone, and mudstone

The seams generally dip at less than 10° (between 3° and 10°) within A, B, and D Pits and between 15° and 25° in E and M Pits. The seams dip in a direction generally between south-west (A and B Pits) and north-northwest (D, E, and M Pits), intersected by large-scale regular and reverse faults with localised steepening of the dip. One of the main structural features is the A-Fault structure, which runs NNW-SSE and separates A Pit from B Pit. This fault dips between 25° and 35° to the west and has a vertical displacement of about 80 m. Numerous smaller fault structures occur within the Pit in various attitudes.

Geotechnical domains are defined as sections of a mining area with similar rock mass characteristics, structural aspects, lithology and responses to excavation.

Some of these geotechnical domains are shown in Figures 8-10, showing the weathered Permian, fresh Permian, and Site characteristic fault systems.

Figure 15: Typical section of M Pit

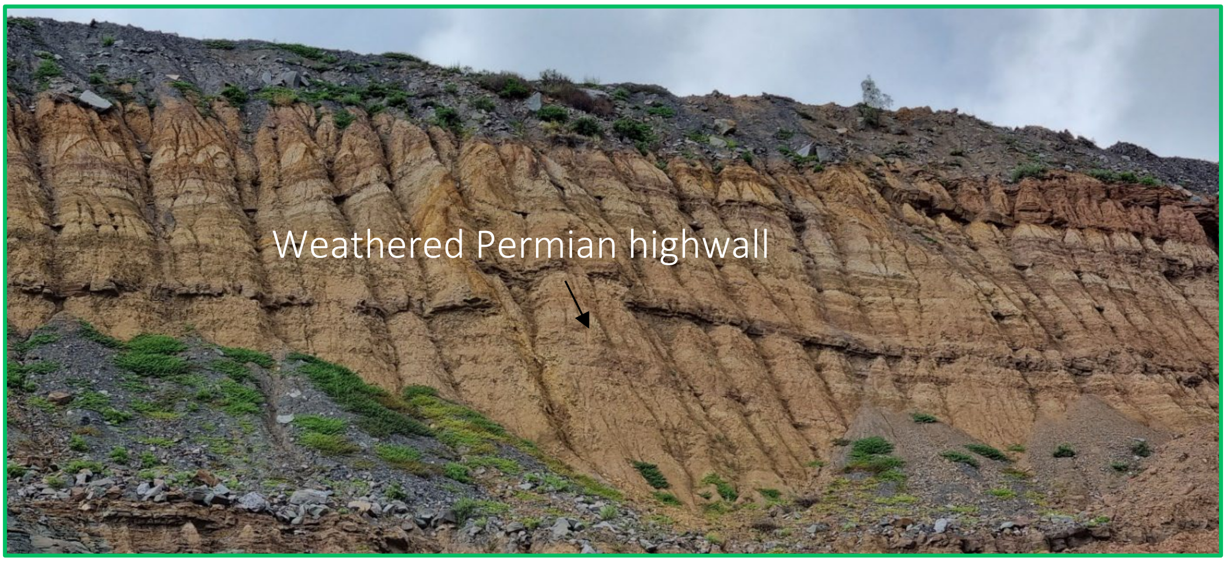

Figure 16: Typical section of M Pit

Figure 17: Typical section of M Pit

The Millennium Mine deposit has been subdivided into seven geotechnical domains based on geological and geotechnical pit wall mapping, as shown in Table *3*.

Table 3: Geotechnical Domains

Domain	Code	Description
Weathered Overburden	WOB	Weathered sandstone and laminated siltstone
Overburden	OB	Interlaminated sandstone, siltstone, and mudstone
Leichardt – Millennium Interburden	Int_L/M	Interlaminated sandstone, siltstone, and mudstone
Millennium – Vermont Upper	Int_M/VU	Interlaminated sandstone, siltstone, and mudstone
Vermont Upper Floor	VU_F	Interlaminated sandstone, siltstone, and mudstone
Coal	Coal	All coal measures
Major Fault Zone	Fault	A, B, C and D Fault zones – highly sheared and weak siltstone, sandstone and coal

3.2 High Wall Mining

A standard slope design must be used for in-situ walls, as illustrated in Figure 18 and 19. The main characteristics are:

- All berms are to be designed to a Reduced Level (RL) to ensure consistent drilling horizons unless following a floor of coal.
- Batter angle in the superficial/weathered rock is to be 45°.
- Rock benches are to be pre-split at 70°.
- The maximum bench height in rock is not to exceed 65 m.

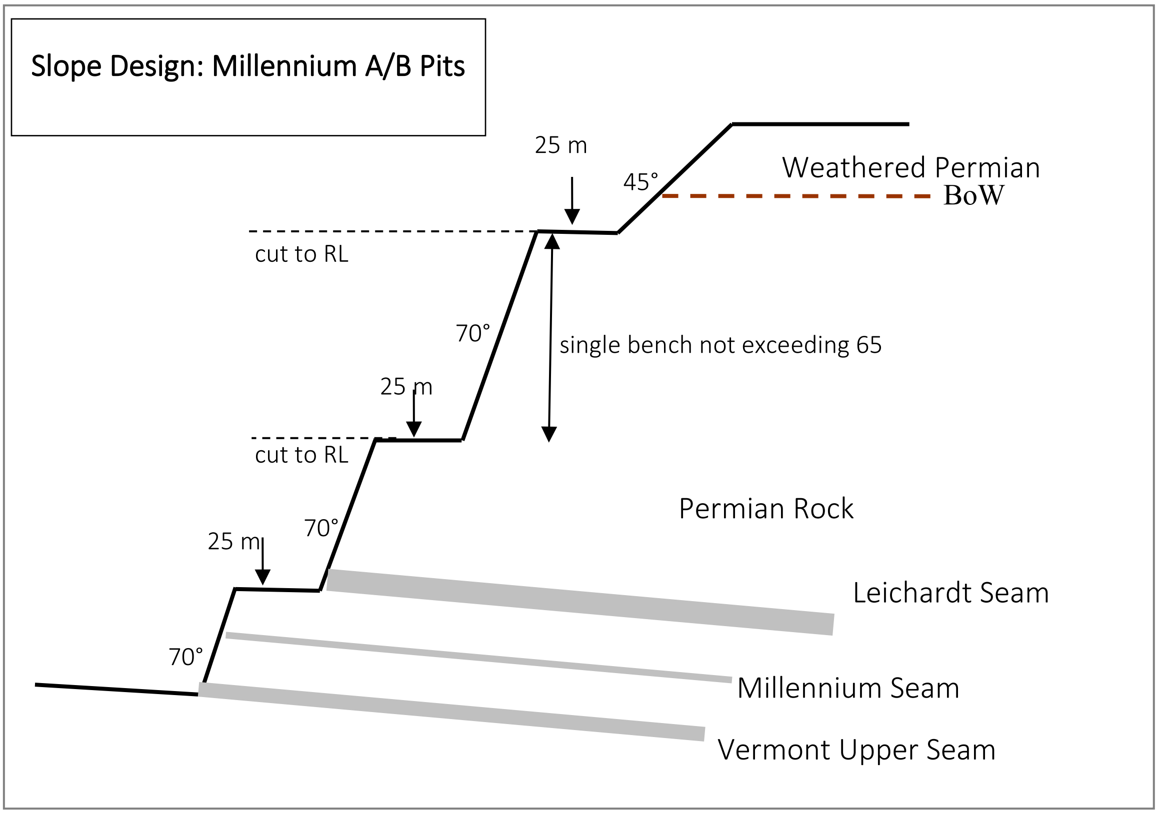

Figure 18: Standard slope design for in-situ walls – Millennium Pit

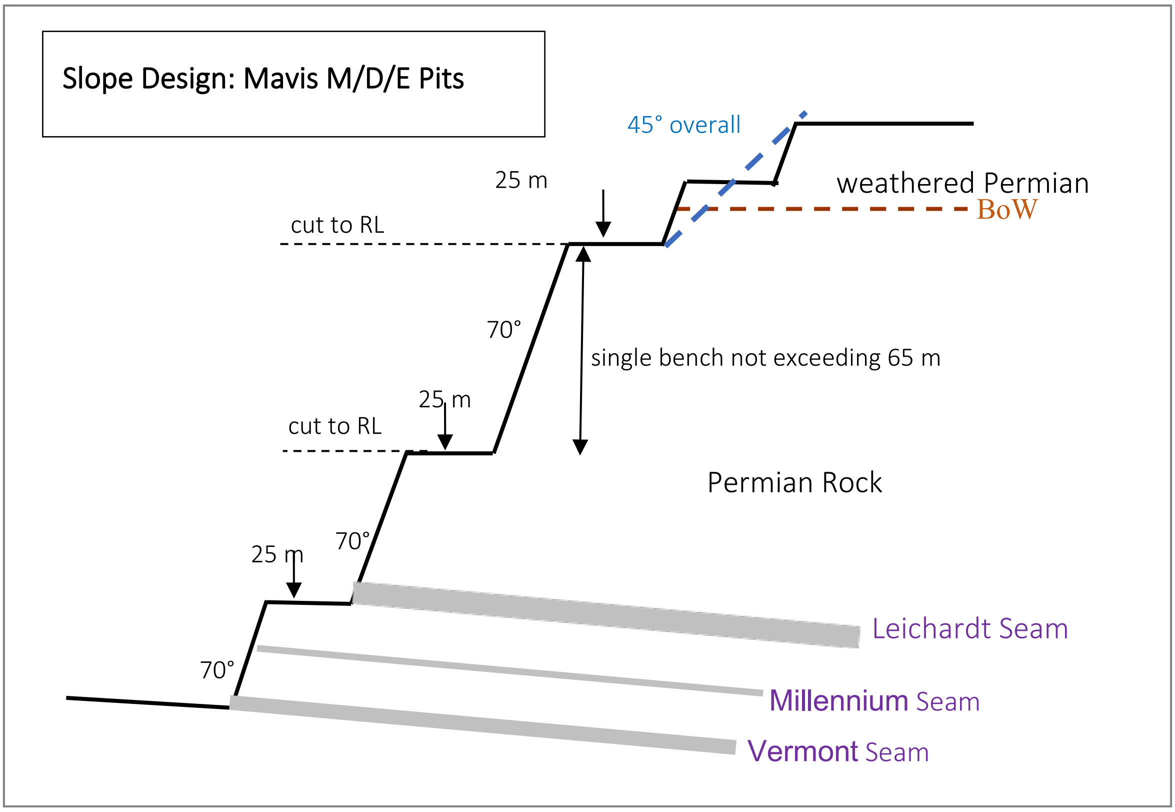

Figure 19: Standard slope design for in-situ walls – Mavis Pit

As indicated in Figures 18 and 19, the standard slope design is applied across all open-cut excavations. Any necessary variation to match local conditions or operational needs is subject to geotechnical review before implementation. Fault zones intersecting the walls might create unstable conditions and are usually assessed to determine if any modification to the standard design is warranted.

Historically, Millennium Mine implemented auger mining of the Leichardt seam, and potentially the Vermont Upper seam, to maximise the reserves recovery. The augering contractor engaged their geotechnical consultant to design the auger panels. The reviewed design information considered the stability of the roof and floor at the portal, targeting a factor of safety of 1.5 at the portal entrance and 1.2 further within the plunge of the auger, the pillar width and the septum's (vertical separation) thickness.

3.3 Information Provided

CM&G reviewed the below reports:

- CM&G (2022) Geotechnical Reference Report
- CM&G (2022) E PIT LOWWALL GEOTECHNICAL ASSESSMENT FOR AUGER MINING
- CM&G (2022) M EXTENSION - GEOTECHNICAL DESIGN REVIEW
- CM&G (2022) MMI010002-BS_A Pit South - Geotechnical Design Review
- GeoTek Solutions (2021) Millennium Mine, D & E Pits, HWAM Geotechnical Assessment v0.4
- GeoTek Solutions (2022) Millennium Mine, M & D Pits, HWAM Geotechnical Assessment v1
- GeoTek Solutions (2022) Millennium Mine, M Pit Trench, HWAM Geotechnical Assessment v1.0
- GeoTek Solutions (2022) Millennium A-Trench HWAM Geotechnical Recommendations
- Topographic surfaces:

- Ground surface (topo_original.00t)
- Base of weathering (bhwe_sf.00t, milbhwe.sft)
- Prime (Millennium master prime model.duf)
- Final landforms (A&B Pits Final Landform 230809.duf, E Pit Final Landform 230726.duf, M&D Pit Final Landform 230726.duf)
- Mavis Downs coal seams (mavll.sfg, mavll.srg, mavlu.srg, mavvl.sfg, mavvl.srg, mavvu1.sfg, mavvu1.srg, mavvu1a.sfg, mavvu1b.srg, mavvu2.sfg, mavvu2.srg)
- Millennium coal seams (milll1.sft, millu.srt, milmu.sft, milmu.srt, milvu1.sft, milvu1.srt)
- Auger working (Mpit.trench_Auger_2023.06.22, Mpit_Auger_2023.06.20, Mpit_Auger_2023.06.27,Apit_Auger_2023.08.01 solids, Apit_Auger_Vermont_Trench_2023.08.04 solids fixed, Bpit_Auger_LL_2023.08.01 solids, Bpit_Auger_LU_2023.08.01 solids, Dpit_Auger_2023.06.30 solids).
- HWM working (Dpit_HWMiner_2023.06.30 solids, Epit_HWMiner_2023.06.30 solids, ABpit_HWMiner_2023.06.30 solids, Epit_HWMiner_2023.06.30 solids)
- Bord pillars (MIL & MAV UG Designs)
- SLR (2023) Groundwater levels (eads_ss_rec_sp154_water_table_ct.shp)
- Gordon Geotechniques (2023) Subsidence report for the Mavis Downs south bord and pillar project)

Faults systems:

- F_001.00t, F_002.00t, F_003.00t, F_004.00t, F_005.00t, F_006.00t, F_007.00t, F_008.00t, F_009.00t, F_010.00t, F_011.00t, F_012.00t
- FLT_001.00t, FLT_002.00t, FLT_003.00t, FLT_004.00t, FLT_005.00t, FLT_006.00t, FLT_007.00t, FLT_008.00t
- a1.00t, a2.00t, a3.00t, a4.00t, a5.00t, a6.00t, a7.00t, a8.00t, a10.00t, a11.00t, a12_dyke_zoneAa.00t, a12_dyke_zoneAb.00t, a12_dyke_zoneAc.00t, a12_dyke_zoneAd.00t, a12_dyke_zoneBc.00t, a12_dyke_zoneBd.00t, a12_dyke_zoneBe.00t, a12_dyke_zoneBf.00t, a14.00t, a17.00t, a18_J.00t, a19.00t, a20.00t, a21.00t, a25.00t
- d1.00t, d2.00t, d3.00t, d4.00t, d5.00t, d6.00t, d7.00t, d8.00t, d9.00t, d10.00t, d11.00t, d12.00t, d13.00t, d14.00t, d15.00t, d16.00t, d17.00t, d18.00t, d19.00t, d20.00t
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3.4 Document Reviews

Reviewed documents in section 3.3 highlight the different strategies and methodologies applied to analyse various aspects of the mining voids during the closure and post-closure phases. Relevant information critical to the stability and deformation analysis was extracted and used in the model setup. Millennium Mine provided the hydrological and geotechnical input parameters inferred from other studies, discussed in Section 4.

4 Stability Assessment Criteria

The factor of safety (FoS) is based on the consequences of failure, such as injury, loss of life, equipment damage, production loss, infrastructure detriment, and uncertainty. Table 4 provides recommended design safety factors for various civil engineering applications. The FoS for slopes can range from 1.25 to 1.5 for long-term stability, depending on the conditions under investigation.

Table 4 Summary of FoS values in literature

Material type	Conditions	Acceptance Level (static)	Reference
Soil earthworks	Normal loads and service conditions	1.5	Meyerhof (1984)
	Maximum loads and worst environmental conditions	1.3	
Earth-retaining structures and excavations	Normal loads and service conditions	2	
	Maximum loads and worst environmental conditions	1.5	
Slopes	Cohesionless soils	1.3	
	Cohesive soils	1.5	
	Based on field vane tests corrected for strain rate and anisotropic effects	1.3	Bjerrum (1973)
		1.25	Bowles (1979)
	The highest value for serious consequences of failure or high uncertainty	1.25-1.5	Gedney & Weber (1978)
		1.5	Hansen (1967)
		1.3-1.5	Meyerhof (1970)
		1.3-1.4	Sowers (1979)
	Lower values for temporary loading	1.5	Terzaghi (1943)
		1.25-1.3	
	Permanent or sustained conditions	1.5	US Navy Department (1962)
	Permanent	1.5	SAICE COP (1989)

The applicability of FoS values used for civil engineering slopes to open pit mine slopes is a topic of discussion. In the past, open pit slope stability assessments have used a margin of safety, as shown in Table 5.

Table 5 Minimum design Factor of Safety (FoS) and Probability of Failure (PoF) criteria for open pit walls, as per the Department of Minerals and Energy Geotechnical Considerations for Open Pit Mines Guideline

Wall Class	Consequence of Failure	Design FoS	Design PoF	Pitwall Example
1	Not Serious	Not applicable		Inactive pit walls not carrying major infrastructure and, where appropriate, TARP provisions can contain potential failures
2	Moderately Serious; can be contained by TARP provisions	1.2	10%	Active pit areas, pit walls not carrying major static or mobile assets and being worked following compliance parameters.
3	Serious; a recognized risk to equipment and operators	1.3	1%	Active pit or industrial areas within the lease where pit walls carry major mine assets/infrastructure or where adequacy of compliance parameters is uncertain
4	Unacceptable	1.5	0.3%	Permanent pit walls near public infrastructure, flood protection levees and adjoining leases

Comparing Table 4 and Table 5, a factor of safety of 1.5 is generally acceptable as an indicator of long-term stability.

