Subsidence and Ground Control Management Plan

Golden Point Underground Mine (GPUG)

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Department	**Underground**
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Approval table

	Position title	Name	Date
Authored by	UG Senior Geotechnical Engineer	Murray McCulloch	Jan 2024
Reviewed by	UG Senior Geotechnical Engineer Principal Geotechnical Engineer	Murray McCulloch Brian Adams	Nov 2024
Approved by	Manager Mining - Underground	Jamie Peters	Sep 2025

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Contents

1 PURPOSE 9

2 SCOPE 9

2.1 Application 9

2.2 Interaction between Surface and Underground Operations 9

2.3 Specific Exclusions 9

3 REFERENCE AND COMPLIANCE 10

3.1 Compliance 10

3.2 References 11

3.3 Consultant Reports 12

4 RISK ASSESSMENT 13

5 MINE OVERVIEW AND GEOLOGY 14

5.1 Mining History, Current Development and Future Plans 14

5.1.1 Historic Mining 14

5.1.2 Current GPUG Mine (Nov 2024) 14

5.1.3 Consented Development 15

5.2 Mining Methods 16

5.3 GPUG Mine Layout 17

5.4 Mine Grid 18

5.5 Geology 19

5.5.1 Regional Geological Setting 19

5.5.2 Local Geology 19

5.5.3 Ore Body 20

5.5.4 Rock Types 22

6 GEOTECHNICAL MODEL 23

6.1 Diamond Core Drilling 23

6.2 Intact Rock Properties 24

6.3 Geological Structure 26

6.3.1 Structural Fabric 26

6.3.2 Large Scale Faulting 26

6.3.3 Hanging Wall Shear 26

6.3.4 Golden Point Fault Zone 26

6.3.5 Northern Gully Fault Family 27

6.3.6 Deepdell Creek Fault 28

6.3.7 Footwall Fault 28

6.3.8 Fault Model 28

6.4 Rock Mass Model 29

6.5 Pre-mining (virgin) Stress Field 29

6.6 Numerical Modelling 31

7 GEOTECHNICAL ENVIRONMENT AND MANAGEMENT 32

7.1 Underground Activities 32

7.2 Critical Controls 32

7.3 High Potential Geotechnical Hazards 32

7.3.1 Rock Fall 33

7.3.2 Faults and other Geological Structure 33

7.3.3 Large Development Span 34

7.3.4 Groundwater 34

7.3.5 Ground Movement (Deformation) 35

7.3.6 Ground Stress 35

7.3.7 Seismic Activity 36

7.3.8 Drill and Blasting-Induced Damage 37

7.3.9 Long Exposure Time 37

7.3.10 Corrosion of Steel Support Elements 37

7.3.11 Poorly Installed Ground Support 38

7.3.12 Changes to the Ground Control System 38

7.3.13 Stope Extraction 39

7.3.14 Inundation and Inrush 39

7.3.15 Subsidence and Caving 40

7.4 Key Risk Areas 41

7.4.1 Development Near Pit 41

7.4.2 Open Pit Crown Pillar 42

7.4.3 Historic Open Pit Backfill 42

7.4.4 Historic UG Workings 43

7.4.5 Deepdell Creek 44

7.4.6 Decline Pillar 44

7.4.7 Development above the Hanging wall Shear 45

7.4.8 Development Faces 45

7.4.9 Stope Brows 46

7.4.10 Multi-level mining 47

7.5 Ground Deformation 48

7.5.1 Development 49

7.5.2 Stoping 49

7.5.3 Squeezing Ground 49

7.6 Subsidence Management Plan 51

7.6.1 Subsidence Risks and Key Operational Controls 51

7.6.2 Subsidence Management Strategy 52

7.6.3 Mine Planning and Design to Limit Subsidence 52

7.6.4 Deepdell Creek Standoff Line (DCSL) 54

7.6.5 Deepdell Creek Orange and Green Mining Zones 55

7.6.6 Numerical Modelling 56

7.6.7 Subsidence Monitoring 57

7.6.8 Subsidence Reporting 57

7.6.9 Subsidence TARP 57

7.6.10 Subsidence Review Team 58

7.6.11 Mitigation Measures for Deepdell Creek 58

7.7 Ground Control Management Process 63

7.7.1 Mine Design Process 65

7.7.2 Geotechnical Design Parameters 65

7.8 Ground Support 66

7.8.1 Standard Ground Support Designs 66

7.8.2 Support Types 67

7.8.3 Trigger Action Response Plans (TARP) 68

7.8.4 Ground Support Installation 68

7.8.5 Ground Support Elements 69

7.8.6 Quality Assurance and Quality Control 70

7.8.7 Ground Support Inspections 72

7.9 Ground Rehabilitation ... 73

7.10 Check Scaling ... 74

7.11 Area Closures and Barricading ... 74

7.12 Ground Failure / Fall of Ground Incidents ... 75

7.13 Communication and Training ... 75

7.13.1 Communication with Mine Personnel ... 75

7.13.2 Training ... 76

7.14 Incident Investigation ... 77

7.14.1 Guidelines for Incident Investigation ... 77

7.14.2 Incident Statutory Reporting Requirements ... 78

7.15 Geotechnical Monitoring ... 78

7.15.1 Monitoring Strategy ... 78

7.15.2 Underground Monitoring ... 79

7.15.3 Surface Subsidence Monitoring ... 81

7.15.4 Groundwater Monitoring ... 82

7.15.5 Surface Water Monitoring ... 82

7.16 Geotechnical Data Collection ... 83

7.16.1 Data Collection Strategy ... 83

7.16.2 Geology Face Mapping ... 83

7.16.3 Geotechnical Mapping ... 84

7.16.4 Drill Core Logging ... 84

7.16.5 Geophysical Logging ... 85

7.16.6 Laboratory Testing ... 85

7.16.7 In-Situ Stress Measurement ... 85

8 RESPONSIBILITIES AND ACCOUNTABILITIES 85

9 RECORDS AND DOCUMENTATION 89

10 AUDIT AND REVIEW 90

11 DEFINITIONS 91

12 REFERENCES 93

13 APPENDIX 94

13.1 Standard Ground Support Designs 94

13.2 Trigger Action Response Plans 135

13.3 Shotcrete and General Purpose Concrete Mix Designs 149

13.4 No Entry Authorisation Forms 150

13.5 Rockbolt and Cable Bolt Grout Mix Guidelines 151

13.6 Example of Hazard Map 152

13.7 Ground Condition Rating (GCR) 153

13.8 Wide Spans and Intersection Cablebolt Design Guidelines 154

13.8.1 Wide Spans 154

13.8.2 Intersections 154

13.9 Corrosion assessment form 155

1 PURPOSE

The purpose of this Subsidence and Ground Control Management Plan (GCMP) is to define a clear and structured approach to controlling and managing surface and underground geotechnical hazards and risks at Golden Point Underground Mine (GPUG) considering the potential impacts on safety, mine production, and the environment. The overarching objectives are:

- to prevent fatalities or injuries related to geotechnical hazards; and
- to manage the risk of unexpected environmental effects.

This GCMP describes the geotechnical environment, details the nature of potential ground instability hazards, and sets out the systems, processes, procedures, and operational controls implemented by OceanaGold in order to control these hazards and reduce associated risk to an acceptable level (as low as reasonably practicable, ALARP).

This GCMP for GPUG is a key component of the Principal Hazard Management Plan (PHMP) for Ground Instability at the Macraes Mining Operation (MAC-257-PHM-000). It also includes ground control processes that are critical to the management of breakthrough into historic underground or open pit workings, and is referenced by the PHMP for Inundation and Inrush (MAC-257-PHM-002).

2 SCOPE

2.1 Application

This GCMP is authorised by the Macraes Underground Mine Manager and applies to all persons in any capacity accessing GPUG; and also to those involved in mine design and geotechnical assessment work. The scope includes:

- All ground instability hazards that may occur within the underground mine environment, including rockfall, roof collapse, wall failure, caving, rock burst, ground support failure, etc.
- All areas of GPUG, including portals, access and ventilation tunnels, stockpiles, shafts, development drives, stoping panels, etc.
- Surface subsidence caused by GPUG underground mine operations.

2.2 Interaction between Surface and Underground Operations

Surface rockfall, slope instability, and subsidence hazards caused-by or impacting GPUG operations must be collaboratively managed by open pit (OP) and underground (UG) groups, and both UG and surface GCMPs set out the collaborative work required to successfully manage OP-UG interaction effects and hazards. However, to avoid repetition and ambiguity the specific hazard controls employed at Macraes are split between documents:

- Surface rockfall and slope stability controls are set out in the GCMP for Surface Operations (MAC-350-PRO-000).
- Surface subsidence management controls for GPUG are set out in this GCMP.

2.3 Specific Exclusions

Management of the following geotechnical hazards are specifically excluded from this GCMP (because they are covered by other documents):

Hazards excluded from this GCMP for GPUG	Refer to other Management Plans
Ground instability hazards at Frasers Underground Mine (FRUG)	MAC-400-PRO-000 Ground Control Management Plan (GCMP) for FRUG
Open pit highwall or other surface slope instability and rockfall	MAC-350-PRO-000 Ground Control Management Plan (GCMP) for Macraes Surface Mining Operations
Surface subsidence hazards (open fractures, step offsets, sinkhole depressions and open crown holes) associated with historic UG or OP workings	
Underground hazards associated with breakthrough into historic UG or OP workings	MAC-257-PHM-002 PHMP for Inundation and Inrush MAC-400-PLN-000 Inundation and Inrush Management Plan – Underground
Flooding or debris flow impacting GPUG due to upstream/upslope TSF instability	MAC-205-MAN-TBC SP11A Operations Surveillance and Maintenance Manual MAC-205-MAN-TBC Mixed Tails Impoundment (MTI) Operations Surveillance and Maintenance Manual MAC-253-TRP-003 Emergency Trigger Action Response Plans (TARP) MAC-205-SOP-TBC SP11A and MTI Emergency Action Plan (EAP)

3 REFERENCE AND COMPLIANCE

3.1 Compliance

This GCMP (forming part of the PHMP for Ground Instability) is intended to comply with relevant health and safety legislation and associated guidelines, as well as OceanaGold's internal standards:

- NZ Health and Safety at Work Act 2015 (HSW Act).
- NZ Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016 (Mining Regulations).
- WorkSafe (2016) Ground or Strata Instability in Underground Mines and Tunnels – Approved Code of Practice.
- OceanaGold Safety Performance Standard for Ground Control (OGC-450-STD-020).

The GCMP is also intended to comply with current resource consent conditions relating the subsidence management:

- Otago Regional Council (ORC) Land Use Consent RM23.783.01, Conditions 10 and 12-15.

3.2 References

Level	Source
Legislation and Guidelines	• NZ Health and Safety at Work Act 2015
	• NZ Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016
	• WorkSafe NZ – Ground or Strata Instability in Underground Mines and Tunnels – Approved Code of Practice – September 2016
Corporate	• OGC-450-STD-005 Integrated Management System
	• OGC-450-STD-020 Safety Performance Standards Manual
	• OGC-450-BWT-003 Underground Ground Control Bowtie
	• OGC-450-CHK-005 Ground Control CCCS
	• OGC-450-GUI-005 Risk Management Guidelines
Site	• MAC-257-PHM-000 Ground Control PHMP
	• MAC-250-RSK-005 Macraes Risk Register
	• MAC-250-RSK-014 Ground Control Underground RA
	• MAC-250-TEM-005 Ground or Strata Instability Audit Template
	• MAC-253-PCP-000 Emergency Management Control Plan
	• MAC-253-PRO-003 Emergency Trigger Action Response Plans (TARPs)
	• MAC-252-PRO-004 Management of Change Procedure
	• MAC-256-PRO-003 Fatigue Management Procedure
	• MAC-256-PRO-000 Drugs and Alcohol Procedure
	• MAC-252-PRO-009 Contractor Management Plan
	• MAC-440-PRO-004 Cable Bolter Operations
	• MAC-440-PRO-006 Concrete Batching
	• MAC-440-PRO-051 Handheld Mining
	• MAC-440-PRO-063 Installing, Grouting and Tensioning Cable and Rock Bolts

	• MAC-440-PRO-021 Jumbo Operations
	• MAC-440-PRO-046 Manual Scaling
	• MAC-440-PRO-064 - Underground Induction Manual
	• MAC-440-PRO-037 Spraymec Operation
	• MAC-440-PRO-069 Pull Testing
	• MAC-440-PRO-073 Ground Awareness
	• MAC-440-PRO-075 – Design and Installation of Spiling Underground
	• How to Guide - Adding Structural Data to Deswik Maps (Draft)
	• Geotechnical inspections (Draft)

3.3 Consultant Reports

Report (ordered by date)	Purpose
Rosengren. K. (2006). Frasers Underground Mine, Geotechnical Review – July 2006. Internal report prepared for OGC by Kevin Rosengren & Associates Pty. Ltd, report number 26003	Wide Spans and Intersection Cablebolt Design Guidelines (considered relevant to GPUG – See Section 13.9)
OreTeck (2019-09-04) Golden Point Underground Project – Geotechnical Review. OreTeck Mining Solutions Ref J000028, Draft Rev0, 4 Sep 2019	Pre-feasibility review
OreTeck (2020a) Updated Golden Point Underground Geotechnical Strategy for the control of potential surface subsidence. OreTeck Mining Solutions Ref J000051, Rev3, 25 Mar 2020	Resource consent application (AEE Appendix D)
OreTeck (2020b) Golden Point Geotechnical Assessment. OreTeck Mining Solutions Ref J000065, Rev1, April 2020	Pre-Feasibility Study
PSM (2020-07-03) Golden Point Underground Waste Rock Stacks. PSM Consult Pty Ltd Ref PSM71-254L, 6 July 2020	Resource consent application (response to RFI)
Geotechnica (2020-05-21) Geotechnical Analysis of Golden Point Underground Project, Geotechnica Draft Report 19006, Rev C1, 21 May 2020 (Appendix E of OreTeck J000065)	Pre-Feasibility Study
AMC (2022-11-18) Review Geotechnical Modelling update for the Undermining of Deepdell Creek (Addendum). AMC Consultants AMC Project 222043, 18 Nov 2022.	Northern Extension AEE

Geotechnica (2022-12-14) Updated Geotechnical Analysis of Mining Beneath Deepdell Creek at the Golden Point Underground Project, Geotechnica_Report_22012_D, 14 Dec 2022	Northern Extension AEE
Tilbatek (2022-05-26) Geotechnical Review – Fault Mining at Golden Point. Prepared by Mick Pfitzner, 26 May 2022	Review of Golden Point Fault Zone Crossing
OreTeck (2023-02-22) Geotechnical Assessment for Golden Point Underground Northern Extension near Deepdell Creek. OreTeck Mining Solutions Ref J000258, Draft Rev4, 15 Dec 2022 (revised 22 Feb 2023)	Northern Extension AEE
WSP-Golder (2023-04-26) Golden Point Underground Mine (GPUG) – GPUG Extension Hydrogeological Assessment. WSP Australia Pty Ltd Ref PS130025-003-R-Rev5, 26 April 2023	Northern Extension AEE
Tilbatek (2023-05-12) Golden Point underground Project – Review of Rock Fall and Ground Support Standards. Prepared by Mick Pfitzner, 12 May 2023	Geotechnical Review
Valenza (2023-06) Macraes mine GPUG Extension Project Hydrogeological Review. Valenza Engineering Pty Ltd. Ref. 396_R_01_Rev2 Final, June 2023.	Northern Extension AEE
Entech (2023) Golden Point Underground Review – August 2023	Geotechnical Review
OreTeck (2023-12-24) Conceptual Geotechnical Assessment Round Hill Underground Extension. OreTeck Mining Solutions Ref J000288, Draft Rev C, 24 Dec 2023	Round Hill West GPUG Extension Concept Study
PSM (2026) Macraes Phase Four Project - Golden Point Underground Extension - Mine Subsidence Assessment. PSM71-373R DRAFT REV2. 24 July 2026	GPUG Extension – Mine Subsidence Assessment

4 RISK ASSESSMENT

The Macraes Underground Operations have identified several common risks with a high potential for a fatality or serious injury to personnel due to a ground failure underground.

The site risk register is to be reviewed after all significant incidents relating to ground control underground. Formal risk assessments are to be undertaken where changes to this PHMP effect safety of personnel. Risk assessments are to be conducted according to the Risk Management Guideline. Changes to this GCMP shall only be authorised by the Manager Mining - Underground.

A risk assessment may be done as part of the Area Design process and Stope Shape Approval process (SSA).

Reference:

- MAC-250-RSK-005 Macraes Risk Register
- MAC-250-RSK-014 Ground Control Underground RA
- OGC-450-BWT-003 Underground Ground Control Bowtie

5 MINE OVERVIEW AND GEOLOGY

5.1 Mining History, Current Development and Future Plans

5.1.1 Historic Mining

Golden Point Underground (GPUG) is located at OceanaGold's Macraes Operation (Macraes) in the South Island of New Zealand. The area has been mined for gold since 1862 and modern open pit mining commenced at the site in 1990. The fringes of the Golden Point orebody were previously mined by underground methods for Gold and Tungsten between about 1880 and 1950.

The current phase of open pit mining at Macraes started with the Round Hill open pit (immediately south of GPUG) from about 1992 and then moved to Golden Point open pit from December 1998 to June 2002. A total of 5.76 Mt at 1.78 g/t Au for 0.33 Moz at a 0.70 g/t Au cut-off grade was mined from Golden Point open pit. Material from 0.50 g/t to 0.70 g/t Au was stockpiled. Round Hill and Golden Point open pits were partially backfilled to arrest block-sliding movement of the Gold Processing Plant and MTI Tailings Storage Facility on the underlying Footwall Fault which had been triggered by the open pit mining.

5.1.2 Current GPUG Mine (Nov 2024)

The two current GPUG portals (ventilation and haulage/access) were developed in late 2020 and are located on the eastern highwall of the 1998-2002 Golden Point open pit, situated at 371 and 355 m RL respectively. A plan of the current mine is shown in Figure 1.

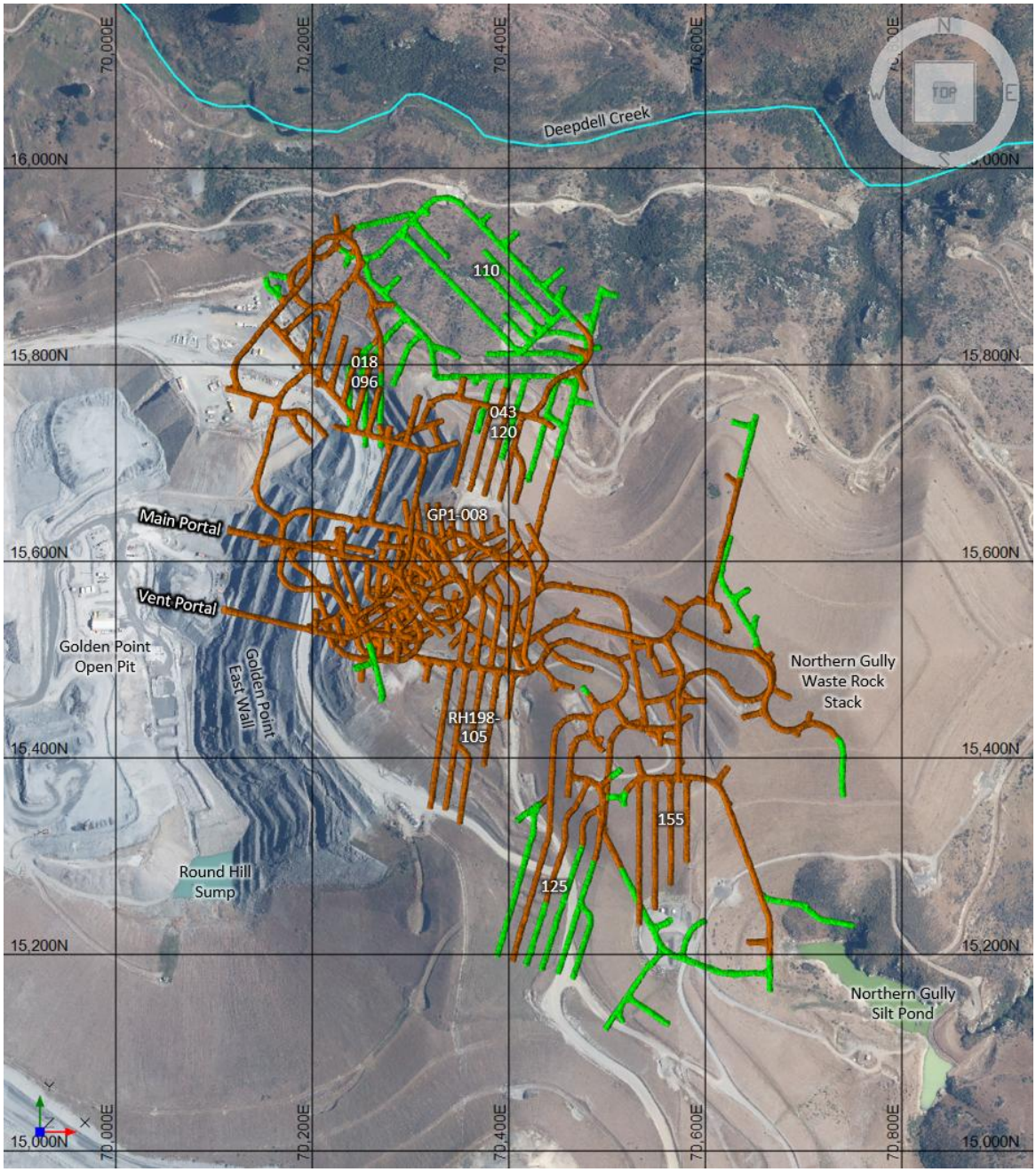


Figure 1: Plan view showing GPUG development to date (Nov 2024).

5.1.3 Consented Development

Resource Consents granted in 2024 provide for:

- General mine expansion down-dip to the east (dark blue); and
- Extension to the north close to and beneath Deepdell Creek (light blue)

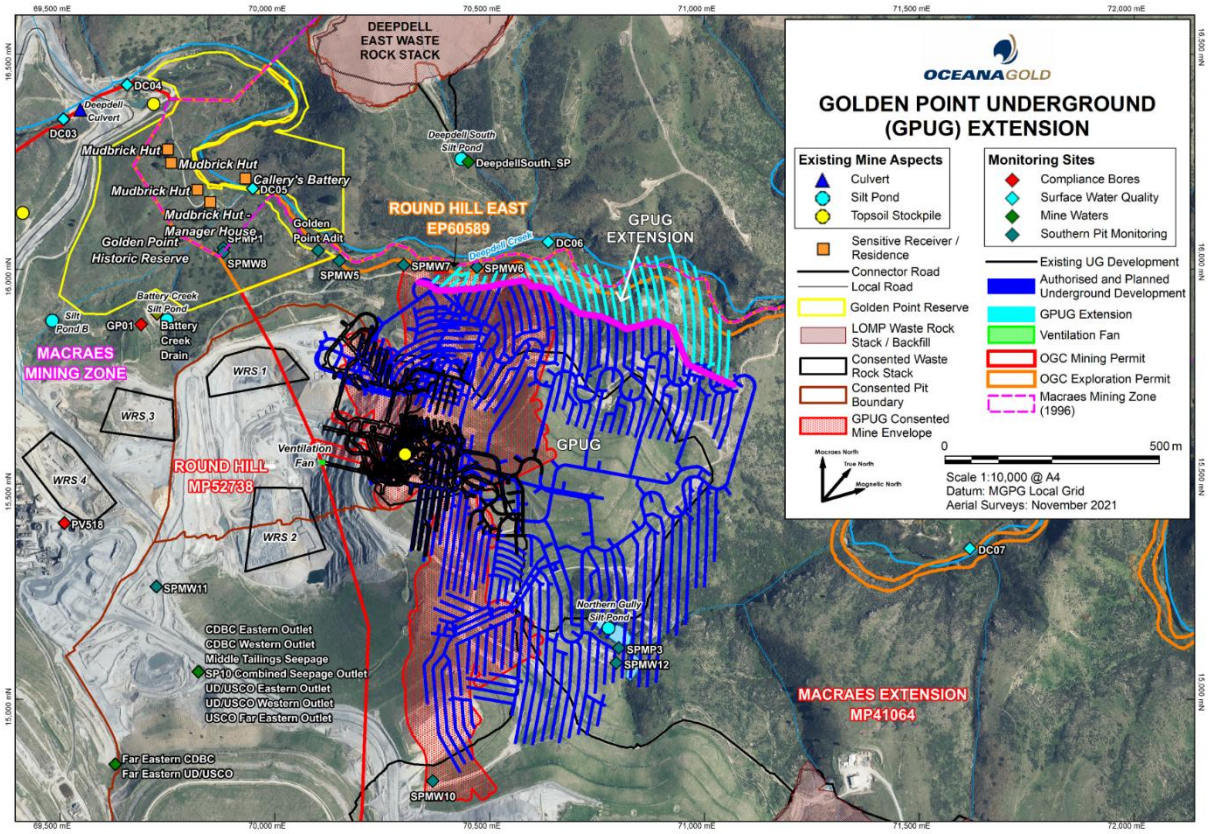


Figure 2. Plan of proposed extension and expansion (from Appendix 1 of Otago Regional Council Land Use Consent RM23.783.01 dated 18 October 2024)

5.2 Mining Methods

Mine development consists of conventional drill and blast practices with jumbos and truck haulage to a ROM pad located within the Golden Point open pit.

The main production mining technique employed is Retreat Long Hole Open Stoping (RLHOS). An overview of this method is shown in Figure 2. The general plan is to extract 10 to 15 m wide stopes (depending on ground conditions and orebody) of various height (depending on thickness of the economic section of the orebody, but generally up to 15 m), separated by 5-6 m yielding pillars that are allowed to gradually deform over time allowing full extraction of the stope.

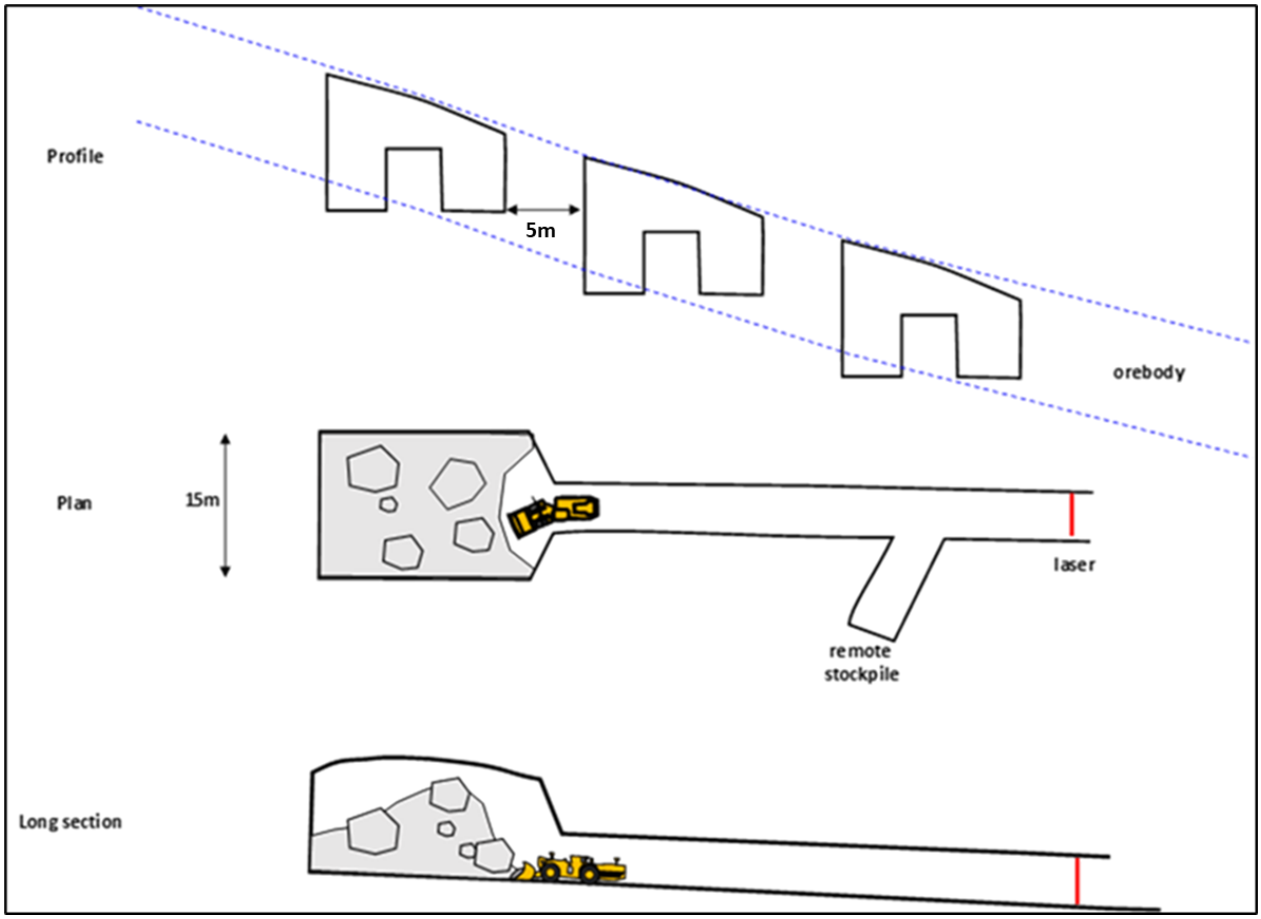


Figure 3: General RLHOS mining Schematic.

5.3 GPUG Mine Layout

The underground mine is laid out around the decline access with stoping panels separated by areas of low grade and offset in the ore zone. The resource is offset to the north by the Deepdell Creek Fault. The Golden Point Fault Zone trends west to east through the central part of the mine (see Figure 3).

The stoping panels are set-up by developing ore drives (5.5mW x 5.5mH) off the main decline and access drives. These drives are then drilled out with a longhole production drill rig using blind up holes to create a nominal stope design. Stope heights can vary, depending on the thickness of ore and the geometry of the hanging wall.

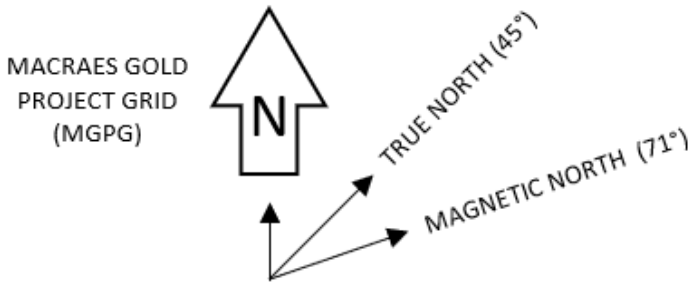
Rock, both ore and waste, is moved using conventional and remote-controlled load haul dump loaders (LHD's or boggers) with 50 tonne articulated dump trucks used for haulage to a run-of-mine (ROM) pad located at the surface. Waste rock is also trucked to surface and dumped at waste rock stacks within the Golden Point open pit.

Figure 4: Overview of the general mine layout at GPUG.

5.4 Mine Grid

All mine design and survey at the Macraes Operation and GPUG is undertaken in a local coordinate system, Macraes Gold Project Grid (MGPG), which is rotated roughly 45° counterclockwise (ccw) from True North. MGPG is aligned such that the Hyde-Macraes Shear Zone (HMSZ) strikes roughly north-south; and the HMSZ and basal Footwall Fault dip at around 20° to the east. All orientations in this document are relative to MGPG North. Magnetic compass bearings should be rotated approximately 71° ccw to MGPG.

Page **18** of **155**



5.5 Geology

5.5.1 Regional Geological Setting

The Otago Schist Belt consists of variably deformed Palaeozoic to Mesozoic metasedimentary schists. The schist belt formed during the Mesozoic Rangitata Orogeny collision between two metasedimentary terranes; the volcanogenic Caples terrane and the quartzofeldspathic Torlesse terrane.

Metamorphic grade increases from sub-greenschist facies on the margins to greenschist facies in the core. The core consists of lower chlorite zone schists and upper garnet-biotite zone schists. Macraes gold-bearing rocks occur at the boundary between the lower and upper zones, in a major regional structure, the Hyde-Macraes Shear Zone. The schist belt has been cut by numerous Cretaceous and Tertiary faults and gold bearing vein systems.

Peak metamorphism occurred during the middle Jurassic with the schists being rapidly exhumed accompanied by extensional faulting (NW and NE orientated orthogonal fault pattern) and associated mineralization. These Mesozoic structures have been later deformed by Cenozoic crustal shortening which continues today.

5.5.2 Local Geology

The Golden Point orebody is situated within the regional Hyde-Macraes Shear Zone (HMSZ), a low angle shear zone within the Otago Schist Belt. The HMSZ can be traced for ~30 km and although gold and scheelite mineralisation can be found along most of the known outcrop, economic deposits are currently confined by drilling to a 13 km interval from Coronation in the north to Golden Bar in the south.

The HMSZ consists of variably altered, deformed, and mineralised schist up to 150 m thick, known as the Intrashear Schist. The thickest part of the shear zone consists of several mineralised zones stacked on metre thick shears. Within the shear zone, mineralisation is generally constrained between the Hanging wall Shear and the Footwall Fault.

The upper boundary between mineralised HMSZ schist (Intrashear Schist) and unmineralized lower greenschist facies schist is commonly a well-defined structure, the Hanging wall Shear. The Hanging wall Shear is typically a wide structure (2-25 m) of strongly deformed rock dominated by dark grey, micaceous, graphitic schist, mylonite and cataclasite with variable amounts of quartz or silicified breccia. Concordant lodes can be up to 15 m thick and are similar to the Hanging wall Shear. Stockwork is generally irregular, discontinuous, and only a significant feature in some areas consisting of milky, narrow sub vertical quartz veins.

The Footwall Fault is a planar fault with well-developed gouge and is particularly susceptible to mining induced movement. The Footwall Fault is younger than the HMSZ and truncates mineralisation at its base.

The rock mass is highly heterogeneous and anisotropic, due to the presence of a pervasive foliation, numerous shears, and fault zones. The ground can be described as greasy in places due to the presence of graphite, associated with the higher-grade ore.

5.5.3 Ore Body

The Golden Point segment of the HMSZ is distinguished by three mineralisation domains. The western and central domains consist of a series of four stacked mineralized lodes beneath and subparallel to the Hanging wall Shear. In the western domain the lodes dip to the east, whereas in the central domain, near the confluence of the Golden Point and Deepdell Faults they dip between 5 and 15° to the north and west (Figure 4: Overview of the general mine layout at GPUG. and Figure 5). The mineralised zones within these domains are typically 5 – 10 m thick.

Further down-dip towards the east, stacked lodes are absent, and mineralisation is focussed on a single structure, the hanging wall Shear within the eastern domain which generally dips approximately 15 to 20° to the east (

Figure 5).

Mining at the Golden Point underground mine will be restricted to the central and eastern domains.

