VULCAN MINE

Mine Operating Procedure
Ground Control Management

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1. PURPOSE

This procedure details the design and operational requirements for minimising the risk to Coal Mine Workers due to geotechnical hazards at Vulcan Mine.

The mine design either creates a substitution or engineering control for the management of geotechnical risk at Vulcan Mine.

2. SCOPE

This procedure is applicable to all persons at the Vulcan Mine including employees, contractors, service providers and visitors.

The controls within this procedure are mandatory.

3. DEFINITIONS

Batter	Inclined component of the highwall or dump slope.
CMSHA	Queensland Coal Mining Safety and Health Act (1999).
CMSHR	Queensland Coal Mining Safety and Health Regulation (2017).
CMW	Coal Mine Worker.
Dump	The cumulative placement of waste rock or overburden to a designed slope profile.
End-wall	The excavated pit walls that terminate at the lateral ends of the mining strip. An end-wall can comprise spoil or in-situ rock.
Highwall	A highwall is the wall of the pit on the advancing side of the excavation, i.e. the newly excavated wall.
JHA	Job Hazard Analysis.
OCE	Open Cut Examiner.
PHMP	Principal Hazard Management Plan.
RL	Relative/Reduced Level.
HST	Health, Safety and Training.
MOP	Mine Operating Procedure.
SSE	Site Senior Executive.
TARP	Trigger Action Response Plan.
TSD	Technical Services Department.
TSS	Technical Services Superintendent.

4. PROCEDURE

4.1. Pit Design Parameters

This section details design requirements for the pits at Vulcan Mine. Unless covered by individual geotechnical assessment by a Geotechnical Engineer, conformance to these designs shall be adhered to.

The design parameters have been calculated from site geological data and are updated periodically upon new information and following hazard identification.

Prior to and during the design process, the VUL-FRM-20-03 - Mine Design Assessment is to be utilised to ensure compliance to design standards. No design will be issued unless approved by the relevant approval authority, the TSS or SSE.

4.1.1. End-walls and High-walls

The high-wall and end-wall design parameters are detailed in the Vulcan Mine Geotechnical Assessment BMS-P23015C-VIT-VUL-M-1-V1.0and BMS-P21017C-VIT-VUL-M-8-V1 and BMS-P23036C-VIT-VUL-M-1-V1.0_Jupiter_Pit_2023_Mine_Plan_Review.

Current chosen wall design parameters are **70**-degree end-wall and **45-50** degree (soft-wall) advancing highwall design.

Table 1: Pit Design Parameters for High-walls/End-walls (Jupiter Pit)

Area	Recommendations
Bulk Sample to depth of 10 m	Rough cut batter Pit depth 10 m
Natural Surface to Base of tertiary	40° - 50° overall batters
Base of Tertiary to Base of Weathering or Floor of Alex Seam	40° - 50° overall batters, maximum height without catch bench 40 m Minimum bench width 10-20m m (unless governed by Geotechnical Engineer's appraisal)
Continuous Presplit	**70° overall batters, maximum height without catch bench 55 m** **Minimum bench width 10-20 m (unless governed by Geotechnical Engineer's appraisal**
Soft-wall	**45°- 50° overall batters, max height without catch bench 40m, minimum bench width 10-20 m (unless governed by Geotechnical Engineer's appraisal)**
Coal	Continuous batter as per the in-situ area.

Limit Equilibrium (LE) analysis is commonly used method to analyse slope stability. The Limit Equilibrium analysis of Vulcan mine on highwall & endwall is shown below. Based on Jupiter pit progression plan two advancing face was analysed for slope stability which is shown in Figure 1.