Regarding seismic assessment, the minimum FoS adopted differs from that of static conditions. In the mining industry, slope stability analysis for mining pits is based on the slope scale and the high consequences of failure. Table 6 provides the widely accepted slope design acceptance criteria (Stacey & Read, 2009).

Table 6 Typical FoS and PoF acceptance criteria values (Stacey & Read, 2009)

Slope scale	Consequences of failure	Acceptance criteria [a]	
		FoS (min) (static)	FoS (min) (seismic)
Bench	Low-high [b]	1.1	NA
Inter-ramp	Low	1.15-1.2	1.0
	Moderate	1.2	1.0
	High	1.2-1.3	1.1
Overall	Low	1.2-1.3	1.0
	Moderate	1.3	1.05
	High	1.3-1.5	1.1

a: Need to meet all acceptance criteria.
b: Semi-quantitatively evaluated.

Based on Table 6, it can be concluded that a minimum FoS of **1.1** is acceptable for seismic analyses.

5 Design Studies

5.1 Topography

Historical topographical surfaces and final landform designs were combined to create a model of the geological settings to simulate stability and deformation conditions.

5.2 Hydrogeology

Millennium Mine's Geotechnical Reference Report (GRR) states that the groundwater table varies from 17 m to 80 m below the ground surface, with an average depth of 32 m across the mine site. Groundwater flow mainly occurs within the coal seams, with expected flow rates ranging from 0.5 L/s to 3.0 L/s.

According to the groundwater review report by AGE (Australasian Groundwater and Environmental Consultants Pty Ltd., February 2014), the average groundwater level is approximately 33 m below ground level (mbgl) based on seven measurements.

Four boreholes were drilled to monitor the groundwater. The latest groundwater levels can be found in Table 7.

Table 7 Current Water Table Monitoring Data

Location	Coordinates		MBGL	GL (mRL)	Water Level (mRL)
MB2	627802	7563273	85.71	297.433	211.723
MB8B	627392	7565798	64.44	260.332	195.892
MB9A	628537	7565604	23.25	254.338	231.088
MB10A	630730	7563772	18.57	235.353	216.783
Average					213.872

Modelling was conducted to simulate long-term seasonal variations, applied in the geotechnical models, considering the seasonal changes that influence surface and groundwater levels. M Mining engaged SLR Consulting to conduct long-term groundwater modelling and KCB Consulting to conduct the surface water modelling. The groundwater models were provided to CM&G and were integrated into the final landform geotechnical model to assess the effects of the groundwater conditions on landform stability conditions. The results of the simulations are presented in Figure 10 and will be utilised in this assessment.

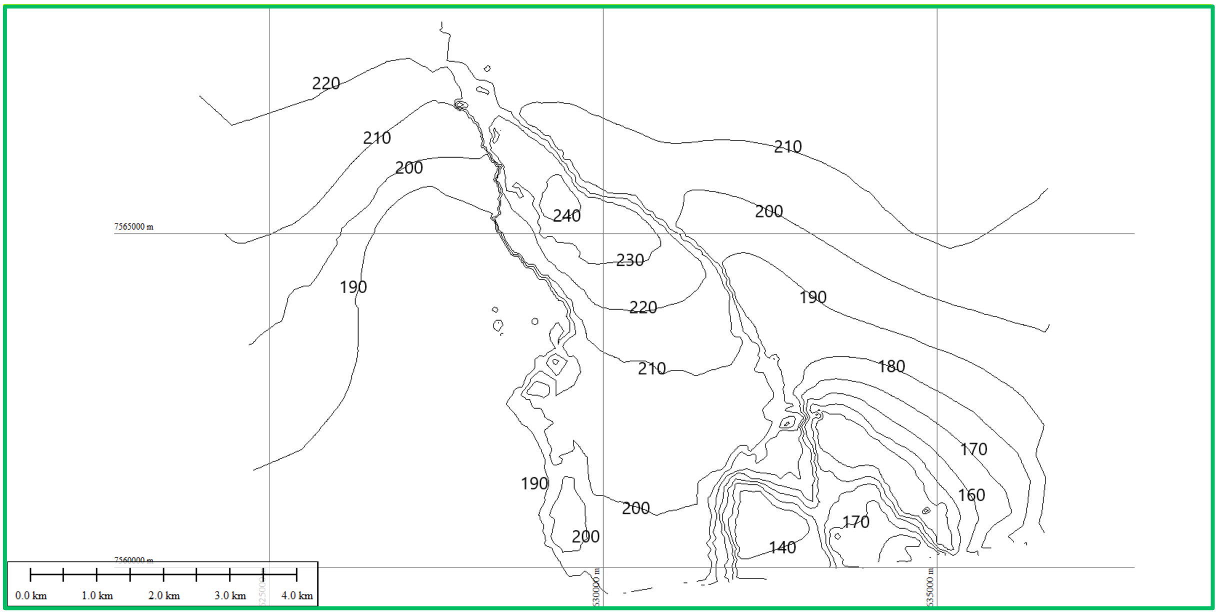


Figure 20: Modelled long-term groundwater contours (*Source: SLR Consulting*)

5.3 Geotechnical Site Investigations

Several geotechnical site investigations have been carried out, some specifically for this study and others for earlier similar projects in the same area.

5.3.1 Previous Geotechnical Investigation

The following previous geotechnical works are relevant to this study:

- In 2022, Blackrock Mining Solutions conducted the numerical analysis of the A Pit highwall auger mining, in which the following values for Poisson's Ratio (υ) and the Young's Elastic Moduli (E_i) $\upsilon = 0.25,\ E_i = 13.5\ GPa$ were applied for all the geomechanical materials, respectively; and
- M Mining undertook geotechnical borehole drilling and laboratory tests in 2015. The laboratory test results are summarised in Table 14. The strength and deformation parameters are listed in Table 7 and Table 8, respectively, and
- M Mining engaged CM&G to compile a Geotechnical Reference Report to present the geotechnical parameters and structural domains at Millennium Coal Mine; the results are Tables 9-11
- CM&G conducted a series of geotechnical assessments. The adopted parameters are listed in Tables 12 and 13.

Table 8 and 9 summarise laboratory testing data for drilled boreholes at Millenium Mine, shown in Appendix A.

Table 8: Deformation parameters from Geotechnical investigation conducted in 2015

Material	UCS (kPa)	Moisture Content (%)	Wet Density (gcm^{-3})	Dry Density (gcm^{-3})	Young's Modulus (GPa)		Poisson Ratio	
					Tangent	Secant	Tangent	Secant
BDLU	32.15	2.18	2.61	2.56	15.000	14.285	0.173	0.133
LU	5.63	3.01	1.47	1.41	2.072	1.653	0.214	0.143
BDVU	22.26	2.54	2.53	2.46	8.436	7.740	0.211	0.135
VU	5.61	4.20	1.41	1.36	2.213	1.828	0.203	0.158

Note: UCS stands for the uniaxial compressive strength

Table 9: Strength parameters from Geotechnical investigation conducted in 2015

Material	Strength Type	Residual		Peak	
		Friction Angle ϕ (°)	Cohesion c (kPa)	Friction Angle ϕ (°)	Cohesion (kPa)
LUROOF	Mohr-Coulomb	28.75	107.25	40.85	1579.35
LLFLOOR	Mohr-Coulomb	29.70	56.23	43.87	1295.23
VUROOF	Mohr-Coulomb	23.70	144.10	45.50	192.50
VUFLOOR	Mohr-Coulomb	35.50	122.80	47.40	568.60
Average	Mohr-Coulomb	29.41	107.60	44.40	908.92

The strength properties of highwall rockmass, endwall rockmass, low wall rockmass and dump materials are critical for stability analysis.

The rock mass properties for material types at Millennium Mine are shown in Tables 10 and 11.

Table 10: Rock mass properties for A, B and C Pits in the Geotechnical Reference Report (CM&G,2022)

Domain	Shear Strength (MPa)	RQD (%)	GSI	Cohesion (kPa)	Friction Angle (°)
Weathered Overburden	9	55*	50	109	35.6
Overburden	41	84	55	574	40.7
Coal	9	28	30	139	27.9
Interburden Leichardt/Millennium	29	89	66	655	38.0
Interburden Millennium/Vermont	32	62	50	378	32.4
Vermont Floor	27	54	51	368	31.3

Fault	8	3	25	74	13.8

Table 11: Typical Bowen Basin Strength Properties in the Geotechnical Reference Report (CM&G,2022)

Material	Unit Weight (kN/m^3)	Cohesion (kN/m^3)	Friction Angle (°)	UCS (MPa)
Category 1 – Unsaturated CAT1U Spoil	18	20	25	0.06
Category 1 – Saturated CAT1S Spoil	20	0	18	0.00
Category 2 – Unsaturated CAT2U Spoil	18	30	28	0.10
Category 2 – Saturated CAT2S Spoil	20	15	23	0.05
Category 3 – Unsaturated CAT3U Spoil	18	50	30	0.17
Category 3 – Saturated CAT3S Spoil	20	20	25	0.06
Category 4 – Unsaturated CAT4U Spoil	18	50	35	0.19
Category 4 – Saturated CAT4S Spoil	20	0	30	0.00
Soil - Unsaturated	20	50	30	0.17
Soil - Saturated	20	15	30	0.05
DW Sedimentary Rock	22	100	30	0.35
DW Sedimentary Rock Blasted	22	40	30	0.14
SW Sedimentary Rock	24	150	35	0.58
SW Sedimentary Rock Blasted	18	60	30	0.21
FR Sedimentary Rock	24	450	42	2.02
FR Sedimentary Rock Blasted	22	100	30	0.35
Oxidised Coal	15	0	30	0.00
Friable Coal	15	30	35	0.12
Sheared Interface	24	0	15	0.00
Sheared Low-wall Floor	20	0	15	0.00
Ripped/Dozed Floor	22	23	25	0.07
Blasted/Cratered Floor	22	30	28	0.10
DW Basalt	20	75	30	0.26
FR Basalt	25	750	45	3.62
Dozed Floor Material	22	0	30	0.00

Remoulded High Plasticity Clay	18	0	10	0.00
Compacted Soil	20	60	30	0.21

Table 12: Historical External Consultant Strength Properties in the Geotechnical Reference Report (CM&G,2022)

Material	Unit Weight (kN/m^3)	Cohesion (kN/m^3)	Friction Angle (°)	Reference
Waste Rock	18	50	30	Simmons and McManus (2004)
Intact Rock Mass	25	350	38	Prime Geotechnics (2007b)
Weak Seam	25	10	18	Prime Geotechnics (2007b)
Wet Tailings (Saturated)	20	0	10	Prime Geotechnics (2007b)
Dry Tailings	15	0	27	Prime Geotechnics (2007b)

Table 13: Shear Strength Parameters Adopted in E Pit Low-wall Stability Assessment (CM&G, 2022)

Material Name	γ (kN/m^3)	c′ (kPa)	ϕ′ (deg)	UCS (kPa)	GSI	mi	D
Cat2 Unsaturated Spoil	18	30	28	-	-	-	-
Cat2 Saturated Spoil	20	15	23	-	-	-	-
Weathered Permian-aged Sedimentary Materials	24	75	30	-	-	-	-
Fresh Permian-aged Sedimentary Materials	24	450	42	-	-	-	-
Coal	15	30	35	-	-	-	-
Leichardt Floor	20	-	-	9000	50	7	0
Shear Surface	20	0	24	-	-	-	-
Buttress	20	0	40	-	-	-	-

5.3.2 Material parameters adopted in this assessment.

Deformation Parameters

In 2022, Blackrock Mining Solutions conducted the numerical analysis of the A Pit highwall auger mining, in which the values $\upsilon = 0.25, E_i = 13.5\ GPa$ were applied for the geotechnical materials for weathered and intact sedimentary rock, and coal seams. However, these parameters are significantly discrepant with the laboratory test results conducted in 2015 geotechnical investigations. Back analyses were conducted for the A-Pit to determine relative long-term deformation trends, where modelled displacements were verified against long-term ground-based radar monitoring trends.

The deformation parameters adopted in the back analysis are listed in Table 14, and the deformation results of the A-Pit highwall are plotted in Figure 21. The calculated total displacements in A-Pit range from 0.048 to 0.24m. The monitored radar monitoring long-term total displacements in the A-Pit highwall are shown in Figure 21. The minimum and maximum values and the general trend from crest to toe of the highwall match well by comparing the calculated results with the monitoring data. Therefore, these parameters are considered reasonable and adopted in the ongoing deformation analysis of M, D, E, A, and B Pits under the final landform conditions.

Table 14 Adopted Deformation Analysis Material Parameters

Material	Poisson's Ratio	Young's Modulus (MPa)
Unsaturated Backfill	0.15	200
Saturated Backfill	0.15	200
Weathered Overburden	0.133	1028.5
Overburden	0.133	1028.5
Interburden	0.135	774
Coal Seam	0.158	182.8
Vermont floor	0.135	774
Fault	0.2	10(Shear)/100(Normal)

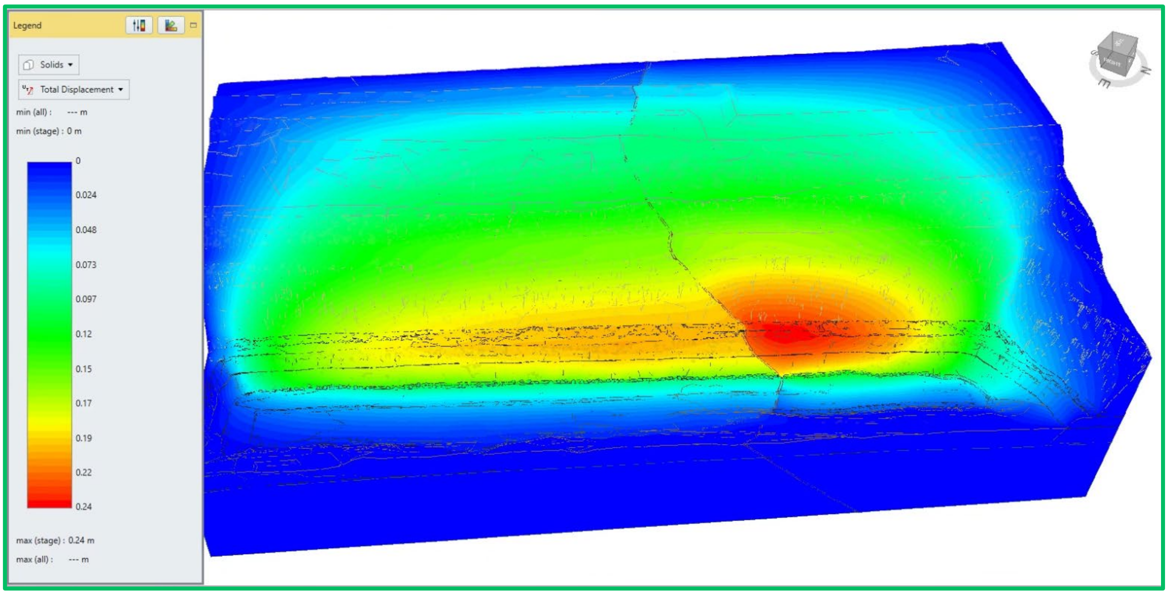


Figure 21 Total Displacements in A Pit Highwall from Back Analysis

Figure 22 Ground-based radar monitoring highwall displacement trends (Dec 2022 – April 2023) in A Pit Highwall.

Strength Parameters

Material strength parameters adopted in E Pit Low-wall Stability Assessment (CM&G 2021) were used in previous Millennium Mine geotechnical engineering assessments. The parameters were deemed valid and reliable in modelling the historical responses of the rockmass to excavation and deformation. Therefore, the strength parameters adopted in this study were taken from the CM&G report and listed in Table 15.

Table 15 Adopted Stability Analysis Parameters

Material Name	γ (kN/m3)	c' (kPa)	ϕ' (deg)
Unsaturated Backfill	18	30	28
Saturated Backfill	20	15	23
Weathered Overburden	24	75	30
Overburden	24	450	42
Interburden	24	450	42
Coal Seam	15	30	35
Vermont floor	24	450	42
Fault	20	0	15

6 Long-term stability analysis

6.1 Assumptions

The PRCP Guideline (DES,2021) requires that the assessment of voids for closure planning must include the following:

- Pit wall geotechnical stability considering the effects of long-term erosion and weathering of pit walls and the effects of significant hydrological events.
- Proposed final slope angles of the highwall of each void - A geotechnical report should focus on how the void will achieve post-closure slopes that will exhibit stability characteristics consistent with the planning and design of the post-closure mine voids.
- Mechanisms for achieving acceptable geotechnical stability must be detailed in the plan. This includes pit backfilling, reshaping, and void configuration through earthwork methods such as backfilling, regrading, buttressing, and benching. Where applicable, methods and techniques for achieving safe slopes must be detailed.

The following design assumptions were adopted to analyse the final landform for the open pit.

- Rockmass parameters were obtained from previous numerical stability assessments.
- Modelled fault structures were considered persistent throughout the model, per the provided structural model.
- The fault structures have been assumed to have a 1m width in Slide3 models and modelled as joint elements in RS3.
- The final landforms provided by the client were used in the stability and deformation analysis.