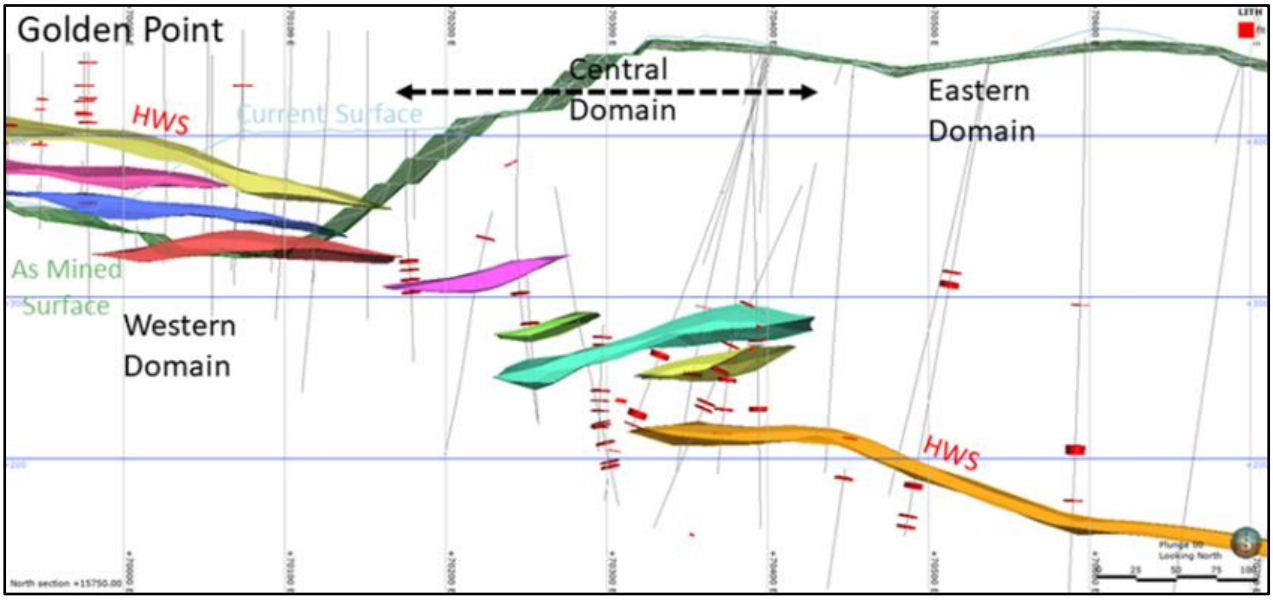


Figure 5: Vertical sections (40 m thick slice) through the Golden Point ore body.

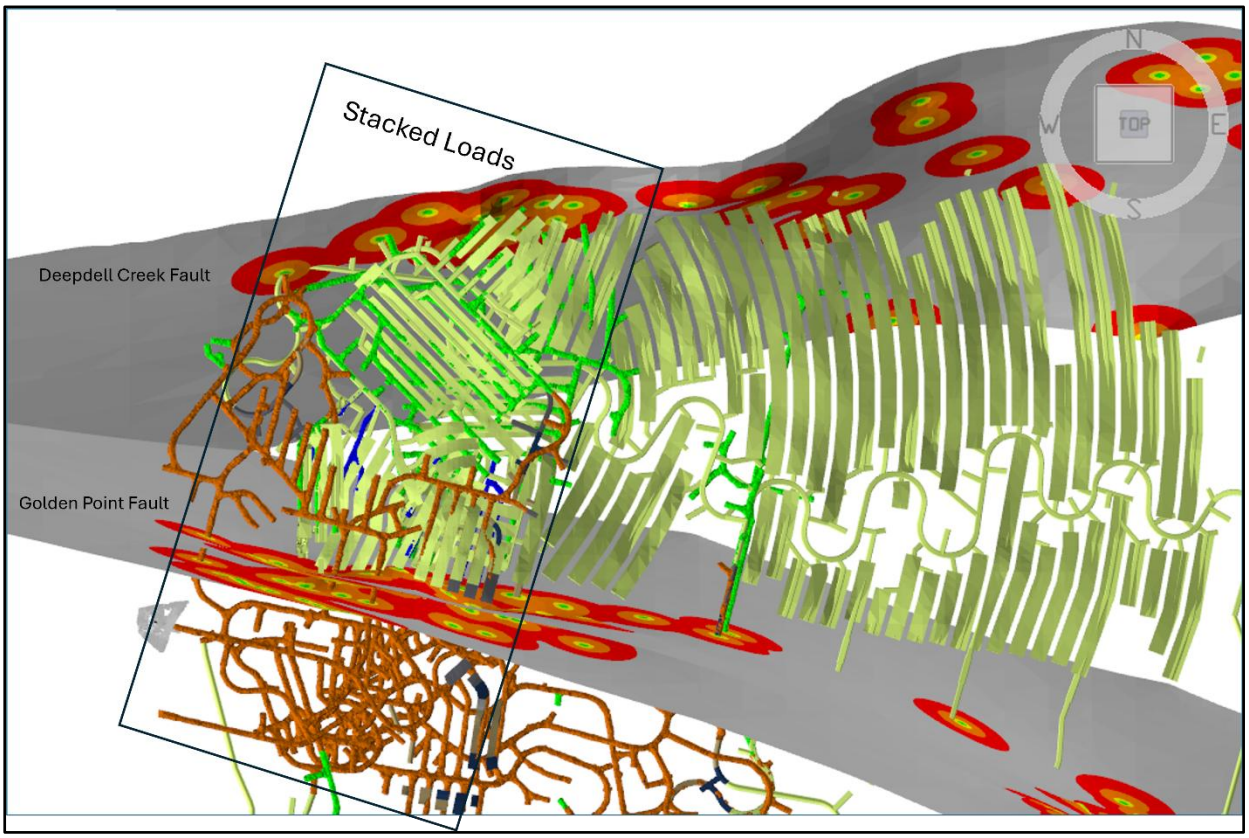


Figure 6: Plan view (cut to RL) showing location of the upper stacked lodes at GPUG.

Gold mineralisation is best developed in the more deformed ore types within the hanging wall and concordant lodes but is only weak and locally developed in stockwork vein sets. The footwall is not typically mineralised. Mineralised lodes are generally a mix of three different rock types:

1. Massive white to light grey quartz veins (decimetre-scale thickness) containing fine- to median-grained size pyrite and arsenopyrite either scattered throughout or aligned along laminae and stylolitic seams (recorded in drill logs as “silicified breccia”).
2. Dark grey to black, graphitic cataclastic breccias (“quartz cataclasite” and “cataclasite”); and
3. Relatively undeformed schist that has been hydrothermally altered and contains disseminated sulphides (“lode schist”). Within each lode approximately half the volume is lode schist and remaining half a mix of silicified breccia and cataclasite.

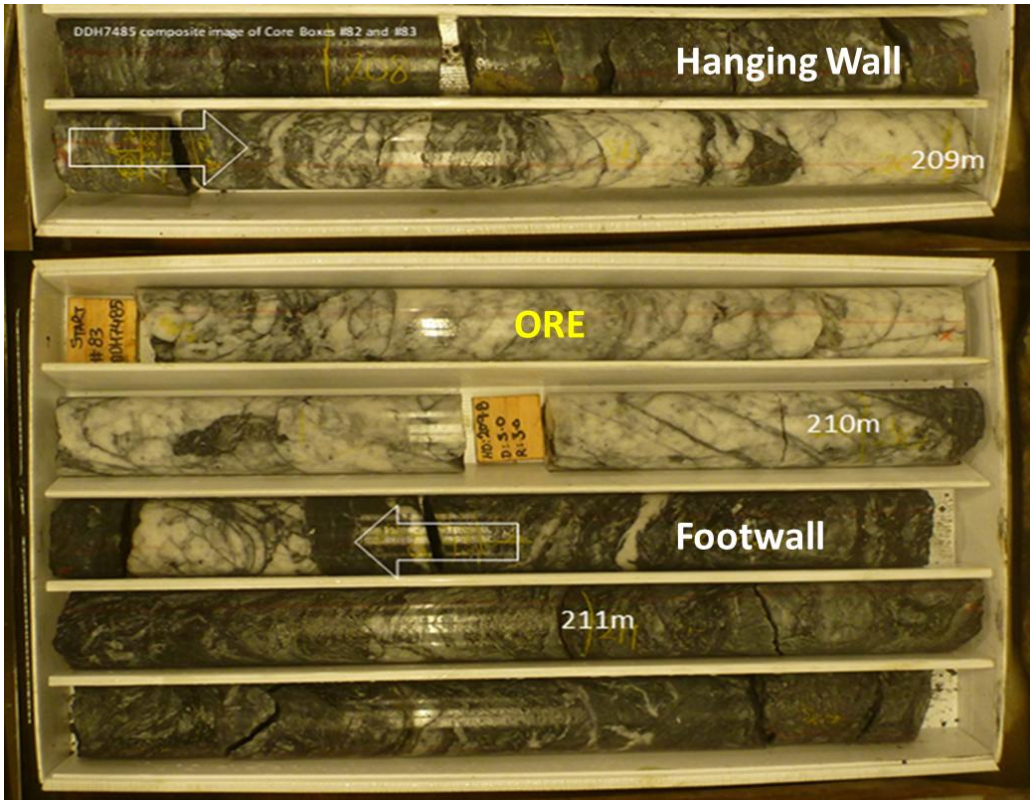


Figure 7: Core photos from DDH7485 showing main rock types within a well mineralized example of the Hanging wall Shear lode. White silicified breccia between 208.5 m-210.3 m (marked with arrows, 15 g/t Au), dark grey quartz cataclasite and lode schist beneath reported an average grade of 6.1 g/t Au.

Within the Golden Point and Round Hill area over 120,000 metres of exploration drilling has been completed. Drilling is ongoing and prospective strikes from 300-400 m+ holes deeper to the east and north will extend the orebody beneath the Deepdell Creek.

5.5.4 Rock Types

Lode Schist

Weakly sheared and silicified schist with minor cataclasite/mineralized breccias or concordant quartz veining. Most common rock type within the ore zone and is typically of fair quality representing normal ground conditions at GPUG.

Quartz Cataclasite

Highly deformed, quartz rich, dark grey/black, fine grained graphitic cataclasite. Can be very weak and is typically found close to the Hanging wall shear.

Cataclasite

Quartz poor, dark grey/black, fine grained graphitic cataclasite. Very weak rock type typically not found as thick units, rarely greater than 0.1m thick. Typically found at the Hanging wall shear contact.

Silicified Breccia

Silicified cataclasite or breccias with quartz veining. Very brittle and fractured rock type. Typically found close to the Hanging wall shear.

Semi-Pelite

Thinly interlayered to laminated medium to dark grey mica-quartz-chlorite and graphitic schist. Found above and below the Hanging wall shear, rock quality is typically good.

Semi-Psammite

Massive light grey-green quartz-feldspar-mica schist with minor amounts of interlayered pelite. Uncommon rock type typically found in pods within the semi-pelite, very good quality rock.

Stockwork Pelite

Semi-pelite with high angle banded or milky mineralized quartz veins. Typically found below lode schist (or quartz cataclasite/silicified breccia when lode schist is absent) with good rock quality.

6 GEOTECHNICAL MODEL

6.1 Diamond Core Drilling

Exploration/resource and geotechnical diamond core holes have been drilled both from surface and from underground at GPUG. Surface geotechnical holes drilled specifically for GPUG are listed in Table 1 and shown in Figure 7. A total of around 5000m of dedicated geotechnical logging has been conducted across 17 diamond drill holes at Golden Point in several campaigns from 2019 to 2022.

Table 1: Geotechnically logged drillholes as part of GPUG studies.

Year	Hole ID	East	North	Elevation	Orientation	Dip	Depth
2019-2020	DDH7415	70258.48	15701.36	419.31	104	74	198.3
	DDH7465	70402.01	15766.98	452.4	220	81	271.3
	DDH7521	70683.48	15821.63	434.77	315	82	294.0
	DDH7555	70523.90	15953.99	362.85	204	66	191.3
	DDH7558	70584.67	15984.27	359.97	175	71	203.7
2020-2021	DDH7670	70128.37	15628.94	371.17	102	13	230.5
	DDH7671	70098.39	15554.33	368.66	103	5	158.0
	DDH7672	70269.33	15510.74	464.15	033	75	277.4
	DDH7673	70249.45	15501.21	464.60	003	79	271.2
	DDH7705	70858.10	15917.04	384.88	360	60	372.0
	DDH7706	70453.60	15962.42	359.35	010	65	212.7
	DDH7696	70735.24	15948.26	355.62	008	70	265.6
	DDH7699	70585.68	15979.78	360.04	010	70	321.3
	DDH7755	70861.63	15915.57	385.17	337	76	307.6
	DDH7776	70937.35	15932.96	368.46	360	70	351.0

	DDH7780	70972.44	15747.58	418.95	330	86	370.5
2022	DDH7955	70337.07	15973.94	359.09	026	60	200.3
	DDH7970	70454.54	15961.50	359.38	026	69	210
	DDH7975	70652.47	15971.82	357.12	355	68	257.7
	DDH7980	70735.24	15948.26	355.62	060	61	320.1

A similar number of geotechnical drillholes also exists from various Round Hill Open Pit studies over the last 20 years, some of which will be relevant to the southern (Round Hill) part of GPUG (refer to PSM71-281R – Round Hill Open Pit DFS Geotechnical Assessment 2023). Over 10,000 m of RQD-logged diamond core exists in the Golden Point area.

Ongoing surface exploration drilling and underground resource and geotechnical drilling will continue to add to this database.

Macraes drillhole data is stored in an AcQuire database.

6.2 Intact Rock Properties

Rock property testing has been conducted at GPUG for the feasibility study and on-going study work. Laboratory testing data has been compiled and summarised for the main rock units and is shown in the following tables.

Table 2: Uniaxial compressive strength (UCS)

Rock Type	UCS (MPa)			Standard deviation	Number of samples
	Min	Max	Mean		
Semi-pelite	10.22	81.1	42.6	24.08	28
Semi-psammite	4.64	136.41	73.3	43.5	13
Lode schist	8.39	83.46	30.9	22.77	11
Semi-pelite stockwork	21.68	50.02	32.39	12.35	4
Silicified Breccia	137.05	155.64	146.3	9.2	2

Table 3: Indirect tensile strength (ITS)

Rock Type	ITS (MPa)			Standard deviation	Number of samples
	Min	Max	Mean		
Semi-pelite	1.45	10.52	6.21	3.17	10
Semi-psammite	2.61	15.27	8.57	3.49	11
Lode schist	3.46	7.85	5.47	2.38	8
Semi-pelite stockwork	3	5.49	4.29		3

Table 4: Multistage Hoek Triaxial

Rock Type	σ3 5MPa			σ3 10MPa			σ3 15MPa		
	Max UCS (MPa)			Max UCS (MPa)			Max UCS (MPa)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Lode schist (Peak)	58.21	65.27	61.74	77.17	85.12	81.15	89.25	98.50	93.88
Lode schist (Residual)	37.75	41.44	39.60	46.86	51.11	48.99	56.53	58.36	57.45

Table 5: Elastic modulus (GPa)

Rock Type	Elastic modulus (GPa)			Standard deviation	Number of samples
	Min	Max	Mean		
Semi-pelite	31.2	46	36.6	5.4	2
Semi-psammite	4	57	35.03	22.6	3
Lode schist	7.92	17.19	15.92	7.49	5

Table 6: Poisson's ratio

Rock Type	Poisson's Ratio			Standard deviation	Number of samples
	Min	Max	Mean		
Semi-pelite	0.241	2.83	0.262	0.02	2
Semi-psammite	0.2	0.33	0.27	0.05	3
Lode schist	0.252	0.334	0.283	0.03	5

Table 7: Density

Rock Type	Density (t/m3)			Standard deviation	Number of samples
	Min	Max	Mean		
Semi-pelite	2.58	2.76	2.67	0.05	28
Semi-psammite	2.6	2.88	2.74	0.05	24
Lode schist	2.54	2.79	2.82	0.72	19
Semi-pelite stockwork	2.62	2.7	2.67	0.02	7
Silicified Breccia	2.56	2.6	2.58	0.02	2

6.3 Geological Structure

6.3.1 Structural Fabric

Pervasive metamorphic foliation is a primary structural fabric within schist rock at Macraes. Foliation causes preferential breakage into tabular-shaped blocks and forms weak planes within the tunnels walls and backs that can develop into wedges or slabs. Foliation planes at GPUG typically follow the orebody, dipping at around 15-20 degrees to the east but may locally be found at any orientation.

Post-metamorphic shearing, mineralisation and tectonic activity has overprinted a variety of other geological defects within the rock mass such as folding, cleavage joints and faults. Mineralisation sometimes creates weak lithological boundaries, while other minerals such as graphite can significantly reduce the shear strength of the rock.

6.3.2 Large Scale Faulting

Faults are planes of weakness within the rock mass that have developed by sustained shear movement. Grinding and breakage of rock along these fault planes produces soft silty gouge or rubbly infill between the two sides of a fault. Small, less developed drive-scale to panel-scale faults may be only a few mm to cm thick, whereas larger mine-scale to regional-scale faults such as the Golden Point Fault can be up to 10's of metres thick and bounded either side by a fractured damage zone.

Several regional and mine-scale faults cut though and around GPUG. Some of these key features are discussed below.

6.3.3 Hanging Wall Shear

The Hanging Wall Shear dips approximately 20° northeast and generally is identified by intensely sheared cataclasite or silicified breccia with variable amounts of dark coloured graphite. It is a well-developed contact with contrasting rock quality with stronger Hanging wall psammites above and weaker sheared material below. Development within the hanging wall shear is generally more difficult with lower rock quality requiring addition ground support.

6.3.4 Golden Point Fault Zone

The Golden Point Fault (previously called the East Wall Fault in the old Golden Point Open Pit, or the Graveyard Fault to the exploration geologists who have lost multiple drill strings to this structure) is a complex zone containing two major structures (Southern Fault Zone and Northern Fault) that are well exposed in the Golden Point Pit wall (Figure 11). The current mine plan for GPUG intersects the fault on numerous occasions, with development through the fault zone already showing squeezing and deformation within weeks on excavation in the 18 Level Access. This fault will present a significant challenge to development throughout the life of the mine at GPUG and development designs should avoid this zone wherever possible.

Development through the fault zone is possible but should be perpendicular to the strike to minimise the distance within the fault zone. A high level of ground control is required including higher ground support standards, spiling bars and slow rates of advance see. Golden Point Fault Requirements memo. Open stoping is not likely to be viable within this fault zone and should be avoided.

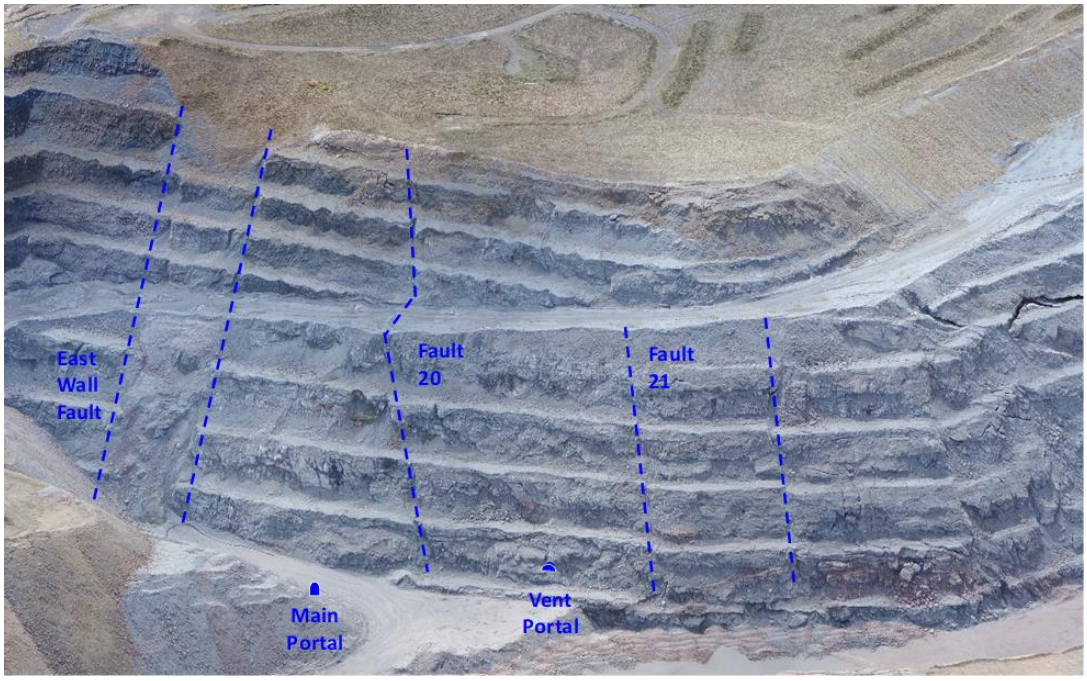


Figure 8: Surface outcrop of main faults in Golden Point eastern wall.

6.3.5 Northern Gully Fault Family

The Northern Gully Fault family (NGF) is a collection of faults that dip moderately to the east and characterized by thick gouge. The fault family has been encountered in several areas of development (Figure 12). These faults are known to deform more readily than the surrounding rock in response to active open pit mining.

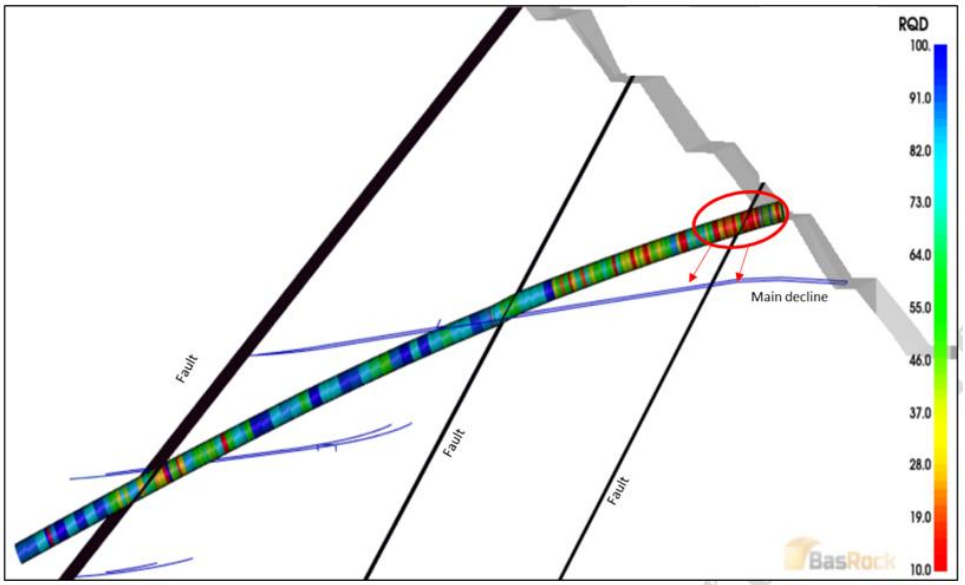


Figure 9: Poor ground conditions in drillhole intersecting NGF's.

6.3.6 Deepdell Creek Fault

The Deepdell Creek Fault sits to the north or the current mine plan and will be intersected by the Northern Exploration Decline and any resource extensions to the north if they eventuate. Its surface expression is within the Deepdell Creek gully. The fault runs ENE-WSW dipping steeply to the south. Within drill core intersections with fault is narrow with only a small zone of influence on the surrounding rock mass.

6.3.7 Footwall Fault

The footwall fault is an extremely planar fault structure comprised of a thick layer of gouge material (up to 1m thick). The structure defines the lower limit of the HMSZ and is approximately 70m below the hanging wall shear.

Underground mining is not expected to encounter this structure. Open pit mining causes ground movement along this structure, which could lead to deformation of the upper declines.

6.3.8 Fault Model

A fault model has been developed for GPUG. Mine-scale and otherwise significant fault planes have been interpreted from surface mapping, underground mapping and drillhole data and modelled as wire-frame surfaces. The GPUG fault model is stored in the following location.

\\mac-fsv02\GPUG\Shared Data\Geology\Faults

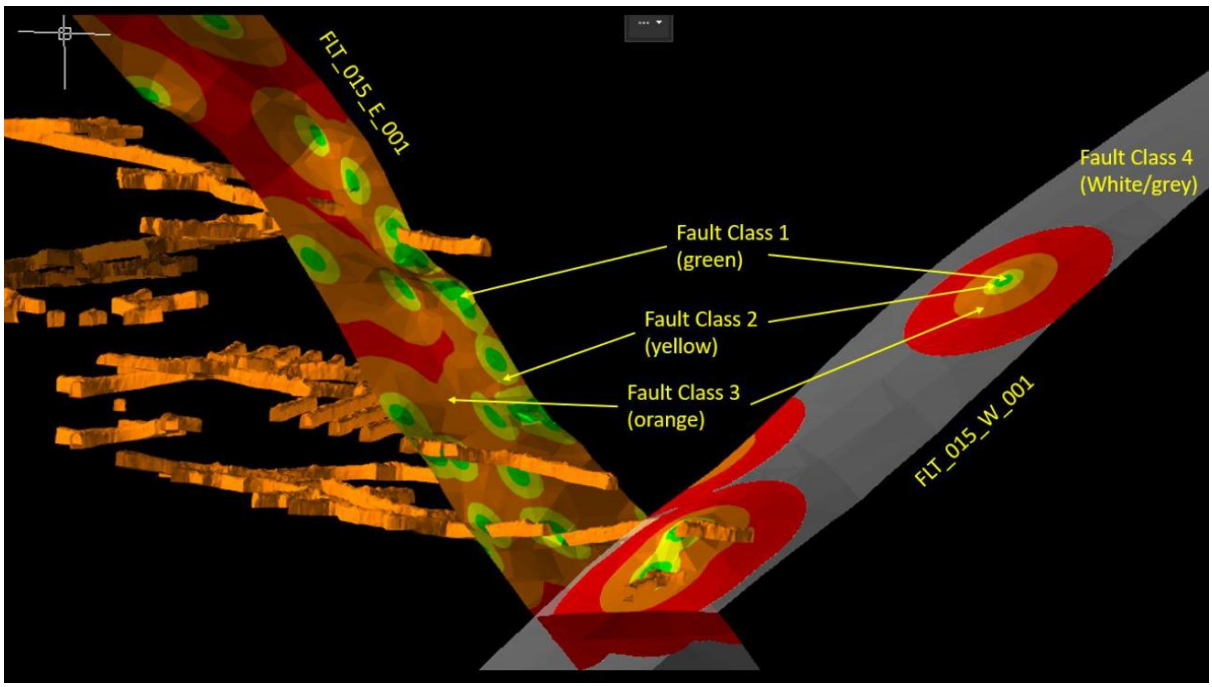


Figure 10: Example faults FLT_015_E_001 and FLT_015_W_001 with colours defining confidence by distance from observations.

6.4 Rock Mass Model

A geotechnical rock mass block model for GPUG was first constructed in 2019 by OreTeck (J000065, 2020b) as part of the GPUG Pre-Feasibility Study and has been updated during the Northern Extension study in 2022-2023 (OreTeck J000258, 2023). The rock mass model is based on logged geotechnical parameters (particularly RQD), from which various rock mass classification values were derived using accepted relationships. Modelled parameters include Q values (Barton, 1974), Laubscher's RMR (RMR90), Geological Strength index (GSI) and Bieniawski's RMR (RMR89).

Further refinement of the rock mass model based on both drilling data and fault modelling is in progress. The current RQD block model is located here:

G:\Shared Data\Geotech\Geotech Model\

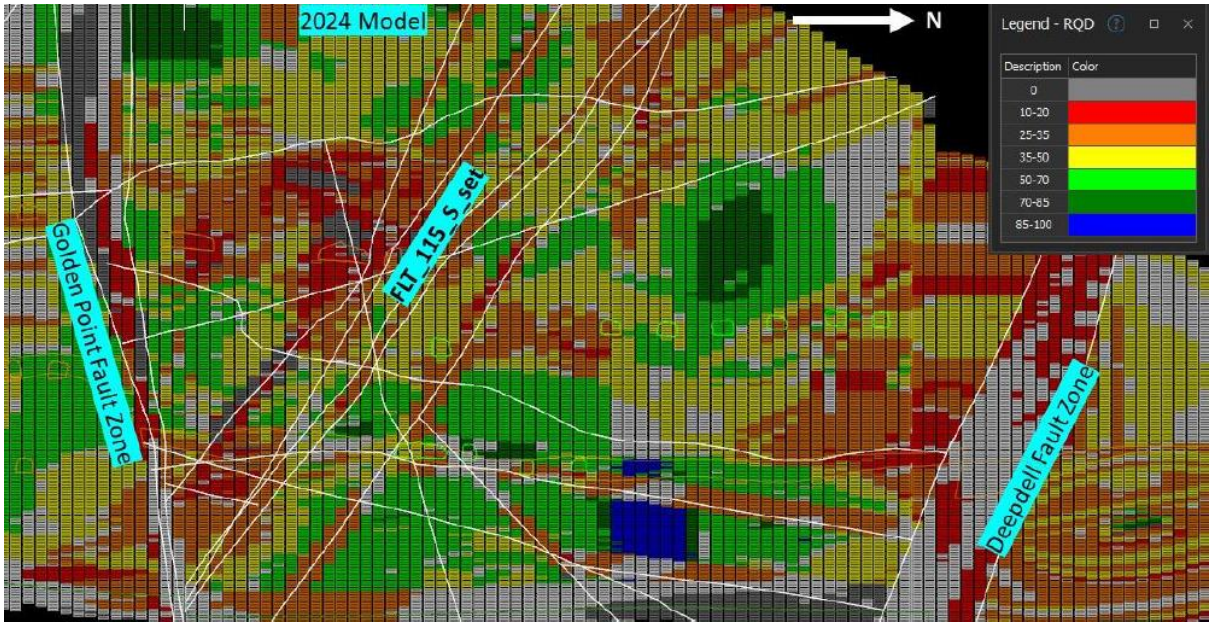


Figure 11: Cross Section through the RQD model between Golden Point and Deepdell Fault Zones

6.5 Pre-mining (virgin) Stress Field

In-situ stress measurements were conducted for the Golden Point Underground project by the Western Australian School of Mines (WASM) in 2020 using the Acoustic Emission method. Measurements were taken on samples from three separate drill holes with results shown in Table 8.

The results of in-situ stress testing indicate that stress could be an issue leading to early onset of squeezing ground. The validity of these results is in doubt as the measurements are upwards of three times that of the nearby FRUG mine and are unusual compared to the known regional stress.

Three of the results have a strong correlation with respect to the in-situ stress regime orientation. One test result (DDH7558) does not correlate with the other three results. The outlying test result has been

taken from a location within close proximity of the Northern Gully fault plane suggesting that a degree of fault drag on the northern gully fault could have caused the stress rotation seen at this location.

The general principal stress orientations used for GPUG are summarised in Table 8. The outlying result noted above was excluded when calculating the overall stress orientation. The results suggest the ratio of σ_1 / σ_v is equal to 5.1 and σ_1 / σ_3 of approximately 2.5 (range of 1.8 – 3.2 from results).

The stress gradient is aggressive and indicates that at shallow depths σ_1 exceeds, or approaches, the strength of several of the prominent lithologies. For example, at a depth of 200 metres, σ_1 exceeds the UCS of lode schist and semi-pelite stockwork and is approximately 90% of the UCS of semi-pelite. This may partially explain the deformation seen underground.

Table 8: Principal stress orientations and magnitudes assessed from Acoustic Emissions testing for GPUG.

Vertical Depth (m)	Drillhole	Stress Component	Magnitude (MPa)	Bearing (°)	Plunge (°)
91.8	DDH7415	σ_1	23.1	266.9	55.29
		σ_2	21.3	69.4	33.45
		σ_3	9.3	164.9	8.21
96.9	DDH7521	σ_1	34.7	266.4	46.19
		σ_2	28.4	98.2	43.19
		σ_3	19.7	2.6	5.96
157	DDH7558	σ_1	28.1	103.5	9.21
		σ_2	20.7	194.9	8.52
		σ_3	14.9	327	77.4
241.6	DDH7521	σ_1	44.5	295.0	16.86
		σ_2	37.3	132	75.42
		σ_3	13.9	26.5	4.83

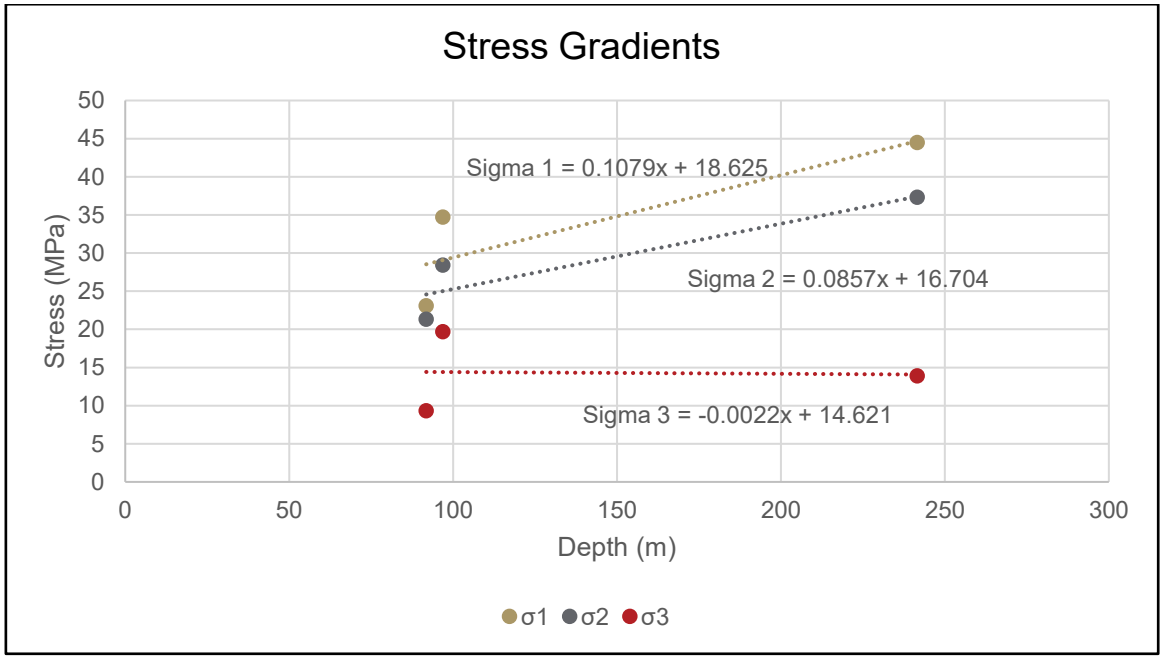


Figure 12: Stress gradients determined for major, intermediate, and minor vertical stress components at GPUG (WASM, 2020).

Table 9: General principal stress orientations at GPUG from AE testing (WASM, 2020).