S1 = SW–NE Advancing Highwall

S2 = S-N Advancing Highwall

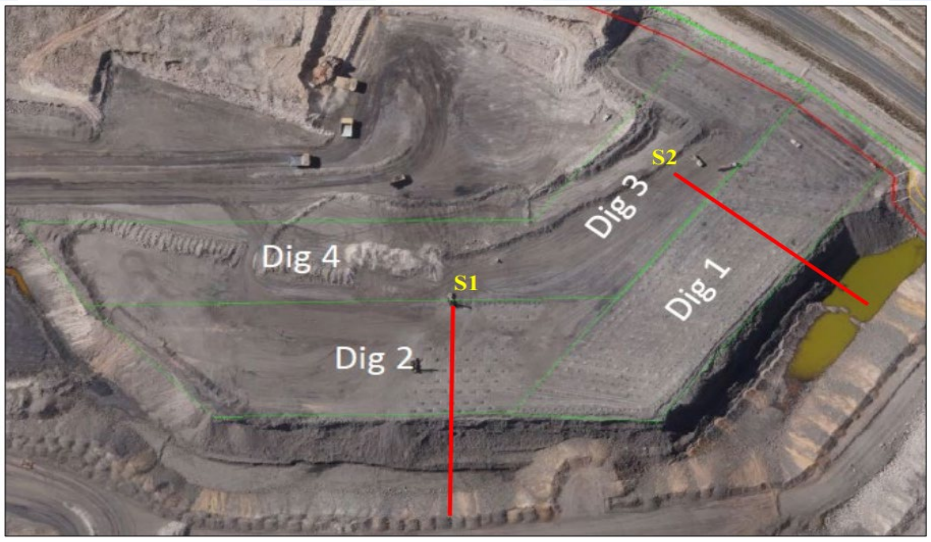


Figure 1: Cross-Section Locations

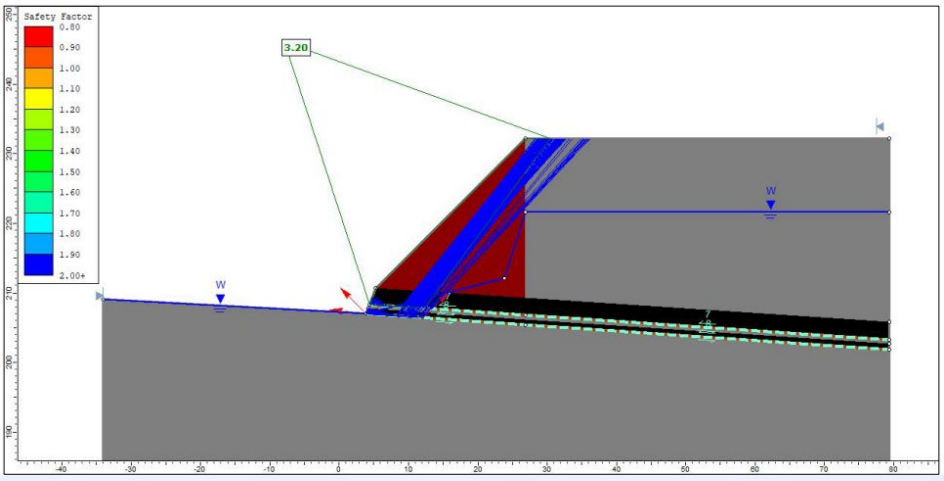


Figure 2: S1-2D LE Analysis Result - Softwall batter (45°-50°)

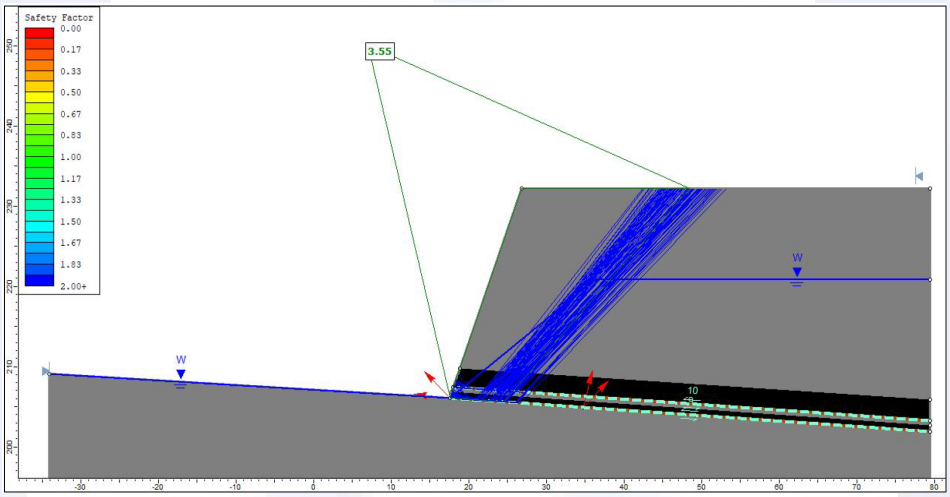


Figure 3: S1-2D LE Analysis Result - Pre-split batter (70°)

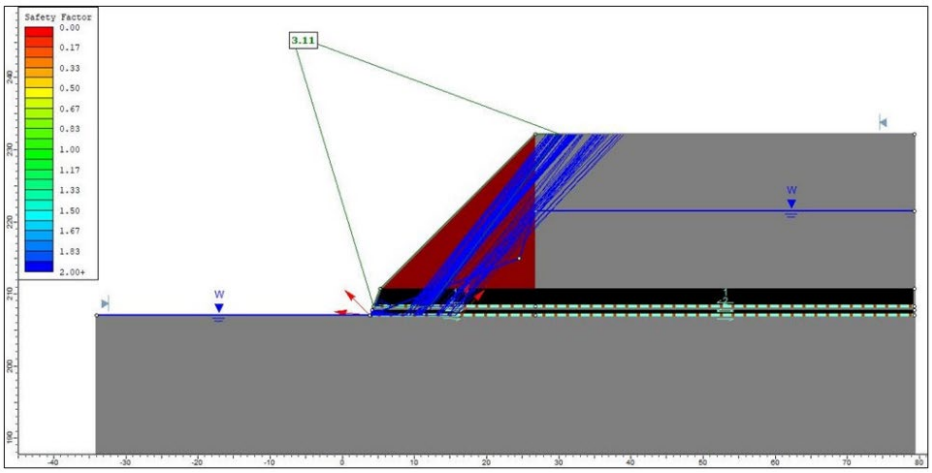


Figure 4: S2-2D LE Analysis Result - Softwall batter (45°-50°)

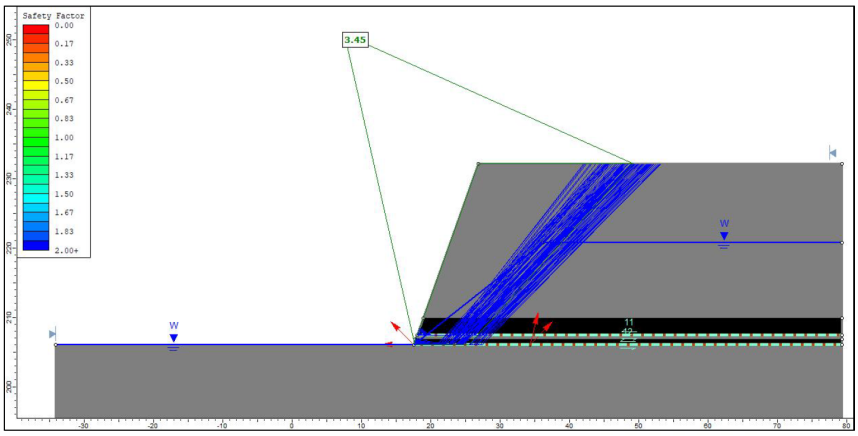


Figure 5: S1-2D LE Analysis Result - Pre-split batter (70°)