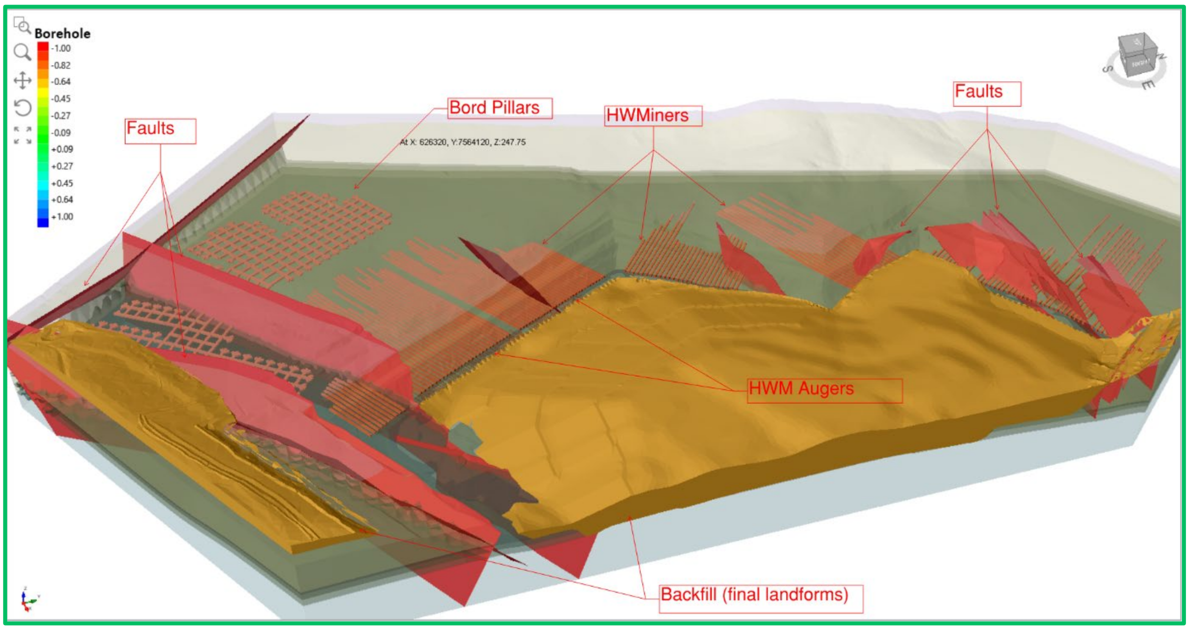


Figure 23 Illustration of geotechnical models (A pit as an example)

6.2 Methodology

Slope stability analyses were conducted using Rocscience's Slide 3 software. Slide 3 is a three-dimensional (3D) slope stability modelling software that applies the limit equilibrium theory to ensure both force and moment equilibrium in its calculations. The analysis involved determining the estimated factors of safety (FoS) for potential shear failure surfaces. FoS represents the decrease in shear strength needed to bring the soil mass to a state of limiting equilibrium. The software computed FoS for all specified trial slip surfaces.

For the FoS computations, the Morgenstern-Price method (Morgenstern & Price, 1965) with a half-sine function for inter-slice forces was chosen. This method allowed the analysis of non-circular shear surfaces that satisfy both moment and force equilibrium. The study involved evaluating multiple trial shear failure surfaces and selecting the critical shear surface most likely to fail.

The minimum factor of safety, as calculated by Slide 3, may indicate a shallow rotational failure surface, suggesting the sloughing of soils along the slope face. However, these small slip surfaces do not significantly impact slope stability. Therefore, the focus of the analyses was on evaluating failure surfaces that could significantly affect the stability of the structures. A failure surface of interest was defined as one compromising the slope crest or resulting in a significant rotational or translational failure.

The deformation of the highwalls and final landform under closure conditions was analysed using "RS3" software developed by Rocscience Inc. The analysis utilised the finite element method.

The geological structures, board pillars, HW Miners, HWM augers, faults, and designed final landforms were modelled in 3D, as depicted in Figure 23.

6.2.1 Sloughing

The analyses discussed herein focus on failures deeper than 1.5 m along the slope faces. Shallower, sloughing, and failures within the surficial soils and the rockfill materials are likely during and after flooding events. However, these sloughing failures are not considered deep enough to affect the overall stability of the landform.

6.2.2 Phreatic Surface

The groundwater level contours were derived from hydrogeological modelling conducted by SLR and were adopted as the input as the phreatic surface in the models.

6.2.3 Seismic Loading

Seismicity can affect the stability of a slope, whether natural (through earthquakes), or through mine-induced blasting and needs to be considered when slope stability analyses are undertaken. Seismic event hazard maps from Geoscience Australia provide the peak ground acceleration values for the Bowen Basin area as an average peak ground acceleration (PGA) value of 0.06g. This is with a 10% chance of being exceeded per annum, equivalent to the PGA with an annual exceedance probability of approximately 1/500 (Burbidge et al., 2010). A factor of 1.3 (AS 1170.4) is applied to achieve the value with an annual probability of exceedance of 1/1000. The seismic coefficient for slope stability analysis is equal to 0.5×PGA (Read, 2009); therefore, the seismic coefficient for pseudo-dynamic analysis in geotechnical modelling programs is 0.039, which has been applied to investigate the seismic effect on the overall Factor of Safety (FOS) of the pits.

6.3 Analysis Results

Tables 16, 17, 18, and 19 summarise the Factors of Safety (FoS) computed from the stability analyses. Appendix B presents representations of the safety map of the GLE method with the critical sliding surfaces and factors of safety.

6.3.1 Pit Highwall Stability

Table 16 Minimum FoS of Highwall Slope at Final Landform under static conditions.

Location	FoS (Spencer)	FoS (GLE / Morgenstern-Price)
M Pit	2.78	2.87
D Pit	2.28	2.61
E Pit	1.27	1.27
A Pit	2.47	2.46
B Pit	1.27	1.24

As depicted in Appendix B1, B2, and B4, the FoS of the highwalls in M, D, and A pits under static conditions have a FoS ≥ 1.5, ensuring their long-term stability under static loading conditions post-closure.

Within Pits B and E, as illustrated in Appendix B3 and B5, whilst the majority of the highwall demonstrates a safety factor well above the specified threshold of 1.5, reaffirming the structural stability of the entire slope, there is a single isolated area that has a FoS of 1.27. Figures 24 and 25 pinpoint a specific location with a FoS of approximately 1.3. It should be noted that a FoS of 1.3 is still considered indicative of long-term stability.

Appendix C7 illustrates a localised area of the highwall that had FoS less than 1.5. These sections were re-analysed using 2D Slide analysis, and the results were like the 3D analysis. The localisation of lower safety factors was mainly located in the Tertiary material of the highwall, which is indicative of the stability conditions of the highwall. Considering that no further work will be done on the highwall in the final landform, the localised areas meet safety requirements for operational stability, as indicated in Table 6.

Figure 24 Details of Sliding Area in Highwall with the Minimum FoS in B Pit

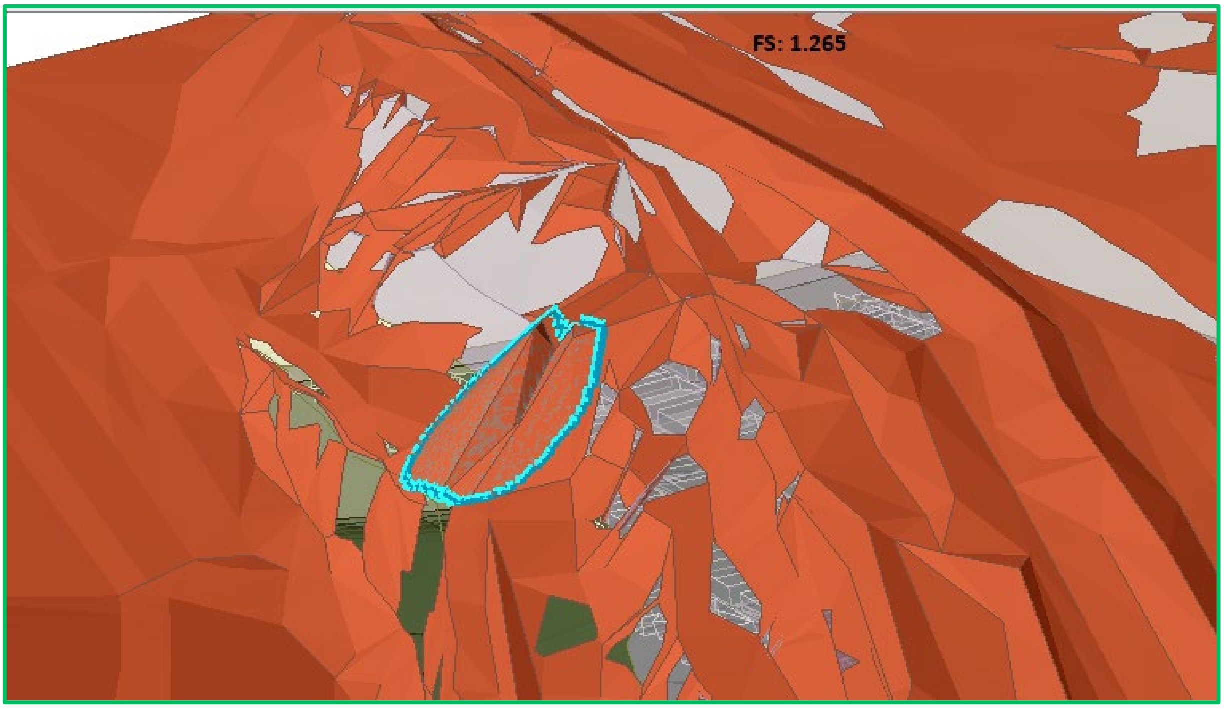


Figure 25 Details of Sliding Area in Highwall with the Minimum FoS in E Pit

In addition, as detailed by Gordon Geotechniques (2023), the buoyancy effect of water will counteract the dead weight load of the rock by up to 40% and hence increase the factor of safety. Therefore, long-term stability can be guaranteed under recovered final landform groundwater levels.

6.3.2 Stability of Final Backfill

Table 17 Minimum FoS of Backfill at Final Landform under static conditions.

Location	FoS (Spencer)	FoS (GLE / Morgenstern-Price)
M Pit	1.18	1.22
D Pit	1.57	1.59
E Pit	1.63	1.62
A Pit	1.87	1.86
B Pit	1.72	1.76

Stability analyses for the final landform backfill slopes indicated long-term stable conditions against the applied criteria. However, M-Pit had a safety factor of 1.2, exhibiting similar modelling results as discussed for the highwalls in Section 6.3.1, as shown in Appendix C1. Appendix C2 shows a 2D version of the localised area in the 3D model. As shown in the 2D model, the section inducing lower global limit equilibrium conditions is the face of the slope with a changed geometry to the rest of the landform's slope, and localised slope geometry is causing the localised reduction in safety factor. Again, a FoS of 1.2 can still be considered a stability indicator.

Based on the above, it can be stated that the overall performance of the slope will meet the long-term slope requirements for PRCP.

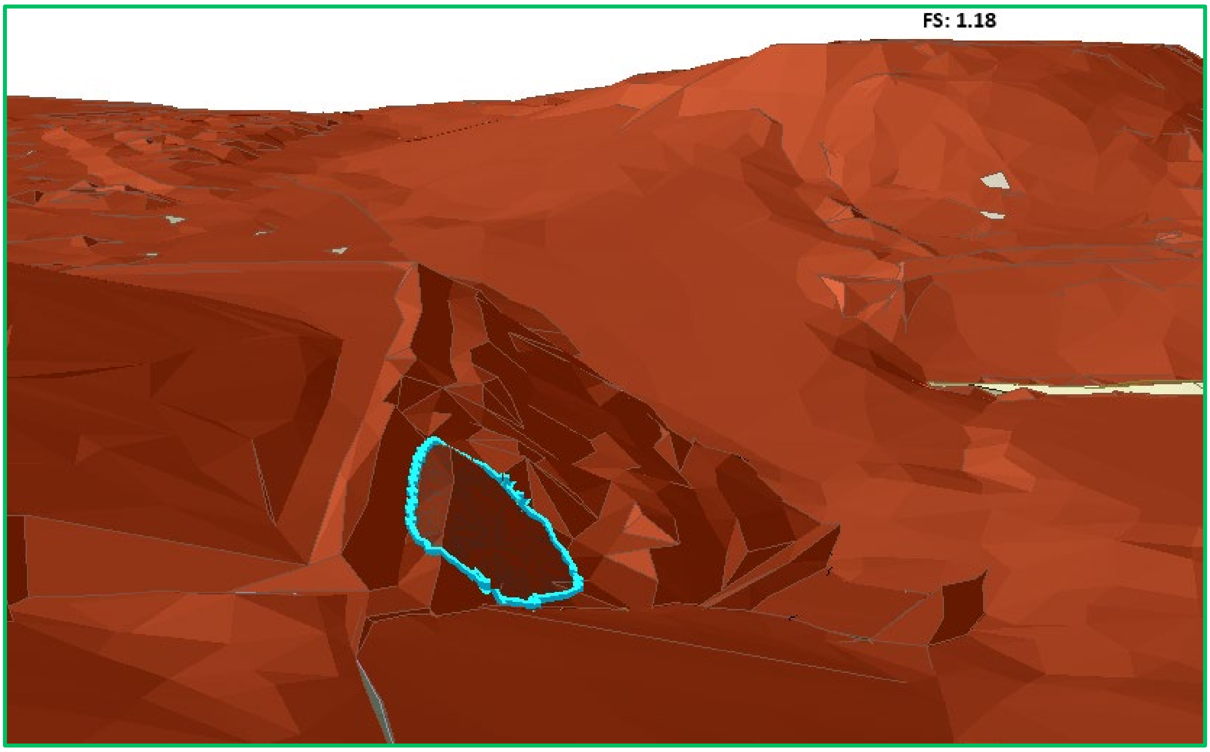


Figure 26 Details of Sliding Area in Backfill with the Minimum FoS in M Pit

6.3.3 Stability of levee

The stability analysis of the B pit levee indicates that the slope is stable, as depicted in Appendix B16.

6.3.4 Seismic Analysis

The seismic analyses for all the pits indicated factors of safety greater than 1.1, which meets the requirements for pseudo-static analysis. Therefore, the slopes are stable under seismic conditions.

Table 18 Minimum FoS at Final Landform under seismic conditions

Location	FoS (Spencer)	FoS (GLE / Morgenstern-Price)
M Pit	1.10	1.12
D Pit	1.35	1.36
E Pit	1.46	1.46
A Pit	1.52	1.53
B Pit	1.44	1.43

6.3.5 Deformation Results

Table 19 summarises the maximum deformation observed in the numerical model analyses. Appendix A includes shows the deformation analysis results for the respective pits. Results indicate that the most significant deformation is localised near the fault systems within respective pits. However, this is not the case for B-Pit, where the maximum deformation occurs in the backfill material. The deformation in B-Pit is attributable to the overall height limit of the backfill material relative to other backfills.

The maximum total displacements are less than 400mm, indicating that the underground mining voids do not induce significant ground settlement. Besides B-pit results, backfill material indicated significant stiffness to deformation. Hence, settlement is unlikely to impact the long-term integrity of the pit walls and final landform. Both the pit walls and final backfill landform can maintain structural stability. Settlements that adversely affect drainage patterns and long-term landforms are not expected.

Table 19 Maximum Deformation at Final Landform

Location	Maximum Deformation (m)
M-Pit	0.14
D-Pit	0.32
E-Pit	0.29
A-Pit	0.35
B-Pit	0.34

7 Limitations and Recommendations

7.1 Limitations

This report is based on the information reviewed from Millennium Mine. Engineering judgment was applied for input parameters derivation. The geotechnical parameters utilised in the stability analysis were obtained from previous site-specific reports and literature reviews. Modelling uncertainties, particularly in representing finer details of the landform, may lead to conservative results in certain instances. Hence, engineering judgment was applied in interpreting the model results.

7.2 Discussion

A complex model was created for analysis, incorporating all the input parameters—Rocscience's software, slide 3 and RS3 were used for the limiting equilibrium and numerical analysis, respectively. Stability analysis was conducted both for the highwall and the final landform backfill material. Static and pseudo-static (seismic) conditions were simulated for the final landform. Targeting a long-term stability factor of safety of 1.5 under static conditions and 1.1 for pseudo-static conditions, the highwall analysis indicated a global minimum factor of safety of greater than1.5 for M Pit, D Pit, and A Pit. Whilst E Pit and B Pit achieved a global minimum factor of safety of 1.3, which is indicative of stable conditions, as these results were localised in the Tertiary material and were not considered to affect the overall slope and stability. Similarly, with the landform analysis for M Pit, where localised lower safety factors were recorded, the overall stability of the backfilled slope met the acceptance criteria.

Deformation analysis assessed long-term settlement and potential subsidence from high wall-void interactions and landform stability settlement. Analysis results indicated a deformation range between 140 mm to 350 mm settlement across the pits, with the highest settlement recorded in A-Pit and the lowest in M-Pit. The deformation analyses also considered the effects of time-dependent rockmass deterioration, which can manifest as highwall cracking or dilation of exposed discontinuities. Long-term radar monitoring trends were analysed, and results were adopted to account for time-dependent effects on stability.