	Bearing (deg)	Plunge (deg)
σ_1 (MPa)	278	40
σ_2 (MPa)	90	51
σ_3 (MPa)	5	1

6.6 Numerical Modelling

As part of both the GPUG Feasibility study (OreTeck J000065, 2020b) and Northern Extension study (OreTeck J000258, 2023), Geotechnica Consulting were subcontracted to run FLAC3D, a three-dimensional non-linear program, to evaluate the non-linear response of the rock mass in relation to the planned underground mining. The model assessed the effects on current and future open pits, potential surface subsidence zones, impact on Deepdell Creek, impact on footwall fault displacement, interactions within the stacked lode area and potential deformation on planned main declines. These reports can be found here:

\\mac-fsv02\GPUG\Geotechnical Engineering\Reports

Impacts to Deepdell Creek have been updated by PSM with a revised 3D numerical model, discussed in 7.6.6.

7 GEOTECHNICAL ENVIRONMENT AND MANAGEMENT

7.1 Underground Activities

Underground mining methods used at GPUG include:

- Development mining using drill and blast methods.
- Retreat long hole open stoping (RLHOS) with pillars.

Specific underground activities undertaken on a regular basis at GPUG include:

- Development and production drill and blast.
- Remote and manned bogging and truck haulage.
- Installation of ground support including split sets, MD bolts, self-drilling anchors (SDA), cables, spiling.
- Diamond drilling for resource definition and geotechnical characterisation.
- Installation and maintenance of infrastructure such as pumps, fans, cables, etc.
- Technical support and quality control activities such as inspections, surveying, monitoring, testing, mapping.

On occasion, high risk activities, as outlined in Schedule 7 of the Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016, may be carried out. Any proposal for a high-risk activity must be notified to Worksafe within the appropriate notification period.

7.2 Critical Controls

Critical controls are controls that have the greatest impact on preventing the risk(s) relating to the principal hazard of ground instability from occurring, or if the risk was to occur the critical control would provide the greatest mitigation of the potential consequences. The Critical Control Checklist Sheet (CCCS) has been developed as an internal audit tool to monitor and review procedures and processes established to prevent or reduce ground instability hazard to an acceptable level.

Reference:

- OGC-450-CHK-005 Ground Control CCCS

7.3 High Potential Geotechnical Hazards

Several common risks with a high potential for a fatality or serious injury to personnel due to a ground failure underground have been identified at GPUG.

The GPUG GCMP is intended to facilitate early recognition and timely control of ground instability hazards. Not all hazards are predictable and accurately defined in advance of mining by such methods as exploration, geological and geotechnical evaluation.

All personnel shall therefore remain responsive to ground conditions and mining variations while working underground.

Reference:

- MAC-250-RSK-005 Macraes Risk Register
- MAC-250-RSK-014 Ground Control Underground RA

7.3.1 Rock Fall

Rock fall is the primary "ground hazard". The main elements which contribute to rock fall include:

- geological structures;
- weak rock mass strength;
- large development span;
- groundwater;
- ground movement;
- stress changes in the rock mass;
- seismic activity;
- drill and blasting-induced damage;
- long exposure time;
- corrosion of steel support elements;
- poorly installed ground support; and
- damage and ultimately failure the ground control system.

7.3.2 Faults and other Geological Structure

Geological structures are natural defects and discontinuities within the rock mass that control the way it breaks and deforms under mining stress or excavation. Features such as faults, foliation, joints and lithological contacts typically form planes of weakness with no tensile strength, and often very low shear strength. The effect of geological structure may be to:

- reduce the overall strength of the rock mass;
- combine to form unstable "wedges" in backs and side walls and/or become exposed as excavations are developed allowing sliding or slabbing failures of side walls; and/or
- facilitate the propagation of caving above a tunnel or stope.

Ground conditions at GPUG can be variable because of structure within the rock mass. Large scale faults will be intersected and mined through during development. All personnel must be vigilant for potential hazards created by geological structure.

Indicators of change in ground conditions due to geological structures include but may not be limited to:

- "greasy" or "black" ground.
- persistent overbreak.
- "cathedralling" on geological structures in backs.
- "scats" in backs.
- "wedge" or "sliding" failure in backs and sidewalls.
- deformation and "bulking" of the rock mass.
- damage or destruction of ground support due to movement of rock mass along structures.
- unexpected falls of ground particularly in stope blocks.
- excessive closure in blastholes.
- blocked flush holes; and
- "running sand" coming out of drill holes.

Any significant change in ground conditions due to geological structures shall be reported on jumbo SIMBIO reports, workplace inspections sheets, hazard reports and to the Shift Supervisor.

Major faults can act as stress concentrators, in that large scale changes in stress tends to show the greatest stress change around these large structures. This leads to increased deformation and damage to the ground support in areas where these structures intersect development drives. This can be particularly evident when the major structures intersect stopes. Changes in the stope such as additional firing or stope failure can induce a more rapid deformation in the development drives along the plane of the structure.

Any significant geological structure in a development drive that directly intersects stoping shall have dynamic support installed in the forms of MD bolts and/or dynamic cables. Geotechnical inspection frequency will also be increased to weekly in these areas while production activities are occurring on or near the geological structure. An adequate array of convergence monitoring will also be installed on these structures to monitor the rate of deformation and response to mining activities.

7.3.3 Large Development Span

The Standard Ground Support Designs are based on the drive dimensions and ground conditions as specified in the Ground Support Type plans (Appendix 13.10).

Any significant increase in the size of an opening over design will have an adverse impact on stability, with openings greater than 30% of design typically regarded as excessive (i.e. for a 5mW X 5.5mH drive exceeding 6.5mW x 7.2mH).

Any significant increase in drive dimensions (width and height) outside of the designed survey instructions, shall be reported on the jumbo SIMBIO reports, workplace inspections and to the shift supervisor.

7.3.4 Groundwater

Groundwater seepages and inflows generally reduce the overall ground condition. The effect of groundwater is to:

- loosen or weaken ground locally around the seep, due to either elevated water pressures or by “washing” out interlocking rock fragments.
- aid in the corrosion of steel, particularly ground support elements; and,
- wash-out, dilute or reduce the strength of shotcrete and grout used in ground support.

Water make is generally from natural sources or drillholes. GPUG groundwater inflow pressures generally reduce with time and do not require specific management ahead of an advancing face. Despite this, specific controls to manage inflows may be required in some instances.

Unexpected groundwater inflow from exploration or other drillholes is potentially a significant hazard as water pressures may be elevated due to standing water within the drillhole. Exploration drillholes are routinely grouted on completion, and the likelihood of uncontrolled, high pressure water inflows are considered low.

Changing flow conditions, when not related to changes in mining process water consumption above, can also be indicative of changing stress conditions, stress increases tending to reduce flows, and stress relaxations tending to increase them.

Any significant or "unusual" groundwater flows shall be reported to the shift supervisor and on workplace inspection sheets.

7.3.5 Ground Movement (Deformation)

Ground movement is common at GPUG because of the soft nature of the rock mass and stress changes due to mining. The rock mass is generally weak due to the incidence of closely spaced low strength fractures, and the ground is generally considered "soft". This means that even small changes in stress magnitude or orientation can produce significant deformation in underground development. The most common indicators of ground movement at GPUG are:

- shotcrete buckled and cracked, particularly in backs and sidewalls out of reach of damage due to equipment.
- cracks opening up in the rock.
- rock noise.
- plates "popped" and pulled through on the collar of ground support bolts.
- floor heave.
- "bagging" in mesh; and,
- "scats" on the floor indicating ongoing deformation.

Ground movement is the primary means to measure ground response at the mine and is the most obvious indicator of changes in ground condition. Ground deformation will be routinely measured as it arises, primarily through convergence monitoring. Other monitoring techniques can also be utilised and are discussed further in Section 7.4.

Changes in ground movement (i.e., increased deformation rates, fresh damage to ground support) are an important indicator of rock mass changes and any significant observation, i.e., any observation indicating unusual conditions or deformation creating or having the potential to create a hazard to personnel, must be reported to the shift supervisor (verbally and by way of hazard reports) and on workplace inspections.

7.3.6 Ground Stress

Changes in ground stress occur as a result of mining, where stress lines "flow" around an opening. This is best envisaged in the same manner that "stream" or "magnetic" flow lines are commonly depicted. A visual example of the stress re-distribution around an excavation is shown in Figure 13.

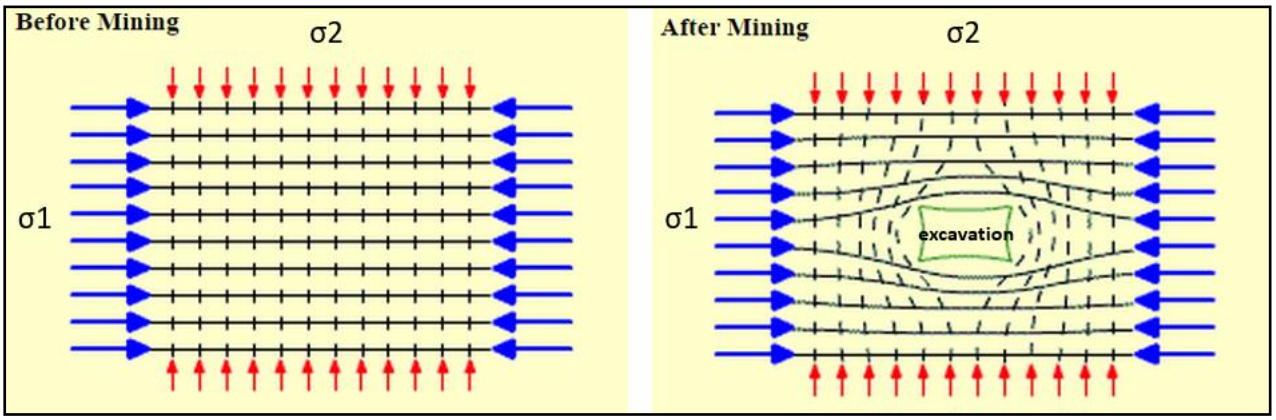


Figure 13: Example of the stress acting on a rock mass before mining and then the stress concentration occurring around the extracted area after mining showing the redistribution of stress.

Much of the ground movement and deformation observed at the mine to date is a result of changes in stress orientation, with some minor elevated stress levels leading to “buckling” failure. Stress will increase with depth and as stoping extraction progresses leading to further redistribution of the stress onto excavations and pillars.

Indicators of increasing stress may include flattening or buckling of rock bolt plates, straining of cable bolt plates, plates “popping” off, bird caging of cable bolts, spalling of shotcrete, rock noise / “talking” rock, and unexplained changes in water inflows.

Stress change has been measured around stoping blocks in the past at FRUG using vibrating wire stress meters, but this practice been discontinued due to difficulties in obtaining meaningful results in a fractured rock mass.

7.3.7 Seismic Activity

Seismicity is the rock mass response to deformation and failure. A seismic event is the sudden release of potential or stored energy in the rock. The released energy is then radiated as seismic waves. Seismic activity can be separated into mining induced and natural seismicity.

Mining induced seismicity is seismic activity induced by mining activities. This is unlikely to occur based on experience from FRUG and at GPUG but will be continually assessed and investigated as mining progresses to depth at GPUG. The reason for this low probability is that the rock mass has a relatively low strength and high deformability which leads to the continual release of energy through deformation of the rock mass (squeezing, floor heave etc.). Mining induced seismicity generating significant seismic events generally requires hard brittle rocks which can store significant energy before failing suddenly.

Natural seismicity is a natural earth process involving earthquakes. Natural seismicity occurs on major fault zones and at present is impossible to predict. Current seismic hazard estimates form Macraes are based on a site-specific seismic hazard analysis was completed for Macraes Mine in 2021 by Bradley

Seismic Ltd[1], and a more recent update of the New Zealand National Seismic Hazard Model (NSHM) by GNS in 2022[2]The Alpine Fault is the largest fault in New Zealand with a predicted magnitude 8.2 earthquake occurring every 260-400 years. An earthquake of this scale is predicted to cause 'strong' (VI) ground shaking at Macraes based on the Modified Mercalli Intensity Scale (MMI), with slight damage occurring.

The North Dunstan and Akatore Faults are two major faults nearby to Macraes Flat. A predicted magnitude seven earthquake on these faults is expected to occur once every 2500 years. An earthquake of this scale would also cause MMI VI ground shaking at Macraes due to the closer proximity of these structures than the Alpine Fault.

It is generally considered that earthquakes have little impact on underground mines in hard rock, apart from shakedown of loose or poorly supported material. This is unlikely to occur at GPUG with current ground support standards installed. The highest risk of damage resulting from a large reginal earthquake is shallow excavations in the uppers section of the mine seeing damage, and the portal location which may be a result of pit wall movement and or rockfalls from the pit walls above the portal.

7.3.8 Drill and Blasting-Induced Damage

Good blasting practices have a significant effect on ground control. Ground control can be enhanced by ensuring that drilling is to design, and the appropriate explosives and timing are used when firing development headings. An example of this is neglecting to use low density explosives in the perimeter holes which can lead to excessive overbreak which in turn increases span and the likelihood of forming wedges that may fail.

7.3.9 Long Exposure Time

A deterioration of ground conditions in an excavation is generally observed with time. This is caused by the progressive weathering weakening of the rock surface due to exposure to air and moisture as well as relaxation around the opening. The ground support in long term excavations is designed to accommodate this expected deterioration.

Due to unavoidable occasional delays in the mining cycle, certain short-term excavations may end up with a longer required service life than initially expected, and the ground support installed may deteriorate over time.

7.3.10 Corrosion of Steel Support Elements

Corrosion is a constant in all underground mines occurring in just about any environment over time, both wet and dry. It is the rate of corrosion which is most important to underground ground support in terms of the loss of load-bearing capacity, and this rate depends on both the properties of the steel and the environment in which the steel elements are installed.

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[1] Bradley Seismic Limited. Probabilistic Seismic Hazard Analysis for Macraes, New Zealand. 23 May 2021.

[2] Gerstenberger MC, Bora S, Bradley BA, DiCaprio C, Van Dissen RJ, Atkinson GM, Chamberlain C, Christophersen A, Clark KJ, Coffey GL, et al. 2022. New Zealand National Seismic Hazard Model 2022 revision: model, hazard, and process overview. Lower Hutt (NZ): GNS Science. 106 p. (GNS Science report; 2022/57). doi:10.21420/TB83-7X19 – Online from https://nshm.gns.cri.nz/

The pH value, concentration of dissolved oxygen and the resistivity are the three basic parameters governing the corrosion process. Apart from theses there are a few others that have effects on the corrosion rate, such as:

- Temperature - the rate of corrosion doubles with every 10° increase in temperature.
- Rock mass quality – more fracturing allows groundwater to flow through the rock mass freely.
- Precipitation from ground water – precipitation from higher pH water acts a protective layer on the metal surface when it forms calcium carbonate (as was observed at FRUG in 4DE3/2UV1 return air drive leading to the surface ventilation shaft).
- Humidity – amount of water contained within the air, in particularly relative humidity >80%.
- Mixing of humid air with fresh air can create "foggy" conditions, which enables the precipitation of water onto the ground support.
- Pollutants within the air, from blasting, rock mass or from machinery.

Li & Lindblad (1999) mention that corrosion of steel support in dry conditions can still occur if the atmosphere is polluted by gases from blasting and exhaust emissions from diesel engines. This process is driven by the content of sulphur and nitrogen oxides and chloride in the air along with the relative humidity.

Stress corrosion cracking is a mechanism of fracture which can occur in most metals and can occur Underground under certain conditions. It involves the progression and growth of cracks within a metal, the cause of which is a combination of stress and environmental conditions. A corrosive environment and a sustained tensile stress can cause formation of cracking, which can grow into the metal rock bolt. The formation of these small cracks can cause sudden and unpredictable tensile failure of the rock bolt at a stress level lower than the bolt is designed for.

Anyone noticing excessive corrosion on steel ground support elements shall report it to the shift supervisor and on workplace inspections.

Any identified corrosion will have a corrosion assessment form (appendix 13.9) filled out and will be entered into the corrosion database. Corrosion assessment forms and corrosion database can be accessed from the following link:

\\corporate.oceanagold.com\OGNZFiles\Macraes\Frasers Underground\05. Geotechnical\Ground Support\Corrosion

Corrosion assessment inspection frequency shall be conducted as per the corrosion TARP (see appendix 13.2)

7.3.11 Poorly Installed Ground Support

Strict procedures are in place at GPUG to ensure that all ground support elements are properly installed *(refer Section 7.8.4 Ground Support Installation)*. Poorly installed ground support must be assessed and replaced when required.

7.3.12 Changes to the Ground Control System

A formal risk assessment shall be undertaken when altering any ground control system. The effectiveness of any change to the ground control system shall be closely monitored by the

Geotechnical Engineers and underground Mining Superintendent / Shift Supervisor to ensure an acceptable performance is being achieved.

Any changes which introduce new support elements or design are to be implemented following the MAC-252-PRO-004 Management of Change Procedure.

7.3.13 Stope Extraction

Stope shall be inspected by all personnel entering a stoping area and asses the stope for any potential instabilities. Indications of instabilities include excessive overbreak, rocks falling in stope, changes in the material within the stope or pillar failures within the stope. A Trigger Action Response Plan (TARP) for open stope stability has been developed by OGC (Appendix 13.2). This TARP has three levels, as follows:

- Level 1 - Green - All Good - no indications of potential instability - normal operations.
- Level 2 - Orange - Caution - one indication of potential instability - restricted access.
- Level 3 - Red - Stay Out- multiple indications of potential instability - no access.

All open stope voids will have a CMS conducted where practicable and safe to do so. The CMS can help determine stability and performance of the stope. Any changes in the performance in the stope will be communicated appropriately to all personnel and the stope traffic lights updated appropriately.

7.3.14 Inundation and Inrush

Potential inundation and inrush hazards to the GPUG operation include uncontrolled inflows from:

(a) Overlying surface water bodies including Deepdell Creek, Northern Gully Silt Pond, and Round Hill Sump, with connection via subsidence-induced fractures, caving to surface or ungrouted drillholes.
(b) Saturated waste-rock backfill within the previously mined Round Hill or Golden Point open pits via caving or inadvertent breakthrough during stoping or development.
(c) Water and/or saturated debris from Golden Point Historic Workings via caving or inadvertent breakthrough.
(d) Ponded water within ungrouted drill holes.
(e) Up-catchment water bodies, impounded tailings or other saturated debris entering though open portals at the base of the partially backfilled Golden Point Pit.

Loss of water from Deepdell Creek leading to reduced stream flow is also an unwanted environmental effect that has been considered in detail during mine planning and preparation of the Assessment of Environmental Effects (AEE) for the planned GPUG northern extension in 2022-2023.

The management of inundation and inrush hazards are specifically addressed in the Principal Hazard Management Plan (PHMP) for Inundation and Inrush (to be finalised).

This GCMP deals specifically with inrush and inundation hazards (a) to (d) above where the hazard can be mitigated and controlled via subsidence management and ground control management within the underground mining operation.

7.3.15 Subsidence and Caving

Subsidence may occur at the surface as the rock mass above the underground mine relaxes, deforms and collapses into the mining voids/stopes. Vertical cave propagation will typically be arrested by a stable span or bulking of the collapsed material, but if it reaches the surface may manifest as a depression or open hole, often predicted by the angle of draw.

Potential impacts of subsidence include:

- Ground damage, including open fractures, step offsets, block tilting, sinkhole/trough depressions, or potentially more hazardous open crown holes
- Slope instability such as rockfall on the Deepdell valley side slopes or Golden Point pit East wall due to tension cracking and tilting at the surface.
- Larger-scale slope instability due to panel collapse or shear strain on adversely oriented fault structures.
- Damage to surface infrastructure which includes power lines, access roads, laydown areas, Golden Point Open Pit highwall, and the Northern Gully Waste Rock Stack.
- Reduced stream flow in Deepdell Creek due to increased hydraulic conductivity of the rock mass and infiltration (refer to Section 7.6).

Angle of draw is defined as the angle between a line drawn vertically from the stope edge and a line drawn from the stope edge at the mining horizon to a point on the surface where the vertical subsidence has reached an acceptably low level, regarded as 20 mm or less in the mining industry based on the typical accuracy that subsidence can be surveyed.

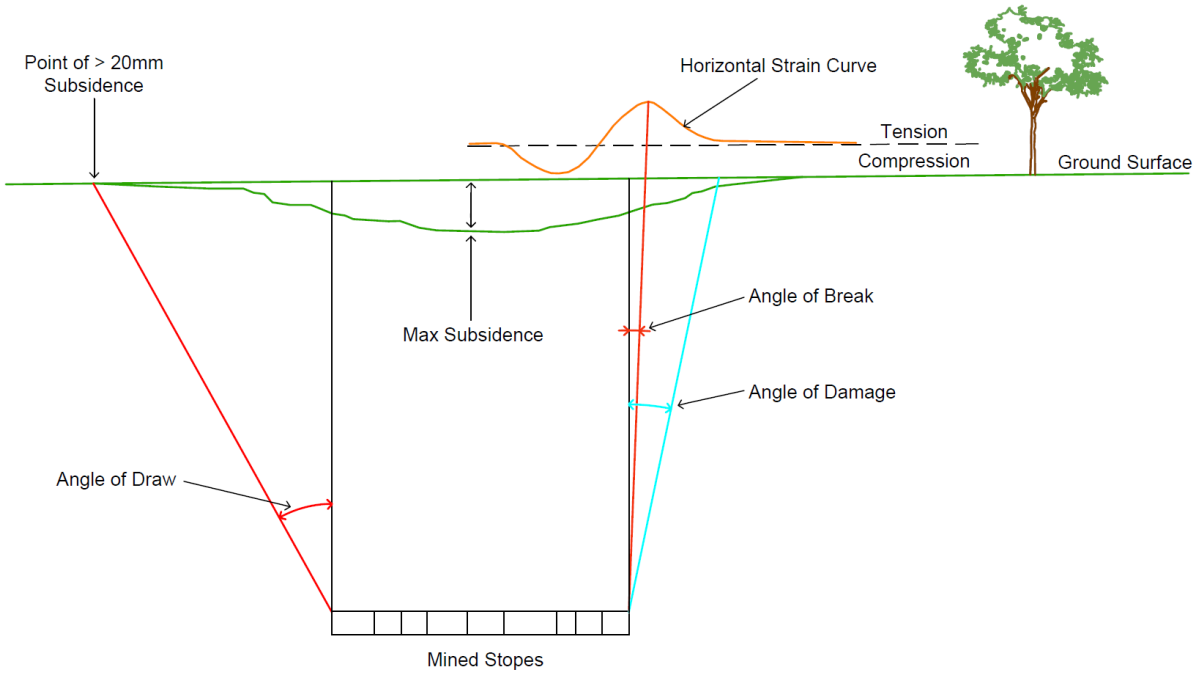


Figure 14 Schematic Cross Section Illustrating Angle of Draw

In 2026, PSM reviewed the available subsidence data, in particular, Interferometric Synthetic Aperture Radar (InSAR) to inform ground behaviour due to mine subsidence. PSM's assessment comprised analyses of ground behaviour to inform and 'calibrate' 3D numerical modelling. The assessment concluded subsidence can be expected at Deepdell Creek when mining stopes directly below the creek. PSM provided recommendations to limit subsidence and adverse effects on flows through Deepdell Creek, as discussed in 7.6.

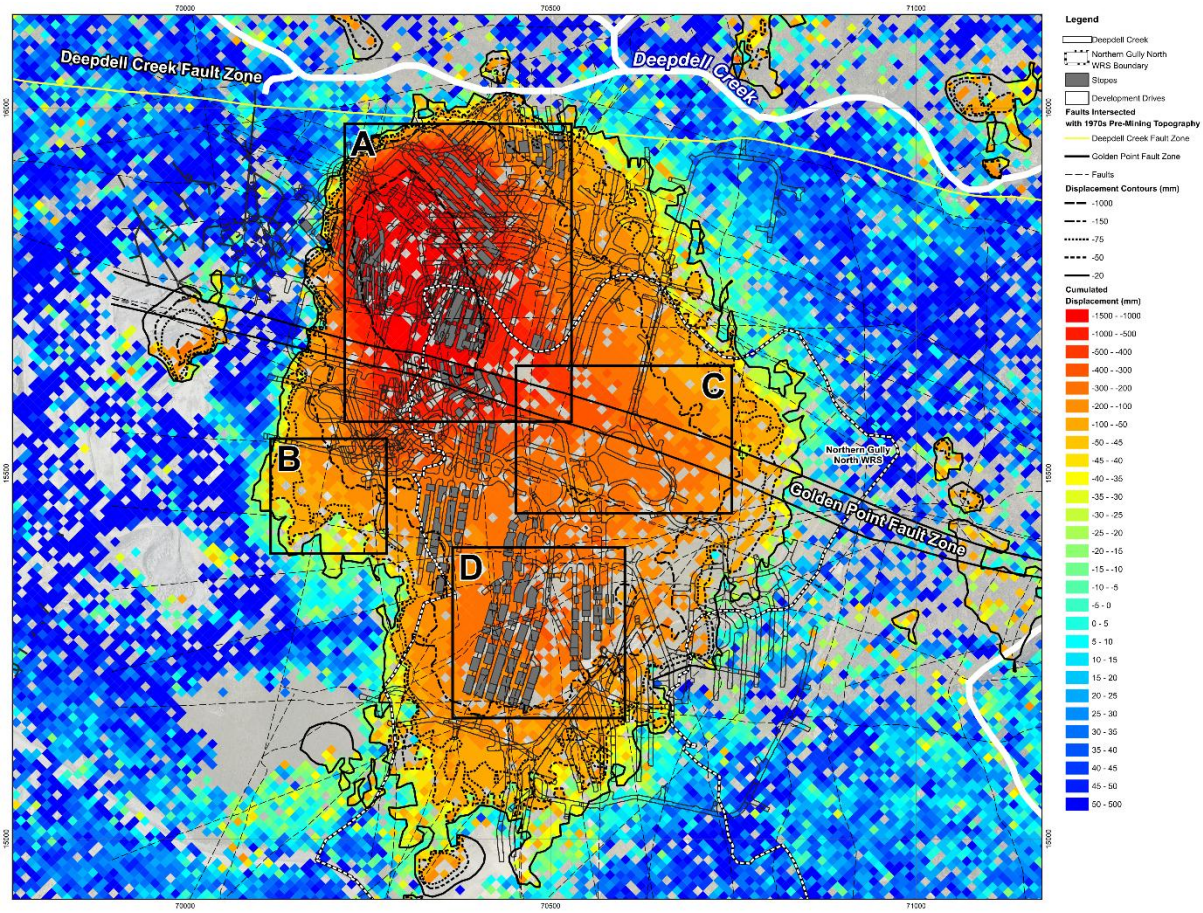


Figure 15. Cumulative InSAR L-Band Cumulated Displacement in LOS Descending Mode – Jan 2024 to Feb 2026 shows representative subsidence magnitude across the GPUG mine area (PSM, 2026).

7.4 Key Risk Areas

7.4.1 Development Near Pit

Any underground workings near the Golden Point open pit are expected to be harder to mine due to the lack of confinement from surrounding rock mass and will see deformation which is related to excavation volume and location as the ground relaxes into the pit void.

Each portal has shotcrete arches for the initial 20m of development to aid in reinforcement of the rock mass and ensure longevity of the excavations. Stopes in the upper stacked lodes that are planned close

to the pit wall (as close as 60 m vertical) will likely see increased deformation/relaxation along foliation and overbreak because of their proximity to the open pit.

7.4.2 Open Pit Crown Pillar

Based on the current planned mining shapes and the Golden Point open pit shell, the minimum vertical crown pillar will be approximately 70 m thick and the minimum distance between stoping and the pit wall is ~50m, shown in Figure 16. This section of stoping is within the upper stacked lode planned stopes.

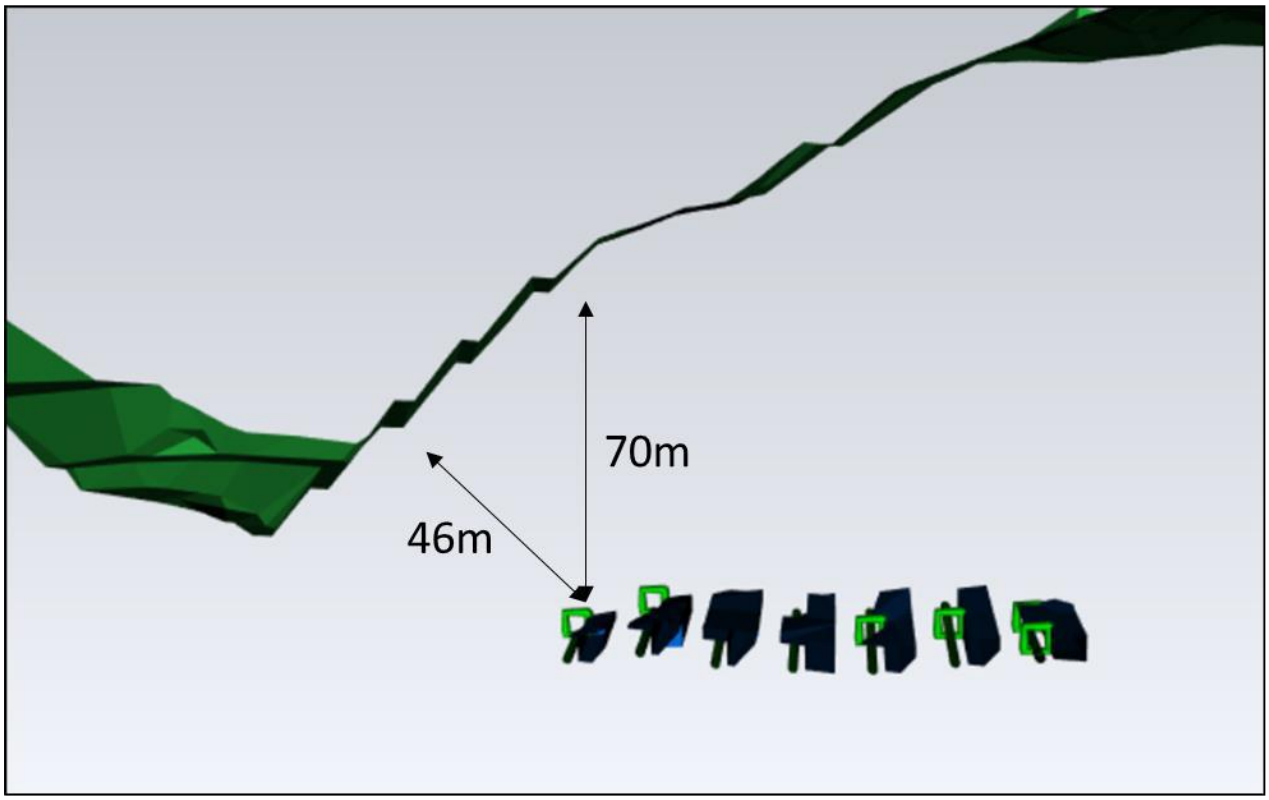


Figure 16: Cross section showing planned stoping and as mined pit shell.

Empirical analysis using the scaled crown stability method has shown the crown pillar between the existing pit wall and planned stopes has significant potential for caving causing surface subsidence. As the upper stoping panel footprint increases, it is expected that crown pillar failure would be seen with surface expression.

Access into the crown pillar area needs to be assessed and have appropriate monitoring systems installed, continuous monitoring will be required and a long-term strategy upon mine closure needs to be developed to mitigate any instability risks posed post closure.

7.4.3 Historic Open Pit Backfill

Any future mine development or stoping close to backfilled Golden Point or Round Hill Pits must consider inrush hazard related to break-through or caving into saturated backfill.

7.4.4 Historic UG Workings

Historic underground workings are located immediately NW of GPUG. Many of the old workings were mined out by the Golden Point Open Pit (2000-2002), The 52HDEC (haulage decline) has been driven beneath parts of the old workings that still exist behind the open pit highwall. The relative location of the historic workings and recent GPUG workings are shown in Figure 17 and Figure 18.

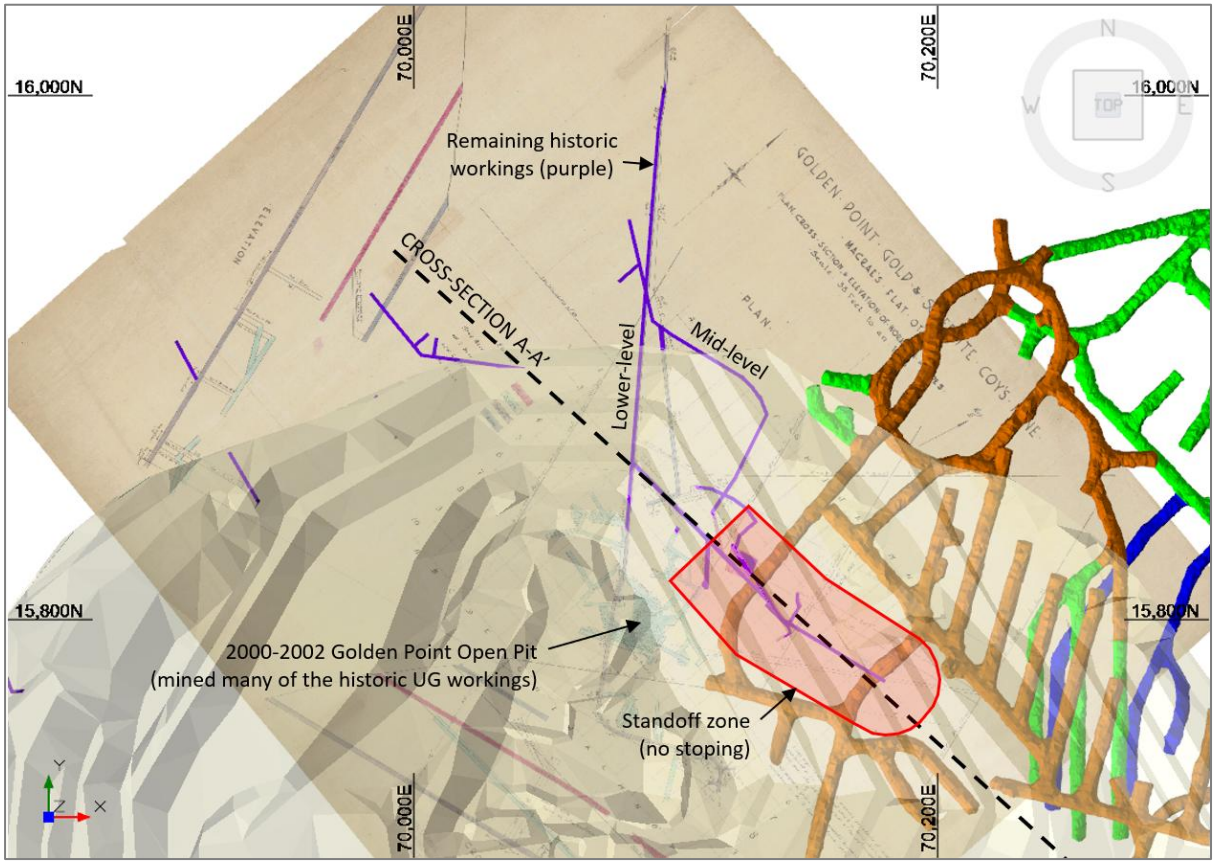


Figure 17. Historic workings known to exist above the NW corner of GPUG.