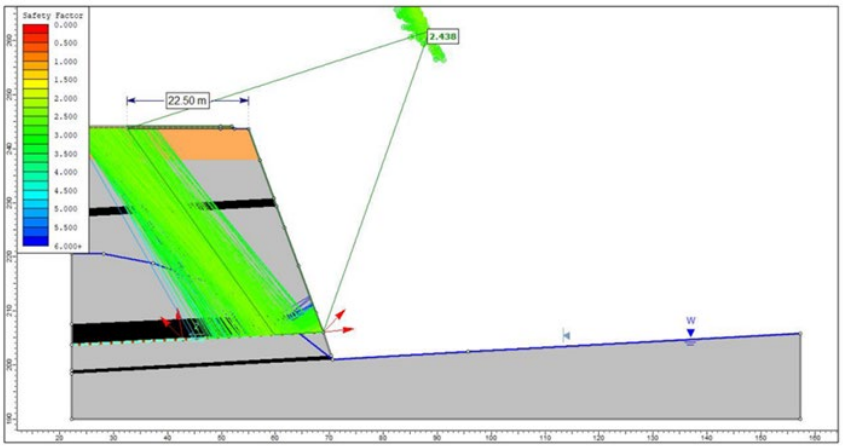


Figure 6: 2D LE Analysis Result – Continuous Pre-Split to DL Seam (eastern wall)

4.1.2 Exclusion and Drop zones

Rockfall analyses has been performed using the Rocscience program RocFall2 to assess the roll out distances, drop zone extents and exclusion bunding requirements. Further detail can be found in BMS-P23036C-VIT-VUL-M-1-V1.0_Jupiter_Pit_2023_Mine_Plan_Review_&_Analysis

The following scenarios were examined:

- **Scenario 1**: 14 m high(approx), upper soft wall batter (45° - 50°) and a 23 m (approximate) 70° pre-split lower batter. (Note: 37 m is the maximum slope height for the Jupiter Pit); Refer to Figure 8 for analysis.

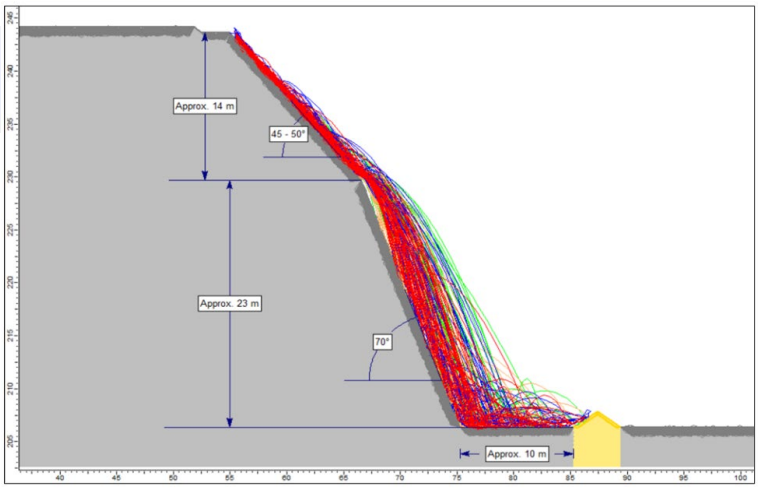


Figure 7: Rockfall analysis for scenario 1

• **Scenario 2**: Continuous 45° – 50° ≤ 20 m height soft wall batter; Refer to Figure 8 for analysis.

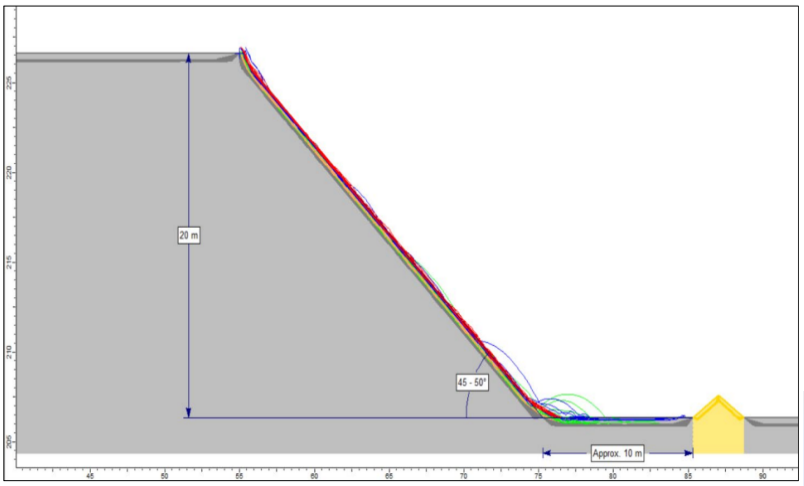


Figure 8: Rockfall analysis for scenario 2

• **Scenario 3**: Continuous 45° – 50° soft wall batter 20 m - 60 m height (approximate); Refer to Figure 9 for analysis.

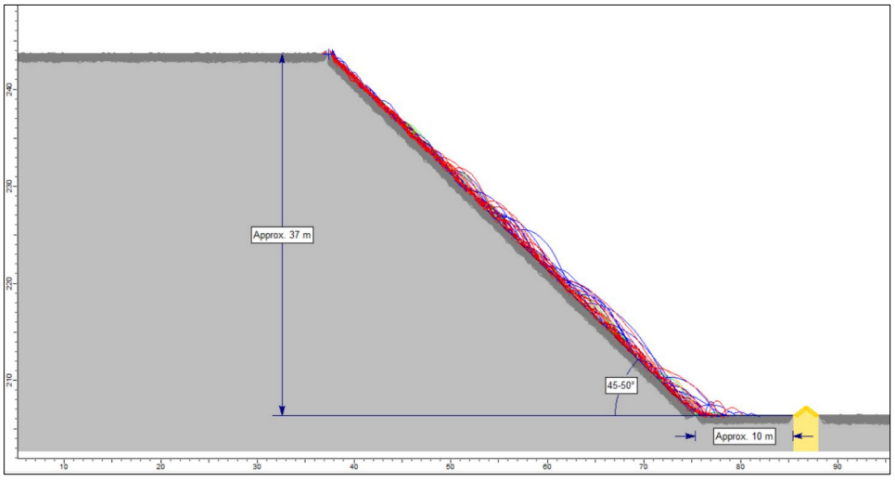


Figure 9: Rockfall analysis for scenario 3

• **Scenario 4**: Continuous 70° batter ≤ 20 m height; Refer to Figure 10 for analysis.