Based on the above methodology and assessments, it can be concluded that the geotechnical analysis approach considered in the analysis of the Millennium Mine addressed Sections 3.6.2, 3.6.3, and 3.6.4 of the Guideline - PRC Plan. The analysis results indicated long-term stability conditions for the final landform and the exposed highwalls. With the final landform modelled integrating long-term degradation/erosion and predisposition to ongoing stability issues as well as associated groundwater changes, the stability and deformation models simulate expected stability conditions for the proposed final landform and provide a basis to conclude that the proposed final landform will be a geostable landform.

8 Conclusion

A summary of the results from stability and deformation analysis was discussed in the report, along with the methodology used to obtain these results. Based on this approach, the long-term geotechnical assessment, which considers the impact of groundwater and underground mining voids, indicates that the planned final landform and pit walls meet widely accepted industry criteria and will remain structurally stable post-closure.

According to the PRCP guideline section 3.8 requirements, monitoring and maintaining the pit voids will be crucial. The monitoring systems proposed in the closure plan should be consistently maintained throughout the closure and post-closure periods to demonstrate the achievement of each proposed milestone.

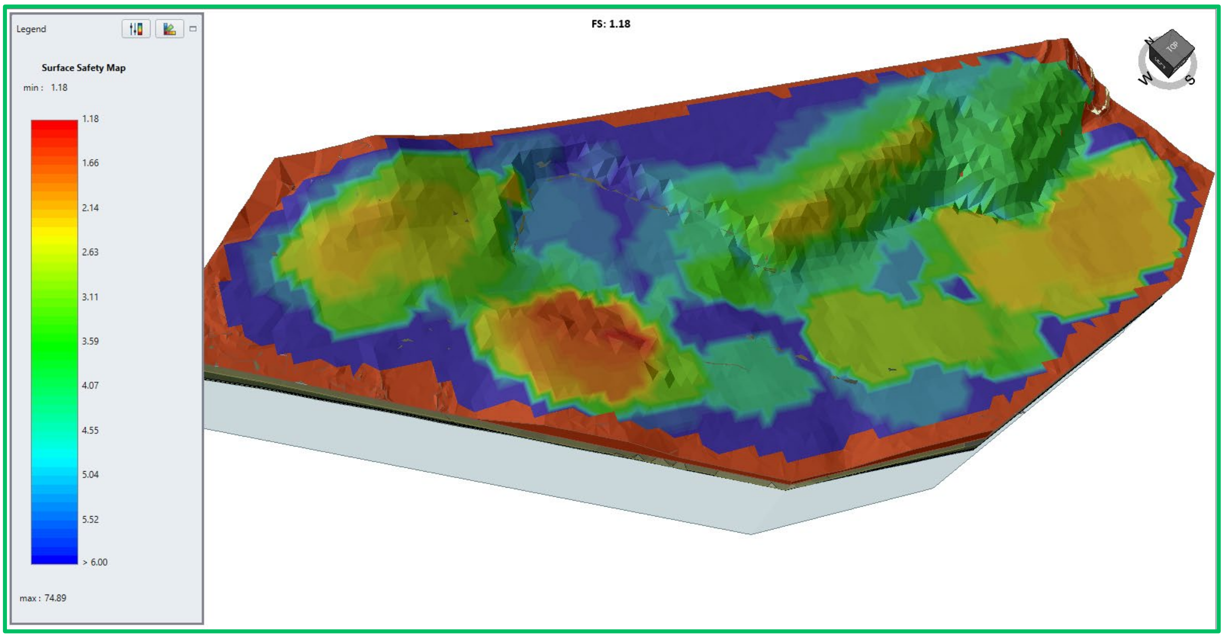
9 References

1. CM&G, 2022. Millennium Mine Geotechnical Reference Report
2. CM&G, 2021. E PIT LOWWALL GEOTECHNICAL ASSESSMENT FOR AUGER MINING
3. CM&G, 2022. M EXTENSION - GEOTECHNICAL DESIGN REVIEW
4. CM&G, 2022. MMI010002-BS_A Pit South - Geotechnical Design Review
5. GeoTek Solutions, 2021. Millennium Mine, D & E Pits, HWAM Geotechnical Assessment v0.4
6. GeoTek Solutions, 2022. Millennium Mine, M & D Pits, HWAM Geotechnical Assessment v1
7. GeoTek Solutions, 2022. Millennium Mine, M Pit Trench, HWAM Geotechnical Assessment v1.0
8. GeoTek Solutions, 2022. Millennium A-Trench HWAM Geotechnical Recommendations
9. Department of Environment and Science, 2023. Guideline: Progressive rehabilitation and closure plans (PRC plans)
10. Stacey and Read (2008) Guidelines for Open Pit Slope Design, CSIRO
11. John V Simmons and Dennis A McManus, 2004. Shear Strength Framework for Design of Dumped Spoil Slopes for Open Pit Coal Mines. Advances in Geotechnical Engineering: The Skempton Conference, 2004, Thomas Telford, London.
12. Australian Standard AS1170.4. Structural design actions Part 4: Earthquake actions in Australia
13. Burbidge et al. (2010) Future Directions for the National Earthquake Hazard Map for Australia
14. Morgenstern, N.R., and Price, V.E., 1965. The Analysis of the Stability of General Slip Surfaces. Geotechnique, Vol. 15, pp. 79-93.
15. Department of Minerals and Energy, 1999. Geotechnical Considerations for Open Pit Mines Guideline
16. Gordon Geotechniques, (2023). Subsidence report for the Mavis Downs South bord and pillar project

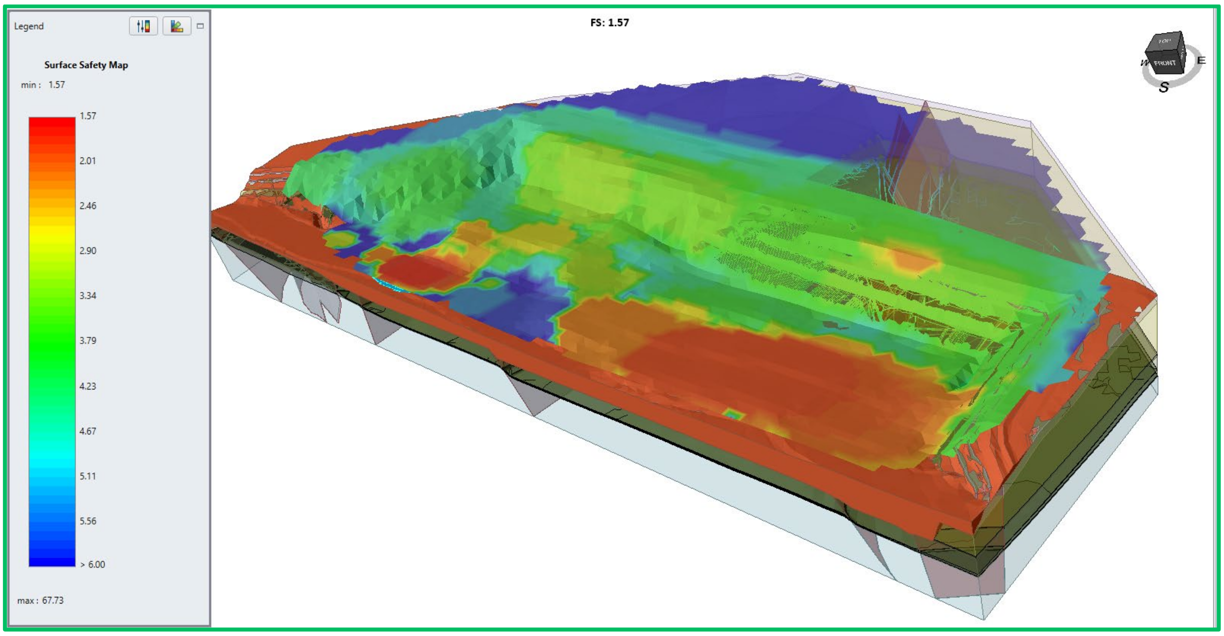
Appendix A: Laboratory Results

Ref.	Borehole	Depth (m)	Sample Type	UCS (kPa)				Young's Modulus		Poisson Ratio		Peak Strength		Residual Strength	
					Moisture Content	Wet Density	Dry Density	Tangent	Secant	Tangent	Secant	c′ (kPa)	Φ (°)	c′ (kPa)	Φ (°)
100991	PMI1090	103.32-103.65	BDLU	29	2	2.62	2.56	15.2	13.1	0.084	0.058				
100992		104.8-105.18	BDLU									37.4	16.5	35.4	2055.2
100993		107.1-107.49	LUROOF	7.69	4.1	1.36	1.3	1.54	1.15	0.19	0.094				
100995		107.54-107.82	LUD	7.55	4.5	2.26	2.03	0.107	0.071						
100997		109.39-109.7	LU, LL									32.5	52.3	47	1714.4
100998		110.68-111.11	LL	43.2	1.6	2.56	2.52	14.3	12.1	0.218	0.145				
100999		103.32-103.65	BDLU	6.51	2.9	2.47	2.4	4.01	2.58	0.103	0.053				
101000	PMI1091	103.32-103.65	BDLU	25.4	3.1	2.49	2.41	7.2	7.54	0.153	0.099				
101001		104.8-105.18	BDLU	49.2	2.1	2.65	2.6	19.5	17.4	0.22	0.165				
101002		107.1-107.49	LUROOF									22.7	235	61	858
101003		107.54-107.82	LUD									23.3	73.5	23.9	1359.2
101004		109.39-109.7	LU,LL	2.53	4.2	1.5	1.44	1.1	1.01	0.302	0.169				
101005		110.68-111.11	LL	11.4	5	1.35	1.29	9.91	7.78	0.344	0.158				
101007		112.27-112.64	LLFLOOR									23.6	108.7	22.1	573
101008		113.95-114.25	BDVU	21	3.2	2.49	2.41	6.69	7.14	0.245	0.197				
101009		116.68-117.04	BDVU	34.5	2.9	2.56	2.49	7.67	8.46	0.264	0.147				
101010		133.11-133.45	BDVU	8.11	3	2.47	2.4	5.3	4.67	0.318	0.185				
101011		135.85-136.25	BDVU	13.1	1.8	2.58	2.53	12.8	11.1	0.107	0.063				
101012		137.57-137.82	VUROOF									23.7	144.1	45.5	192.5
101014		139.24-139.57	VU1A	8.02	4.4	1.36	1.3	2.29	2.18	0.247	0.299				
101015		139.57-139.88	VU1A	5.96	4.5	1.28	1.23	2.97	2.35	0.326	0.159				
101016		140.22-140.53	VU1B	2.85	3.7	1.6	1.54	1.38	0.953	0.037	0.016				
101017		141.31-141.8	VUFLOOR									35.5	122.8	47.4	568.6
101282		154.31-154.61	BDLU	25	1.5	2.69	2.65	18.1	19.1	0.233	0.21				
101284		155.56-156.86	LUROOF									31.6	104	43.1	2045
101285		157.55-157.88	LU	2.01	2.2	1.32	1.3	0.318	0.329	0.341	0.224				
101287		158.68-159.06	LL1	8.65	1.9	1.4	1.37	2.4	2.25	0.17	0.133				
101288		160.26-160.51	LL1	4.5	1.3	1.48	1.47	1.14	0.824	0.022	0.008				
101291		163.51-163.84	LL2	2.84	1.9	1.26	1.24	1.01	0.774	0.391	0.282				
101292		164.2-164.54	LL2	3.53	2	1.28	1.25	1.12	0.69	0.169	0.218				
101293		166.22-166.58	LLFLOOR									33	7.7	62.5	1598.3
101294		168.53-168.94	BD	29.4	2.4	2.55	2.5	8.28	8.13	0.221	0.154				

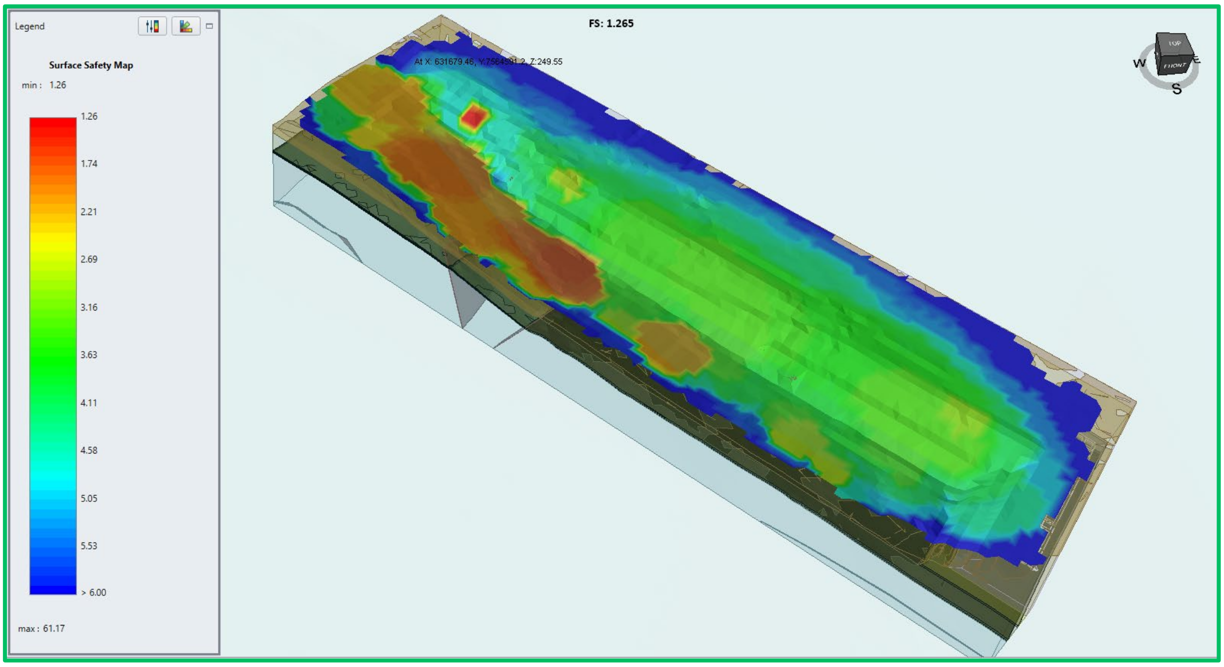
Appendix B: Stability and Deformation Analysis Results



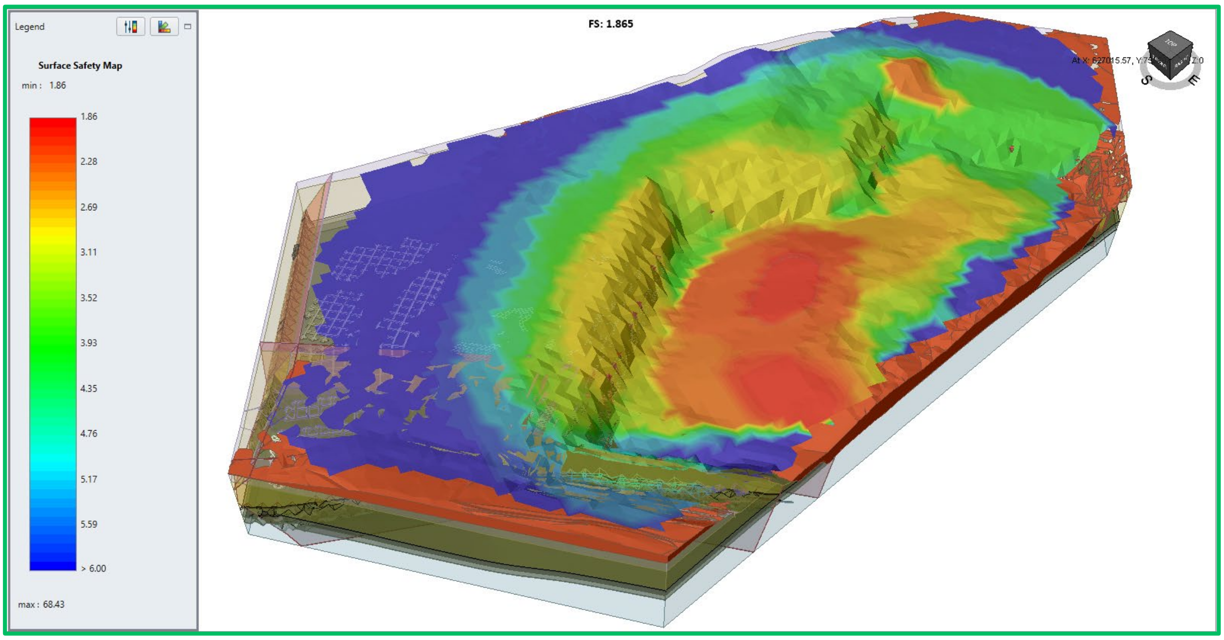
Appendix B1: Safety Map and Minimum GLE FoS of M-Pit at Final Landform under Static Conditions