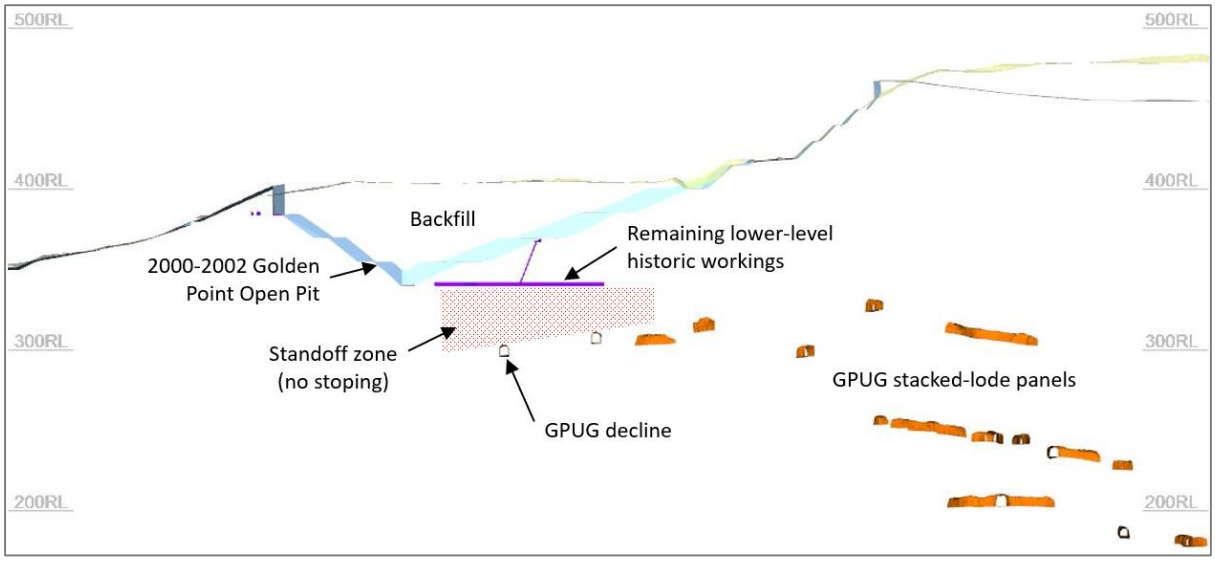


Figure 18. Cross-section A-A' showing the relationship between historic and current workings.

Hazards in proximity to historic workings include:

- Caving due to reduced confinement
- Inrush of water, gas or loose backfill
- Uncertainty in location, extent and condition of historic workings

These hazards were managed during decline development by implementation of a standoff zone either side of the known workings. Specific controls are detailed in the Inrush and Inundation Management Plan. No more mining is currently proposed near historic workings.

7.4.5 Deepdell Creek

The potential for mining induced subsidence to cause impact on streamflow is a key environmental risk that was the subject of detailed geotechnical studies (OreTeck 2023; Geotecnica 2022), and hydrogeological studies (WSP 2023; Valenza 2023) during the preparation of an area design to extend the mine north towards and beneath Deepdell Creek.

PSM (PSM, 2026) undertook an assessment of the previous measured ground behaviour to inform predictions of mine subsidence. The analyses simulated large deformations at the creek that have potential to impact stream flows. Limits for subsidence and strain were developed based on available literature. PSM also provided recommendations for data collection to inform future ground behaviour before mining near the creek.

The subsidence management plan set out in Section 7.6 is intended to manage the residual risk associated with higher-than anticipated subsidence strain leading to adverse effects on Deepdell Creek.

7.4.6 Decline Pillar

Modelling of the decline pillar (i.e. decline location away from stoping) was undertaken by Geotechnica as part of the GPUG feasibility study to assess the effect of deformation through the planned mine life, this is used to highlight any significant issues with the serviceability of the decline.

Expected convergence and strain rates have been modelled for the planned decline through the mine life. As can be seen maximum displacements are in the region of 50 mm with a strain rate of 2%. The second area of increased deformation is the lower decline this is assessed to be the result of increased abutment stresses caused by the lager mining footprint in this area. The change in strain and displacement is shown in Figure 19.

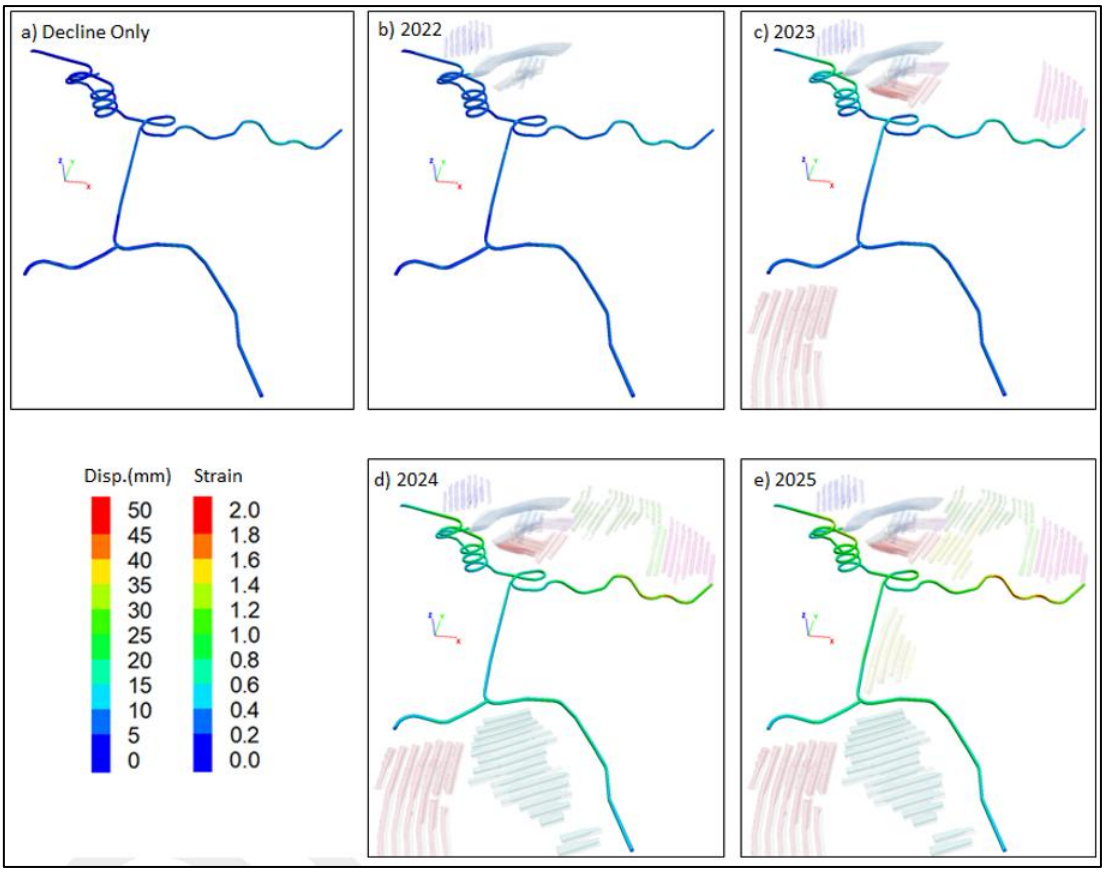


Figure 19: Modelled decline pillar convergence from the 2020 Geotechnica report.

7.4.7 Development above the Hanging wall Shear

Ground above the hanging wall is typically more competent than the hanging wall shear rock, it does have other challenging geotechnical hazards.

The rock mass above the Hanging wall Shear is typically blocky with very planar and continuous structures. These structures can combine to form unstable blocks. When in this rock mass, the tunnel orientation may influence ground instability, further kinematic analysis needs to be done if significant development is planned.

7.4.8 Development Faces

Unsupported development faces pose an increased risk to personnel working around them from an unexpected rock fall occurring.

All development faces at GPUG must be supported as per ground support standard Face Mesh – Support Type F1 to F3 (see Appendix 13.1) and no person shall approach the face until the support is fully installed to this standard.

7.4.9 Stope Brows

Stope brows pose an increased risk to personnel working around them from unexpected rock fall occurring in the drive and/or open stope. Brow support is used to prevent any unplanned rock fall occurring at the brow as per the Standard Ground Support Designs outlined in Appendix 13.1.

Individual brow positions are assessed by the geotechnical department as per the pre-production Ground conditions TARP (see Appendix 13.1).

Rock fill bunds are used to prevent fall dirt from the open stope entering the drive. A bund shall be in place any time the brow of a stope has been 'cracked' i.e. is not choked solid with dirt.

The requirements for all stope bunds are (also see Figure 22):

- span wall to wall.
- have height (1.5 m minimum) and width (2 m minimum) which is enough to safely stop any fly rock from entering the drive.
- Initially be positioned a minimum of 5 m back from the stope brow. Any movement of the bund towards the brow shall only occur following inspection and approval by the Shift Supervisor, who must verify that adequate catch capacity remains to contain rockfall and prevent material entering the drive.
- be positioned no closer to the stope than the last fully installed row of brow support.
- have enough of a catchment area as to effectively catch any rock fall in the stope – i.e. the rill must not be touching the bund.
- be constructed of dry, <1 m sized rocks; and
- have a flattened top of at least 1 m wide.

If the bund does not meet these requirements, then personnel are not to approach within 10m of the brow.

Bunds need to be assessed for their effectiveness by all personnel entering a stoping area.

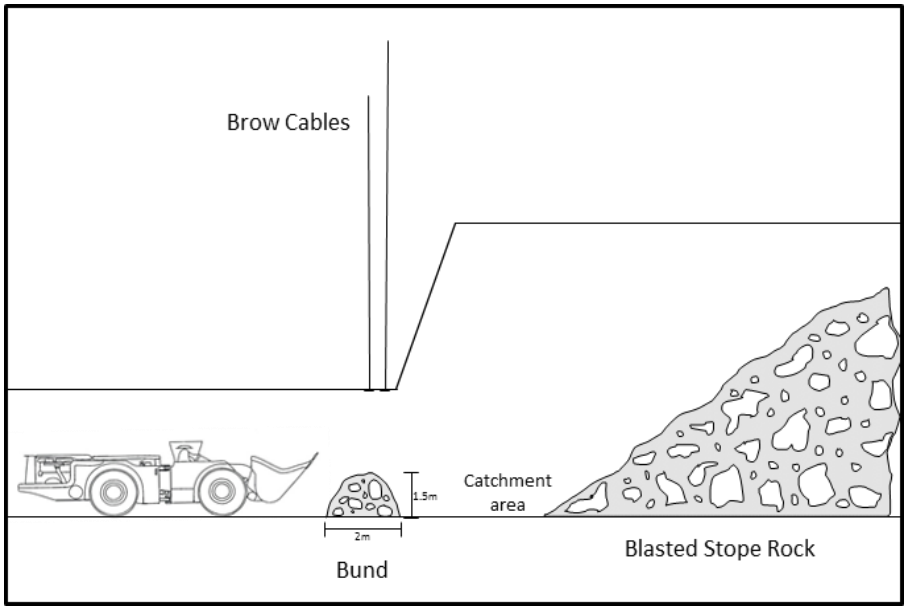


Figure 20: Example of a suitable stope bund.

7.4.10 Multi-level mining

The upper part of GPUG contains several vertically stacked lodes which require multi-level extraction with up to three panel levels in the same area. These will be mined in order from top down to largely eliminate the risk of upward cave propagation into a working area. However, in some circumstances, stopes may be developed close to and beneath an active working area and rigorous controls are required to manage the risk of cave interaction with underground working areas.

In addition, the interaction and coalescence of caving and subsidence from vertically stacked panels may lead to a greater risk of crown-hole development or greater-magnitude subsidence effects at the surface. Areas affected by multi-level mining are shown in Figure 21.

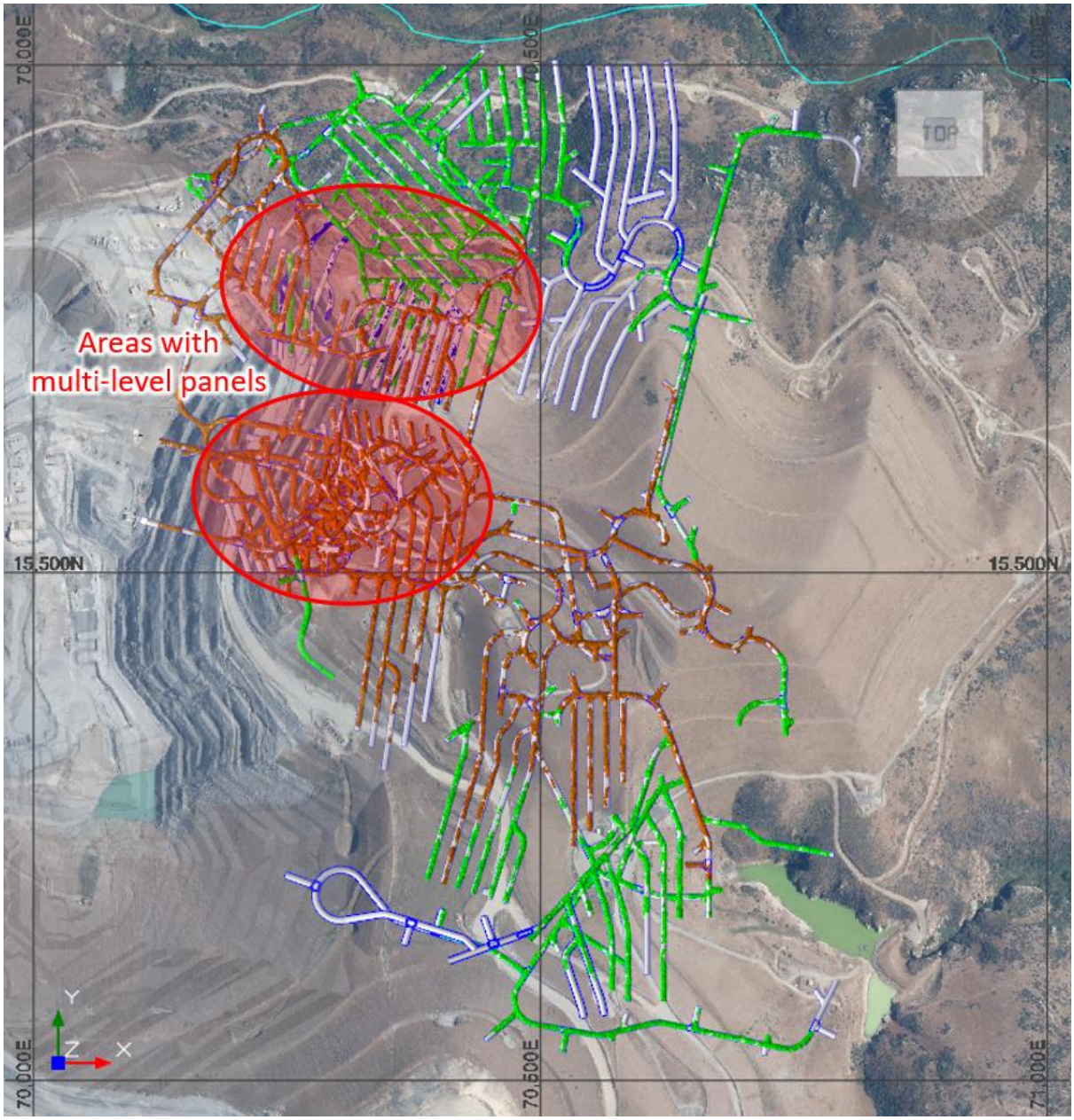


Figure 21. Areas with multi-level workings.

7.5 Ground Deformation

Based on early development and production at GPUG, the mine is expected to experience ground deformation in response to a wide range of mechanisms.

7.5.1 Development

Ground deformation during development has been observed in fault crossing zones (especially relevant to crossings of the Golden Point Fault) and many other parts of the mine. It is a natural response of the rock as it relaxes into the void upon excavation. Poorer quality rock, higher in-situ stresses and fault structures will typically act to increase the degree of relaxation.

7.5.2 Stoping

Ground deformation during stoping is common and typically becomes severe as the size of the stoping block increases.

Two mechanisms are at work during stoping:

1. Increase in abutment stresses due to removal of material supporting overlying rock.
2. Rock relaxation into the stope voids.

Rock relaxation is typically a short lived and short-range process and generally ceases once the stope voids have choked off during caving. Its onset can be very sudden especially during a stope caving event.

Abutment stresses can cause severe deformation at brows and in adjacent drives to a stoping panel. They typically occur gradually but for longer periods of time. If the abutment stresses are below the strength of the rock, deformation will eventually stabilize. Conversely, if the abutment stresses are higher than the strength of the rock, “squeezing” will occur (see Squeezing Ground Section 7.5.3).

7.5.3 Squeezing Ground

Squeezing ground is described as “The time dependent large deformation which occurs around a tunnel and is essentially associated with creep caused by exceeding a limiting shear stress. Deformation may terminate during construction or continue over a long-time period” (Barla, 1995).

Squeezing ground specific to GPUG is due to several contributing factors, such as:

- a weak rock mass.
- highly structured rock mass including a pervasive foliation with thin (<1mm) laminations.
- low friction coatings on structures, including chlorite, clay, and graphite; and
- elevated ground stress, especially where stress is at least half the compressive strength of the rock.

Closure will typically involve deformation of the entire drive including the floor (heave). Typical observations that are made in weak, foliated rock masses like that encountered at GPUG include:

- Shearing of foliation on the drive footwall and hanging wall leading to offsets and ‘guillotining’ of the support elements. This can sometimes be difficult to identify without the use of an observation hole or borehole camera.
- Stress-induced fractures subparallel to the drive backs (and floors), leading to significant ‘bulking’ as the fractures shear and dilate. This in turn results in deformation and closure between the floor and backs of the drives and probably drives much of the shearing in the walls.
- Rotation of the stresses may increase the tendency to shear in the footwall and hanging wall.

- The initial indication of significant bulking above the backs is usually the development of an open crack where the backs meet the hanging wall.
- Buckling of the drive walls may occur if shearing is prevented.

These failure mechanisms are summarised in Figure 22Figure 22: Summary of mechanisms associated with high deformation ground behaviour observed in foliated weak rocks under high stress conditions (Sandy et. al. 2010).

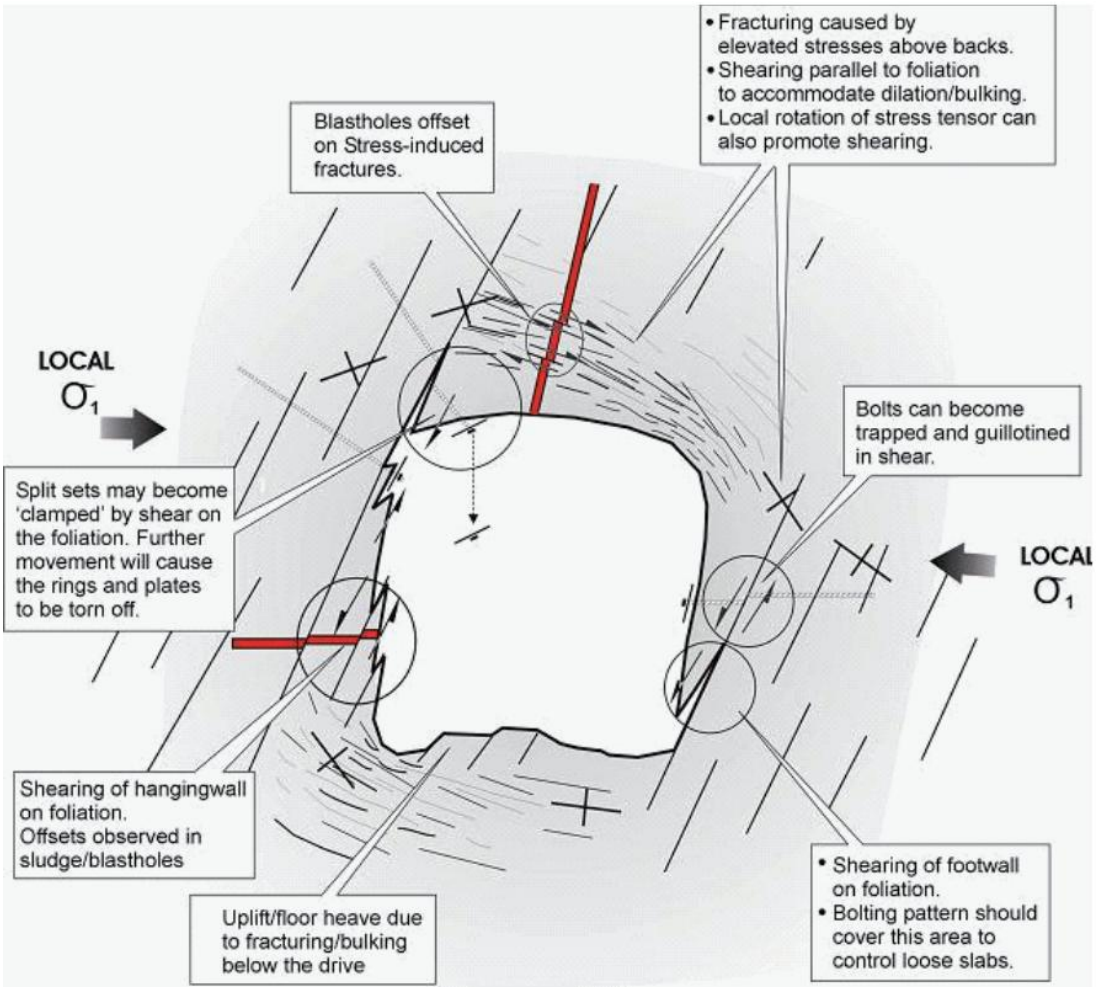


Figure 22: Summary of mechanisms associated with high deformation ground behaviour observed in foliated weak rocks under high stress conditions (Sandy et. al. 2010)

Squeezing ground is difficult and uneconomic to stop with the required support pressures impractical in the mining situation. Squeezing ground can be managed through a variety of options including:

- increased ground support standards using dynamic support elements such as MD bolts, dynamic cable bolts and OSRO straps which allow yielding of the support element with movement of the rock mass.
- regular monitoring utilizing surface points to measure drive closure (refer to 7.15.2.1 instrumentation).
- observation holes to detect shearing.

- regular inspections.
- damage/hazard observation maps (see Appendix 13.8).
- regular replacement of damage ground support; and
- drive stripping and re-supporting (rehab).

7.6 Subsidence Management Plan

7.6.1 Subsidence Risks and Key Operational Controls

Potential impacts associated with subsidence of the rock mass above GPUG were listed in Section 7.3.15. These are summarised into four key hazards in Table 10, along with the key operational controls required to manage the associated risks.

Table 10. Summary of subsidence risks and key operational controls

Hazard	Potential Risk/Consequence	Key Operational Controls (Risk Mitigation Measures)
Surface settlement, tilting and cracking due to widespread subsidence	Infrastructure damage and safety of staff in these areas	Tracking the progression of ground deformation, and monitoring critical infrastructure (power lines, access roads, laydown areas, Golden Point highwall, Northern Gully WRS). Implementing exclusion zones where required.
Crown hole development due to chimney caving into UG work area above or to surface	Sudden development of falling/engulfment safety hazard with minimal warning	Observation holes and monitoring to track the progression of caving in the most susceptible areas, particularly on highwall access ramp. Implement exclusion zones where required.
Slope instability and rockfall on Deepdell valley side slopes and Golden Point highwall	Rockfall safety at toe of highwall and for personnel visiting Deepdell valley area	Regular monitoring of ground displacement and tilt. Mapping of rockfall sources and periodic inspection. Implement exclusion zones where required.
Loss of Deepdell Creek flows into subsidence-damaged rock mass	Environmental impacts on stream ecology, water quality, and increased water make in the underground mine	Track the progression of underground deformation, seepage inflow, groundwater pressures, strain at surface and in boreholes as the mine develops. Implement Deepdell Creek Subsidence TARP to trigger risk control actions if monitoring limits are exceeded.

Broad area surface subsidence with minor surface cracking and tilting is expected to be generally unnoticeable and acceptable with insignificant risk for areas without critical surface infrastructure or significant natural qualities such as Deepdell Creek.

7.6.2 Subsidence Management Strategy

A strategy for management of surface subsidence and caving was prepared for GPUG by PSM (2026). The general process is to:

- Compile a preliminary geotechnical model for the GPUG mine area.
- Undertake 3D numerical stress-strain modelling to assess the likely subsidence effects of proposed mining. This was completed by OreTeck/Geotecnica in 2020, 2022 and PSM in 2026
- Improve the geotechnical model based on additional data collection including the installation of additional monitoring prisms and instrumentation.
- Monitor strain development within the rock mass around and above mine development and stoping panels. This includes UG convergence monitoring, a surface deformation network, Deep borehole extensometers/TDR, and surface LiDAR monitoring.
- Calibrate numerical modelling with measured rock mass strain and improved geotechnical model inputs to inform predicted stope performance beneath Deepdell Creek.
- Modify the mine design and Deepdell Creek Standoff Line (Section 7.6.4) as required to manage ground deformation risk.
- Continue to monitor the progression of subsidence.
- Implement a Deepdell Creek Trigger Action Response Plan (TARP) to link deformation and groundwater monitoring results to specific mine planning actions.

7.6.3 Mine Planning and Design to Limit Subsidence

Mine design supported by numerical modelling is the primary tool used for subsidence management, particularly in the vicinity of Deepdell Creek. The design strategy is based on modifying the mine layouts in the life-of-mine (LOM) plan through partial extraction or appropriate stand-off distances to protect specific surface structures and water resources. Specifically, this is achieved with appropriate pillar design, limited stope spans, control of mining area hydraulic radius and restricted extraction percentage. Figure 23 shows the current LOM plan with reduced extraction in the vicinity of Deepdell Creek.

During medium and short-term mine planning surface subsidence risk must be assessed during the Area Design and Stope Shape Approval process. Areas that have known geological structures or poorer rock mass conditions that could result in increased surface subsidence or sudden plug type failures bounded by steeply dipping structures may require specific localised mine design like that adopted for high consequence areas.

Where surface subsidence or caving may have significant impact on surface structures or other underground development, it is critical to ensure that:

- positioning of the planned mining relative to the infrastructure is appropriate. This can be achieved by suitable exclusion zones/stand-off from these areas; or
- partial extraction is achieved by minimising mining spans and leaving rigid pillars to ensure that the likelihood of surface subsidence or caving is minimised.

Page **52** of **155**

Tight backfilling may also be considered in these critical areas to reduce available void and minimise subsidence and potential for chimney caving, by reducing the height of cave propagation by choking off the cave through bulking of the failed material.

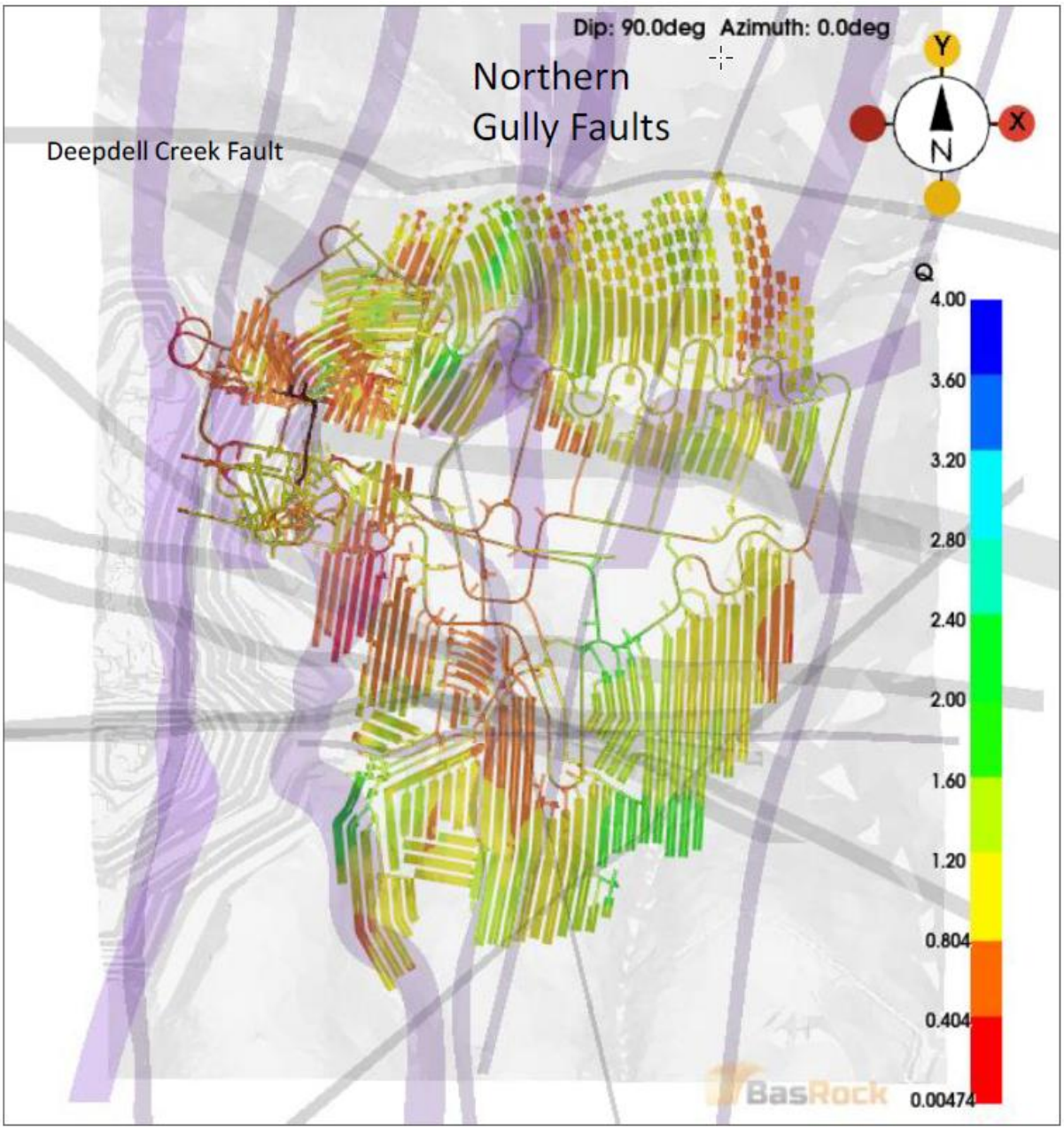


Figure 23. Plan showing the current GPUG LOM plan (July 2025) with reduced extraction near Deepdell Creek to the north.

7.6.4 Deepdell Creek Standoff Line (DCSL)

The Deepdell Creek Standoff Line (DCSL) is used to manage subsidence effects on Deepdell Creek. The DCSL originates from the 2023 GPUG Extension Resource Consent Application and has been updated by PSM during the 2026 GPUG Mine Subsidence Assessment. The DCSL is used in mine planning as a starting offset to reduce extraction when mining approaches to the angle of draw from the creek.

The DCSL is defined by angle of influence of 24° projected from the of Deepdell Creek centreline, perpendicular to the creek, until it intersects the top of the orebody. (Figure 24). The DCSL comprises this projection together with an additional 25m horizontal offset either side of the projected line. Any mining within this zone is referred to as the Orange zone (Section 7.6.5).

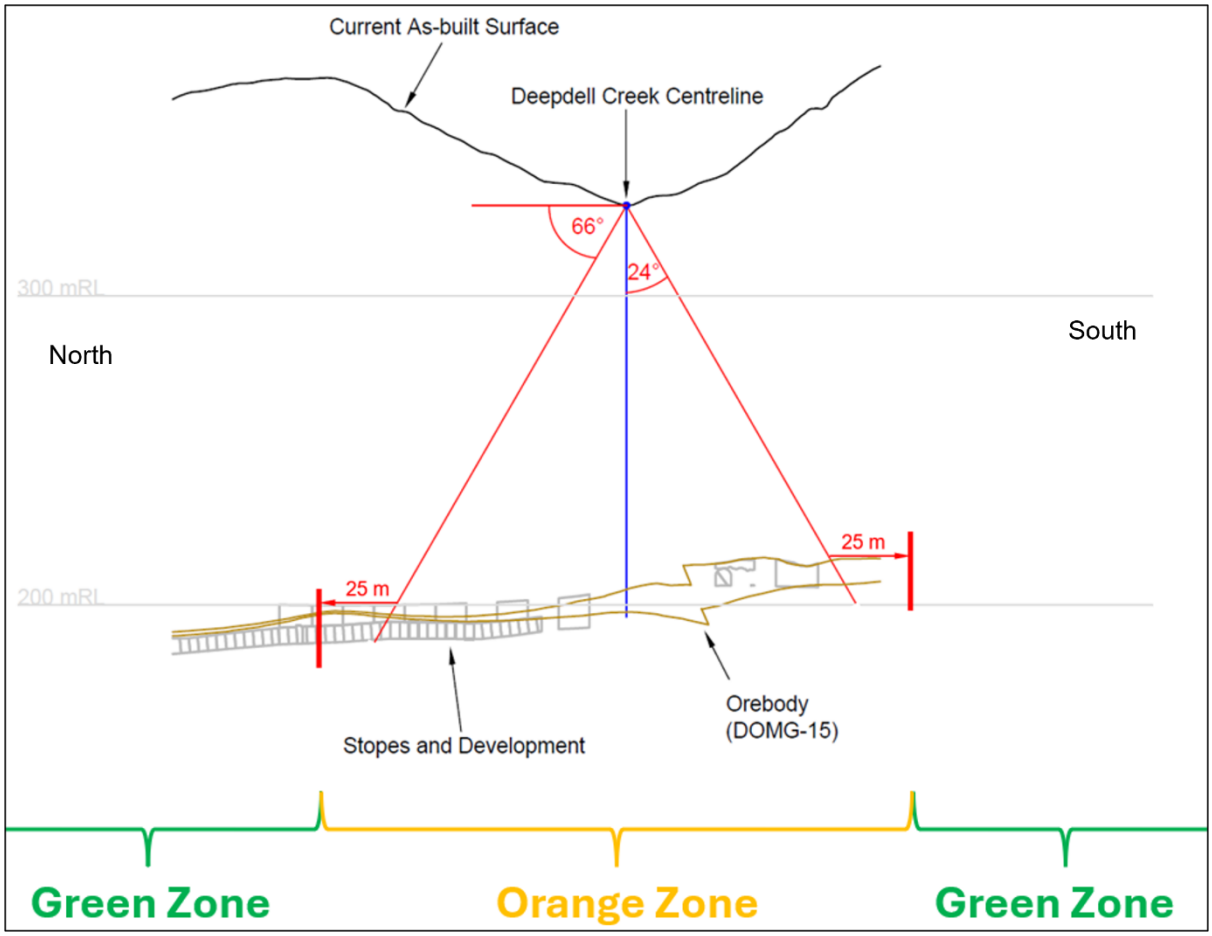


Figure 24. Cross Section defining the basis of the Deepdell Creek Standoff Line (DCSL) and the boundary of the Orange Zone.