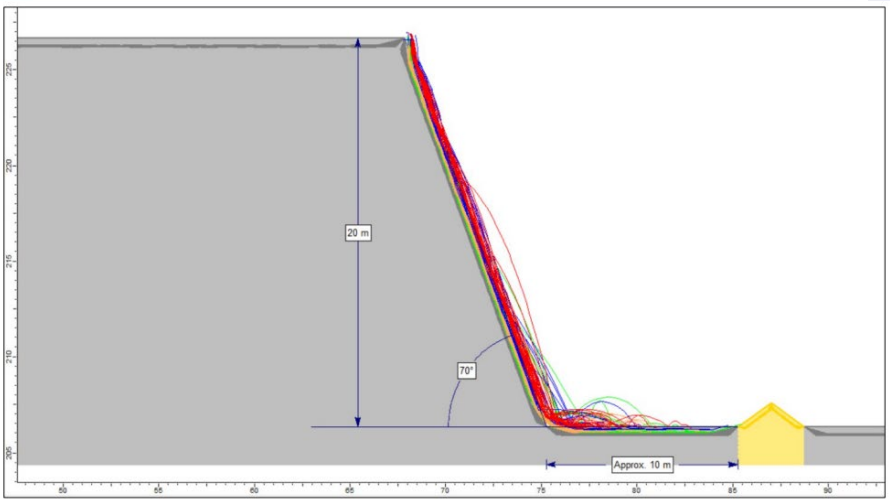


Figure 10: Rockfall analysis for scenario 4

• **Scenario 5**: Continuous 70° batter 20m - 60m height.

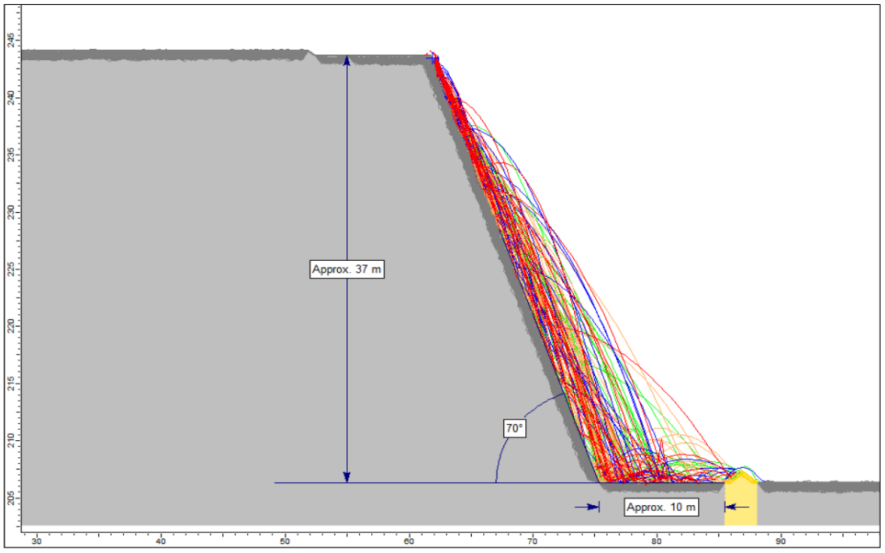


Figure 11: Rockfall analysis for scenario 5

The analysis concludes the Rockfalls from the crest of the advancing highwall slopes (all geometries) would be restrained within the 10 m exclusion zone and within the bund. For the 37 m 70° pre-split highwall, approximately only 1% of rocks would breach the exclusion bund. Furthermore, for the Continuous 45° – 50° ≤ 20 m height soft wall batter, rock falls would be contained within a 5 m exclusion zone.

4.1.3 Stockpiles and Truck Dumps

The dump and stockpile design parameters are detailed in the Vulcan Mine Geotechnical assessment or Geotechnical memorandums and are summarised in Table 2.

Table 2: Spoil Levels for Soft-walls, Stockpiles and Truck Dumps

Spoil Level	Recommendations
Dump foundation	Minimal mud on floor. Dewatered floor where possible. No friable, slaking, dispersive rock on floor. Tertiary material to be avoided for construction of spoil dump base. Consultation with the Geotechnical Engineer where floor dip exceeds 10% for adequate controls. Risk Assessment or geotechnical engineer appraisal required for dumping into excessive mud or water if this cannot be avoided. Establish bunded exclusion zone around toe of active dump to ensure separation between coal mine workers and the active dump. Drainage: Adequate drainage away from dump foundation to limit excessive water build-up. ROM and Product Stockpile foundations to be designed with consideration for suitable material and drainage from stockpile base.
Truck dump profile	Normal truck dumping lift heights (as defined by spoil categories in appendix A): • 10 m for weathered rock (Cat 1 spoil); • 20 m for weathered mixed rock (Cat 2 spoil); • 30 m for mixed rock (Cat 2 - 3 spoil); with dry/competent floor. If floor condition is compromised, a JHA shall be completed. Higher tip heads or material competency may be operated where risks associated with edge cracking and/or subsidence are risk assessed or controlled with Geotechnical Engineer appraisal. For multiple lift dumps (base case – refer Figure 4): • Minimum bench width between dump lifts shall be 10 m or as governed by overall slope angle intercept of 34°; and • Slope angle of dump face profile no greater than 37°.