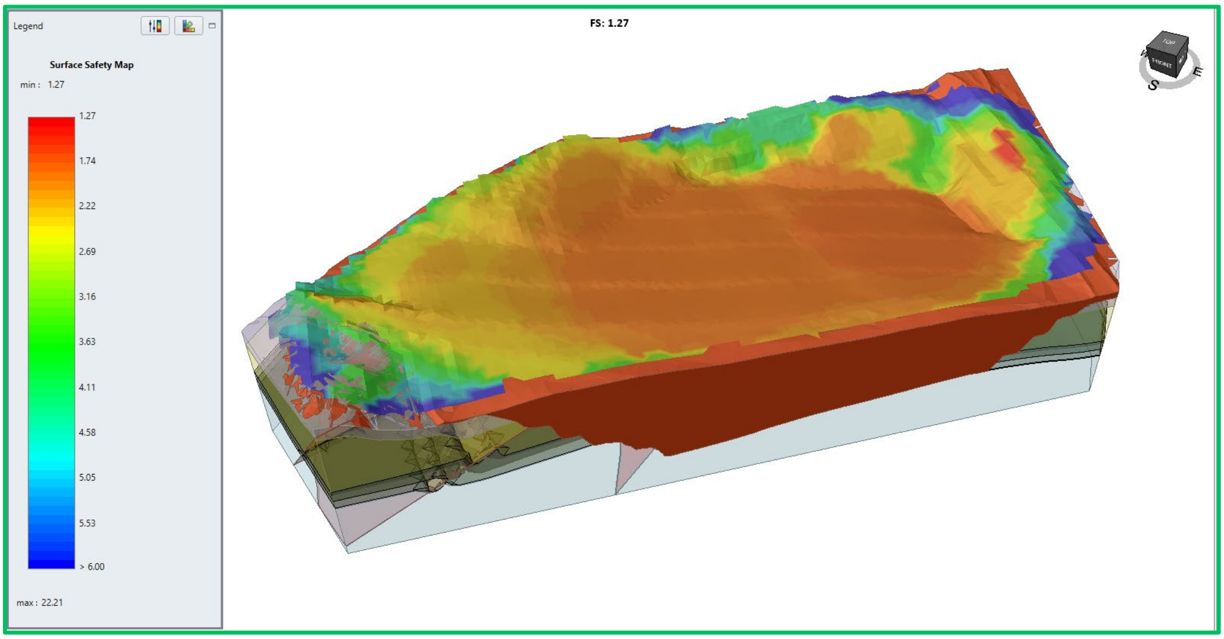
Appendix B2: Safety Map and Minimum GLE FoS of D-Pit at Final Landform under Static Conditions



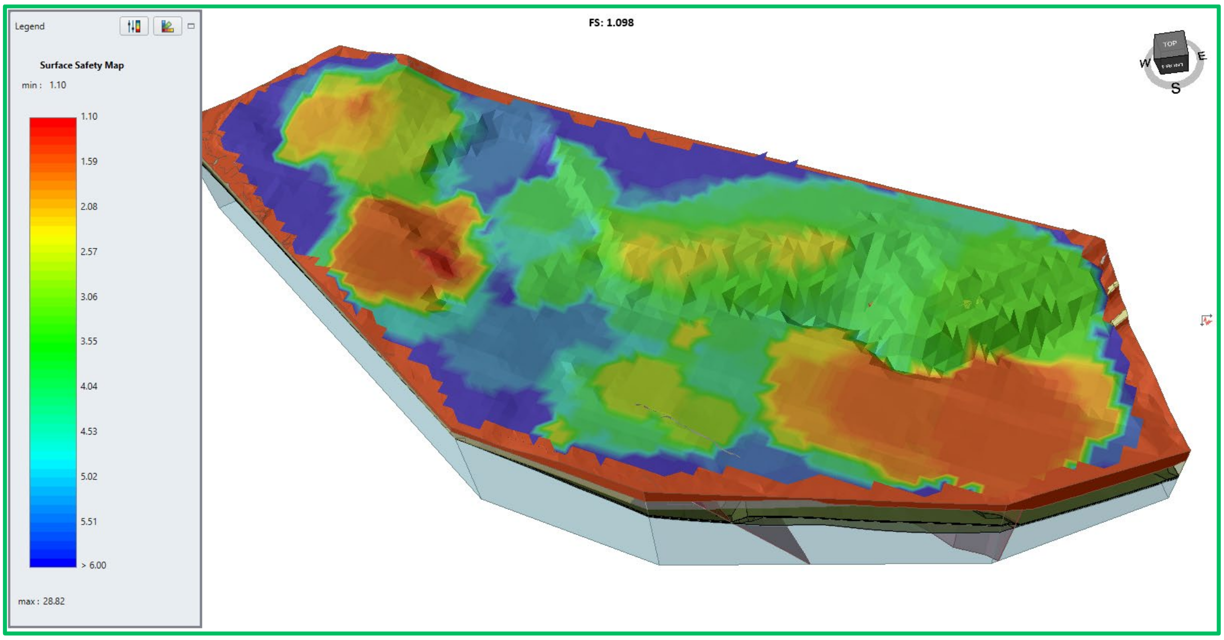
Appendix B3: Safety Map and Minimum GLE FoS of E-Pit at Final Landform under Static Conditions



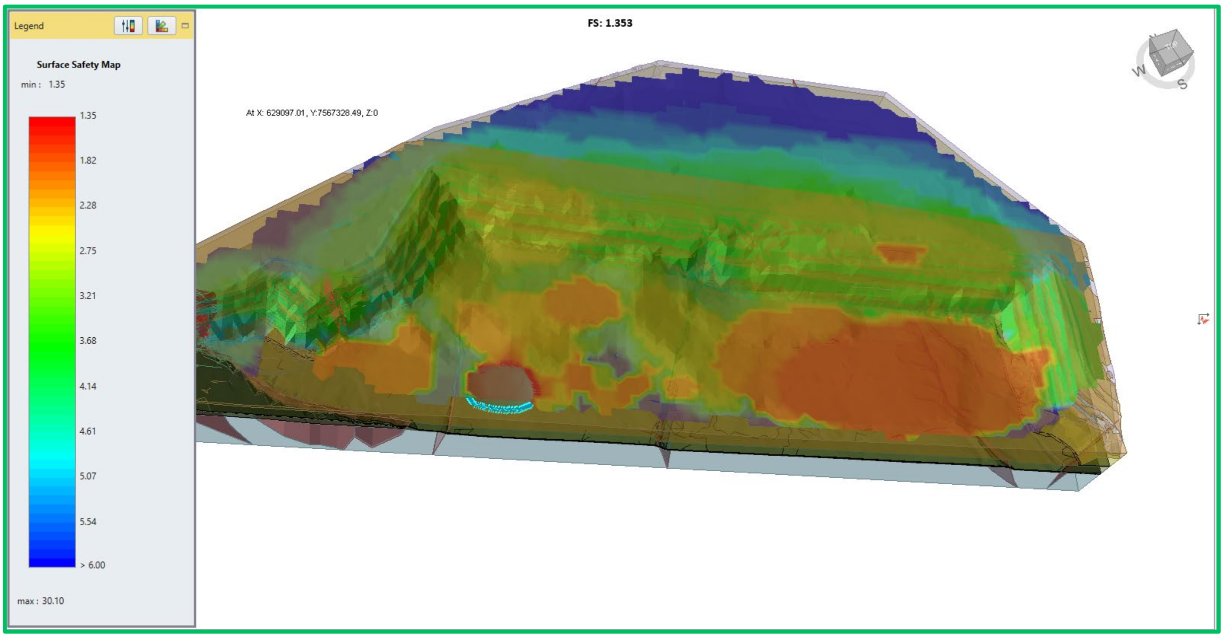
Appendix B4: Safety Map and Minimum GLE FoS of A-Pit at Final Landform under Static Conditions



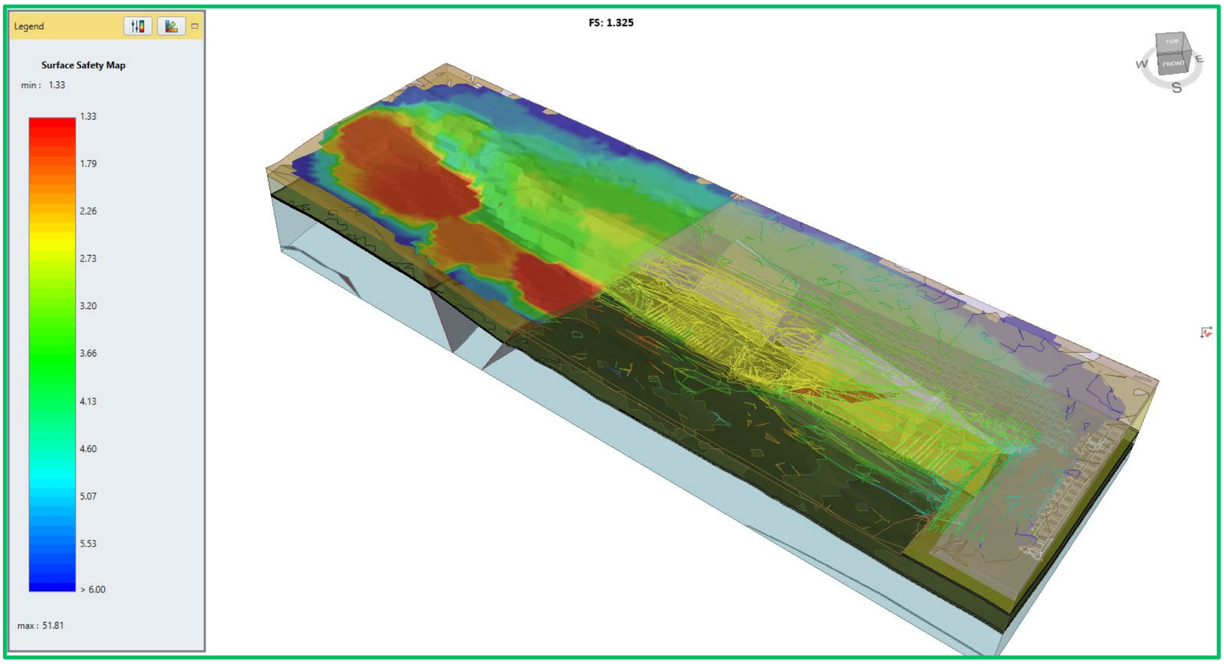
Appendix B5: Safety Map and Minimum GLE FoS of B-Pit at Final Landform under Static Conditions



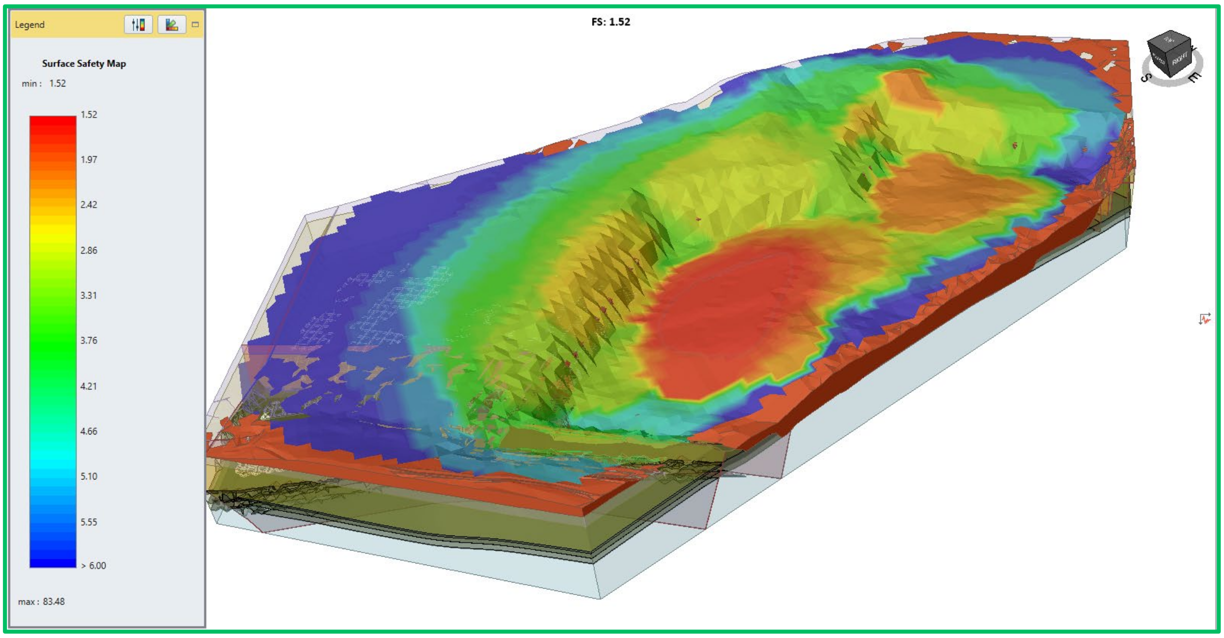
Appendix B6: Safety Map and Minimum GLE FoS of M-Pit at Final Landform under Seismic Conditions



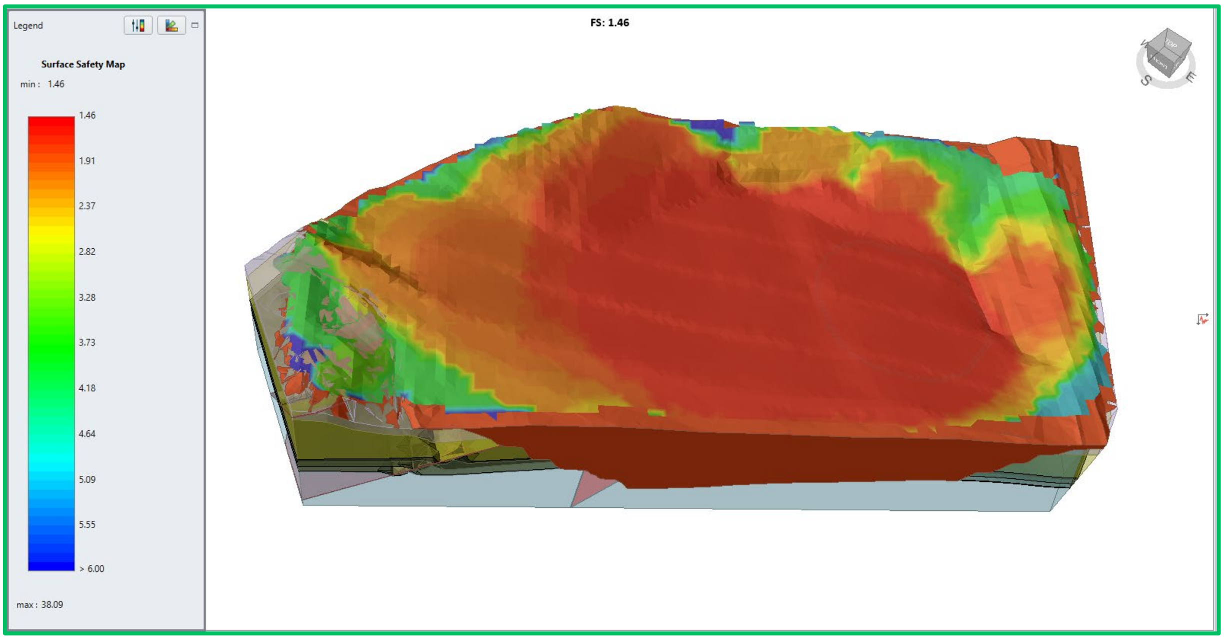
Appendix B7: Safety Map and Minimum GLE FoS of D-Pit at Final Landform under Seismic Conditions



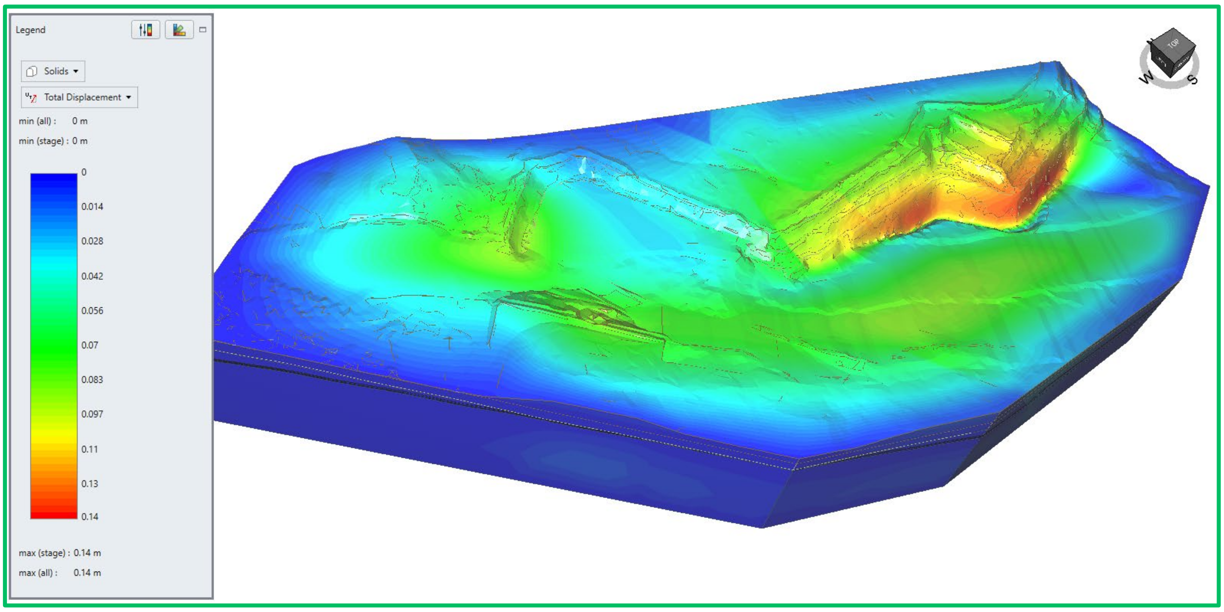
Appendix B8: Safety Map and Minimum GLE FoS of E-Pit at Final Landform under Seismic Conditions