7.6.5 Deepdell Creek Orange and Green Mining Zones

Based on the 2026 PSM GPUG subsidence assessment, a standoff zone referred to as the 'Orange Zone' has been developed based on the current geotechnical model and subsequent 3D modelling. This zone is delineated by the DCSL, mining may only occur within this zone following satisfactory results of ongoing monitoring, observations, detailed site investigation, numerical modelling and geotechnical assessment that indicate the risk of adverse subsidence effects on Deepdell Creek remains within acceptable limits, i.e. less than the limits recommended by PSM (2026).

Recommended preliminary limits for deformation at the Deepdell creek centreline are listed as follows:

- Strain – 5 mm/m or 0.5%
- Subsidence - -400 mm.

Development within the Orange Zone shall be subject to the standard Area Design process. This process requires review and approval by all relevant operational and technical stakeholders and shall consider monitoring results, site investigations, numerical modelling, and geotechnical assessments prior to mining proceeding within the zone. Development methodology, including drive alignment, excavation sequencing, and any operational or geotechnical controls required to manage subsidence-related risk, shall be determined through the Area Design process. Mining within the Green Zone may occur without restriction; however, deformation monitoring shall continue to support future studies and predictions of ground behaviour.

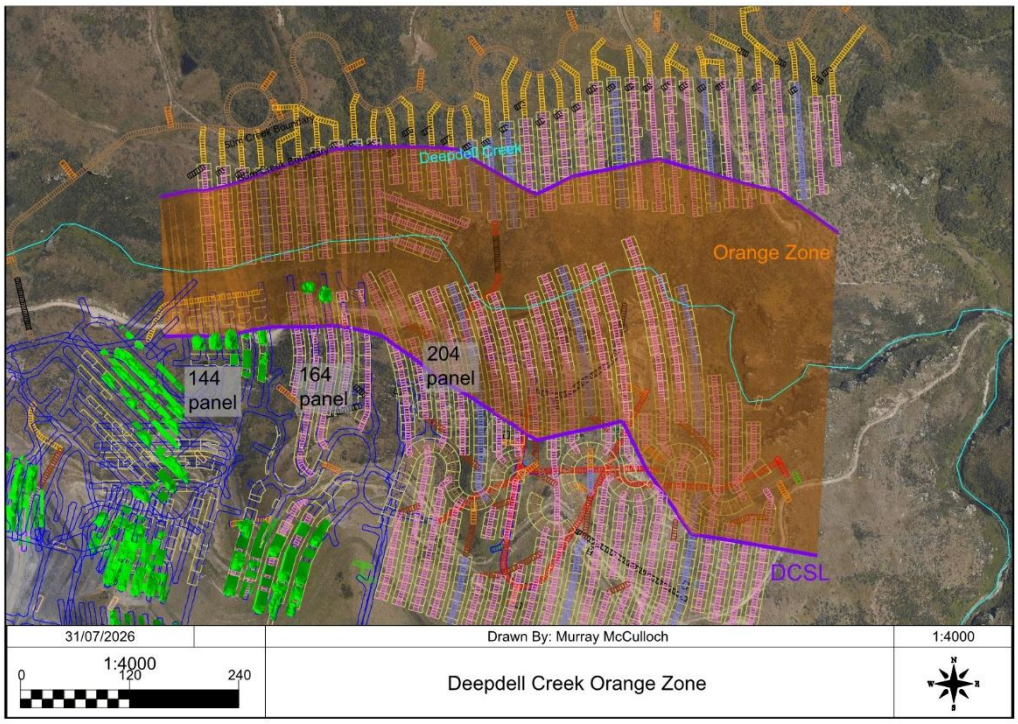


Figure 25. Mine Orange Zone based on the DCSL.

7.6.6 Numerical Modelling

3D numerical modelling was undertaken by PSM (2026). The objective of the model was to inform potential impacts to sensitive receptors located above and near the underground development.

PSM undertook a detailed analysis of measured ground deformation, largely informed by InSAR data from the previous ~2 years. The numerical model was 'calibrated' by adjusting rock mass parameters until the simulated deformations closely matched measured subsidence. Forward analyses of the planned GPUG extension were undertaken to predict ground deformation.

The geotechnical model is a primary input of the numerical model, particularly the condition and geometry of geological faults. During the GPUG extension mine subsidence assessment, PSM adopted the fault model developed by OGNZL with some modifications to faults along and surrounding Deepdell Creek.

Since completing the initial numerical model, PSM has refined the fault model along Deepdell Creek. The revised faults closely align with drive mapping and available borehole data. The refined model also adjusted the rock mass shear strengths to better align to conditions observed in borehole data. Re-running the numerical model with the revised fault model has indicated strain and subsidence are less than the recommended limits for Panels 144 and 164 (PSM, 2026).

As mining continues eastward, it is recommended that:

- the geotechnical model is updated with new mapping and drilling data – specifically to updated fault locations and conditions, and
- monitoring data (ie prism, GNSS, extensometers, and InSAR) is collected to be used in future numerical analyses to calibrate and inform future predictions of deeper mine extensions.

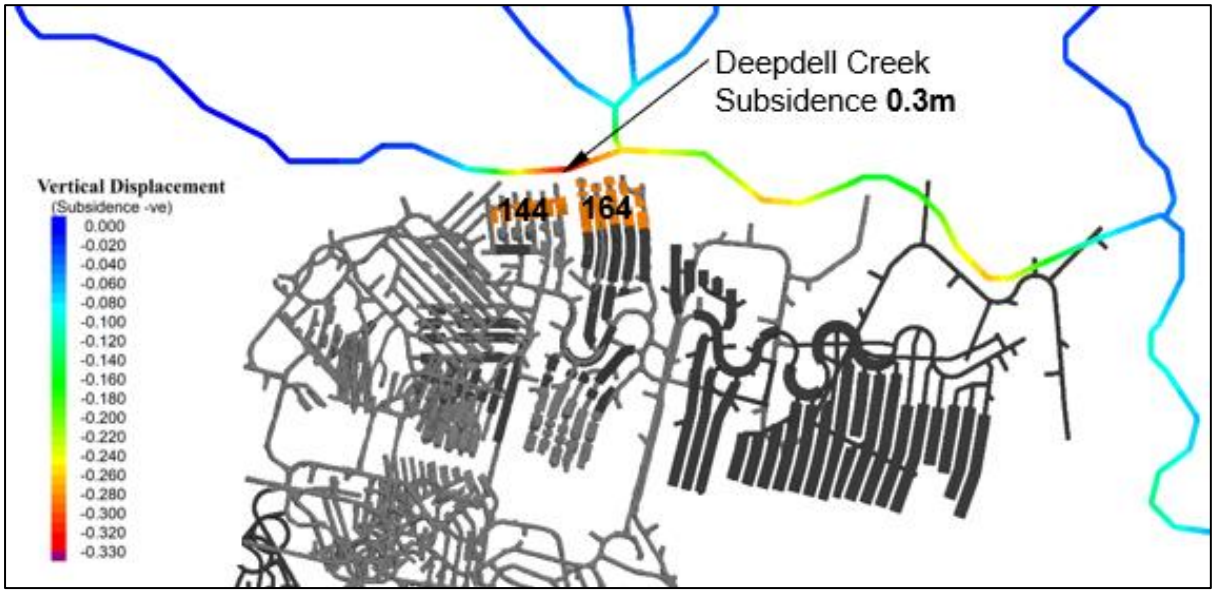


Figure 26. Subsidence Predictions along Deepdell Creek for stoping at Panels 144 and 164 (PSM, 2026)

7.6.7 Subsidence Monitoring

Surface deformation and underground closure measurement and monitoring of trends form a fundamental part of the surface subsidence management strategy. The measurements can be used as a comparison to the predicted displacement from numerical modelling and used to calibrate future modelling of surface subsidence predictions.

Underground excavations are included in the monitoring programme to measure and compare back to the predicted convergence by numerical modelling analysis to close the mine design loop.

Groundwater inflow to the mine, groundwater pressures, and Deepdell Creek flow also form part of the monitoring system which is used to trigger subsidence TARP actions.

A comprehensive subsidence monitoring network has been established to monitor subsidence associated with GPUG with elevated attention to the vicinity of Deepdell Creek. The purpose of the network is to:

- Measure 3D displacement vector time history of subsidence
- Identify development of potential rock fall hazard
- Compare surface strain with numerical modelling predictions
- Compare groundwater behaviour with modelled response
- Provide triggers for the Deepdell Creek Subsidence Trigger Action Response Plan (TARP).

The monitoring program currently consists of:

- InSAR satellite monitoring
- Global Navigation Satellite System (GNSS) points specific to the Deepdell Creek area
- Borehole extensometers, installed south of Deepdell Creek above the 144 and 164 panels
- Vibrating wire piezometers (VWP) near Deepdell Creek; four tips installed within four boreholes
- Underground convergence points at various sites underground
- Underground LiDAR convergence
- Underground seeps inflow observations.

7.6.8 Subsidence Reporting

Monthly subsidence monitoring reports will be prepared by the UG Geotechnical Team.

An annual summary of subsidence monitoring results will be prepared and issued to the Resource Consent Authority (ORC) by 31 March each year.

7.6.9 Subsidence TARP

A Deepdell Creek Subsidence Trigger Action Response Plan (TARP) is used at GPUG to initiate operational and strategic actions based on subsidence monitoring results.

The TARP is a separate document located G:\Shared Data\Geotech\TARPs

7.6.10 Subsidence Review Team

A Subsidence Review Team (SRT) is a multi-disciplinary group defined in the TARP to assess risk and define appropriate mining and mitigation actions on the basis of TARP trigger levels.

7.6.11 Mitigation Measures for Deepdell Creek

A comprehensive subsidence monitoring network has been established to monitor surface subsidence over the entire mine site in general with particular attention being paid to the vicinity of Deepdell Creek. The purpose of the network is:

- Measure 3D displacement vector time history of subsidence,
- Identify development of potential rock fall hazard,
- Compare surface strain with numerical modelling predictions,
- Compare groundwater behaviour with modelled response,
- Provide triggers for subsidence TARP and,
- Ultimately to provide early warning of conditions that may lead to loss of Deepdell Creek stream flow and enable implementation of operational or engineering mitigation measures. E.g. grout curtains.

The monitoring program currently consists of

- InSAR (TerraSAR-X), InSAR (SAOCOM) satellite monitoring
- Prisms and GPS
- Borehole extensometers
- Borehole Vibrating Wire Piezometers
- Underground convergence points
- Underground LiDAR convergence
- Underground seeps inflow observations

GPUG underground mine is planned to extend under Deepdell Creek into the recently defined Orange Zone. Stoping within the Orange Zone can commence only when:

- The geotechnical model is refined and results of detailed numerical analyses indicate the predicted deformations is less than the limits recommended by PSM, or
- stopes are supported to limit caving, ie backfilling.

7.6.11.1 InSAR (TerraSAR-X), InSAR (SAOCOM) satellite monitoring

The Macraes mine site is monitored by two InSAR satellites namely the TerraSAR-X which orbits on an 11-day cycle and SAOCOM which orbits on a monthly cycle. Satellites monitor the extents of subsidence over the entire mine site to millimetre accuracy providing early indications of large-scale subsidence. Satellites have limitations in that they rely on line of sight measurements and do not provide vector movements. In addition, vegetation can affect their effectiveness.

An example of a satellite scan is shown in Figure 27.

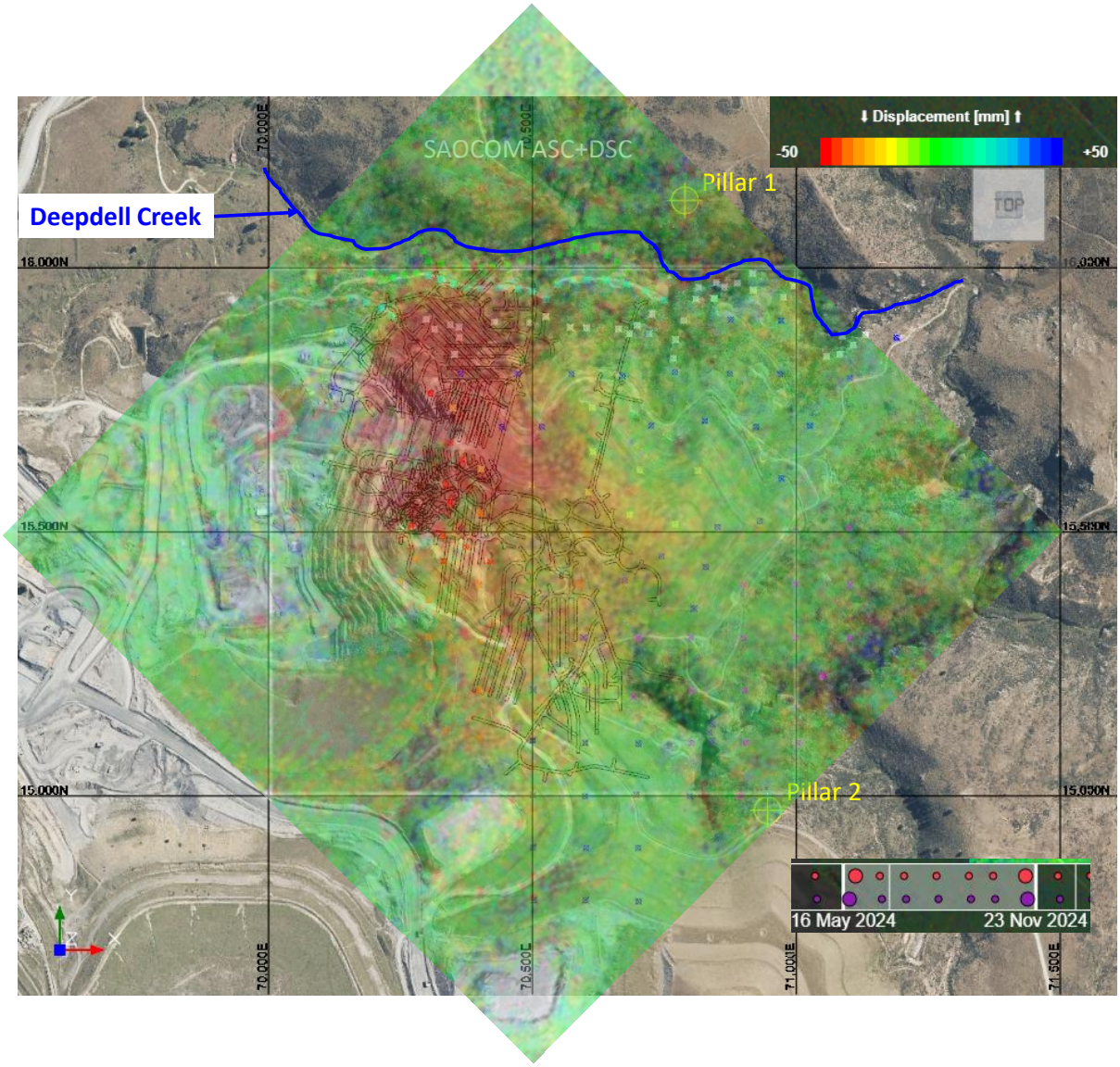


Figure 27 The surface displacement between 16the May 2024 and 23rd November 2024 derived from SAOCOM satellite scans.

7.6.11.2 Prisms and GPS

Currently 109 prisms and 25 GPS points have been installed as part of the GPUG subsidence monitoring network, with the Deepdell Creek being targeted. It is planned to install a further 29 GNSS points and 12 prisms by the end of 2026. The prisms are manually “picked up” according to the TARP frequency but frequency can be increased any interval. Prisms provide accurate three-dimensional vector representations of displacement, velocity and acceleration. Time histories of individual sites or groups of sites are used to identify areas on the move. The limitations of prisms are that they are spot measurements and the ability to identify trends is dependent on the acquisition frequency. i.e. how often they are picked up.

A series of GPS stations have been set up along the fence line parallel with Deepdell Creek. These are surveyed weekly.

Figure 28 shows the location of the prisms installed and recommended in the GPUG region.

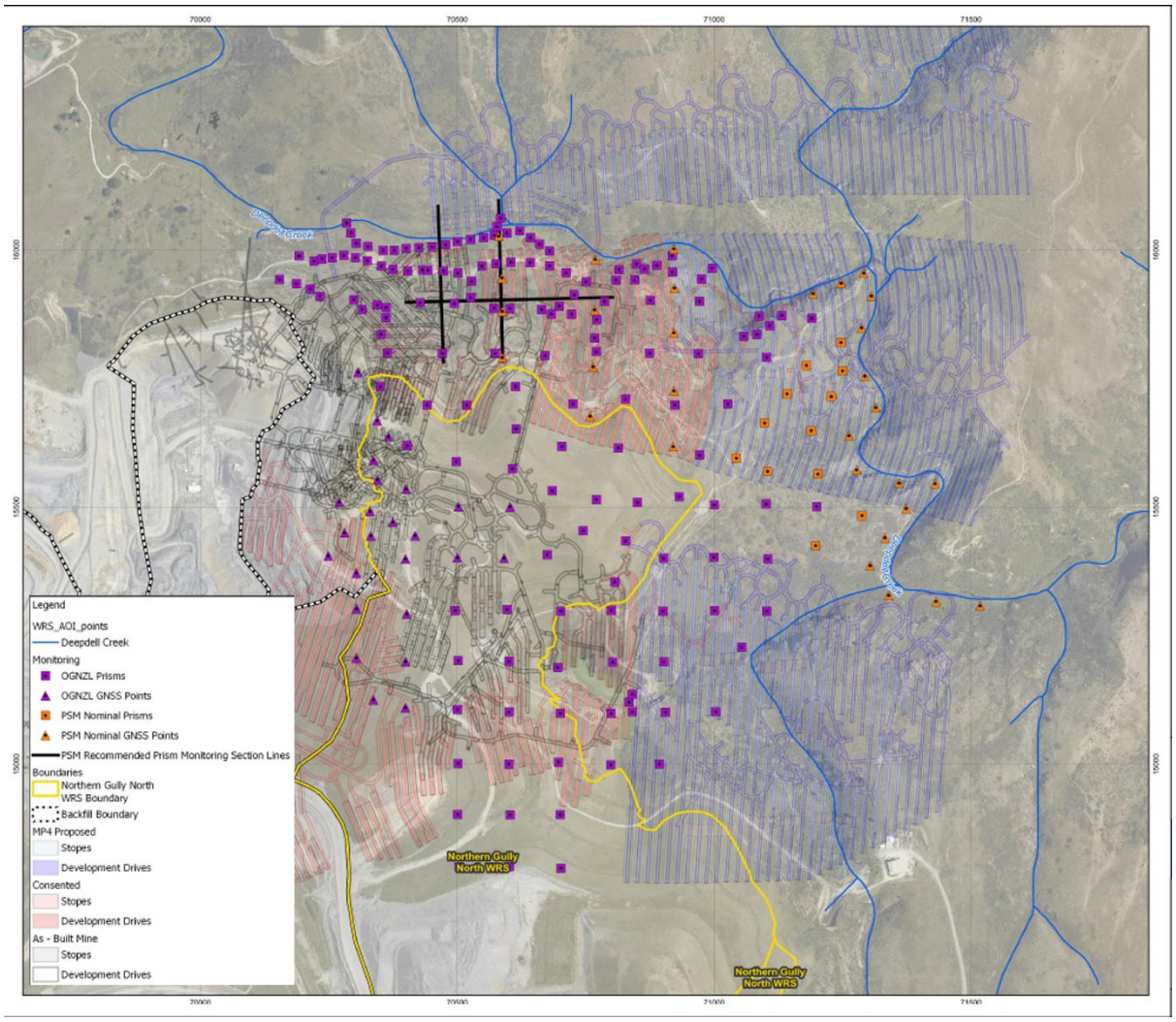


Figure 28. The proposed GPUG Subsidence Monitoring Network in 2026.

7.6.11.3 Borehole Extensometers

Two extensometers were installed immediately above the planned mining in August 2025. The first extensometer, DDH8169, was installed above the 144 panel, in a 125m long hole and extends to 25m above existing development. This extensometer has 6 anchors, at 20m intervals, from 20m to 120m downhole depths. The first anchor is approximately 25m above the ore zone. The second extensometer, DDH8169, was installed above the planned 164 panel. This extensometer is in a 190m long hole with the first anchor installed approximately 8m above the ore zone – 170m downhole depth. Figure 29 shows the location of both extensometers in plan. Figure 30 shows a section view of the location of both extensometers relative to the surface topography and Deepdell Creek.

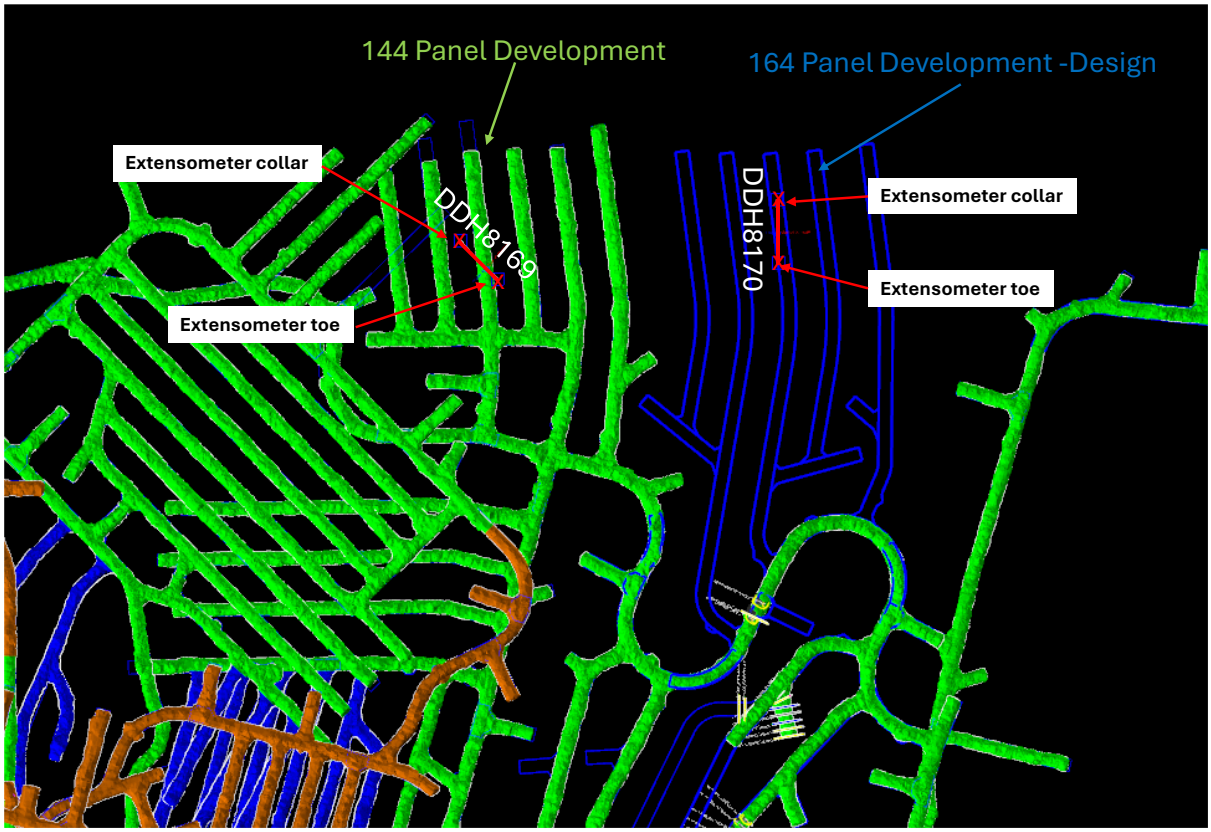


Figure 29. Plan view of the location of the extensometers installed above the 144 and 164 panels.

Measurements are taken automatically every hour with data transmitted to a central server and as of July 2026 are not showing any movement.

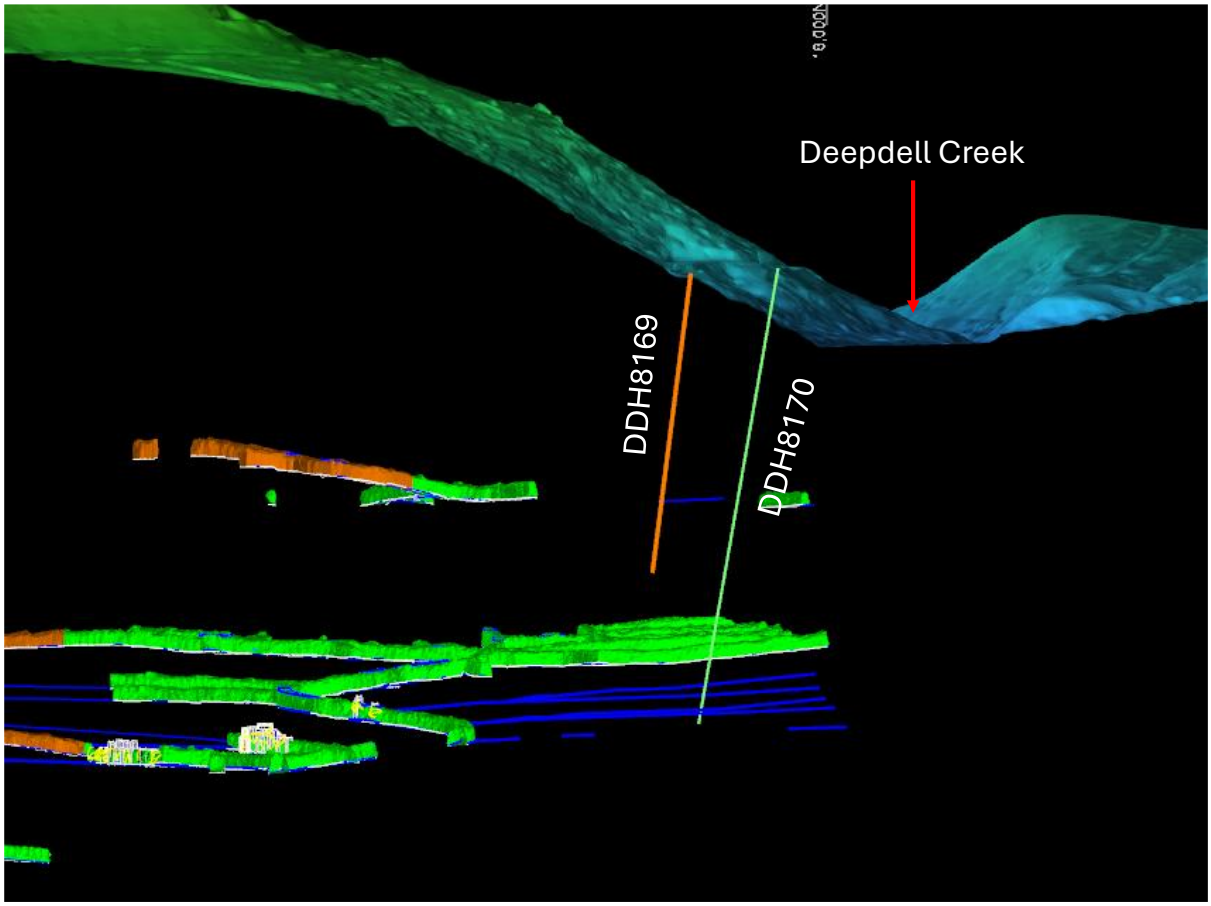


Figure 30. Section view showing the location of the two extensometers relative to the surface topography and Deepdell Creek,

7.6.11.4 Vibrating Wire Piezometers (VWP's)

Piezometers are used to monitor changes in ground water pressures below Deepdell Creek. To date, 16 VWP's have been installed in the vicinity of Deepdell Creek (see Figure 25), 4 in each of 4 holes.

7.6.11.5 Underground Convergence Disto points

The underground Geotechnical Engineers establish pairs of measurement points at various sites underground. The distance between the pairs is measured periodically using a laser distometer. Changes in the distance indicate strain changes in the rock and assist in the identification of unusual trends. This data is also used as part of the underground TARP procedures. The limitation in this technique is the small number of measurement points and that they are snapshots in time giving no indication as to what happened between consecutive measurements.

7.6.11.6 Underground LiDAR Convergence Monitoring

Page **62** of **155**

Drives are scanned periodically during development. Scans can be compared permitting the identification of areas of deformation. Stope scans are undertaken to identify unusual overbreak or caving which may manifest as deformation at the surface. Scans are undertaken daily or weekly.

7.6.11.7 Underground Seepage Inflow Observations

Data collected from the monitoring measures mentioned above, feed into the TARPS. If the TARP criteria require mining to cease then site will examine the monitoring data in detail to determine what measures are required for mining to recommence and then to determine whether these are logistically possible from a technical, practical and scheduling perspective. Given, the environmental sensitivity of the Deepdell Creek, the GPUG Subsidence Monitoring Program is designed to detect and address small changes early.

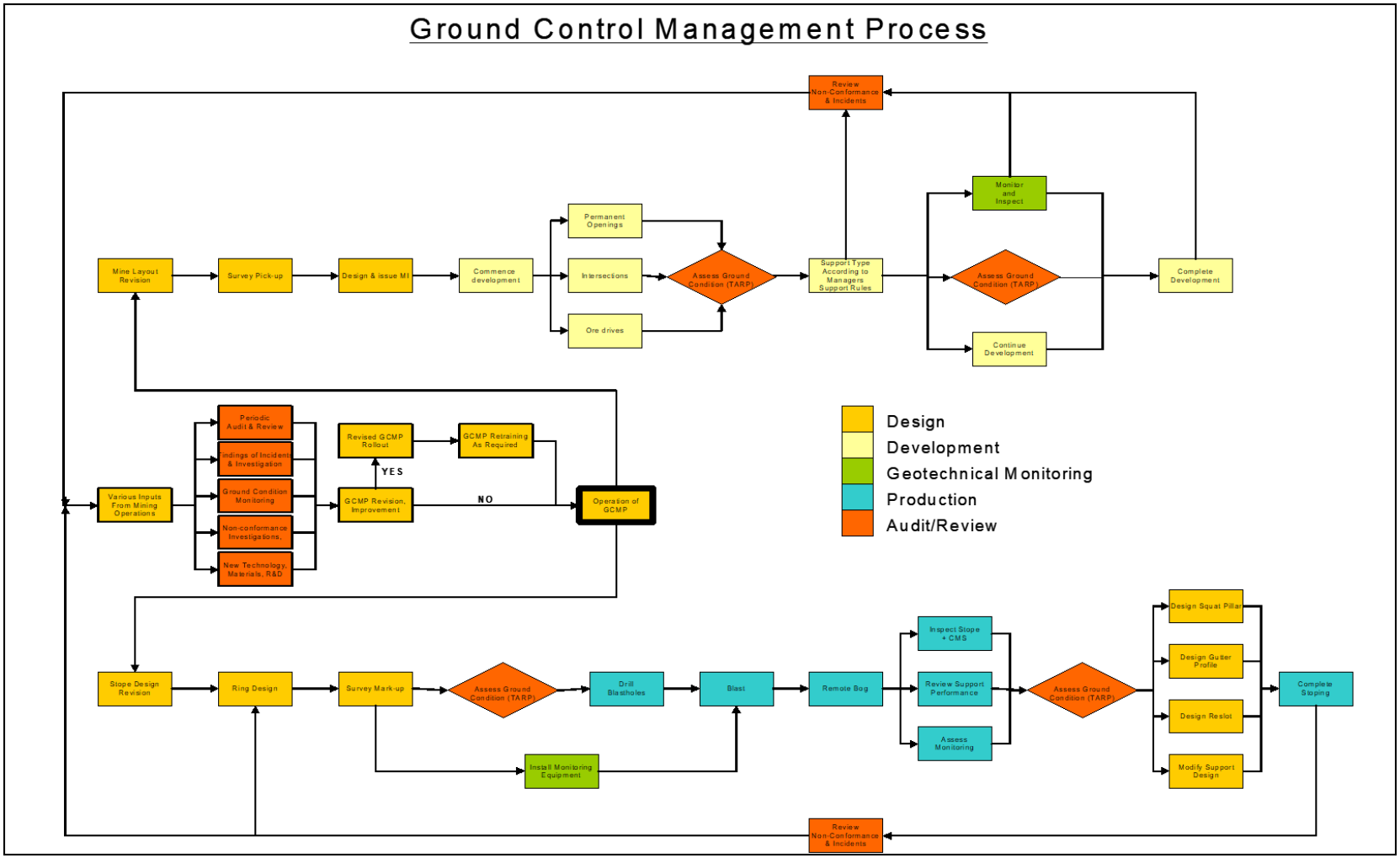
7.7 Ground Control Management Process

No extraction or development shall take place at GPUG unless the area has been assessed and an appropriate support system designed, documented and authorised by the Underground Mine Manager through the Area Design or Stope Shape Approvals processes. Ground control management shall be specifically discussed in the weekly planning meetings and as events require. Specifically, ground control management shall be discussed:

- weekly, as a minimum (covering all relevant geotechnical & operational issues).
- during planning of production in a new stope block, production area or development heading.
- following the results of any significant monitoring program; and
- additionally, as required to assess changes in geotechnical conditions (as identified by the TARP), stope layout, or changes in operational needs of development.

The process for the geotechnical risk management at GPUG is highlighted by the flowchart on the proceeding page. The identification, mitigation and evaluation of geotechnical hazards shall be an integral component of the complete management system.

Current Geotechnical Hazard Areas are listed in the Mine Status Dashboard on Teams which is issued to each crew at start of shift. The status of each hazard area is defined by the TARP status, and specific controls are managed via TARP actions.


Ground Control Management Process
Review Non-Conformance & Incidents
Mine Layout Revision
Survey Pick-up
Design & issue MI
Commence development
Permanent Openings
Intersections
Ore drives
Assess Ground Condition (TARP)
Support Type According to Managers Support Rules
Monitor and Inspect
Assess Ground Condition (TARP)
Continue Development
Complete Development
Periodic Audit & Review
Findings of Incident & Investigation
Ground Condition Monitoring
Non-conformance Investigations,
New Technology, Materials, R&D
Revised GCMP Rollout
GCMP Retraining As Required
YES
NO
Various Inputs From Mining Operations
GCMP Revision, Improvement
Operation of GCMP
Design
Development
Geotechnical Monitoring
Production
Audit/Review
Stope Design Revision
Ring Design
Survey Mark-up
Assess Ground Condition (TARP)
Drill Blastholes
Blast
Remote Bog
Inspect Stope + CMS
Review Support Performance
Assess Monitoring
Assess Ground Condition (TARP)
Design Squat Pillar
Design Gutter Profile
Design Reslot
Modify Support Design
Complete Stoping
Install Monitoring Equipment
Review Non-Conformance & Incidents

7.7.1 Mine Design Process

The design of openings, ground support and pillars shall be undertaken in a systematic manner, in line with mine design guidelines and consider:

Geological factors including:

- distribution of regional structures.
- distribution of rock types; and
- groundwater conditions.

Geotechnical factors including:

- known or predicted geological structure and zones of weaker rock.
- rock strength parameters.
- expected change in stress.
- groundwater; and
- ground response from mining based on monitoring data.
- Numerical modelling results

Mining factors including:

- excavation dimensions, geometry and orientation.
- mining method and sequencing.
- required use of excavation (including expected level of personnel traffic).
- depth.
- ground support equipment and constraints; and
- required life of area or excavation.

Formal mine designs occur using an Area Design process involving approvals from each of the mine departments and final sign off by the Manager Mining - Underground.