Spoil Level	Recommendations
	Drainage: Adequate drainage away from dump crest to limit excessive water build up.
Final Landform	Waste dumps will be recontoured to 15% slope (Refer figure 9 & 10) The final void will be backfilled. Drainage will be constructed to be compliant with the Erosion and Sediment control Plan (WRM, 2020)
ROM / Product Stockpile	ROM Stockpiles: Maximum design height of 7 m. Stockpiles above 7 m will require pushing down before being worked with a loader. Draining the water off dumps or stockpiles away from the active edge of the dump or stockpile, so the stability of the active dump or stockpile face is not compromised. Wet materials that have a risk of slumping, shall not to be dumped near or over the tip edge. Wet material shall be dumped as directed by the Supervisor/OCE
Reject Material dumps	No rejects are to be dumped above RL 250 or within 10 m of the final dump profile. For dry rejects: • Paddock stack at approved dump location; or • Dumping over tip-head in accordance with • VUL-SOP-133_Discharging Loads from Fixed and Mobile Plant. For wet rejects, the design of reject cells is to be in accordance with constraints as determined by the Geotechnical Engineer. It is expected that Vulcan Mine will not generate wet rejects. Regular Supervisor/OCE inspections of this area, paying particular attention to crack development at the tip-head.

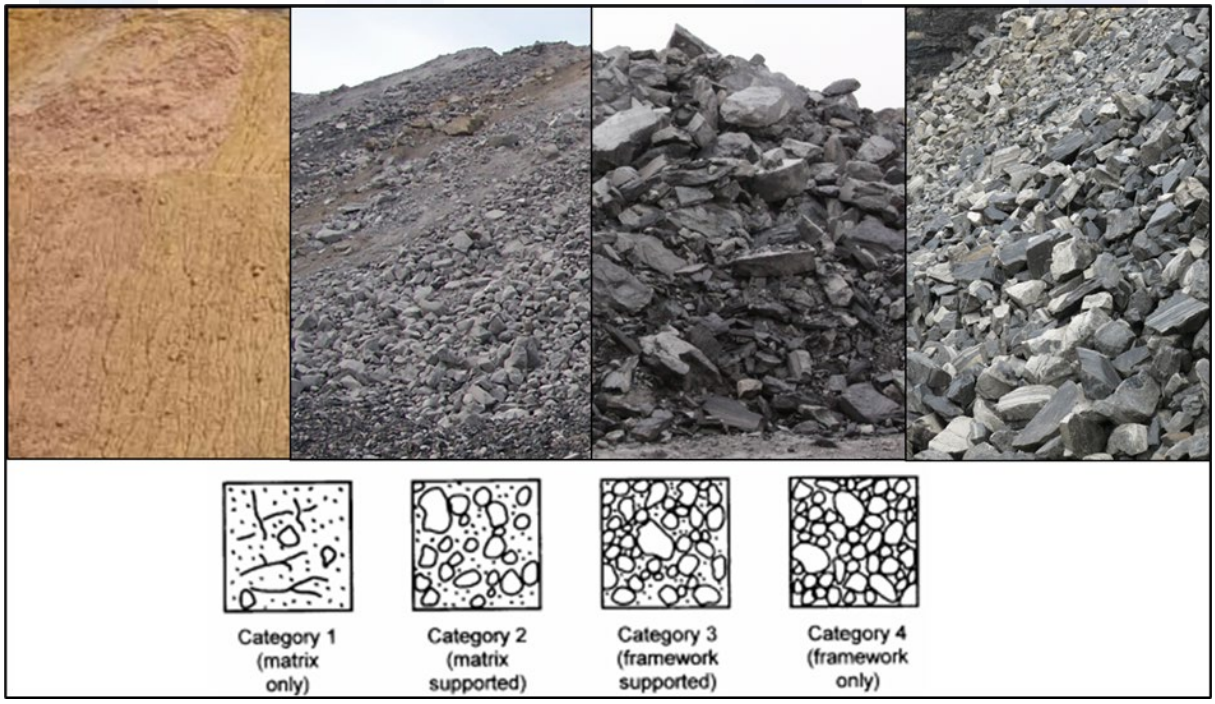


Figure 12: Examples of each of the spoil types

Spoil Type	Bench Height (m)	Min. Berm Width (m)	Method	Overall Slope Angle (°)	FoS
Category 1	10	10	Auto-Ref	24	1.21
			Block		1.23
Category 2	20	10	Auto-Ref	31	1.26
			Block		1.37
Category 2.5 (Base Case)	30	10	Auto-Ref	34	1.28
			Block		1.40
Category 3	40	10	Auto-Ref	34	1.39
			Block		1.49
Category 4	40	10	Auto-Ref	34	1.53
			Block		1.64

GLE/Morgenstern-Price FoS reported

Figure 13: Spoil Dump Bench Height Recommendations

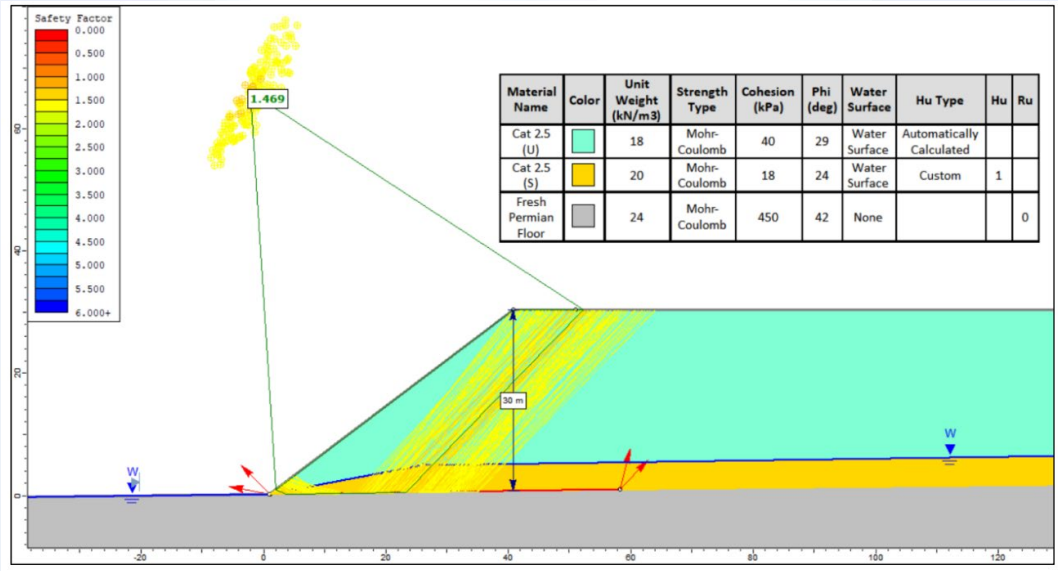


Figure 14: 30 m Height In-Pit Spoil Dump Stability Analysis

4.2. Design Implementation

The Vulcan Mine weekly planning process communicates hazards and the design information through to operations. Principal hazards identified in the mining areas are communicated in the planning process. This document details the operational requirements for each active mining area. Included in this plan are key controls required for the management of ground control.