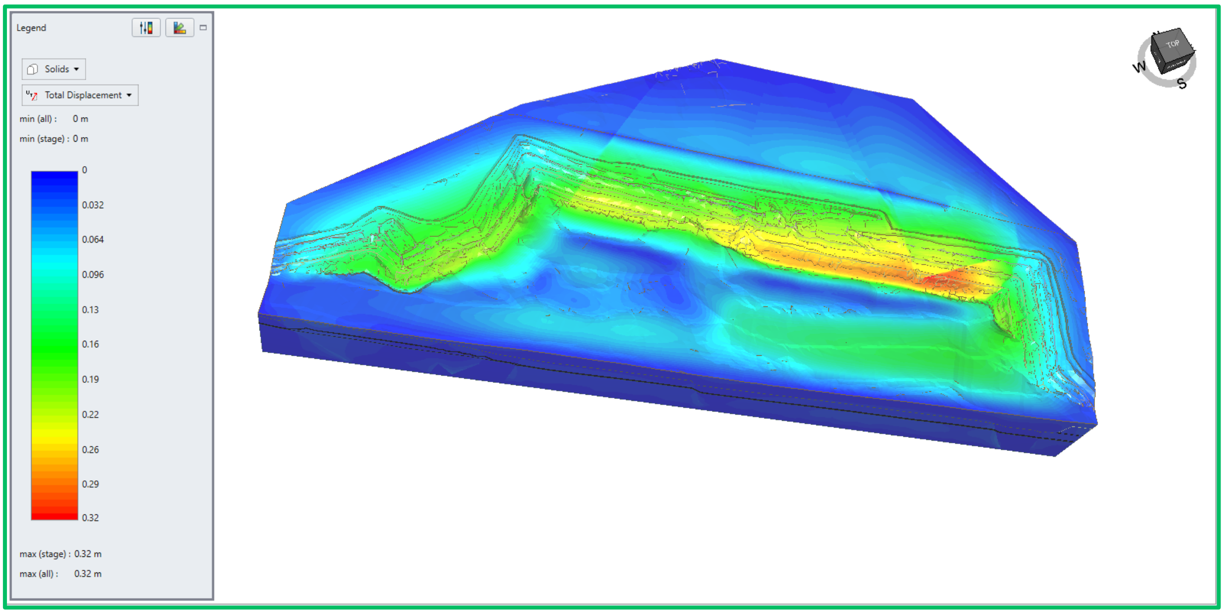
Appendix B9: Safety Map and Minimum GLE FoS of A-Pit at Final Landform under Seismic Conditions



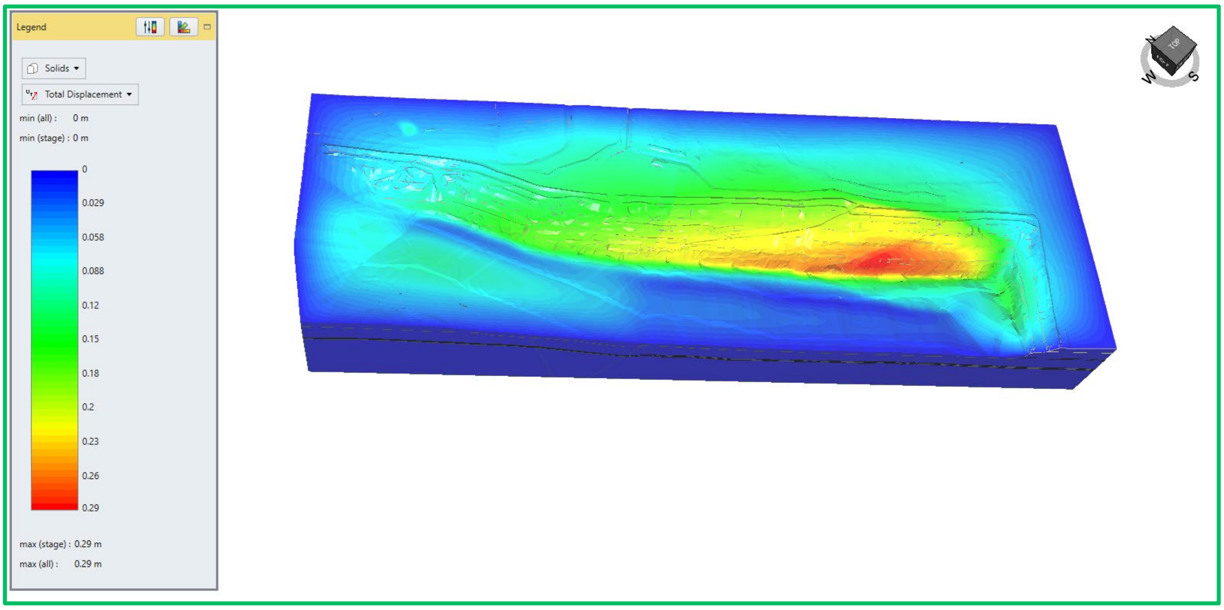
Appendix B10: Safety Map and Minimum GLE FoS of B-Pit at Final Landform under Seismic Conditions



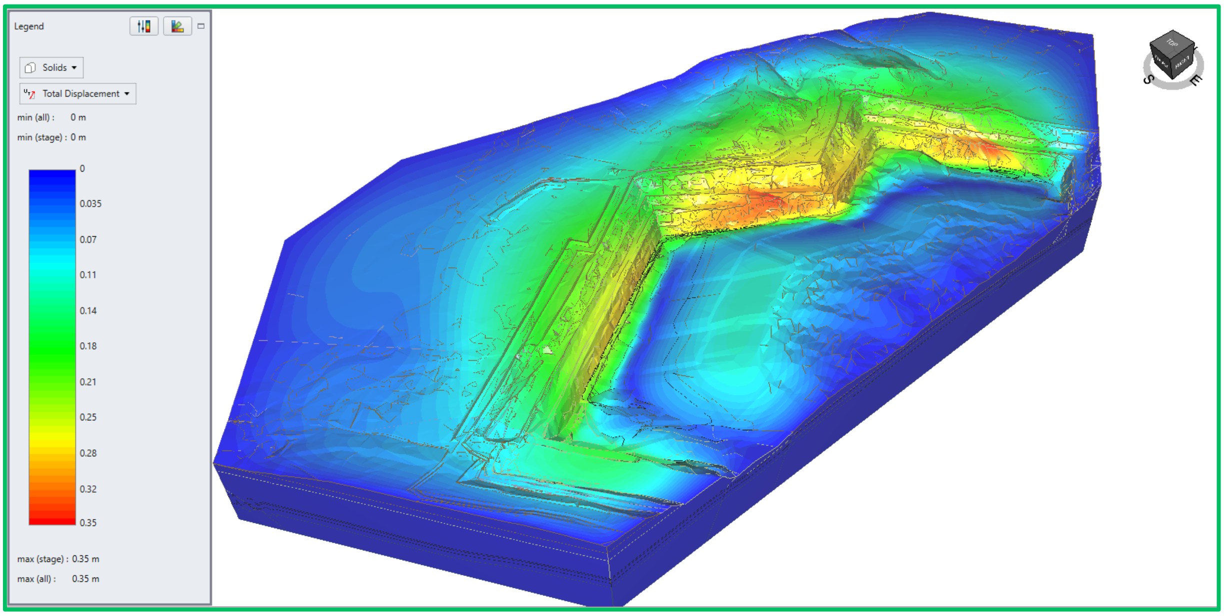
Appendix B11: Deformation contours of M-Pit at Final Landform



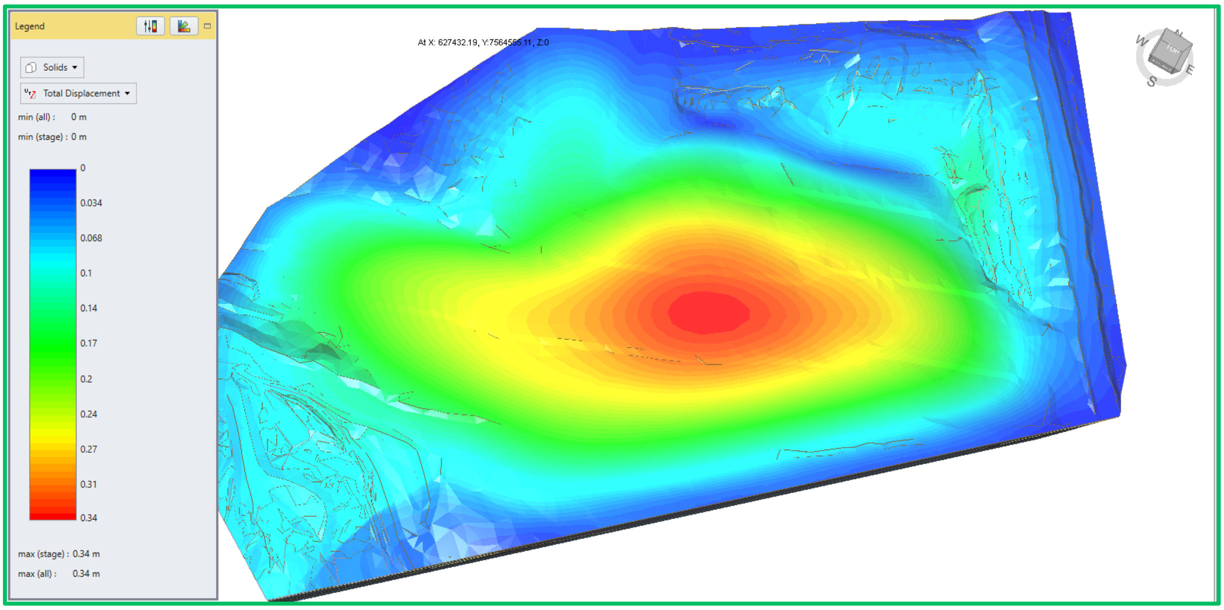
Appendix B12: Deformation contours of D-Pit at Final Landform



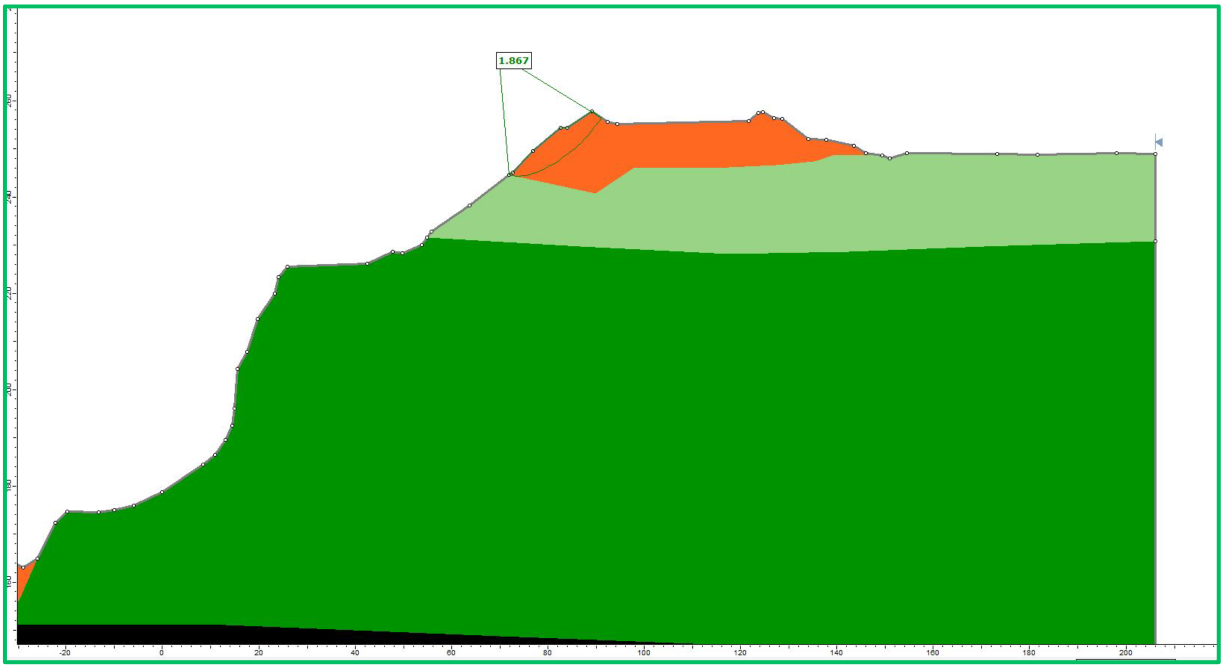
Appendix B13: Deformation contours of E-Pit at Final Landform