The stope extraction geometry and sequence are formulated so as to minimise the exposure to poor ground. This is undertaken when the Geotechnical Engineers review the Area Designs. Over the longer term, the geometry and sequences are optimised as part of the Life of Mine (LoM) review process which is conducted annually.

Stope Shape Approvals (SSA) are used to convert Life of Mine stope designs into a formally approved stope shapes to be used for drill and blast design.

7.7.2 Geotechnical Design Parameters

Initial mine design was based on a main decline located within the ore body with dimensions of 5.5mW x 6.0mH, accessing a series of ore drives with dimensions of 5.0/5.5mW x 5.0/5.5mH. In general, two options for ore drive designs exist.

1. Ore drives designed at 21 m centres, to give a 15 m wide stope separated by 6 m yielding pillars. For competent ground/higher RQD.
2. Ore drives designed at 16 m centres, to give a 11 m wide stope separated by 5 m yielding pillars. For poor ground/low RQD.

The yielding pillars are designed to provide initial support to the stope span to allow for extraction of ore with minimal dilution. As stoping progressed, the expectation is for the yielding pillars to eventually fail.

Extraction sequence is critical during stoping and shall follow the guidelines below:

- maintain a lead-lag distance of less than 30 m.
- if a drive is within 10 m laterally of a planned stope, the higher-level stope shall be mined first to prevent any potential for stope wall collapse into the drive above (standard stoping layouts of 21 m centres, 15 m wide stopes and 6 m pillars do not apply to this rule as the drive is typically >10 m from the planned stope); and
- in multi-level stoping, the highest level shall be stoped before any lower levels are stoped.

The stope widths and yielding pillar design have to date been successful. Pillar widths less than 5m are not recommended.

Underground mine design shall conform to:

- Any main decline shall have an appropriate pillar from active production to reduce ground deformation (nominally 50m pillars).
- Development within internal regional pillars will experience increased stresses, which must be considered during design.
- Stoping retreat shall wherever practical, be based upon a centre-out approach, whereby stoping panels are retreated towards solid abutments, and not internal regional pillars.

7.8 Ground Support

7.8.1 Standard Ground Support Designs

The Standard Ground Support Designs (Appendix 13.1) specify the minimum ground support required in all standard development designed at GPUG. Trigger Action Response Plans (TARP) are also a critical part of ensuring the correct ground support is installed, these are given in Appendix 13.2.

They must be approved by the Manager Mining - Underground, and they must be displayed in locations readily accessible to all mine workers in accordance with regulation 118 of the Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016, accompanied by TARPs. Nothing in the Standard Ground Support Designs prevents a worker from installing extra support than is outlined in the plans.

The Standard Ground Support Designs have been developed through observation, test results, numerical modelling, empirical assessment, and consultation with industry experts. Any significant change to the ground support standards requires a formal risk assessment, management of change and monitoring to assess the ground response.

Ground support design is based on the following parameters:

- All ground support calculations shall be based on an average rock density of 2.65 t/m³
- All cable bolt calculations shall be based on 15.2mm twin strand cable bolts.
- Intersection and wide span cable bolting calculations shall be based on recommended design from Kevin Rosengren & Associates (2006). These design tables are given in Appendix 13.8.

All mine designs shall undergo a formal approval process including approval from the Senior Geotechnical Engineer and Manager Mining - Underground.

There are Ten basic support types including support for:

- (P) permanent drives (galvanised support elements).

- (C) potential corrosive environment (encapsulation of support elements).
- (T) temporary drives of less than 2 years' service life (non-galvanised support elements).
- (S/SL) shotcrete support (stockpiles, pillars and slots).
- (F) face support.
- (IP/IPA) Pillar support.

- (SB) Spiling bar support
  - (I/IA) intersections.
  - wide openings (>6m wide with a hydraulic radius >1.5m); and
  - (B/ICB) brow support.

The basic support type may be modified depending on the ground condition ranging from:

- good (best ground), support level 1; to
- fair, support level 2; to
- poor, support level 3.

The Trigger Action Response Plans (TARP) set out the conditions under which a change in support type is to occur.

- The TARP provides a description of ground condition indicators which, where observed separately or individually may indicate a change in Support Type for individual headings.
- This is not an exhaustive or exclusive list, and all personnel are encouraged to review every heading every shift to ensure safe operation.

Copies of the Standard Ground Support Designs and TARP's shall be prominently displayed and kept:

- in the Shift Supervisor's office.
- in the Mining Superintendent's office.
- in the Underground Main office.
- in the crews crib room; and
- on all Jumbos.

The Mining Superintendents shall ensure that all Shift Supervisors responsible for ground support during development are familiar with the GCMP, Standard Ground Support Designs and TARPs.

7.8.2 Support Types

The Standard Ground Support Designs are included in Appendix 13.1. These standards are designed and presented to include:

- support type.
- support spacing.
- angle of support installation.
- mesh type.
- mesh overlap.
- shotcrete thickness.
- drive height; and
- drive width.

The Geotechnical Engineer shall recommend the appropriate support type for the expected ground conditions. The Geotechnical Engineers shall sign-off on all support plans before they are issued to operations.

The operator shall report any deviation to the standard and the reasons for it, to the shift supervisor, which will then be passed onto the geotechnical department. Operators will also record any changes in their SIMBIO report.

7.8.3 Trigger Action Response Plans (TARP)

TARP's provide a list of indicators that can be used to guide the selection of the appropriate support type as defined by the Standard Ground Support Designs. Refer to Appendix 13.2 for all the TARP's currently in use at GPUG.

The aim of a TARP is to ensure a response to changing ground conditions occurs at an early stage.

The key indicators (of change) are:

- drilling conditions.
- overbreak extent and persistence.
- ground water.
- GCR rating (refer to Appendix 13.7).
- Ground movement.
- incidence of large-scale structure; and
- ground movements as evidenced by "popped" plates, scats, etc.

In addition, the Geotechnical Engineer may dictate extra support based on geotechnical monitoring and/or visual inspections. The Superintendent may also vary the support type to increase support at his own discretion to ensure continuity of production in a safe working environment. The Superintendent shall confirm the change with the Geotechnical Engineer as soon as practicable.

7.8.4 Ground Support Installation

The designed support shall be installed in accordance with all relevant GPUG operating procedures and as outlined in the Standard Ground Support Designs and TARP's.

Operators shall observe the ground conditions and monitor effectiveness of ground support installation (e.g., drilling rates, water loss/gain, bolting problems, etc.).

Regulation 117 (Installation of ground or strata support) of the Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016 states Oceana Gold must ensure:

- no person enters an area of the mining operation that has unsupported ground or strata unless that person is installing or supervising the installation of ground or strata support; and
- where any mine worker who is installing or supervising the installation of ground or strata support will be exposed to a hazard associated with unsupported ground or strata, temporary support is provided to protect that mine worker from the hazard.

At GPUG, a geotechnical assessment and risk assessment has determined that no person shall enter unsupported ground in any area or under any circumstances as the risk from being struck by a rock fall is too high. The use of temporary support is not to be used at GPUG.

Unsupported ground is defined as any area beyond the last row of fully installed rock bolts. A fully installed row of rock bolts is defined as a completed row of rock bolts as specified in the ground support plan for the specified work area.

Rock bolts provide the primary support function at GPUG. The safety of every person underground depends on their correct installation.

- Bolt hole diameter and length shall be drilled to specification.
- Rock bolt plates shall be installed as flush as possible to the rock face. the plate supports the surface of the opening and helps prevents shallow rockfalls. If shallow failure does occur, this can lead to excessive and ongoing failure.
- Mesh shall be pushed as far as possible into intimate contact with the rock surface.
- Mesh serves to help prevent the rock surface unravelling and generally to keep the surface intact.

Visual impediments pose a risk to being able to effectively inspect the ground. Any areas where the visual impediments are going to be impracticable to be removed for geotechnical inspections (fan hangers etc.), dynamic support is required to be installed, predominantly this will be MD bolts.

Due to high exposure foot traffic and potentially long programs, diamond drilling locations shall be inspected by geotechnical personnel before the diamond drilling rig enters the area. If diamond drilling is planned for greater than two weeks in one area then the lower walls must be supported, with support determined by geotechnical personnel. If drilling is within 5m of a development face, then the minimum face supports required is level 2.

7.8.5 Ground Support Elements

Ground Support Element	Specification	Hole size	Assumed Capacity for Design	Application	**Notes**
Fibrecrete (Shotcrete)	Fibre reinforced (refer Appendix 13.3)	Na	40Mpa	Poor ground, Pillars, Stockpiles, Heavy traffic areas	• *Hydroscaling must be completed before application.* • *Thickness as specified by ground support design.*
Welded Wire Mesh	Galvanised, 100mmx100mm welded mesh 5.6mm gauge, 2.4mx3.6m or 2.4mx4.2m	Na	1t	Surface support all areas	• *Pushed up to fit excavation shape.*
Mesh Straps	Black, 100mmx100mm welded mesh, 8mm gauge, 0.3mx6.0m	Na	2.5t	Brow support	
OSRO Straps	Black, 170mmx60mm pig tailed, 10mm/6.3mm gauge, 0.3mx5.8m or 0.3mx4m	Na	700MPa	Brow support	
Split Set Bolt (Friction bolt)	Black or Galv, 47mm diameter, 2.4m or 3m length	43mm - 45.5mm	18t tensile, 4t per m of embedment	Development and rehabilitation support	• *Gauges on jumbos for determination of appropriate bit size.* • *Installed with 4mm dragonfly plate.*
MD bolt	Black or Galv, 47mm diameter, 2.4m or 3m length	43mm - 45.5mm	29t	Development and rehabilitation support	• *Gauges on jumbos for determination of appropriate bit size*

					• *Installed with 6mm dragonfly plate.*
Cable bolts	Black, bulbed every 1m, 15.2mm twin strand, length varies with design	54mm-76mm	25t per strand	Development, brow, intersection, pillar and rehabilitation support	• *Cable to be clean before installation.* • *Installed with 300mmx300mmx10mm flat plate, barrel and wedge installed on both strands tensioned to 7t.* • *Grout to cure for a minimum 12 hours (GP cement).*
Dynamic Cable bolts	Black, smooth strand, 15.2mm, debonded with yielding anchor	64mm-76mm	31t	rehabilitation support	• *Cable to be clean before installation.* • *Installed with 300mmx300mmx10mm flat plate, barrel and wedge installed and tensioned to 7t.* • *Grout to cure for a minimum 12 (GP cement) before tensioning.*
Self-drilling anchor (SDA)	R32S, hollow bar, 3m length	54mm-64mm	37t	Spiling, pillar, rehabilitation support	• *SDAs to be clean before installation.* • *Installed with 200mmx200mmx10mm dome plate and nut.* • *Grout to cure for a minimum 12 (GP cement) before tensioning.*
Shotcrete Arch	N16 rebar, 2.4-3m length, 300mmWx200mmD	Na	-	Fault crossing or Special support	• *Installed with 2.4m split sets and 150mmx150mm dome plates.* • *Encapsulated with 40MPa shotcrete.*
Pumpable Resin	Thixotropic two-*part* polyurea silicate	Na	35MPa	Bolt encapsulation	• *1:1 component ratio.*

7.8.6 Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) is an integral part of the ground control process to ensure that all ground support:

- meets the manufacturers design performance criteria.
- is installed as per the recommended installation guidelines (refer section 7.8.4); and
- is installed as per the approved Standard Ground Support Designs, in terms of layout, support, element type, number of bolts, steel type, surface support type, etc.

7.8.6.1 Pull Testing

Pull testing on installed ground support elements shall be conducted as per the Pull Testing Procedure MAC-440-PRO-069.

  - pull testing shall be conducted on split set bolt and MD bolts, other bolts may be tested on an as needed basis.
- pull testing frequency shall be calculated at 0.5% of installed bolts (1 in every 200);
  - pull testing shall be conducted by suitably trained personnel.
  - pull testing shall test to the manufacturers design pull out strength; and
  - pull test results shall be reported to all personnel at least every quarter.

7.8.6.2 Shotcrete / Fibrecrete

Testing of batched and sprayed shotcrete must be undertaken to demonstrate that it routinely meets the minimum mix design requirements. The following types of testing will be used to assess and control the quality of the delivered product and the applied product:

Table 11: Summary of Quality Testing Requirements and Acceptance Criteria

Test	Test Sample	Frequency	Responsibility	Acceptance Criteria	Australian Standard
UCS	Cylinder	2.5% of loads (1 test per 40 loads)	Batch Plant Operator / Batch Plant Supervisor/Geotechnical Engineer	40 MPa for all samples (28-day strength)	AS1379
Slump	Concrete Slump Test	One for every load at batch time and as necessary	Batch Plant Operator	Minimum 150 mm Maximum 190 mm	AS1379 AS1012.3.1-1998
RDP	Round Determinate Panel	6 monthly	Batch Plant Operator / Geotechnical Engineer	Minimum 450J	ASTM C1550-20
Early Age Strength	Penetrometer	1 load weekly	Batch Plant Supervisor/Geotechnical Engineer	1MPa after 2 hours	N/A
Thickness Testing	N/A	Every cut that is sprayed	Jumbo Operator	>50 mm or >100 mm	N/A

Should the acceptance criteria for a given shotcrete batch not be met, then the Geotechnical Engineer shall undertake an investigation to determine the causes, and to instigate any follow-up action if required. Any variations of the shotcrete thickness below the accepted criteria shall be investigated by the shift supervisor, superintendent, or geotechnical engineer before taking the next development round, to determine if additional support is required.

Results for shotcrete QA/QC results are located.

\\mac-fsv02\GPUG\Geotechnical Engineering\Shotcrete

7.8.6.3 Ground Support Audits

Audits on 5% of installed ground support are to be completed on a weekly basis by the Geotechnical Engineers, Superintendent and Shift Supervisors. Audits are recorded in the SIMBIO database.

Any headings where ground support installed is found to be below the minimum required standards set out in the Standard Ground Support Designs or poorly installed, must be followed up and if required extra support installed to bring the development up to standard.

7.8.6.4 Bolt Encapsulation UCS Testing

. Samples are to be taken from a typical batch of grout or resin prepared for rock bolt encapsulation and cast into moulds for testing. Three samples are to be taken each time. Samples are tested for Unconfined Compressive Strength (UCS) at 7 days (one sample) and 28 days (three samples) curing. Test results are to meet the criterion shown in Table 12.

Table 12: Grout, water to cement ratio requirements.

Grout Water: Cement (W:C) Ratio	Frequency	UCS (MPa)	Acceptance %
Thick Grout (W:C = 0.3 – 0.35)	One set monthly	40	100%
Conventional Grout (W:C = 0.35-0.45)	One set monthly	35	100%
Polyurea Silicate Resin	One Set Monthly	35	100%

7.8.7 Ground Support Inspections

All accessible horizontal and vertical development shall be inspected for ground deformation and the condition of installed ground support by the geotechnical department at scheduled intervals specified in the underground inspection schedule spreadsheet, located at:

G:\Geotechnical Engineering\development Inspections\Underground Inspection Sheets\Underground Inspections Schedule.xlsx

The inspection sheets and schedule shall be reviewed and modified monthly by the geotechnical engineers and as conditions change as per the monitoring TARP guidelines (refer Appendix 13.2).

A scheduled underground inspection shall have an accompanying inspection sheet, located at:

G:\Geotechnical Engineering\development Inspections\Underground Inspection Sheets\Underground Inspections Sheets

All completed inspections sheets shall be scanned and entered into INX InControl as an inspection.

All intersections shall have a geotechnical inspection prior to the release of the mining instruction for the first turnout cut, with intersection suitability and ground support requirements determined as per the development intersection TARP (refer Appendix 13.2).

If the ground cannot be effectively inspected during a geotechnical inspection due to a visual impediment (twin vent bags, foggy air, etc.) the visual impediment needs to be removed. This may include turning off ventilation bags or turning off primary vent in the case of foggy air in the return airways. If a scheduled geotechnical inspection cannot be undertaken due to a visual impediment and

the inspections is on its due date or overdue, then the drive needs to be chained off with an unauthorised entry barricade until an effective inspection can be undertaken.

In conjunction with scheduled development inspections, all stope brows shall be inspected by a technical services team member and/or the shift supervisor and Superintendent prior to firing to ensure the correct brow support has been installed.

Once fired, stopes are to be inspected on a regular basis or as issues or hazards are raised by operations. Only the geotechnical team and suitably trained and competent personnel shall conduct a geotechnical stope inspection. Stope inspection forms are conducted on SIMBIO, which includes a photographic record.

Brows shall be inspected by the shift supervisor or geotechnical engineer prior to redrilling any holes within the first two rings of the brow.

As well as scheduled inspections, regular underground inspections of areas are conducted by geotechnical engineers on all underground visits. In addition, inspection of underground workplaces must occur on entry to the work area by all personnel. It is also the responsibility of the Mine Superintendent and Shift Supervisors to regularly monitor compliance of ground control standards as well as changing ground conditions and report any deficiencies with the ground control system or issues/hazards to the geotechnical department.

7.9 Ground Rehabilitation

Ground rehabilitation (referred to colloquially as “rehab”) can involve:

- The replacement of support which has failed or been damaged such that it is not suitable to maintain excavation stability.
- Installation of additional support when increased deformation of the rock mass is expected.
- Scaling and bleeding of loose rock followed by re-support of the rock mass.

Ground rehabilitation can often be more hazardous than typical development support and will generally require a higher skill level on the part of the operators involved.

These hazards can include, but are not limited to:

- unexpected rock fall during drilling.
- ground voids.
- tight spaces.
- bolts not anchoring securely; and
- ground deformation and ground support failure.

Rehabilitation plans are issued for all significant works. The plans are designed by the geotechnical department and signed by Mining Engineers, Geotechnical Engineers, and Mining Superintendent. A rehabilitation risk assessment can be completed if required, priority for the completion is assessed and included on the plan. This allows for scheduling and for operations to have clear work priorities based on the hazards present. Rehab plans are uploaded into Simbio and included in the weekly mine plans.

An active list of rehabilitation jobs is maintained by the geotechnical department and updated as jobs are added and completed. This can be found here: \\mac-fsv02\GPUG\Shared Data\Geotech\Rehab plans .

It is the responsibility of the Geotechnical Engineers to ensure that the information from this list is transferred to the relevant operations personnel and discussed in the weekly planning meeting.

Following completion of a rehab job the area shall be inspected by the geotechnical department, Superintendent and/or shift supervisor to ensure the job has been satisfactorily completed. One inspection is completed then the original rehab plan is signed and given to the geotechnical department.

7.10 Check Scaling

Scaling may be carried out mechanically, using a jumbo and drill steels and/or hydroscaler on the Spraymec, or manually using a hand-held scaling bar either from a man-cage or from floor-level. All headings are mechanically scaled before ground support and reinforcement is installed. This is to remove any loose rock material and to establish a good profile.

It is a requirement that all personnel carry out a workplace inspection prior to working in an area. All personnel working underground have the responsibility of identifying areas that require manual scaling and remediate the situation. Inspections of active mine development are also carried out by supervisors and geotechnical engineers, which may result in areas identified for check scaling.

All underground mining personnel are required to be trained in scaling practices as part of their key competencies as per MAC-440-PRO-027 Manual Scaling. All manual scaling undertaken is to be recorded in SIMBIO.

7.11 Area Closures and Barricading

If ground support is not to standard or badly damaged to the point that could lead to a fall of ground, then a no unauthorised barricade must be in place. This barricade must be placed a minimum 5m from the location of poor ground. This includes if a drive has been rehabbed to a certain point and poor ground exists in front of the rehab, the barricade shall be placed 5m back from the last installed rehab bolt, unless additional controls are in place (e.g. suitable bund).

If ground deformation and/or support damage becomes too hazardous for general access and/or the drive is unused and unlikely to be used soon, the area or drive shall have a “No Entry” barricade in place. A closure plan will be conducted to assess any risks associated with closing off the area. A No Entry barricade shall be a physical barrier composed of a chain strung across the drive with a single No Entry sign attached to the centre of the chain. The chain shall be secured to the sides by d-shackles to prevent accidental removal.

If the drive is unlikely to be accessed again, then a mesh barricade and bund shall be erected instead of a chain barricade. A mesh barricade shall be composed of sheets of mine mesh spanning the width of the drive and secured to a chain which is secured to the walls by locked d-shackles. A single No Entry sign shall be attached to the centre of the mesh barricade.

The Manager Mining - Underground shall be informed of all No Entry barricade placements. All No Entry areas are documented in the No Entry register, kept in the underground offices meeting room. All personnel who have installed a No Entry barricade shall sign and enter the date, location and reason for the No Entry barricade. Only the Manager Mining - Underground shall authorize access into a No Entry area or the removal of a No Entry barricade.

A No Entry Authorisation form (refer Appendix 13.4) shall be completed prior to entry, to risk assess all potential hazards prior to entry. All completed No Entry authorisation forms shall be filed in a folder in the Technical Services office.

Any drive that is currently unused but is likely to be active soon shall have a "Inactive Heading – Geotechnical Re-Entry Required" chain barricade erected. Upon re-entry of the drive a geotechnical inspection is required by the geotechnical department or suitably trained personnel to assess any potential geotechnical risks.

7.12 Ground Failure / Fall of Ground Incidents

Any actual or suspected unplanned fall of ground must be immediately reported to the underground supervisor. The area shall be made safe by means of barricades to keep personnel away from the ground instability.

All unplanned fall of grounds shall be assessed to determine whether the fall of ground could have resulted in serious harm to a mine worker had the circumstances been different as per Regulation 131 of the Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016.

If the fall of ground could have resulted in serious harm to a mine worker had the circumstances been different then an investigation shall be carried out via the ICAM process. The ICAM investigation can be found on SharePoint with the following link:

https://oceanagold.sharepoint.com/corporate/health/Pages/Incident-Reporting,-Classification,-Investigation,-Corrective-%26-Preventive-Action.aspx

If the investigation reveals that the cause of the ground control is attributable, in part or in full, to a ground support design fault, then the design shall be reviewed by an independent and competent person who was not involved in the development of the original ground support design.

All falls of ground are to be recorded and entered in a database held by the geotechnical department. The database is located:

G:\Geotechnical Engineering\Ground control Management Plan\FRUG_Rock Noise and FoG Database.xlsx

All records of any ground failures that caused or had potential to cause serious harm to any person (including records of the investigation into the causes of the failure) shall be kept at least until the date that is 12 months from the date on which the mining operation is abandoned.

7.13 Communication and Training

7.13.1 Communication with Mine Personnel

A communication process that ensures a two-way flow of information between operators and mine management shall be fostered.

The process shall ensure that:

- operators are provided with an understanding of expected ground conditions, anticipated support, mining procedures and any relevant changes in support design prior to implementation.

- personnel are aware of typical warning signs of ground deformation and ground support loading which suggest that the installed support may be under load and/or inadequate and in need of review.
- close communication exists between all members working under the GCMP; and
- management have an early opportunity to respond to unexpected mining conditions and/or support system behaviour.

Changes in ground conditions, significant geotechnical events, and new hazards are communicated to the operators at the daily shift change meetings. Either the Geotechnical Engineer, Shift Boss or Foreman will inform the operators as to the nature of the event and what precautions have been put in place. The Geotechnical Engineers will inform the technical group at the daily technical services meeting.
All operators are encouraged to report hazards to the Shift Boss and/or Geotechnical Engineer. Reported hazards will be investigated and feedback will be given at the shift change meeting or Toolbox meeting.

All operators are given Ground Awareness training when they start at Macraes. Refresher courses are given annually.

7.13.2 Training

Competency and training requirements shall be outlined for all personnel undertaking tasks associated with the management of ground control underground. The training shall include hazard identification and awareness, ensuring that all personnel are aware of the risks and hazards associated with their workplace and the tasks that they are required to undertake.

Only trained and competent persons shall be appointed as geotechnical staff.

The training department shall review training and competence of operators on a regular basis.

The geotechnical department in conjunction with safety and training officers shall provide information sessions to underground crews to help improve the overall understanding of ground support and to update crews on any major hazards or changes to the geotechnical environment that all underground personnel need to be aware of. The expectation is that this will result in improved practices.

Following any significant changes to the GCMP, TARPs or Standard Ground Support Designs, additional training to underground crews and relevant GPUG staff shall be given.

Training modules have been developed for employees and contractors and outlines their duties with regard to ground control. Training shall consist of an initial course followed by periodic refresher training and shall cover:

- factors involved in ground control;
- detection of structural changes in the ground;
- ground support theory and practice;
- ground monitoring;
- reporting;
- installation of support;
- roles and responsibilities of all personnel under the GCMP; and
- TARPs.

All persons affected by the requirements of this plan shall understand the plan, their responsibilities and training requirements as outlined in Table 13.

Table 13: Training requirements.

Trainee	Training Requirement
All workers	• Area specific training. • Familiarised with underground ground control management practices during inductions and two-yearly re-inductions. • Job specific training through SOPs and training manuals (both theory and practical). • Understanding of the requirements within this plan. • Additional training will be conducted whenever significant changes are made to this plan.
Supervisors	• B Grade tunnel managers ticket.
Mine surveyor	• Certificate of Competence as a mine surveyor.
Manager Mining - Underground	• First class mine managers certificate.
UG Senior Geotechnical Engineer	• Rock mechanics/Engineering Geology Master's degree or equivalent tertiary qualification.

7.14 Incident Investigation

Following the occurrence of an incident related to uncontrolled ground movement, general priorities shall be to:

- remove personnel from positions of potential harm;
- barricade and sign off the affected area;
- reduce or eliminate hazards sufficiently to enable safe recovery or treatment of injured personnel;
- investigate, collect data and report; and
- agree upon and implement a recovery plan.

The Oceana Gold Health and Safety guidelines provide guidance as to responsibilities, communications, reporting and other requirements for incident investigation.

Incidents shall be reviewed at Special Meetings, Safety Meetings and at daily production meetings.

7.14.1 Guidelines for Incident Investigation

Only appropriately experienced personnel shall be used in incident investigation. Consideration shall be given to whether external opinion or other skills are also required.

Records of all investigations, including associated analyses, conclusions, recommended actions and action completion shall be maintained by the Geotechnical Engineers and/or Frasers underground management.

As relevant, ground control incident investigation may include:

- inspection of the incident site;
- photography and sketches of the incident site;
- soliciting of verbal and written statements from personnel involved in the incident;

- soliciting of verbal and written statements from personnel associated with the incident (e.g., Superintendents, Shift Supervisors, Leading Hands, Operators);
- compilation of a chronology of events;
- review of equipment and materials in use;
- assessment of compliance with the GCMP;
- review of data;
- review of design;
- back analysis;
- root cause analysis;
- review of ground support design or operating practice; and
- review the GCMP.

7.14.2 Incident Statutory Reporting Requirements

Ground instability related incidents shall be reported to the relevant authorities (WorkSafe) by the Manager Mining - Underground as required by Schedule 5 of Mining Operations and Quarrying Operations Regulations 2016, specifically:

- Any failure of ground control that prevents persons from passing through the area or otherwise exposes them to danger.

7.15 Geotechnical Monitoring

7.15.1 Monitoring Strategy

Geotechnical monitoring is undertaken at GPUG with strategic and tactical objectives:

- Strategic objective: monitoring is implemented to provide data for back analysis for continuous improvement in mine design.
- Tactical objectives: Monitoring is implemented to control the risk of geotechnical hazards.

Strategic monitoring and observation are undertaken at a macro scale focused on gathering data for long term planning and design, while tactical monitoring is undertaken at a micro scale and focuses on regular inspections of the mine.

The installation of monitoring devices shall be primarily managed by the UG Geotechnical Engineers with inputs from the technical team and external parties as necessary. In general monitoring falls into two categories:

- planned monitoring on a project scale (macro); and
- on an as required basis (micro).

Monitoring both currently and previously conducted includes:

- visual observations and inspections by geotechnical engineers;
- extensometer monitoring of ore drives to test brow stability;
- deployment of ‘Tell Tales’ in targeted locations (intersections, brows, strategic openings) and other locations where ground conditions or structure justify monitoring;
- crack monitoring utilising simple indicators such as glass slides;
- CMS (laser-based Cavity Monitoring Survey) pickups of stopes to monitor stope voids, stope back failures and pillar failures;
- convergent monitoring using laser disto meters to measure drive closure;
- SMART cable bolts;
- Multi Point Borehole Extensometers (MPBX);
- high risk single access headings greater than 200 m long;

- Hovermap Lidar change comparison;
- Cyclops convergence monitoring; and
- monitoring of stress change around stoping blocks using vibrating wire stress meters.

Future monitoring programs may target:

- mining induced stresses on extraction;
- deformation of the rock mass during development and production;
- mining induced seismic activity;
- the reaction or effect of ground support on the rock mass; and
- long term excavation stability (assessment of actual vs. planned/modelled).

Where possible the location(s) of all monitoring equipment to be installed shall be agreed in advance of development/production in the weekly planning meetings.

For each installation or program, a formalised monitoring recording schedule shall be documented and maintained. This schedule shall document the location and type of monitoring to be carried out, time last read, the reading frequency, and how the recorded data is to be used, communicated, and archived.

7.15.2 Underground Monitoring

7.15.2.1 Deformation Inspections

Observation is the most widely used and effective tool for inspecting rock mass conditions and monitoring ground deformation, seepage, and the condition of installed ground support. Good observations require frequent inspections of active areas, including walking through development (rather than driving) and having good lighting available. Inspections are carried out during all underground visits by the geotechnical department, which occur on a regular basis and as required to check on specific hazards or changing conditions. Scheduled inspections are also undertaken on key development where ground deformation and support damage are either expected or has already occurred.

Visual inspection of deformation is generally carried out in tandem with Ground Support Inspections (refer to Section 7.9 above).

7.15.2.2 Convergence Points

Drive closure, or convergence, is most effectively measured with a series of convergence points located on the surface of a drive.

A convergent point is a fixed reflective surface that can be accurately measured repeatedly with a laser distance finder (‘disto’). The fixed reflective surface can be as simple as two paint marks for temporary measurements, or cemented dyna-bolts with a reflective washer.

An in-house database has been developed and is used to analyse and visualize all convergence points underground. The software determines convergence rates based on the measurements of a point. Data from the program is then output into the Convergence printout spreadsheet in order to determine which points are next required for measurement.

The database is located here:

I:\Frasers Underground\FRUG PD

An example of a convergence monitoring map created by the database shown in Figure 318.

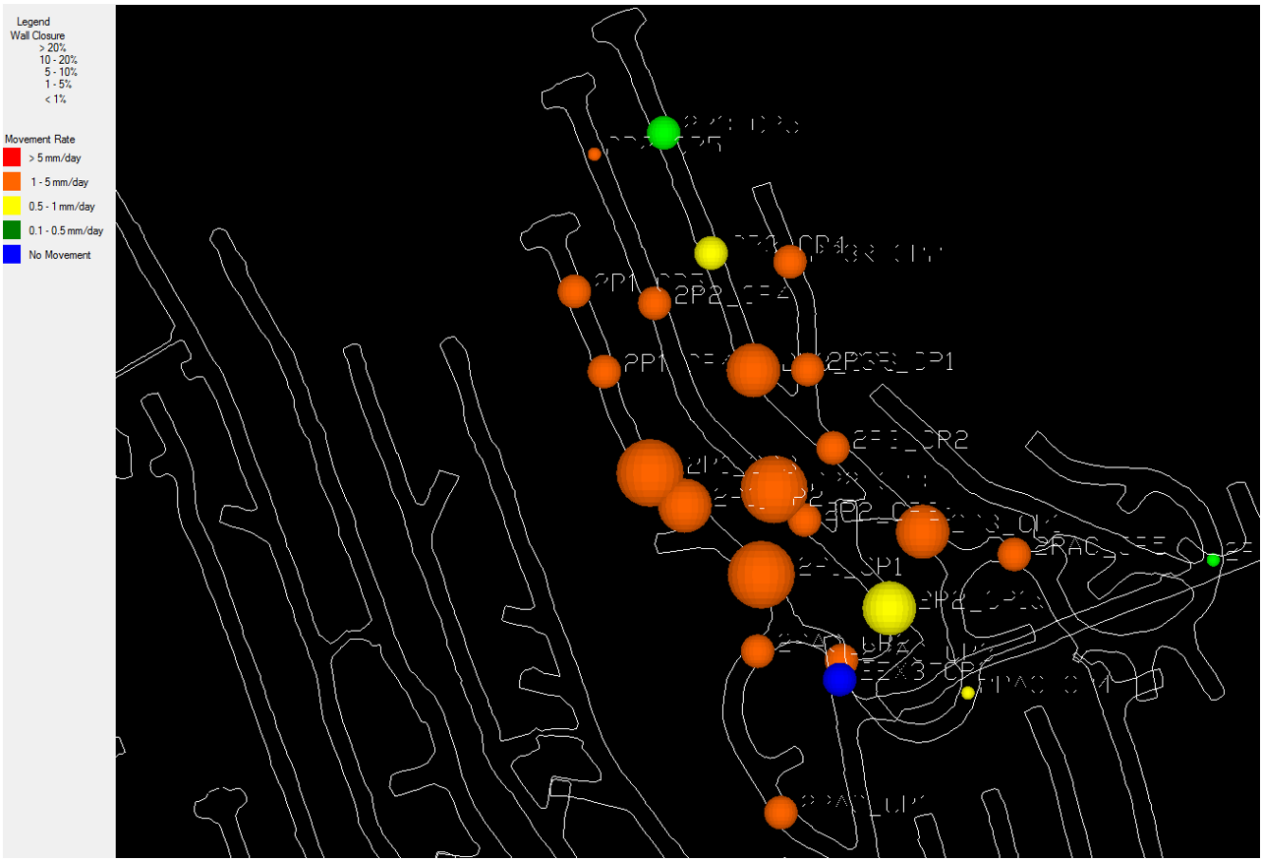


Figure 31: Example of a convergence monitoring map.

7.15.2.3 Borehole Extensometers

Deformations over large distances into the ground require sophisticated instruments to accurately measure ground displacement. A borehole extensometer is a type of geotechnical instrument that is used to measure the stability, movement, and behaviour of rock masses adjacent to mine openings at various depths. They work by measuring the position of an internal rod relative to a reference/anchor point (or “head”). This information is then read from the device via an electronic reader.

Multi-point borehole extensometers are the most used product in underground mines. The mulit-point name refers to the fact the instrument has multiple anchors or reference points along its length which simultaneously monitor deformation at each point. This makes for more accurate and useful readings.

There are currently 8 extensometers installed at GPUG.

7.15.2.4 Sliding Crack-Meters

Cracks forming in key infrastructure such as concrete bulkheads, can be monitored with crack meters. Glass slides are typically used by fixing a glass slide on either side of a crack. One of these glass slides will have a millimetre grid pattern with cross hairs attached to it to determine apparent movement and direction.

7.15.2.5 Tell Tale Extensometers

Tell tales are a basic extensometer used to measure shallow deformations (less than 10m) in a drive. Two wires are installed into a bore hole which can measure displacement in two horizons around an opening.

They are typically installed in blocky rock masses where rock shearing is limited. They are unsuitable for monitoring squeezing and shearing ground conditions and would only occasionally be employed at GPUG, predominantly in drives above the Hanging wall.