The weekly mine plan supplements the design data as detailed in each area's mine design assessment. This includes dig designs, high-wall and end-wall mapping & compliance to plan. These plans are communicated to the wider workforce and the Geotechnical Engineering Consultant.

The mine design assessment is a running document for strip/terrace design. Upon completion of a strip/terrace or design, this document is peer reviewed and signed off before being uploaded to the mine plan and this information is kept in the Mine design register for future design reference and auditing purposes.

4.3. Control Data

Compliance with the requirements of this procedure shall be reviewed through the application of workplace inspections as specified in VUL-MOP-003b-Ground Control Monitoring.

5. ROLES AND RESPONSIBILITIES

This is detailed in the VUL-PHM-003-Geotechnical PHMP.

6. REFERENCES

- BMS (2019), *Vulcan Complex Geotechnical Assessment*, Report No. 20191029_VR, Blackrock Mining Solutions Pty Ltd, 29 October 2019.
- BMS (2020), *Jupiter Final Landform Slope Stability Assessment Memorandum*, Memo Ref. BMS-20200304-VIT, Blackrock Mining Solutions Pty Ltd, 4 March 2020.
- BMS-P23036C-VIT-VUL-M-1-V1.0_Jupiter_Pit_2023_Mine_Plan_Review__Analysis.
- Coal Mining Safety and Health Act 1999 (Qld)
- Coal Mining Safety and Health Regulation 2017 (Qld)
- VUL-FRM-20-03-Mine Design Assessment
- VUL-PHMP-003-Geotechnical PHMP
- VUL-SOP-133_Discharging Loads from Fixed and Mobile Plant.
- WRM (2020), *Vulcan Bulk Sampling Project Erosion and Sediment Control Plan,* WRM Water & Environment Pty Ltd, 31 July 2020.

7. REVIEW

This document shall be reviewed at minimum two yearly, or as follows:

- when there is a change of method and/or technology and/or legal or other requirement that may affect the accuracy of this document;
- when operational changes occur that effect the currency of the document;
- when there has been a significant event to which this document was relevant; and
- as a result of relevant audit findings.

8. DOCUMENT CONTROL

Version	Date	Description	Document Controller
01	13/07/2020	Initial draft/risk workshop	Shane Johnson
02	28/10/2020	Review and formatting	Rachael Dacker
03	08/09/2021	Review and formatting	Rachael Dacker
04	16/08/2023	Review and Update	Allira Spencer