Appendix B14: Deformation contours of A-Pit at Final Landform

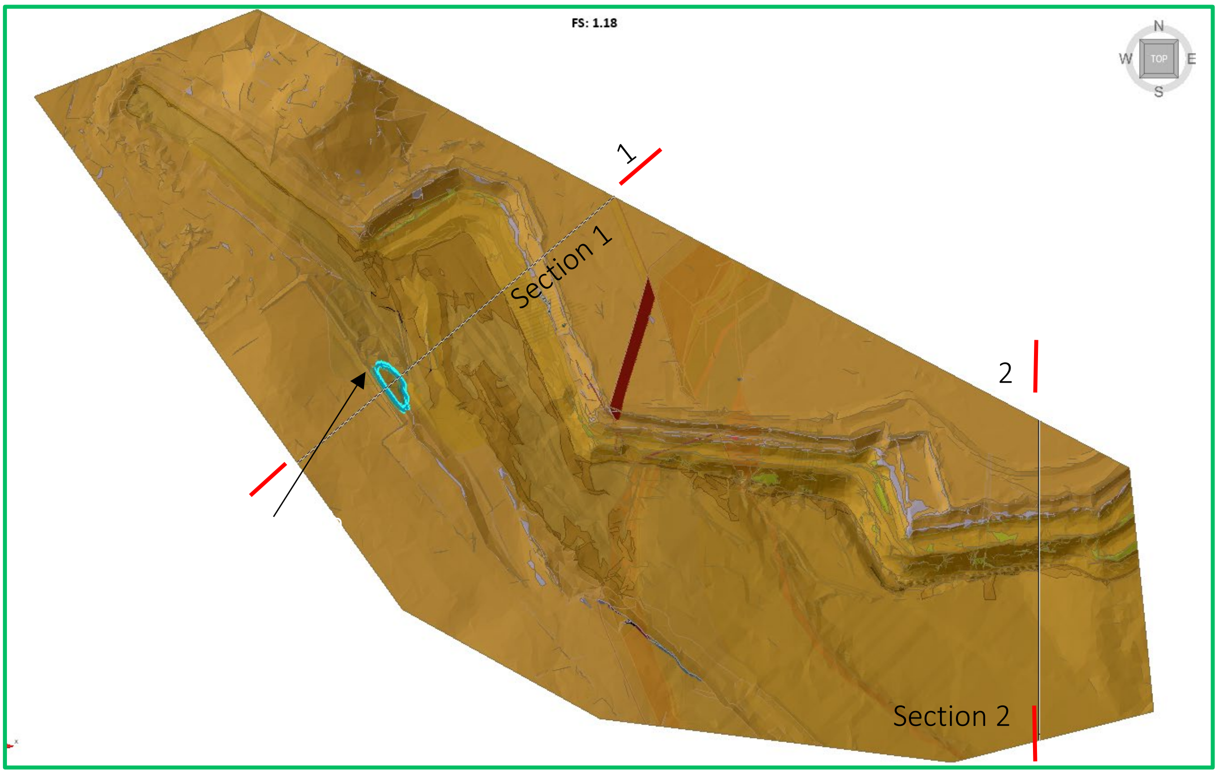


Appendix B15: Deformation contours of B-Pit at Final Landform

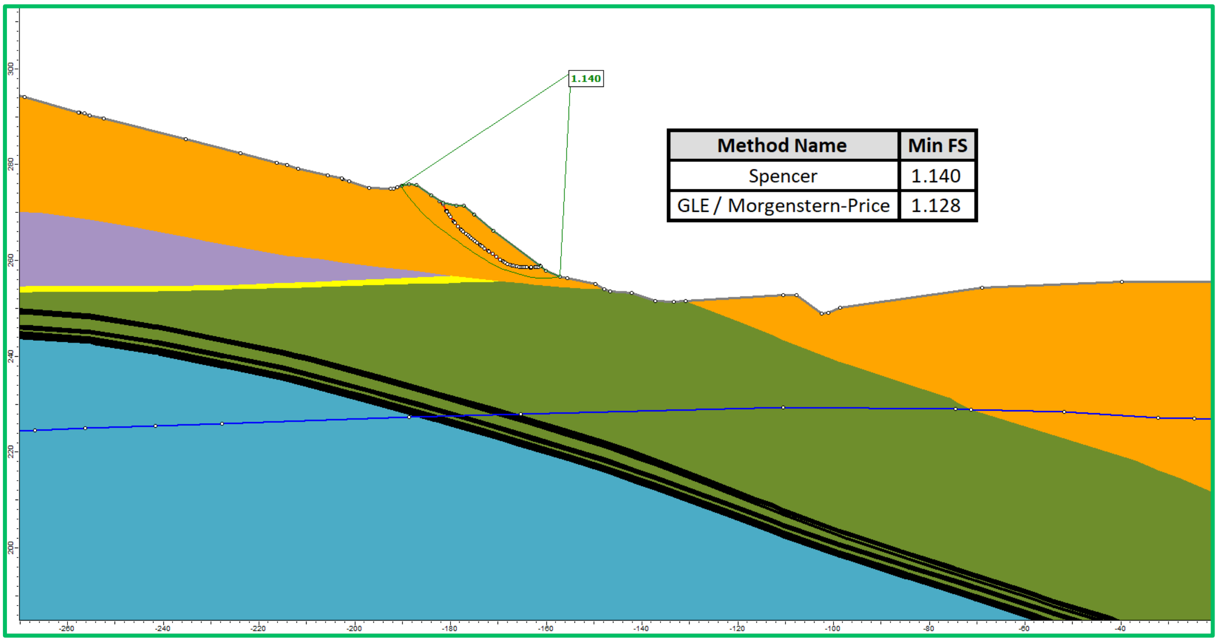


Appendix B16: Stability of B-Pit Levee

Appendix C: 2D Validation of Stability Analysis Results

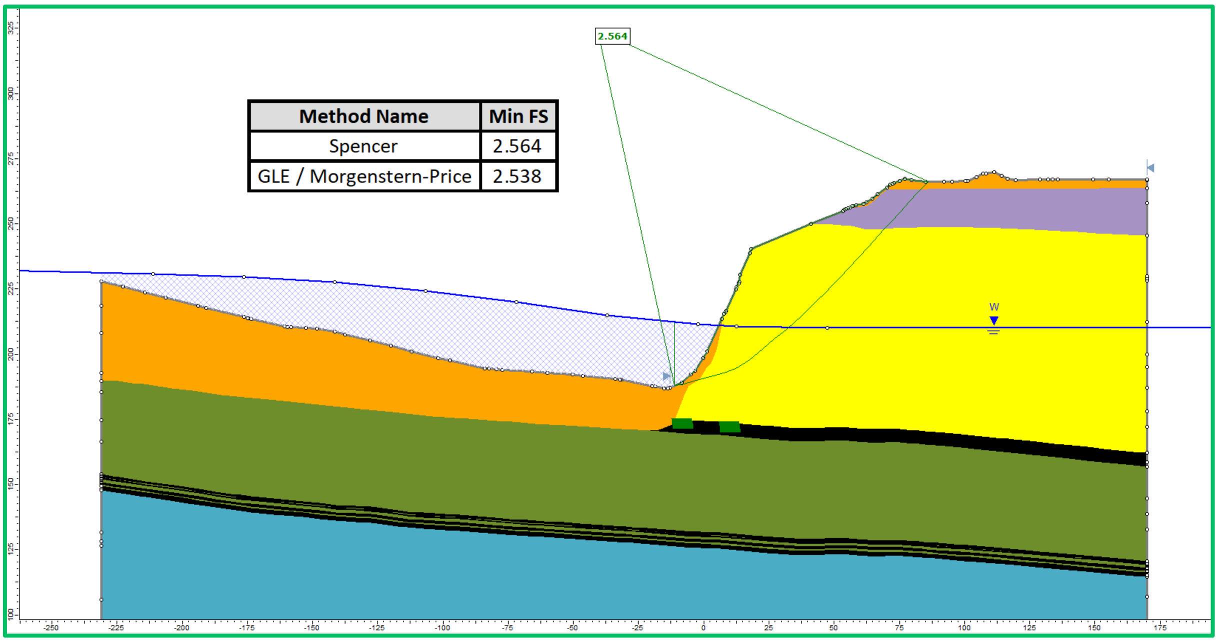


Appendix C1: 2D stability validation sections of M Pit

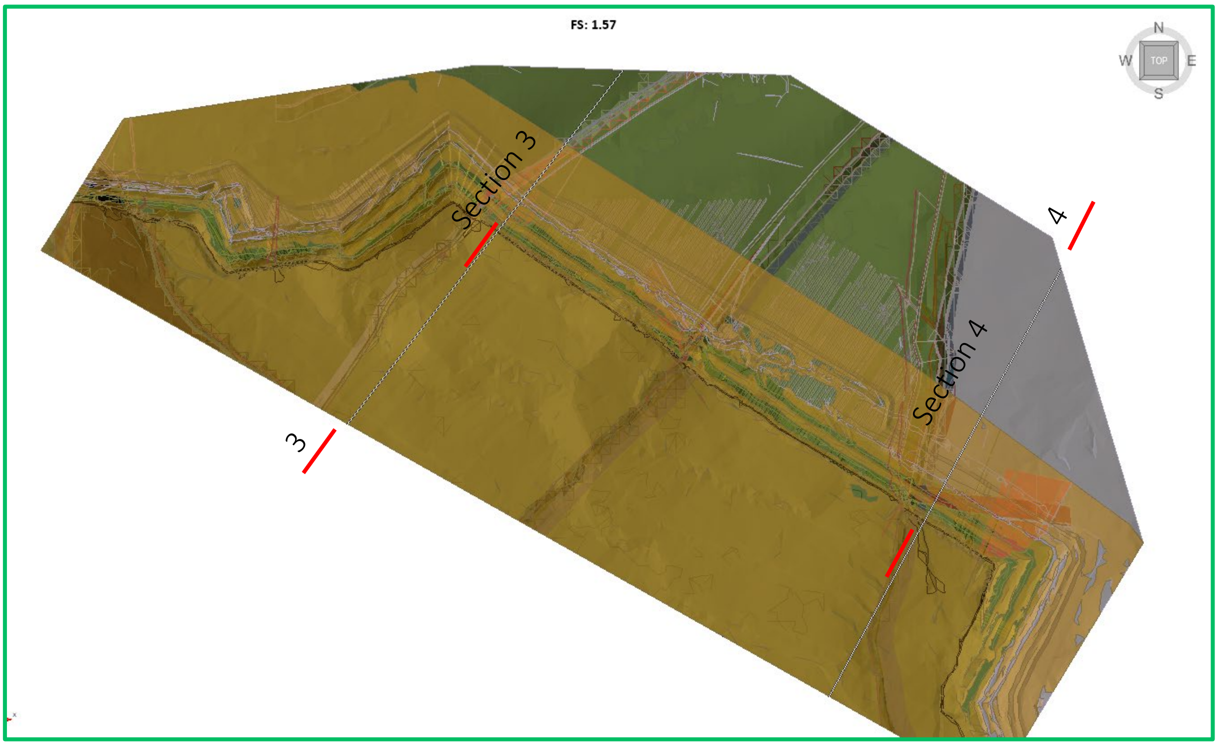


Method Name	Min FS
Spencer	1.140
GLE / Morgenstern-Price	1.128

Appendix C2: Section 1 2D stability validation results of M Pit backfill.

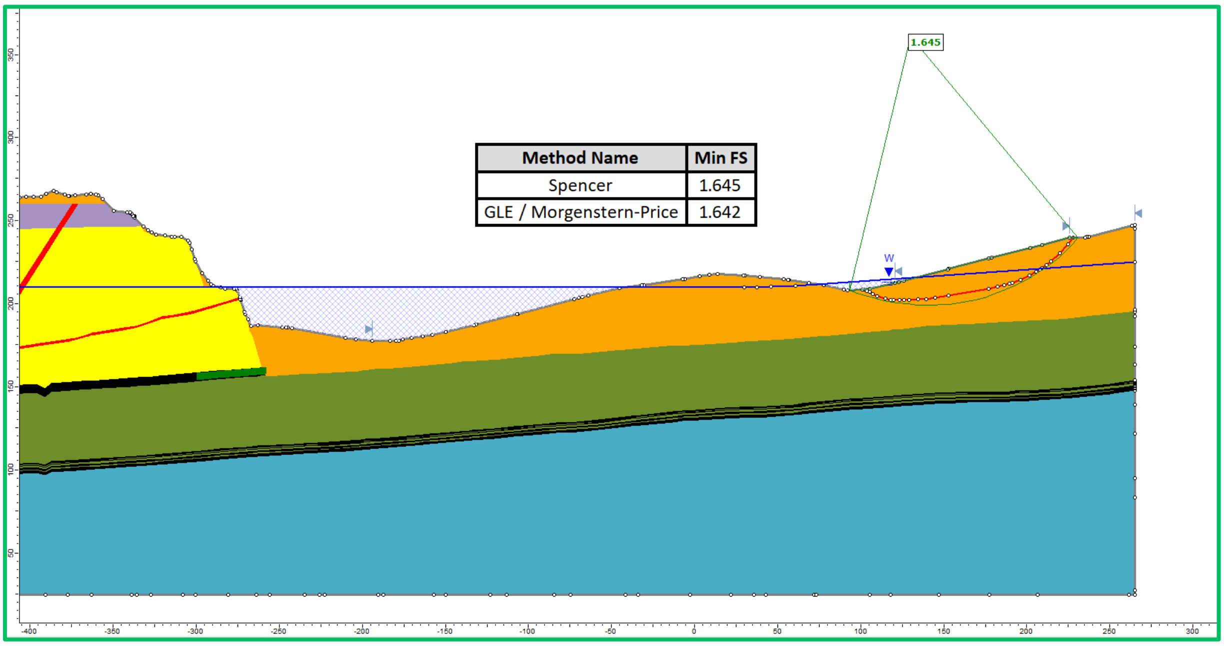


Appendix C3: Section 2 2D stability validation results of M Pit highwall

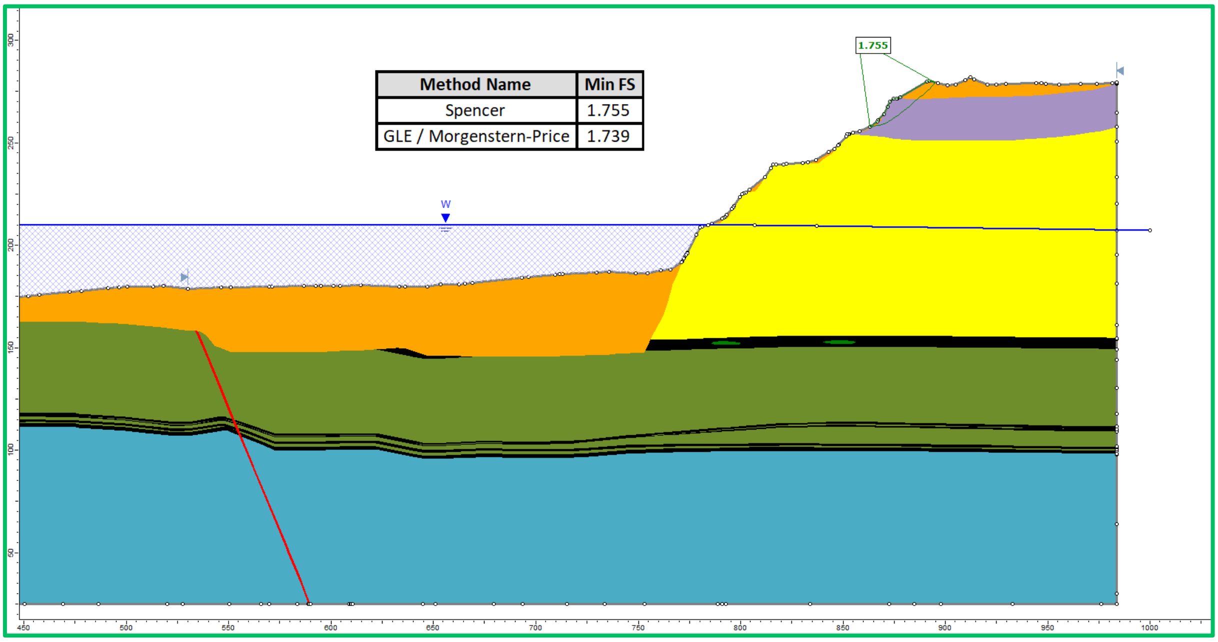


Appendix C4: 2D stability validation sections of D Pit

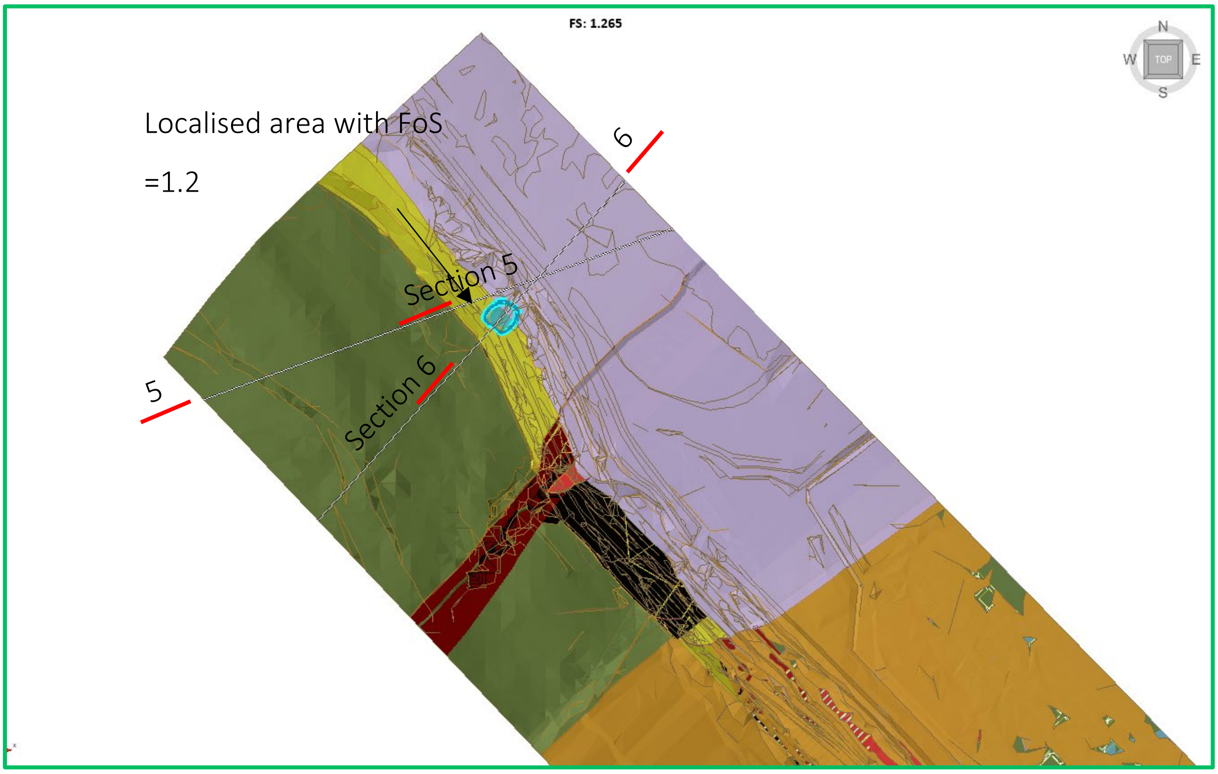
Figure 27



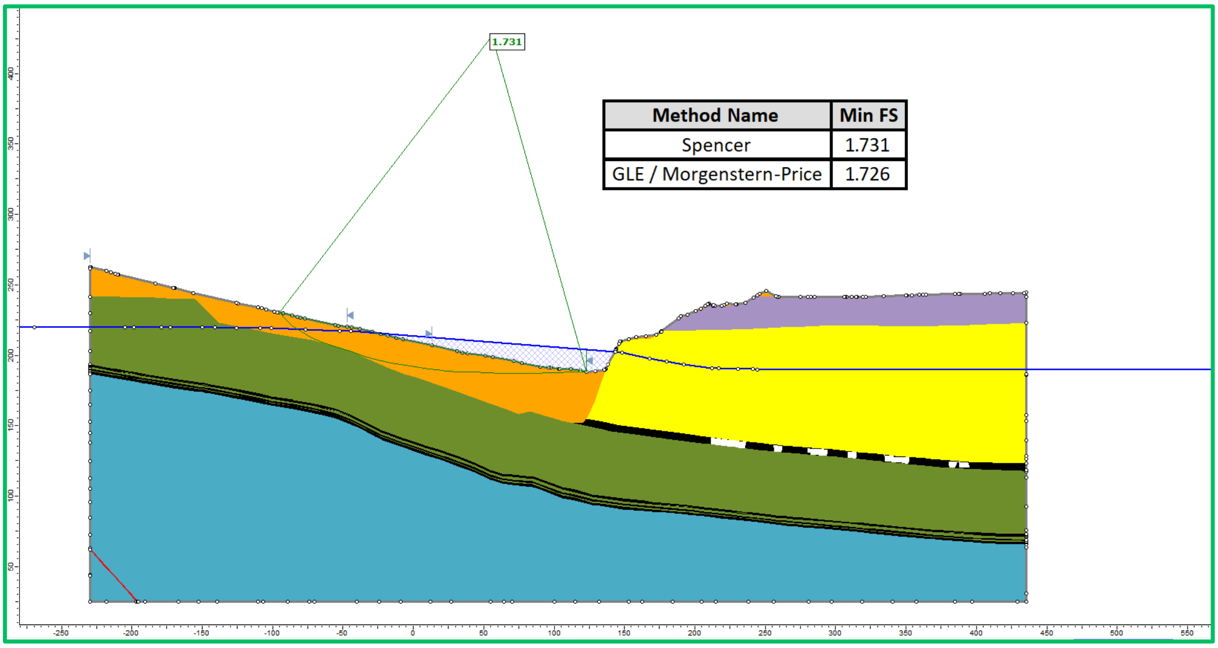
Appendix C5: Section 3 2D stability validation results of D Pit backfill.