7.15.2.6 xCell Cyclops

xCell Cyclops are an automated convergence monitoring system, which can provide real-time measurements of drive closure if network is available in the installed location. The Cyclops are installed by screwing the mounting nut onto a MD bolt, once installed a laser measure the distance to a targeted point. Drive displacement/rate can then be determined by comparing the laser measurements. Automated alarms can be set for total displacement and displacement rate, which are related to the convergence monitoring TRAP.

7.15.2.7 Convergence Monitoring by LiDAR scanning

Critical areas of high deformation are scanned using a Hovermap Lidar and uploaded to void mapper for comparison between scans. This enables a visual representation of the deformation between scans.

7.15.2.8 Stope Cavity Monitoring System (CMS)

All stopes are survey scanned once bogging is completed to determine the over break or under break and stope outline in comparison to the design. Intermediate CMS's may be requested by the Geotechnical Engineers at any other time if concerns are raised about stability.

CMS data collected throughout the life of a stope is located within the Survey directory:

G:\Shared Data\Survey\CMS

7.15.3 Surface Subsidence Monitoring

The following techniques are employed to monitor subsidence at the ground surface above the active UG mining operation.

7.15.3.1 Satellite InSAR

Satellite InSAR (Interferometric Synthetic-Aperture Radar) data is used to provide line-of-sight detection of ground surface change between subsequent passes of radar-equipped satellites. An external InSAR supplier is contracted to provide X-band deformation updates on an 11-day cycle. Subsidence data is reviewed by the geotechnical team to identify unusual trends or expanding areas of subsidence. InSAR is also used to ensure ground-based surface monitoring equipment is suitably located.

7.15.3.2 Surface Deformation Surveys

The following techniques are currently employed for subsidence monitoring above GPUG:

- Manual survey prism monitoring on the Golden Point Highwall.
- Manual survey GPS points above the active panels.

- Periodic UAV photogrammetry surveys.

7.15.3.3 Surface Borehole Strain Monitoring

The following installations are planned for 2025.

- Multi-anchor deep surface borehole extensometers that should be place towards the centre of the mine areas, which will provide relative displacements between anchors of the extensometer.

7.15.4 Groundwater Monitoring

7.15.4.1 Underground Seepage Inflows

Underground seepage is monitored visually and reported where unexpectedly high inflows occur.

7.15.4.2 Borehole Groundwater Pressures

Multi-level vibrating wire piezometers (VWP) have been installed in four surface boreholes in the vicinity of Deepdell Creek:

- DDH7955
- DDH7970
- DDH7975
- DDH7980

7.15.5 Surface Water Monitoring

7.15.5.1 Deepdell Creek Flow

Deepdell Creek flows are gauged is several locations along the stretch of Deepdell Creek near to GPUG. This allows rapid assessment if Creek flow loss was to occurring.

7.15.5.2 Northern Gully Pond Levels

The Northen Gully Silt pond level is monitored on a weekly basis.

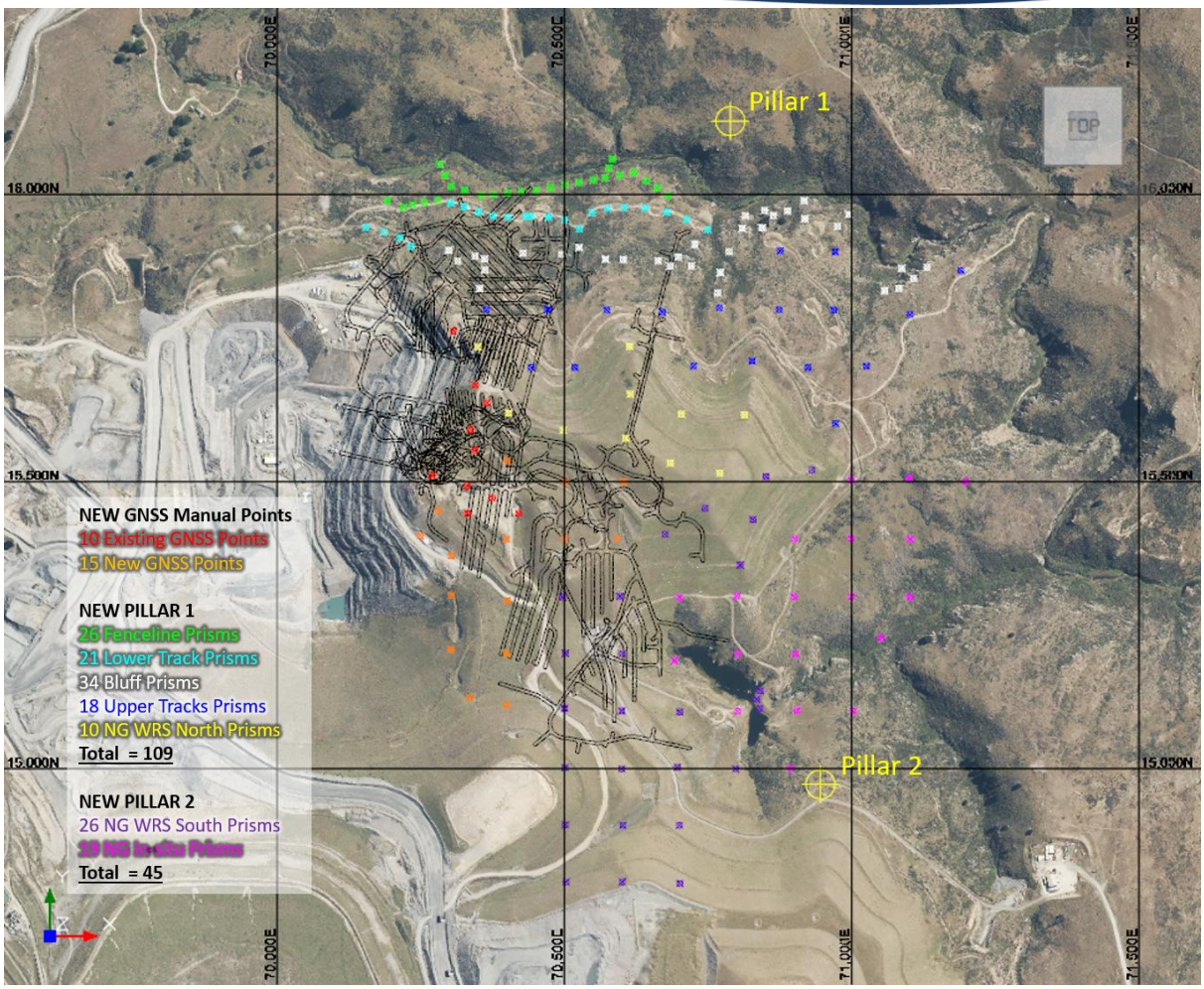


Figure 32. GPUG Surface deformation survey network

7.16 Geotechnical Data Collection

7.16.1 Data Collection Strategy

Ongoing data collection is important to validate modelled ground conditions and improve models for planning and design. Geotechnical data is important to characterise the rock mass as inputs to be used in the empirical mine design and stability assessment. This data can also be used to assess crown pillar stability and caving potential based on underground spans, rock mass quality and depth below surface.

7.16.2 Geology Face Mapping

All development headings that are mapped by the Geologists to record the general geological information and a basic geotechnical assessment. This includes an assessment of the rock mass quality to determine a Ground Condition Rating (GCR) for each of the walls, backs and face as well as the collection of all structural measurements. An internal technical procedure for face mapping is held by the geology department which should be referenced for further information. This can be found at:

I:\Frasers Underground\04. Geology\Standard Operating Procedures

The definitions used for assigning a GCR number is outlined in Appendix 13.7.

Face mapping is presented each morning to technical team at morning safety meetings with any issues or concerns discussed.

The GCR data collected from each face map is entered into the acquire database.

7.16.3 Geotechnical Mapping

The Geological and Geotechnical department shall ensure all development is mapped and analysed. Mapping is used to capture structural data for characterisation and classification and to identify the structurally controlled hazards at the time of mapping.

The mapping interpretation shall attempt to assess any identified hazards on three scales:

- development scale;
- stope scale; and
- mine scale.

The Geotechnical department shall ensure that the mine scale fault model is reviewed and updated monthly or if critical structural data is acquired through pickups or diamond drilling.

The geotechnical department can then determine whether a re-design of ground support, change of standard ground support design, and/or extra ground support is required. Any potential hazards shall be conveyed to all staff as they become apparent and used for planning purposes, particularly regarding safety of personnel and stope production.

7.16.4 Drill Core Logging

Basic geotechnical data including strength, weathering, RQD and fracture spacing is collected from all diamond drill holes.

Selected drillholes are geotechnically logged for the entire hole using a the standard Macraes geotechnical logging template. Parameters documented are:

- RQD;
- fractures / m;
- joint number (Jn);
- joint roughness (Jr);
- joint filling (Ja);
- rock strength (IRS); and
- plus notes on the nature of the structures.

The above parameters allow rock mass classifications for Q, (and RMR estimates) and assist in determining likely ground conditions. This is particularly important for exploration holes into new mining areas where little or no geotechnical data exists about rock mass conditions.

Where oriented core is available discontinuity orientation data may also be collected as specified by the geotechnical department. Core oriented alpha and beta angles for joints and significant features are recorded.

Consultation is generally undertaken with the Geology Department regarding upcoming drilling programmes and those holes requiring extra attention to the geotechnical logging and oriented core drilling.

7.16.5 Geophysical Logging

ATV, OTV and FWS logging of boreholes is optionally used to obtain rock strength and structural defect data from exploration drill holes.

7.16.6 Laboratory Testing

Geotechnical data has been gathered from logging suitable samples for rock property testing from drill core (see 6.2 Intact Rock Properties).

7.16.7 In-Situ Stress Measurement

Additional In-situ stress measurements were recommended by OreTeck (2023) to improve confidence in future numerical modelling.

8 RESPONSIBILITIES AND ACCOUNTABILITIES

The Manager Mining - Underground has the overall responsibility for GPUG and must authorise this GCMP and any revisions of the document.

Mine operations will ensure the effective implementation of this GCMP, and that designs and plans are followed.

The Geotechnical Engineering Department, in conjunction with Mine Operations, will determine the appropriate levels of monitoring and response to movement. The Geotechnical Engineering Department will undertake design of ground control systems and monitor the quality of their installation.

Ground Control management roles and responsibilities of team members are tabulated below:

ROLE	RESPONSIBILITY
Senior Site Executive and Asset President	▪ As set out in the PHMP for Ground Instability
Manager Mining - Underground	▪ Ensure adequacy of, and approve this GCMP for Golden Point Underground Mine, including all reviews/updates ▪ Ensure operational compliance with the PHMP and this GCMP is understood by all personnel (employees, contractors, visitors, consultants, etc) and used as the primary tool to manage risks/hazards associated with Ground Control Underground ▪ Ensure that a system is in place and functioning for the management of Ground Control Underground ▪ Approve all Standard Ground Support Designs ▪ Ensure that an external audit of compliance to this GCMP is conducted at least every 3 years and an internal review at least every two years, in

	accordance with Section 10 (Audit and Review) and in tandem with the PHMP and risk assessments ▪ Ensure that the necessary funding and resources are provided to manage ground instability hazards in line with this GCMP
UG Mining Superintendent	▪ Ensure that those people under their charge who have responsibilities under the PHMP for Ground Instability and this GCMP understand and perform those duties; ▪ Ensure this management plan is understood by relevant mine workers and used as the primary tool to manage risks/hazards associated with Ground Control ▪ Contribute to the design and implementation of the various Support Types; ▪ Ensure Information relating to ground control are effectively communicated to keep workers up to date on current conditions ▪ Communicate minutes and outcomes of all relevant meetings to all mining crews ▪ Identify corrective actions for all hazards that are reported ▪ Undertake inspections of mine workings and ground support ▪ Ensure Shift Supervisors and Operators are aware of and conduct necessary QC checks on installed ground support i.e. pull collars and extra bolts for routine pull testing, shotcrete depth testing and shotcrete samples for compressive testing ▪ Ensure crews are reporting all unusual observations, ground noise or ground (control) related events on their Stop and Think tasks and to the shift supervisors ▪ Review Stop and Think inspections, TARP levels and end of shift reports and report to the Geotechnical Engineer any ground control related issues ▪ If the ground is “worse” than expected, adjust Support Type to meet safety and operational needs. This change shall be reported to the Geotechnical Engineer and the area shall be subsequently inspected with the Geotechnical Engineer ▪ Ensure that the appropriate changes in support hardware are made in accordance with the MI’s, TARP’s, and other instructions
UG Supervisors	▪ Ensure correct SOP’s for Ground Control Underground are followed ▪ Ensure relevant emergency procedures are known and followed ▪ Ensure all Ground Control activities are in accordance to this plan and any other relevant standard operating procedures that may exist for the work being undertaken ▪ Conduct regular task observations on work involving Ground Control processes ▪ Inspect underground workings and ground support ▪ If the ground is “worse” than expected, adjust Support Type to meet safety and operational needs. This change shall be reported to the Geotechnical Engineer and the area shall be subsequently inspected with the Geotechnical Engineer ▪ Report any deterioration in ground conditions or support behaviour to the geotechnical team as soon as practicable

	▪ Conduct regular QA/QC checks on installed ground support
Jumbo Operators	▪ Develop headings and install support in accordance with the Ground Control Management Plan, Standard Ground Support Designs and TARPs ▪ Report any changes or anomalies in ground conditions or support behaviour to the shift supervisor ▪ Report in writing any changes or anomalies in ground conditions or support behaviour on SIMBO plods for the geotechnical team to review
UG Senior Geotechnical Engineer	▪ Be primarily responsible for ground control within underground operations, liaising with management, planning, and operational staff to ensure that the requirements of this GCMP are understood and administered ▪ Collaborate with UG and OP mine planners, and the wider Macraes geotechnical team to ensure that potential geotechnical risks (including those which may involve interaction between OP and UG mines) and critical controls are identified during planning in advance of operations ▪ Specify the ground support type for each area and situation ▪ Provide geotechnical input into the ground control management process ▪ Provide education and presentations on changes to ground support standards ▪ Provide quarterly geotechnical ground awareness training sessions to all mining crews ▪ Undertake inspections of underground work areas ▪ Provide geotechnical inputs to relevant planning meetings ▪ Ensure that required QA/QC testing of support performance is carried out ▪ Ensure ongoing monitoring of the ground control and geotechnical environment ▪ Manage ongoing data collection and geotechnical model updates ▪ Maintain relevant principal hazard management plans so that they are available to technical and operational staff to aid decision making in a timely manner ▪ Periodically review and manage change of this GCMP ▪ Determine and communicate trigger levels and TARP's ▪ Lead the design of the various support types, in terms of Standard Ground Support Designs

UG Geotechnical Engineer or Geotechnical Technician	• Regular inspections of the underground environment in accordance with the Subsidence and Ground Control Management Plan ▪ Assess Jumbo SIMBIO Reports and where appropriate provide feedback to operators ▪ Manage the installation, reading and interpretation of monitoring equipment and ensure findings are communicated to management in a timely manner ▪ Conduct regular stope inspections ▪ Conduct rock bolt pull testing • Weekly QA/QC on installed ground support ▪ Develop cable bolt and rehabilitation plans for potentially unstable areas ▪ Report areas of concern to the Senior Geotechnical Engineer, Superintendent or other relevant staff.
UG Mine Surveyors	▪ Report to the Mine Manager, Superintendent and Geotechnical Engineer any development or intersection that exceeds design dimensions by greater than 30% ▪ Survey all stope voids, if it is safe to do so and communicate results ▪ Provide regular (Weekly) overbreak analysis and sections of development ▪ Survey the locations of all types of monitoring instruments and boreholes drilled throughout the mine and enter them in the appropriate database ▪ Pick up any geotechnical structures or geotechnical points of interest as instructed by the geotechnical or geology departments ▪ Ensure that relevant geotechnical information is relayed onto mining instructions
Senior Geologist	▪ Ensure data and information including face, line mapping, and GCR, are regularly collected and ensure this data is updated in the database ▪ Ensure that the geological model is updated and that the geology and structure indicated on plans is current ▪ Report areas of concern to the Geotechnical Engineer, Superintendent or other relevant staff ▪ Provide advice on any geological issues as they relate to ground support
Mine Geologists	▪ Assist with collection, interpretation and maintenance of the structural mapping database ▪ Conduct regular inspections of stope voids noting any overbreak in the backs and/or pillars and report findings to the technical team in a timely manner ▪ Conduct stope reconciliations and report on dilution and any structural anomalies ▪ Report areas of concern to the Geotechnical Engineer, Superintendent or other relevant staff ▪ Provide advice on any geological issues as they relate to ground support

Geologists	▪ Record GCR on face mapping sheets ▪ Conduct geotechnical assessments of all mapped faces including collection of all structural measurements and create structural disks in Deswik mapping ▪ Present face mapping to the technical team at morning safety meetings. ▪ Conduct daily stope inspections and report any geological or geotechnical issues to the shift supervisor and geotechnical engineer ▪ Discuss current stope status with the technical team at morning safety meetings
Health, Safety and Training Department	▪ Ensure there is a training plan to achieve competency in SOP's for all OGL employees and contractors related to this PHMP ▪ Review Ground Control Underground SOP's
All employees/ contractors or visitors	▪ Conduct stope and think inspections before working in an area taking note of any ground related issues ▪ Notify your supervisor immediately of any ground control related hazard and fill out an appropriate hazard report ▪ Follow all relevant SOP's within or referred to in this document ▪ If unsure of risks employees are to stop work and immediately contact their supervisor

9 RECORDS AND DOCUMENTATION

OceanaGold uses the on-line safety management system and software INX to record and store safety, health and hygiene and training requirements. Records are stored securely and indefinitely within this facility.

InControl is used for event and incident reporting, action tracking, audits, inspections, task observations, Mine Record Entries and Management of Change.

Minesight, Surpac and Deswik three-dimensional mining software are used for all mine designs and planning. All geotechnical information such as drill holes, faulting, GCR and void models are stored in databases within these programs.

Investigations for all ground control incidents shall be undertaken in accordance with Regulation 131 of the Mining Operations and Quarrying Operations Regulations 2016 and recorded in InControl.

This GCMP document is a controlled document secured within the OceanaGold document control system Team Binder and published to the site through SharePoint.

Any changes made to this document must be documented in the revision reference and authorized by the Manager Mining - Underground.

Records of all reviews and revisions must be kept for at least twelve months from the date the mining operation is abandoned.

OceanaGold must, on request, provide these records to an inspector or a site health and safety representative.

OceanaGold must report notifiable events to WorkSafe according to Schedule 5 of the Mining Operations and Quarrying Operations Regulations 2016.

10 AUDIT AND REVIEW

This GCMP shall be reviewed every 2 years as a minimum and/or in any of the following circumstances:

- Following any event or investigation that impacts on this plan.
- Any amendments to the site risk register impacting this plan.
- Any amendments to legislation impacting this plan.

The GCMP shall have an Independent external audit at least once every three years from the date the plan was made.

The purpose of reviewing and auditing the GCMP is to:

- ensure that the GCMP remains relevant to the mining conditions as they evolve;
- confirm that the GCMP is being implemented and operating in practice;
- provide feedback on performance as input to the review process;
- identify those aspects of the plan requiring revision and/or improvement; and
- initiate discussion and recognition of improvement opportunity.

For the purpose of this management plan:

a) A Review is an internal, informal and ongoing assessment of the suitability of the GCMP. Ground conditions and the mining method have historically been changeable requiring extensive adjustment to support designs and practices. It is important going forward that the GCMP is treated as a “live” document which is essentially always under review at any one time.

b) An Audit is a more formal, external, review of the GCMP and its application. Audits should be captured as a “summary letter” from the party undertaking the audit.

Condition 12 c) of Land Use Consent RM23.783.01 requires that:

> *The Consent Holder must review and update the plan as necessary during mining including whenever there is any change in the methods or procedures used for geotechnical hazard monitoring or operating procedures and shall provide the updated plan to the council for certification that it meets the requirements of this condition and Condition 13.*

11 DEFINITIONS

TERM	DEFINITION
Area Design	An area design, which is signed off by engineers, geologists, surveyors, geotechnical engineers, ventilation engineers, Superintendent and approved by the Manager Mining - Underground
Back(s)	The roof of an underground excavation
Bagging Ground	Sagging loose rock behind surface support which generally requires bleeding
Bleed	To scale loose/bagging rock from behind mesh support
Brow	The last complete row of rock bolts before the entrance to a vertical opening such as a stope, cave or rise
Chandeliers	A rock bolt that is not installed correctly and is partly hanging out of the drill hole
Crown Pillar	The ground between the open pit and underground workings
Drive / Heading	The main travel way and access to a mining area
External Audit	An audit in which the lead auditor, at the least, has no constant operational ties to the mine
Factor of Safety (FoS)	The support capacity divided by support load
GCMP	Ground Control Management Plan
Ground Condition Rating (GCR)	Rock mas rating scale developed specifically for Macraes underground operations (refer to Appendix 13.7)
Ground Support	An element installed around an underground excavation to maintain stability
Ground Support Note	A written instruction specifying additional ground support to that required by the Standard Ground Support Designs. This should include a sketch and detail of the ground support elements to be installed
Floor Heave	The process of the floor of an underground mining area being forced upward due to ground pressure/deformation
Hydraulic Radius	A unit of measure for the size and shape of an opening. It is defined as the surface area divided by the perimeter
Internal Audit	An audit conducted by the mine personnel
Intersection	The area where two (or more) headings meet, or cross one another
Mining Instruction (MI)	A formal document that has been approved (signed off) by senior technical staff and management. It should clearly outline the design of development, survey controls, minimum ground support and relevant geological,

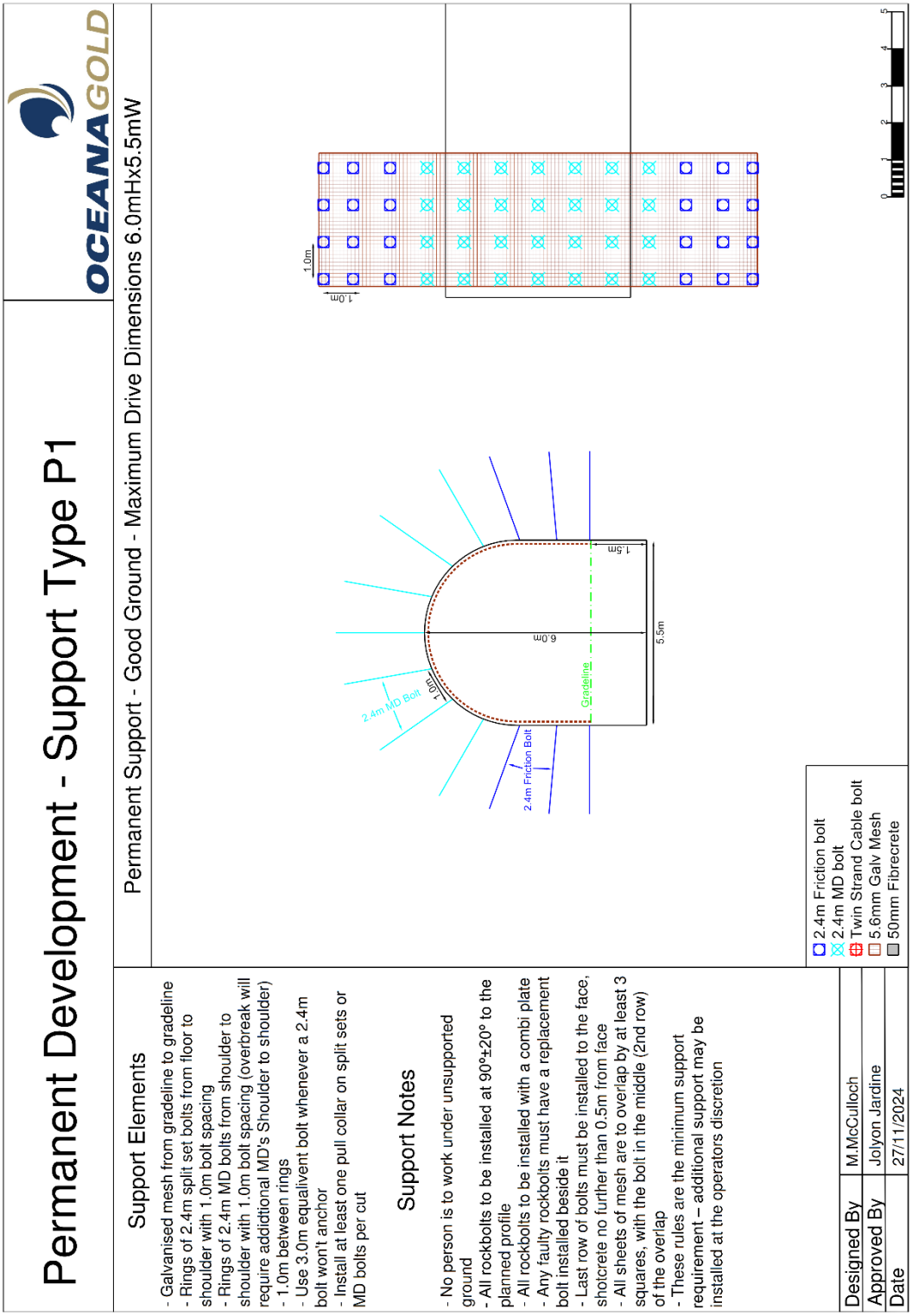
	geotechnical and other points of note, and clearly state the limit of development
Modified Drill And Blast	To modify the standard drill and blast practices when poor ground is encountered. Typically involves drilling of uncharged pre-split holes and tightening up the drill pattern to lessen the burden
Non-Yielding Pillar	A pillar designed to protect strategic and infrastructural openings such as declines against the effects of stoping
Primary Support	The installation and application of shotcrete, mesh and rock bolts
Regional Pillar	A pillar designed to separate or compartmentalise stopes or stoping blocks to provide regional stability within a panel
Rehab	Replacement of damaged or inadequate ground support
Scaling	Scaling is the act of making ground safe using a scaling bar to locate and remove loose rock from walls, face and backs of the workplace
Spall	Spall are flakes of a material that are broken off a larger solid body and can be produced by a variety of mechanisms, including because of projectile impact, corrosion, weathering, or excessive rolling pressure (as in a ball bearing). Spalling and spallation both describe the process of surface failure in which spall is shed
Stability Pillar	The intact rock between panels
Standard Ground Support Designs	Drawings that specify and define the location and type of support to be installed in a heading
Spiling	To insert a spile(s) into the ground ahead of development to pre-support the ground for the next cut
Spiling Bars	A steel bar used for spiling; typically long lengths of rebar grouted into the ground
TARP	Trigger Action Response Plan defines (1) ground support based on observed conditions during development, and (2) actions based on ground conditions in stopes
Unsupported Ground	Any area beyond the last completed, fully installed and secure row of rock bolts toward the work face that has not been sounded, rattled, scaled and fully supported in accordance with the Ground Support Standard for the specific work area. No personnel shall venture under unsupported ground
Yielding Pillar	A pillar left between stopes to control ground conditions to allow stope extraction. Yielding pillars are designed to fail as the brow retreats

12 REFERENCES

- Barla, G. Squeezing rocks in tunnels. ISRM News Journal, 3/4, 1995. pp. 44–49.
- Li, C., Lindblad, K. (1999). Corrosivity classification of the underground environment. Rock Support and Reinforcement Practice in Mining. *Proceedings of the International Symposium on Ground Support, Kalgoorlie, Western Australia, 15-17 March, 1999.*
- Sandy et. al. (2010). Managing the Transition from Low Stress to High Stress Conditions. *Second Australasian Ground Control In Mining Conference / Sydney, NSW, 23 - 24 November 2010.*
- Li, J. et. al. (2005). *Report on Intact Rock Properties Testing for Oceana Gold Limited, New Zealand.* Internal report prepared for OGC by Western Australian School of Mines (WASM): unpublished.

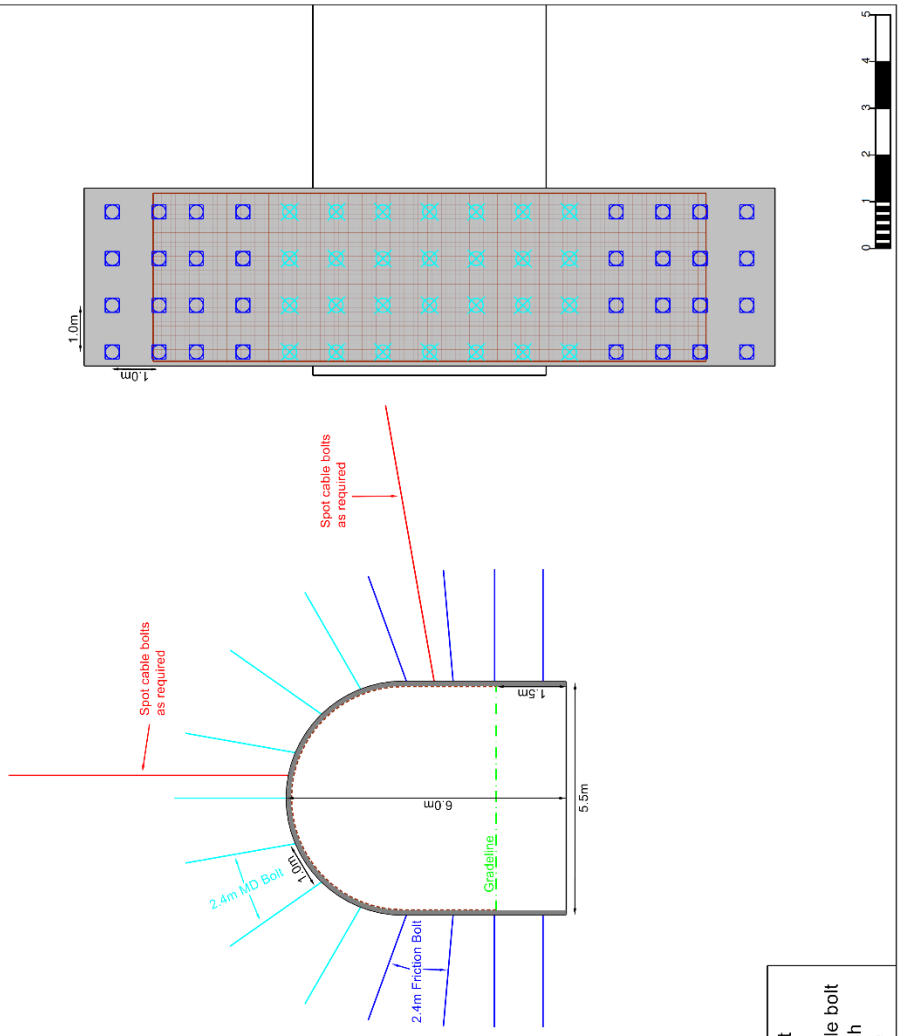
13 APPENDIX

13.1 Standard Ground Support Designs



Permanent Development - Support Type P2

Permanent Support - Fair Ground - Maximum Drive Dimensions 6.0mHx5.5mW



Support Elements

- 50mm Fibrecrete from floor to floor to the face
- Galvanised mesh from gradeline to gradeline
- Rings of 2.4m split set bolts from floor to shoulder with 1.0m bolt spacing
- Rings of 2.4m MD bolts from shoulder to shoulder with 1.0m bolt spacing (overbreak will require addidtional MD's Shoulder to shoulder)
- 1.0m between rings
- Spot cable bolts at operations or geotechnical instruction
- Use 3.0m equalivent bolt whenever a 2.4m bolt won't anchor
- Install at least one pull collar on split sets or MD bolts per cut

Support Notes

- No person is to work under unsupported ground
- All cablebolts must be grouted and plated before firing the next cut
- All rockbolts to be installed at 90°±20° to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Permanent Development - Support Type P3

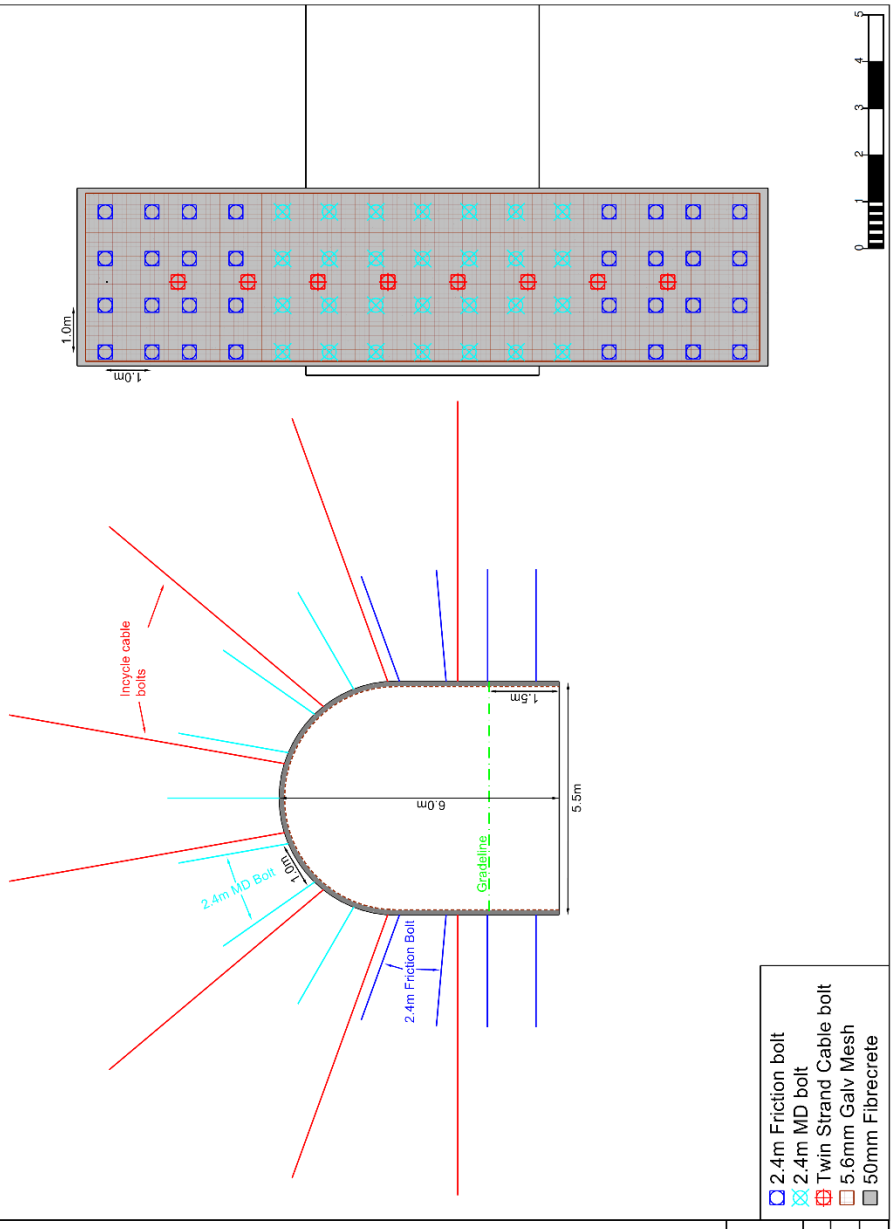
Permanent Support - Poor Ground - Maximum Drive Dimensions 6.0mHx5.5mW