Design analysis for other areas such as Shallow pit and final landform

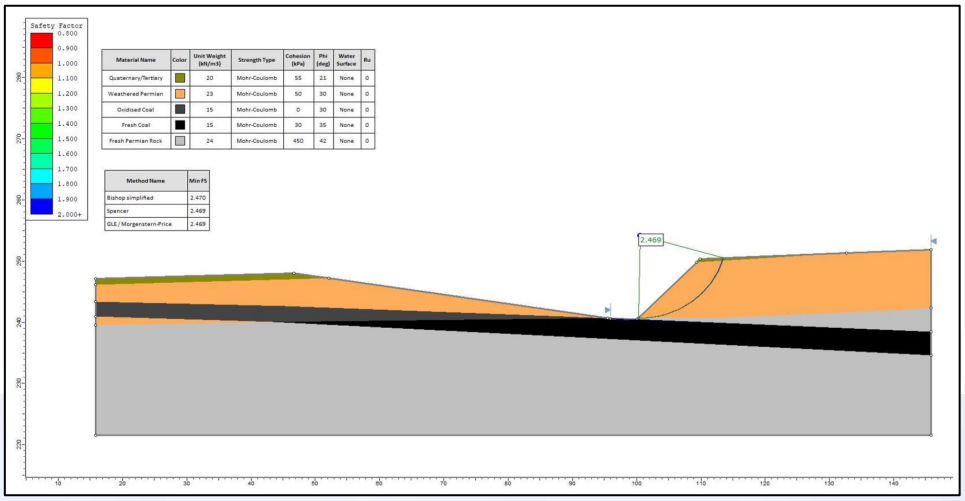


Figure 15: Shallow Pit Slope Stability

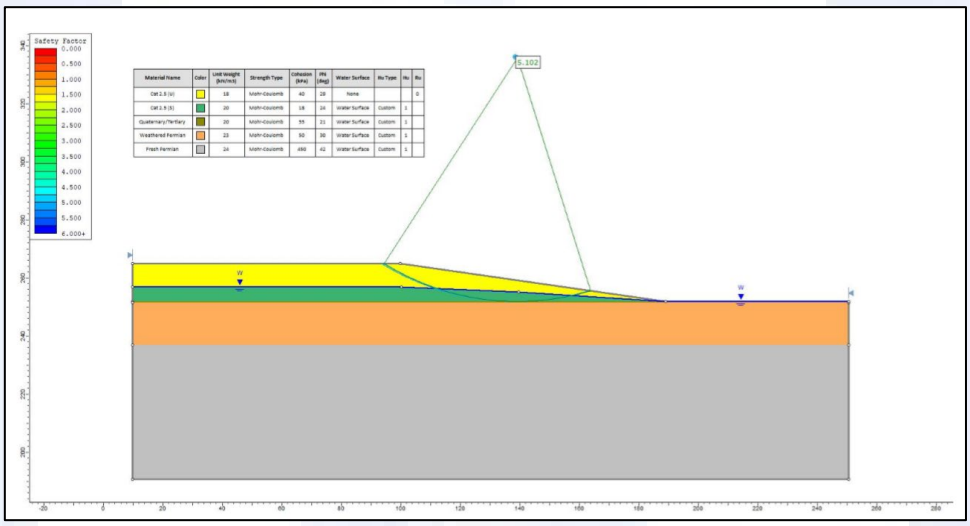


Figure 16: Final Ex-pit Landform Stability

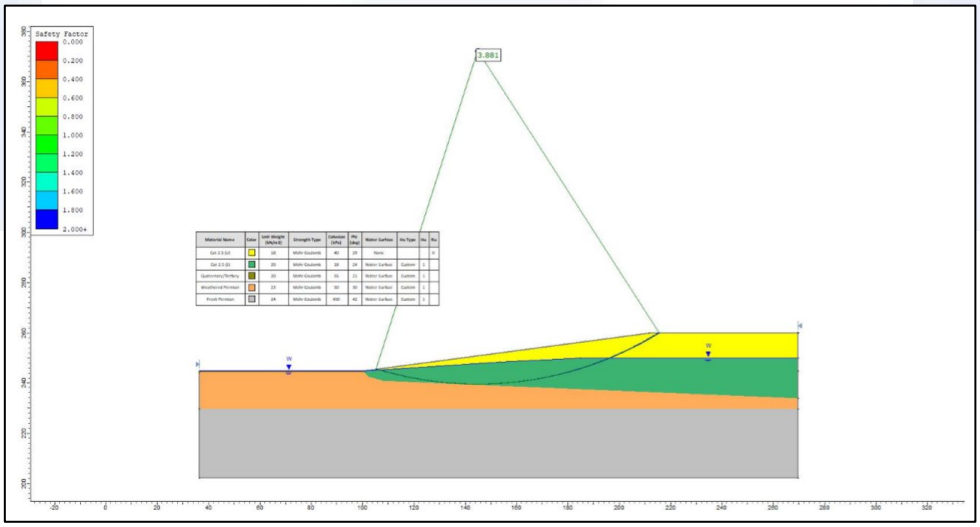


Figure 17: Final In-pit Landform Stability

9. APPENDIX A – MINE DESIGN ASSESSMENT – Template & Example

Vulcan Mine Safety and Health Management System
VUL-FRM-20-03-Mine Design Assessment

VUL-FRM-20-03- Mine Design Assessment | **DIG PLAN** | **VULCAN MINE**

Top view
> Indicate the attack point
> Access Ramp grade
> Crest & Toe
> Length & Width
> Faults & Hazards
> Coal roof contour
> RL for Each pass
> Coal LOX line if required
> Sectional view lines
> Ensure compass in adjusted accordingly
> Include scale of design

Short cross section view
> Slope/batter angle
> RL (background white & font in blue)
> Height in three points
> Indicate Coal roof & floor
> Coal dip in %

Long Cross section view
> Slope/batter angle
> Fl. (background white & font in blue)
> Height in three points
> Indicate Coal roof & floor
> Coal dip in %

DIG NOTES

SAFETY NOTES
- The implementation of this plan may create numerous open edges. These will require safety bunds to be installed by operating crews and monitored by crew supervisors.
- Chamfer corners to allow for geostability
- Operations to complete a risk assessment if there is an interaction between active dumps and mining area/active circuit.
- All relevant SOP & SWP regarding bunds shall be followed.

ENGINEERING SAFETY CHECKLIST

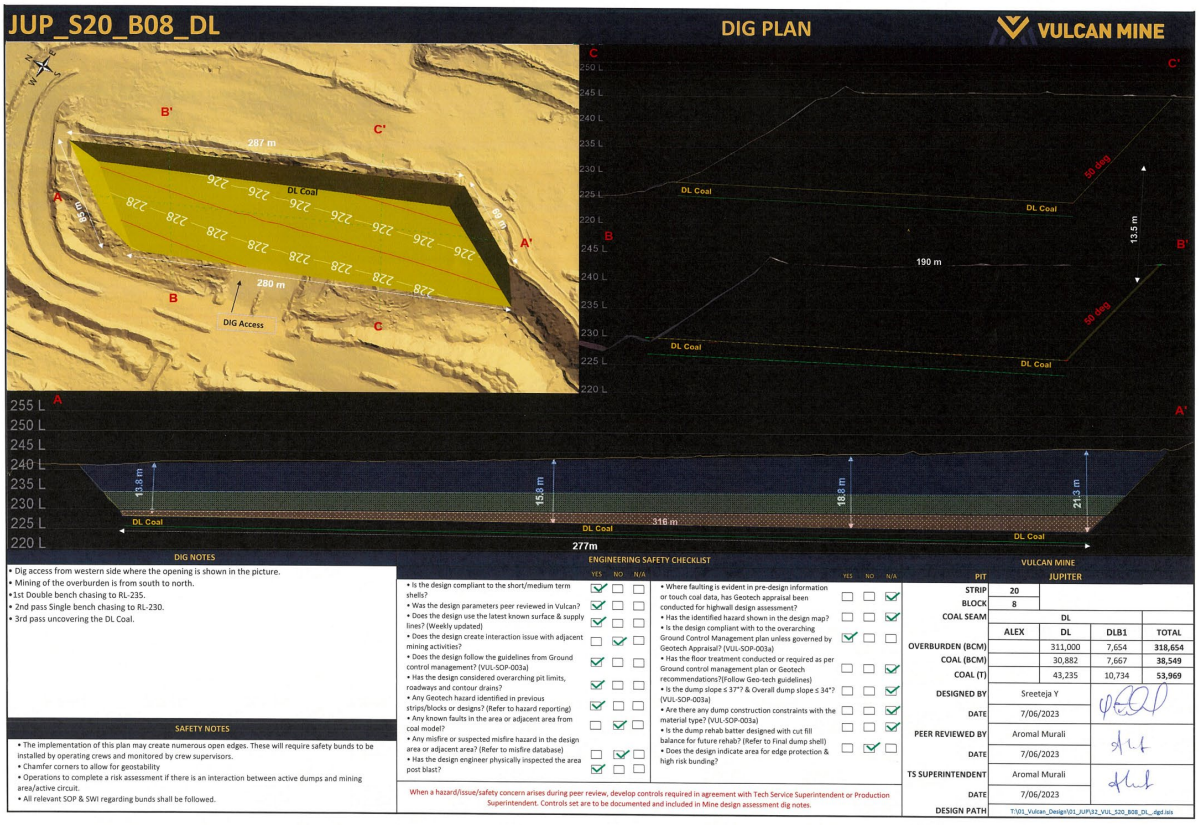
	YES	NO	N/A
• Is the design compliant to the short/medium term shells?			
• Was the design parameters peer reviewed in Vulcan?			
• Does the design use the latest known surface & supply lines?			
• Does the design create interaction issue with adjacent mining activities?			
• Does the design follow the guidelines from Ground control management?			
• Has the design considered overarching pit limits, roadways and contour drains?			
• Any Geotech hazard identified in previous strips/blocks or designs?			
• Any known faults in the area or adjacent area from coal model			
• Any misfire or suspected misfire hazard in the design area or adjacent area?			
• Where faulting is evident in pre-design information or touch coal data, has Geotech appraisal been conducted for highwall design assessment?			
• Has the identified hazard shown in the design map?			
• Is the design compliant with to the overarching Ground Control Management plan unless governed by Geotech Appraisal?			
• Has the floor treatment conducted or required as per Ground control management plan or Geotech recommendations?			
• Is the dump slope ≤ 37°? & Overall dump slope ≤ 34°?			
• Are there any dump construction constraints with the material type?			
• Is the dump rehab batter designed with cut fill balance for future rehab?			
• Does the design indicate area for edge protection & high risk bunding?			