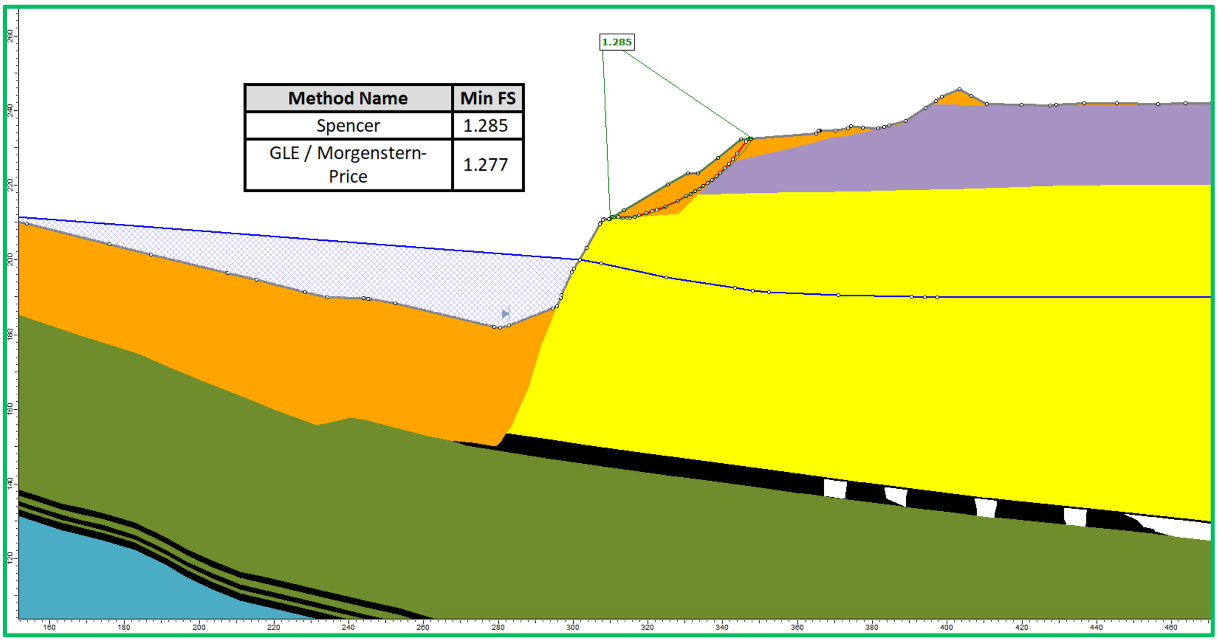
Appendix C6: Section 4 2D stability validation results of D Pit highwall



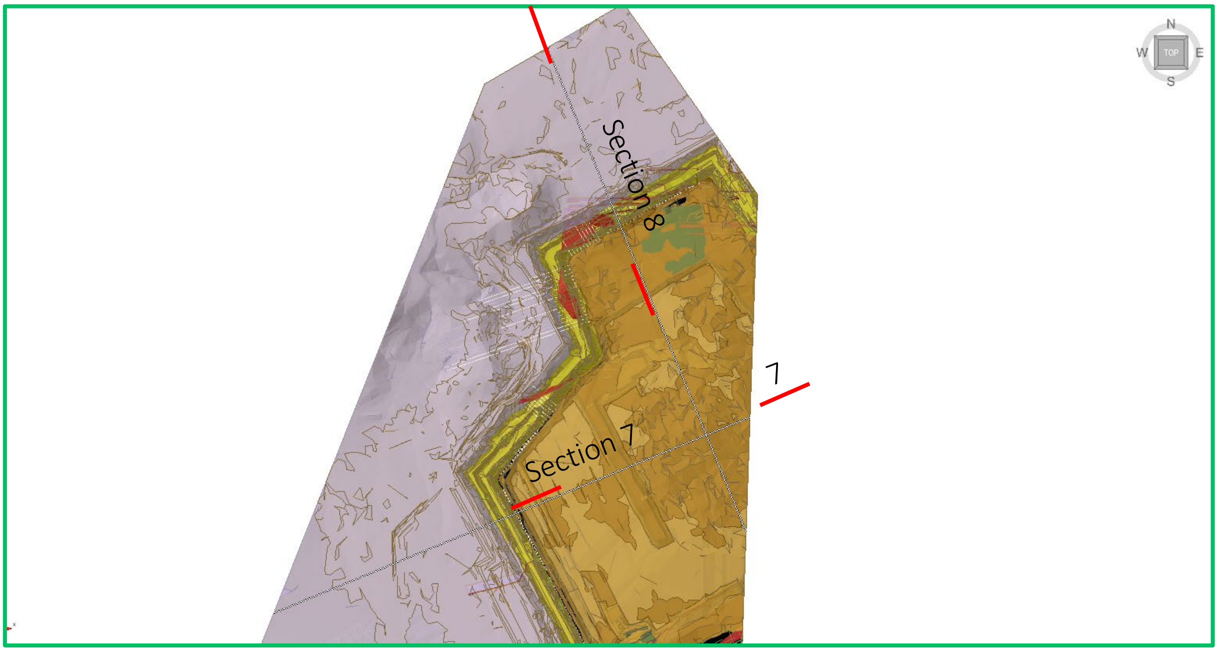
Appendix C7: 2D stability validation sections of E Pit



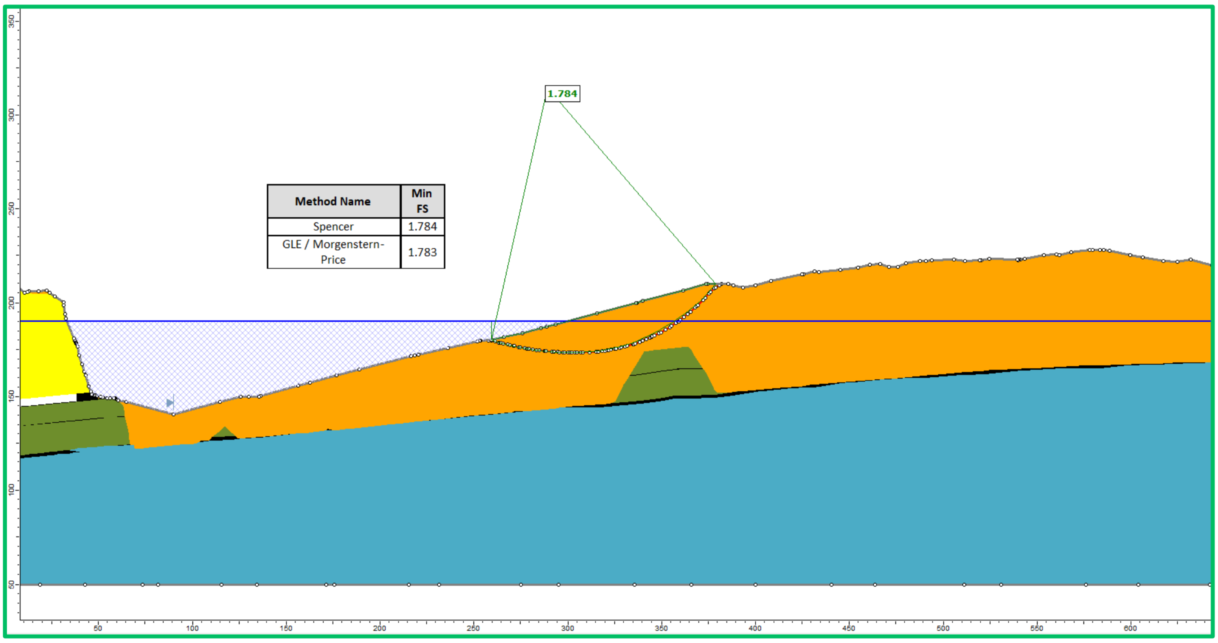
Appendix C8: Section 5 2D stability validation results of E Pit backfill.



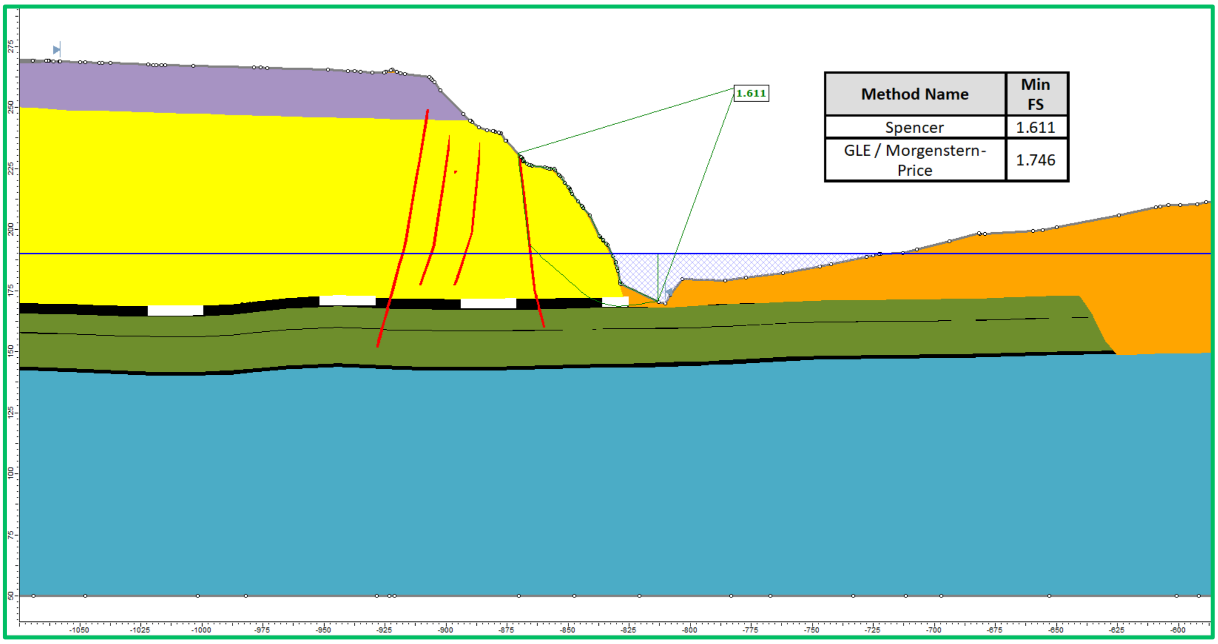
Appendix C9: Section 6 2D stability validation results of E Pit highwall



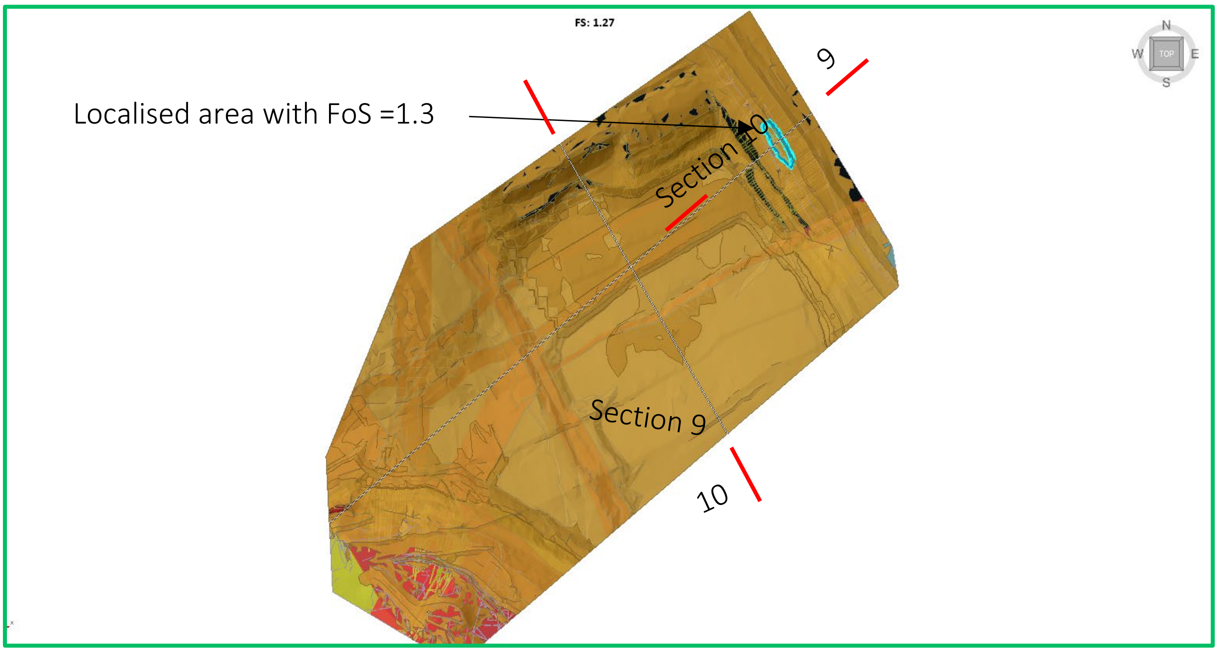
Appendix C10: 2D stability validation sections of A Pit



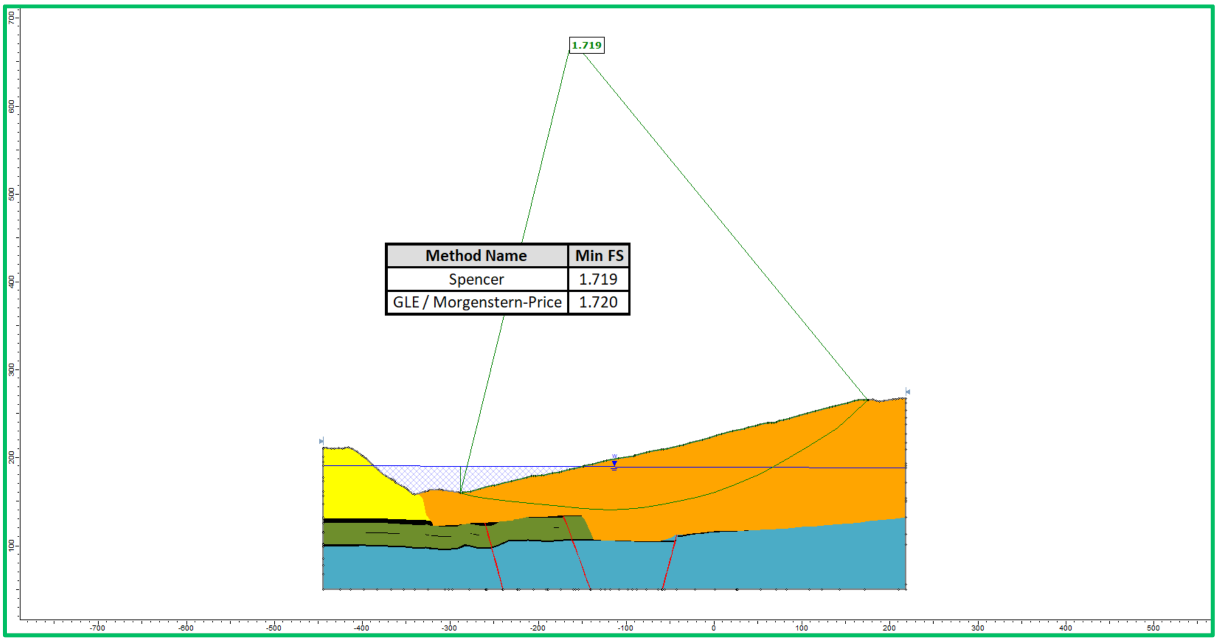
Appendix C11: Section 7 2D stability validation results of A Pit backfill.



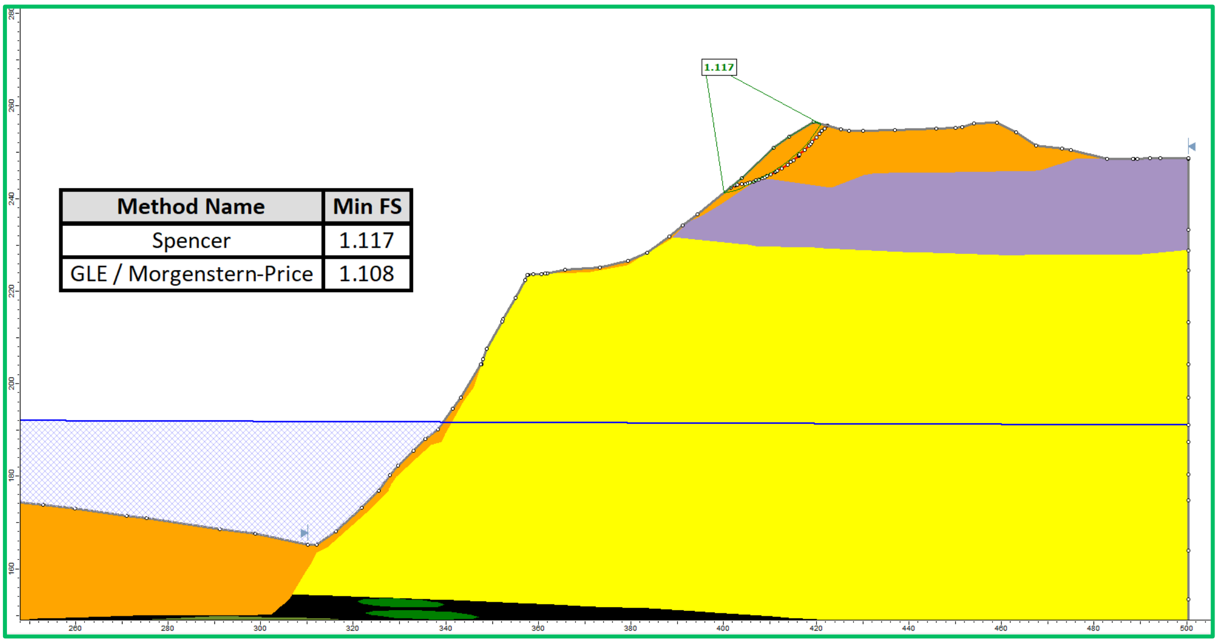
Appendix C12: Section 8 2D stability validation results of A Pit highwall



Appendix C13: 2D stability validation sections of B Pit



Appendix C 14: Section 9 2D stability validation results of B Pit backfill.



Appendix C15: Section 10 Stability validation results of B Pit highwall