When a hazard/issue/safety concern arises during peer review, develop controls required in agreement with Tech Service Superintendent or Production Superintendent. Controls set are to be documented and included in Mine design assessment dig notes.

VULCAN MINE

PIT	JUPITER			
STRIP				
BLOCK				
COAL SEAM	ALEX			
	ALEX	DL	DLB1	TOTAL
OVERBURDEN (BCM)				0
COAL (BCM)				0
COAL (T)	0			0
DESIGNED BY				
DATE				
PEER REVIEWED BY				
DATE				
TS SUPERINTENDENT				
DATE				
DESIGN PATH				

Version	Approval Date	Review Date	Print Date	Page 1 of 1
1	15/08/2023	15/08/2026	15/08/2023	UNCONTROLLED DOCUMENT WHEN PRINTED



DIG NOTES
- Dig access from western side where the opening is shown in the picture.
- Mining of the overburden is from south to north.
- 1st Double bench chasing to RL-235.
- 2nd pass Single bench chasing to RL-230.
- 3rd pass uncovering the DL Coal.

SAFETY NOTES
- The implementation of this plan may create numerous open edges. These will require safety bunds to be installed by operating crews and monitored by crew supervisors.
- Chamfer corners to allow for geostability
- Operations to complete a risk assessment if there is an interaction between active dumps and mining area/active circuit.
- All relevant SOP & SWI regarding bunds shall be followed.

ENGINEERING SAFETY CHECKLIST

	YES	NO	N/A
• Is the design compliant to the short/medium term shells?	✓		
• Was the design parameters peer reviewed in Vulcan?	✓		
• Does the design use the latest known surface & supply lines? (Weekly updated)	✓		
• Does the design create interaction issue with adjacent mining activities?		✓	
• Does the design follow the guidelines from Ground control management? (VUL-SOP-003a)	✓		
• Has the design considered overarching pit limits, roadways and contour drains?	✓		
• Any Geotech hazard identified in previous strips/blocks or designs? (Refer to hazard reporting)	✓		
• Any known faults in the area or adjacent area from coal model?		✓	
• Any misfire or suspected misfire hazard in the design area or adjacent area? (Refer to misfire database)		✓	
• Has the design engineer physically inspected the area post blast?	✓		
• Where faulting is evident in pre-design information or touch coal data, has Geotech appraisal been conducted for highwall design assessment?			✓
• Has the identified hazard shown in the design map?			✓
• Is the design compliant with to the overarching Ground Control Management plan unless governed by Geotech Appraisal? (VUL-SOP-003a)	✓		
• Has the floor treatment conducted or required as per Ground control management plan or Geotech recommendations?(Follow Geo-tech guidelines)			✓
• Is the dump slope ≤ 37°? & Overall dump slope ≤ 34°? (VUL-SOP-003a)			✓
• Are there any dump construction constraints with the material type? (VUL-SOP-003a)			✓
• Is the dump rehab batter designed with cut fill balance for future rehab? (Refer to Final dump shell)			✓
• Does the design indicate area for edge protection & high risk bunding?			✓

When a hazard/issue/safety concern arises during peer review, develop controls required in agreement with Tech Service Superintendent or Production Superintendent. Controls set are to be documented and included in Mine design assessment dig notes.

VULCAN MINE

PIT	JUPITER			
STRIP	20			
BLOCK	8			
COAL SEAM	DL			
	ALEX	DL	DLB1	TOTAL
OVERBURDEN (BCM)		311,000	7,654	318,654
COAL (BCM)		30,882	7,667	38,549
COAL (T)		43,235	10,734	53,969
DESIGNED BY	Sreeteja Y			
DATE	7/06/2023			
PEER REVIEWED BY	Aromal Murali			
DATE	7/06/2023			
TS SUPERINTENDENT	Aromal Murali			
DATE	7/06/2023			
DESIGN PATH	T:\01_Vulcan_Design\01_JUP\32_VUL_S20_B08_DL_dgd.isis			

10. APPENDIX B – WEEKLY PLAN COMMUNICATIONS

10.1. Weekly Plan Examples