Support Elements

- 50mm Fibrecrete from floor to floor to the face
- Galvanised mesh from floor to floor
- Rings of 2.4m split set bolts from floor to shoulder with 1.0m bolt spacing
- Rings of 2.4m MD bolts from shoulder to shoulder with 1.0m bolt spacing (overbreak will require additional MD's Shoulder to shoulder)
- 1.0m between rings
- Incycle cable bolts at 1.5m bolt spacing, lowest hole must not be higher than 2.5m off floor
- 2.5m between cable bolt rings
- maintain 1.5m bolt spacing if overbreak is encountered eg. a 8mHx6mW drive requires a minimum 11 cable bolts
- minimum cable bolt lenth 6m, extend cable bolt length untill 2m of solid ground is encountered
- drive dimensions greater than 8mH/7mW require minimum 8m cables
- Use 3.0m equalivent bolt whenever a 2.4m bolt won't anchor
- Install at least one pull collar on split sets or MD bolts per cut

Support Notes

- No person is to work under unsupported ground
- All cablebolts must be grouted and plated before firing the next cut
- All rockbolts to be installed at 90°±20° to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement additional support may be installed at the operators discretion



Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Permanent Development - Support Type P4

Support Elements

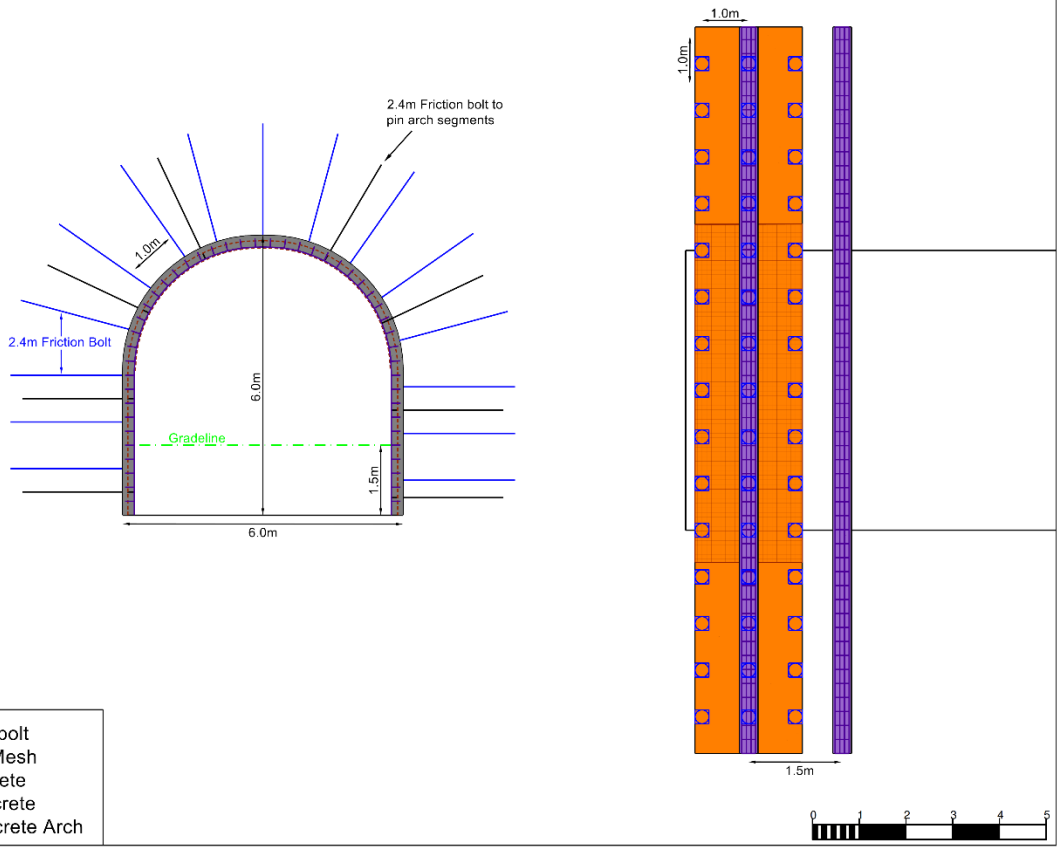
- 100mm Fibrecrete from floor to floor to the face (50mm to be installed after bolt and mesh)
- Galvanised mesh from floor to floor
- Rings of 2.4m split set bolts from floor to floor with 1.0m bolt spacing
- 1.0m between rings
- 250mm Shotcrete arches at 1.5m spacing
- Shotcrete arches to be installed vertically
- Additional mesh from shoulder to shoulder with 2.4m split sets on 1.0m x 1.0m spacing, to be kepth within 10m of the face

Support Notes

- No person is to work under unsupported ground
- All rockbolts to be installed at 90º±20º to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Permanent Support - Major Fault Ground - Maximum Drive Dimensions 6.5mHx6.2mW



- 2.4m Friction bolt
- 5.6mm Galv Mesh
- 50mm Fibrecrete
- 100mm Fibrecrete
- 200mm Fibrecrete Arch

Corrosive - Support Type C1

Support Elements

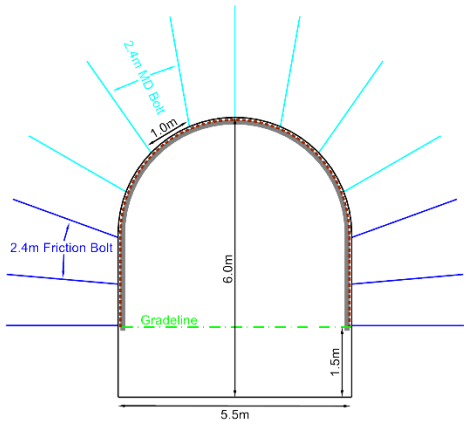
- Galvanised mesh from floor to floor, before shotcrete
- Rings of 2.4m split set bolts from gradeline to shoulder with 1.0m bolt spacing
- Rings of 2.4m MD bolts from shoulder to shoulder with 1.0m bolt spacing (overbreak will require addidtional MD's Shoulder to shoulder)
- 1.0m between rings
- Encapsulation of bolts and mesh with fibrecrete or TSL
- Use 3.0m equalivent bolt whenever a 2.4m bolt won't anchor
- Install at least one pull collar on split sets or MD bolts per cut

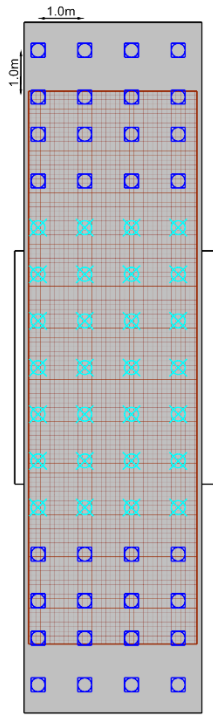
Support Notes

- No person is to work under unsupported ground
- All rockbolts to be installed at 90º±20º to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Corrosive Support - Good Ground - Maximum Drive Dimensions 6.0mHx5.5mW





- 2.4m Friction bolt
- 2.4m MD bolt
- Twin Strand Cable bolt
- 5.6mm Galv Mesh
- 50mm Fibrecrete

0 1 2 3 4 5

Corrosive - Support Type C2

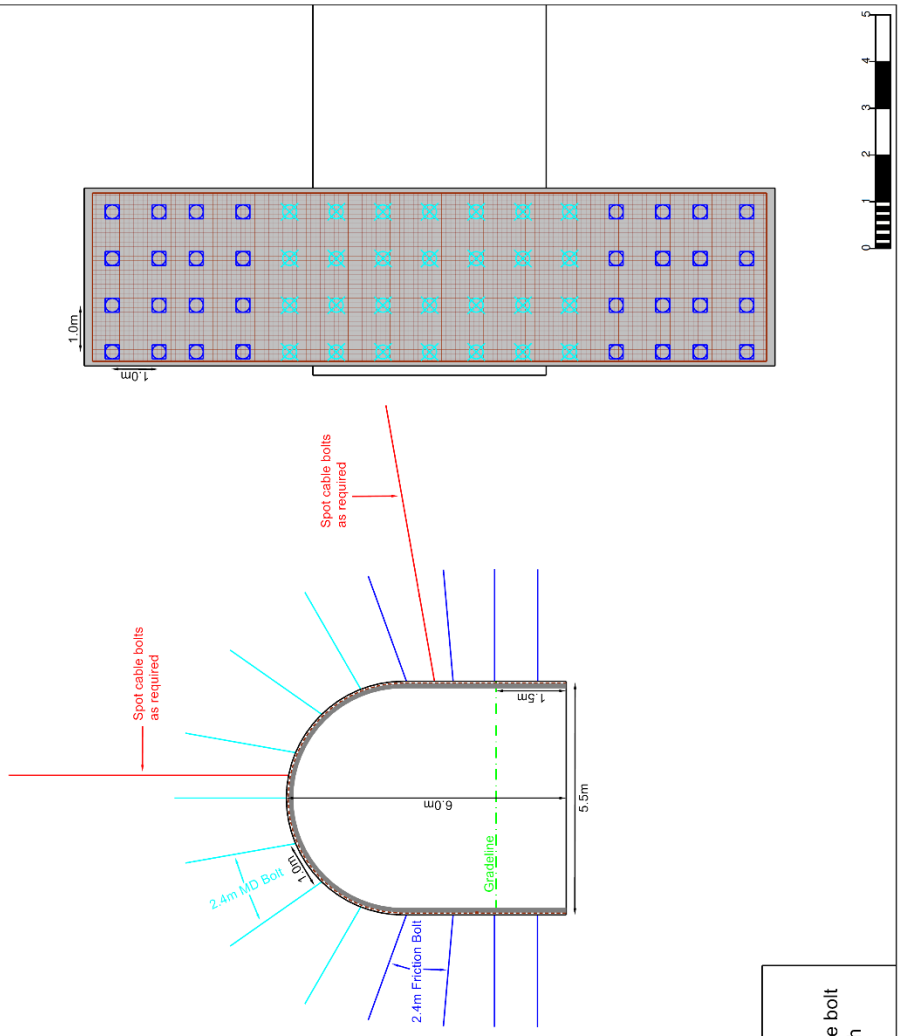
Corrosive Support - Fair Ground - Maximum Drive Dimensions 6.0mHx5.5mW

Support Elements

- Galvanised mesh from floor to floor, before shotcrete
- Rings of 2.4m split set bolts from floor to shoulder with 1.0m bolt spacing
- Rings of 2.4m MD bolts from shoulder to shoulder with 1.0m bolt spacing (overbreak will require addidtional MD's Shoulder to shoulder)
- 1.0m between rings
- Encapsulation of bolts and mesh with fibrecrete or TSL
- Spot cable bolts at operations or geotechnical instruction
- Use 3.0m equalivent bolt whenever a 2.4m bolt won't anchor
- Install at least one pull collar on split sets or MD bolts per cut

Support Notes

- No person is to work under unsupported ground
- All rockbolts to be installed at 90°±20° to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion



Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Corrosive - Support Type C3

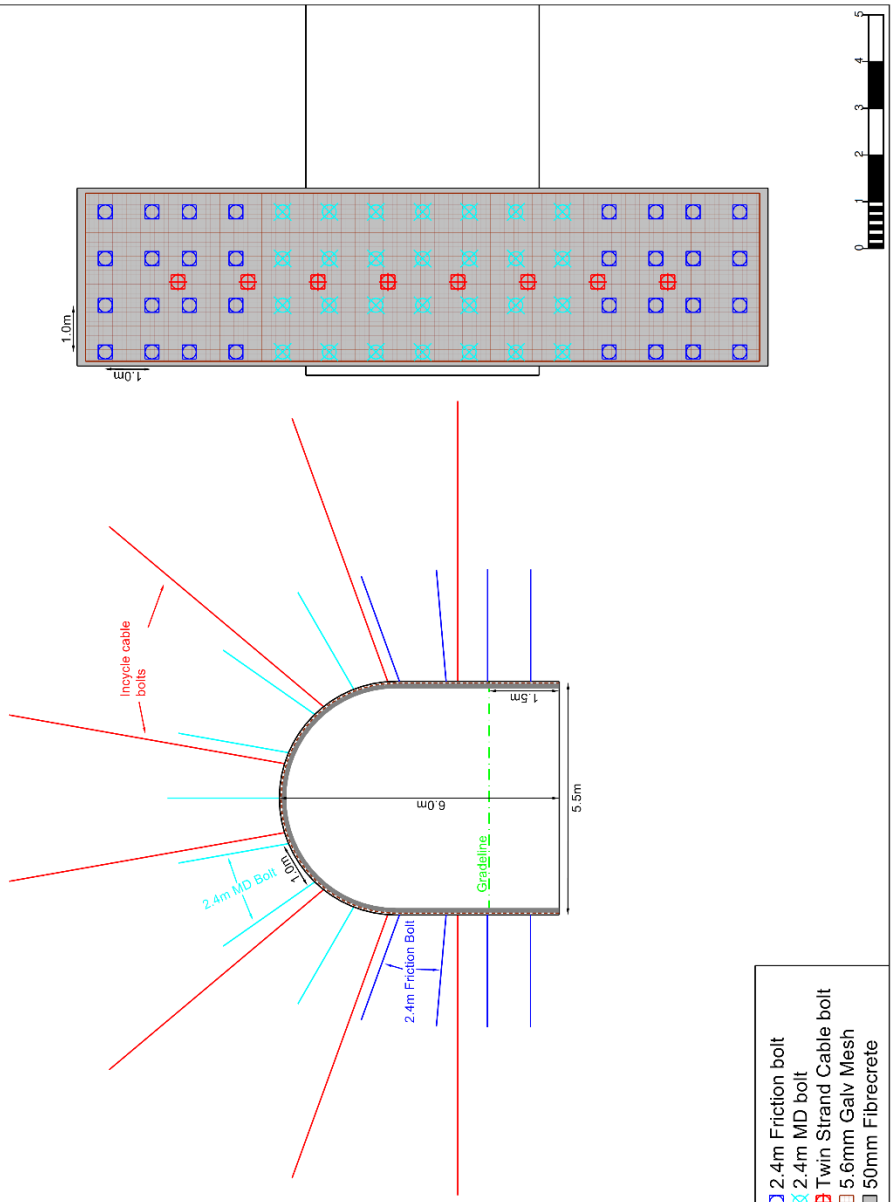
Corrosive Support - Fair Ground - Maximum Drive Dimensions 6.0mHx5.5mW

Support Elements

- Galvanised mesh from floor to floor, before shotcrete
- Rings of 2.4m split set bolts from floor to shoulder with 1.0m bolt spacing
- Rings of 2.4m MD bolts from shoulder to shoulder with 1.0m bolt spacing (overbreak will require additional MD's Shoulder to shoulder)
- 1.0m between rings
- Incycle cable bolts at 1.5m bolt spacing, lowest hole must not be higher than 2.5m off floor
- 2.5m between cable bolt rings
- maintain 1.5m bolt spacing if overbreak is encountered eg. a 8mHx6mW drive requires a minimum 11 cable bolts
- minimum cable bolt lenth 6m, extend cable bolt length untill 2m of solid ground is encountered
- drive dimensions greater than 8mH/7mW require minimum 8m cables
- Encapsulation of bolts and mesh with fibrecrete or TSL
- Use 3.0m equalivent bolt whenever a 2.4m bolt won't anchor
- Install at least one pull collar on split sets or MD bolts per cut

Support Notes

- No person is to work under unsupported ground
- All cablebolts must be grouted and plated before firing the next cut
- All rockbolts to be installed at 90°±20° to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion



Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Temporary Development - Support Type T1

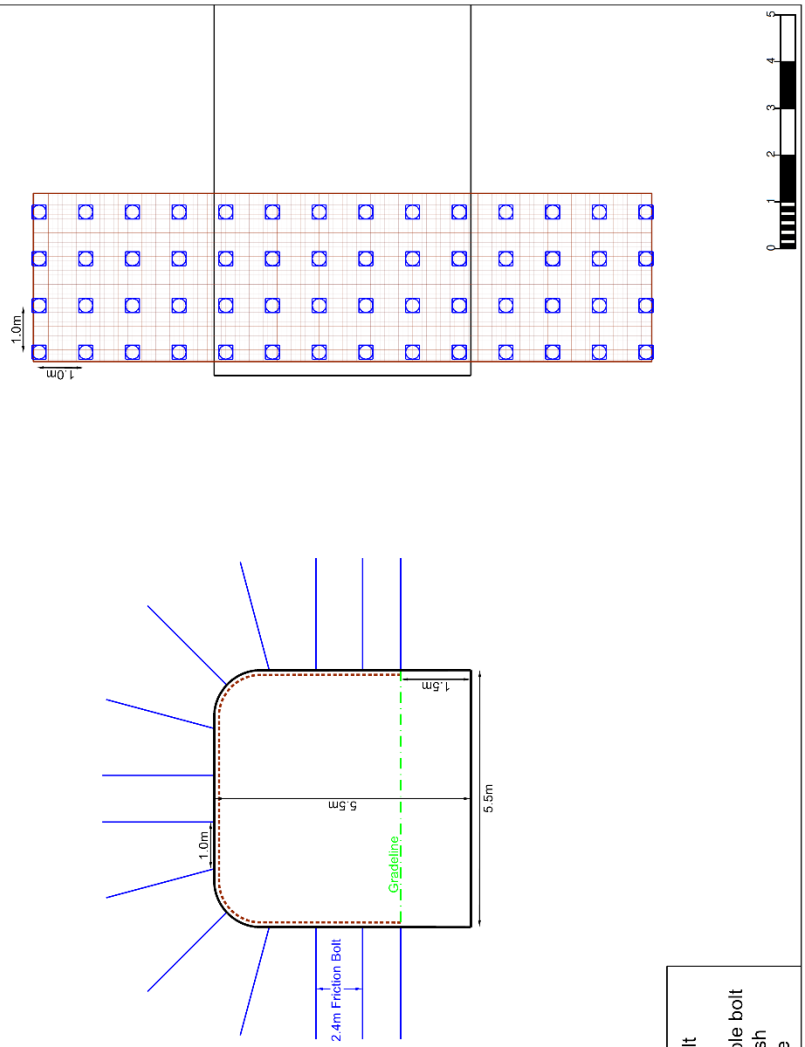
Temporary Support - Good Ground - Maximum Drive Dimensions 5.5mHx5.5mW

Support Elements

- Galvanised mesh from gradeline to gradeline
- Rings of 2.4m split set bolts from gradeline to gradeline with 1.0m bolt spacing
- 1.0m between rings
- Use 3.0m equalivent bolt whenever a 2.4m bolt won't anchor
- Install at least one pull collar on split sets or MD bolts per cut

Support Notes

- No person is to work under unsupported ground
- All rockbolts to be installed at 90°±20° to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion



- 2.4m Friction bolt
- 2.4m MD bolt
- Twin Strand Cable bolt
- 5.6mm Galv Mesh
- 50mm Fibrecrete

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Temporary Development - Support Type T2

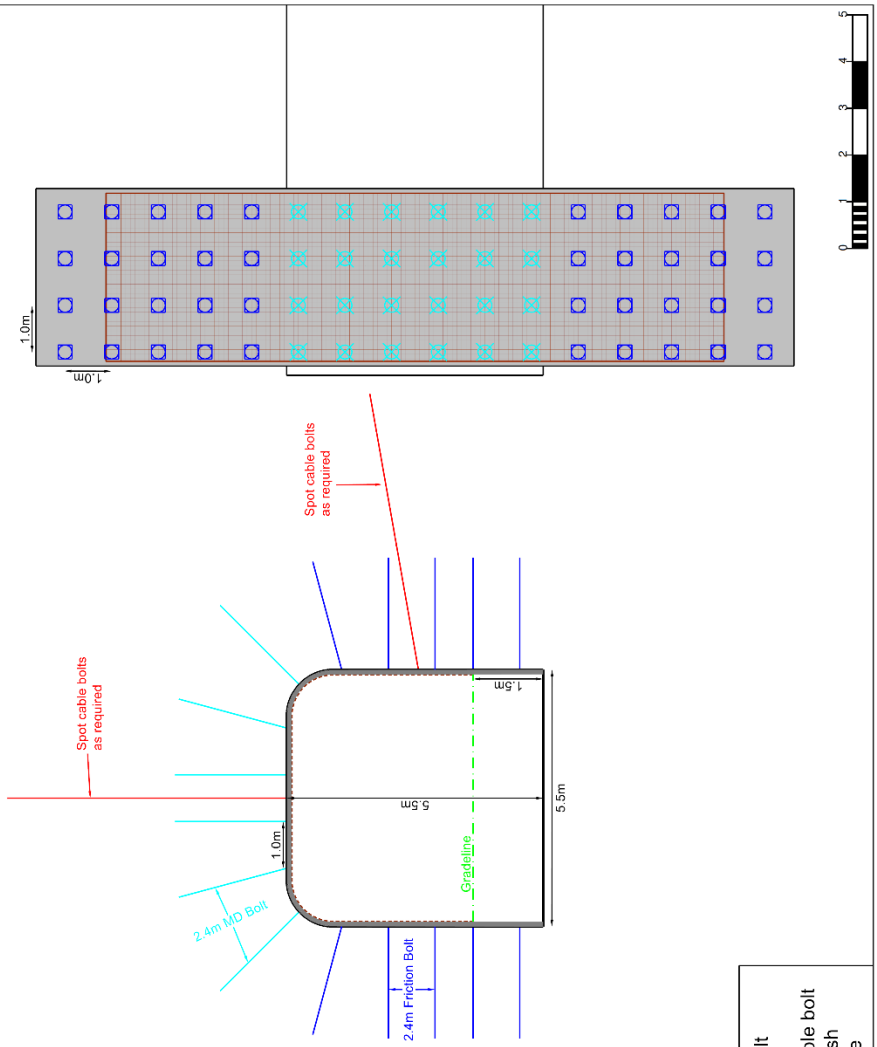
Temporary Support - Fair Ground - Maximum Drive Dimensions 5.5mHx5.5mW

Support Elements

- 50mm Fibrecrete from floor to floor to the face
- Galvanised mesh from gradeline to gradeline
- Rings of 2.4m split set bolts from floor to shoulder with 1.0m bolt spacing
- Rings of 2.4m MD bolts from shoulder to shoulder with 1.0m bolt spacing
- 1.0m between rings
- Spot cable bolts at operations or geotechnical instruction
- Use 3.0m equalivent bolt whenever a 2.4m bolt won't anchor
- Install at least one pull collar on split sets or MD bolts per cut

Support Notes

- No person is to work under unsupported ground
- All cablebolts must be grouted and plated before firing the next cut
- All rockbolts to be installed at 90°±20° to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

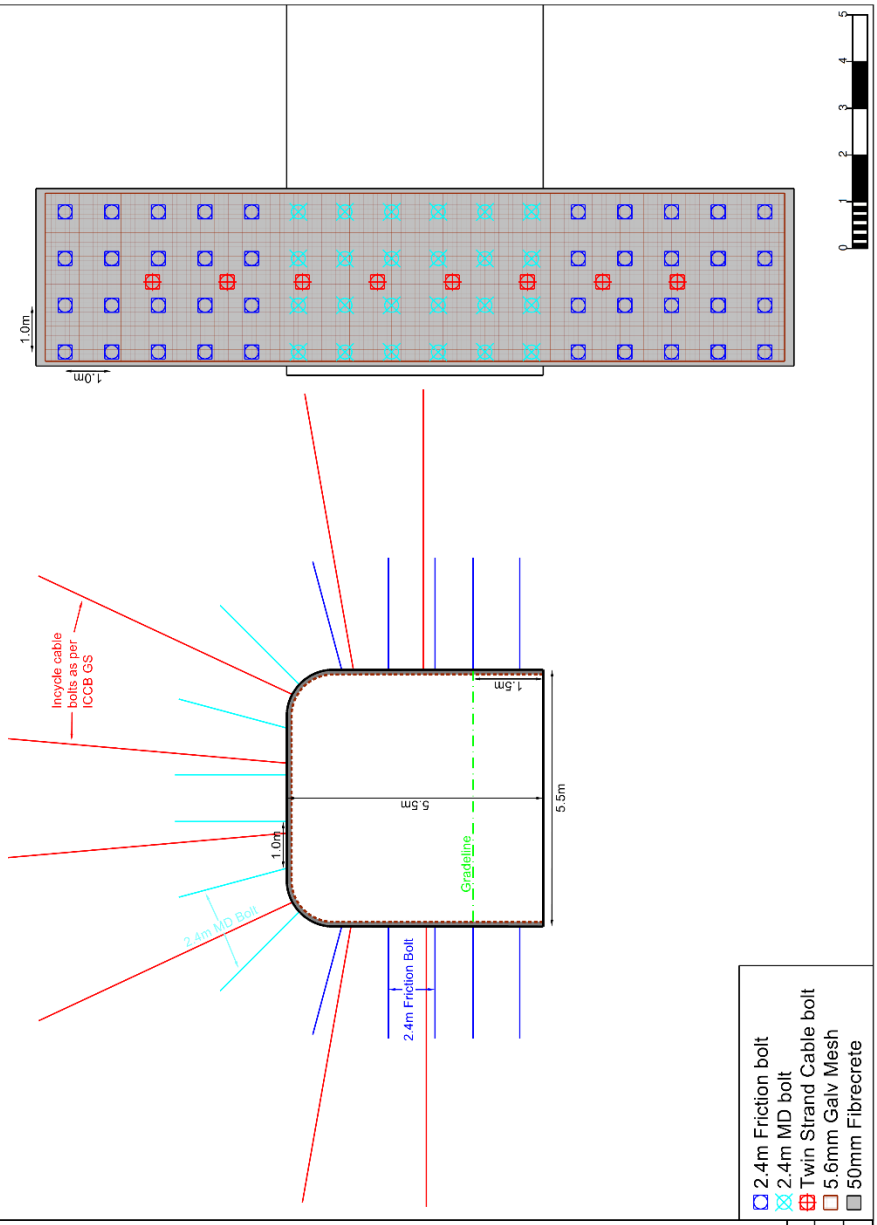


- 2.4m Friction bolt
- 2.4m MD bolt
- Twin Strand Cable bolt
- 5.6mm Galv Mesh
- 50mm Fibrecrete

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Temporary Development - Support Type T3

Temporary Support - Poor Ground - Maximum Drive Dimensions 5.5mHx5.5mW



Support Elements

- 50mm Fibrecrete from floor to floor to the face
- Galvanised mesh from floor to floor
- Rings of 2.4m split set bolts from floor to shoulder with 1.0m bolt spacing
- Rings of 2.4m MD bolts from shoulder to shoulder with 1.0m bolt spacing
- 1.0m between rings
- Incycle cable bolts at 1.5m bolt spacing, lowest hole must not be higher than 2.5m off floor
- 2.5m between cable bolt rings
- maintain 1.5m bolt spacing if overbreak is encountered eg. a 8mHx6mW drive requires a minimum 11 cable bolts
- minimum cable bolt lenth 6m, extend cable bolt length untill 2m of solid ground is encountered
- drive dimensions greater than 8mH/7mW require minimum 8m cables
- Use 3.0m equalivent bolt whenever a 2.4m bolt won't anchor
- Install at least one pull collar on split sets or MD bolts per cut

Support Notes

- No person is to work under unsupported ground
- All cablebolts must be grouted and plated before firing the next cut
- All rockbolts to be installed at 90°±20° to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

- 2.4m Friction bolt
- 2.4m MD bolt
- Twin Strand Cable bolt
- 5.6mm Galv Mesh
- 50mm Fibrecrete

Stockpile Internal - Support Type S1

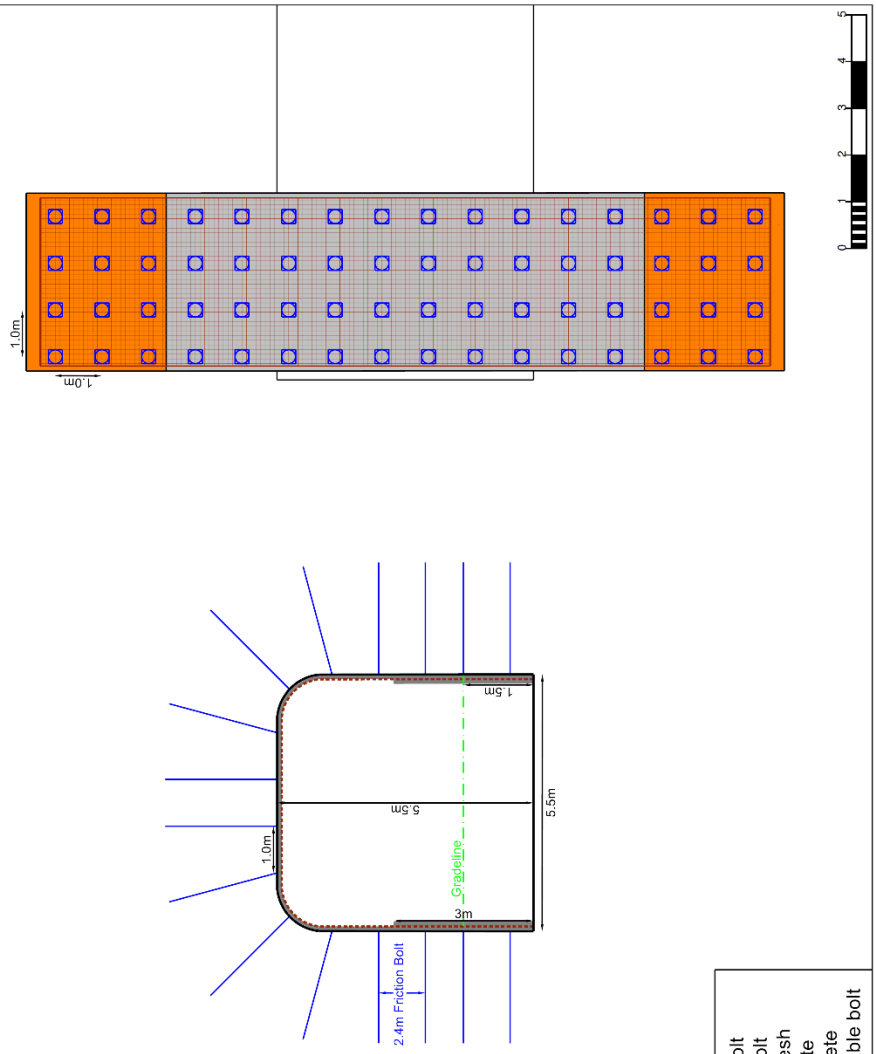
Stockpile Support - Good Ground - Maximum drive dimensions 5.5mWx5.5mH

Support Elements

- 50mm fibrecrete floor to floor
- Galvanised mesh from floor to floor, after shotcrete
- Rings of 2.4m split set bolts from floor to floor with 1.0m bolt spacing
- 1.0m between rings
- Additional 50mm fibrecrete after bolt and mesh on walls from floor to 3.0m
- Use 3.0m equalivent bolt whenever a 2.4m bolt won't anchor
- Install at least one pull collar on split sets or MD bolts

Support Notes

- No person is to work under unsupported ground
- All rockbolts to be installed at 90°±20° to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion



Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Stockpile Internal - Support Type S2

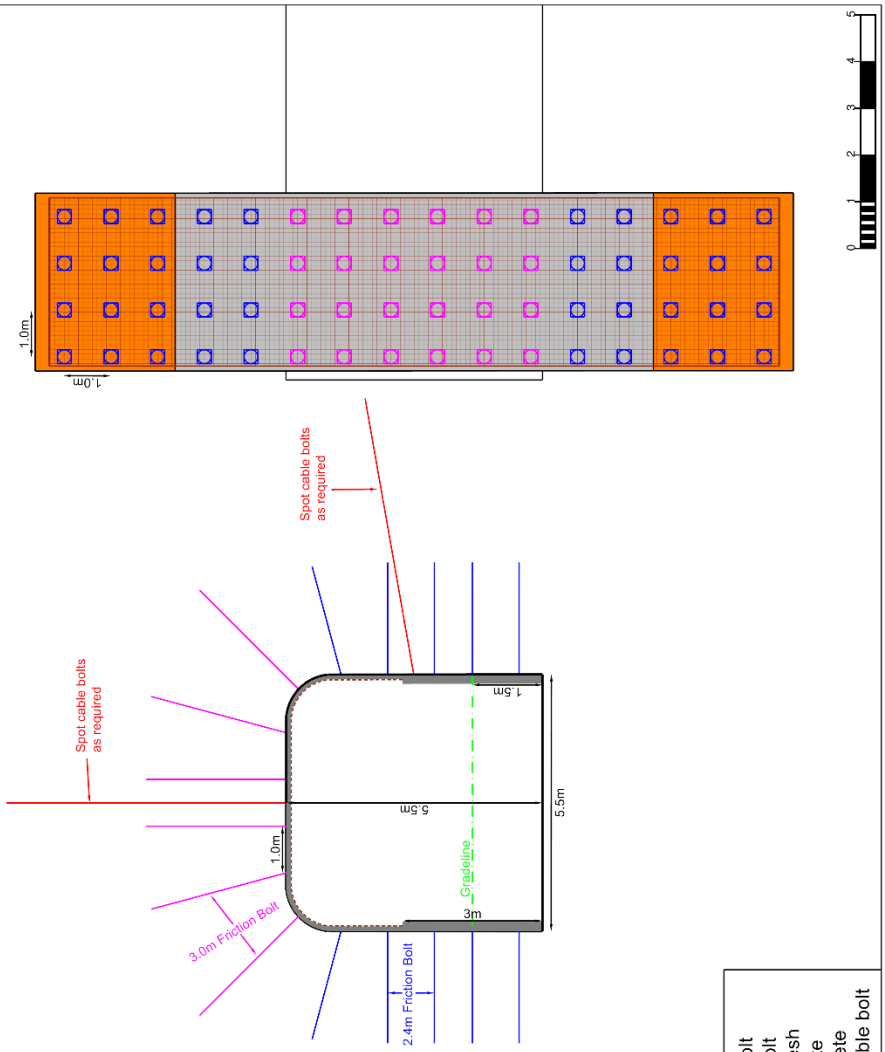
Stockpile Support - Fair Ground - Maximum drive dimensions 5.5mWx5.5mH

Support Elements

- 50mm fibrecrete floor to floor
- Galvanised mesh from floor to floor, after shotcrete
- Rings of 2.4m split set bolts from floor to shoulder with 1.0m bolt spacing
- Rings of 3.0m split set bolts from shoulder to shoulder with 1.0m bolt spacing (overbreak will require addictional 3m splitset bolts Shoulder to shoulder)
- 1.0m between rings
- Additional 50mm fibrecrete after bolt and mesh on walls from floor to 3.0m
- Spot cable bolts at operations or geotechnical instruction
- Use 3.0m equalivent bolt whenever a 2.4m bolt won't anchor
- Install at least one pull collar on split sets or MD bolts

Support Notes

- No person is to work under unsupported ground
- All cablebolts must be grouted and plated before firing the next cut
- All rockbolts to be installed at 90°±20° to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

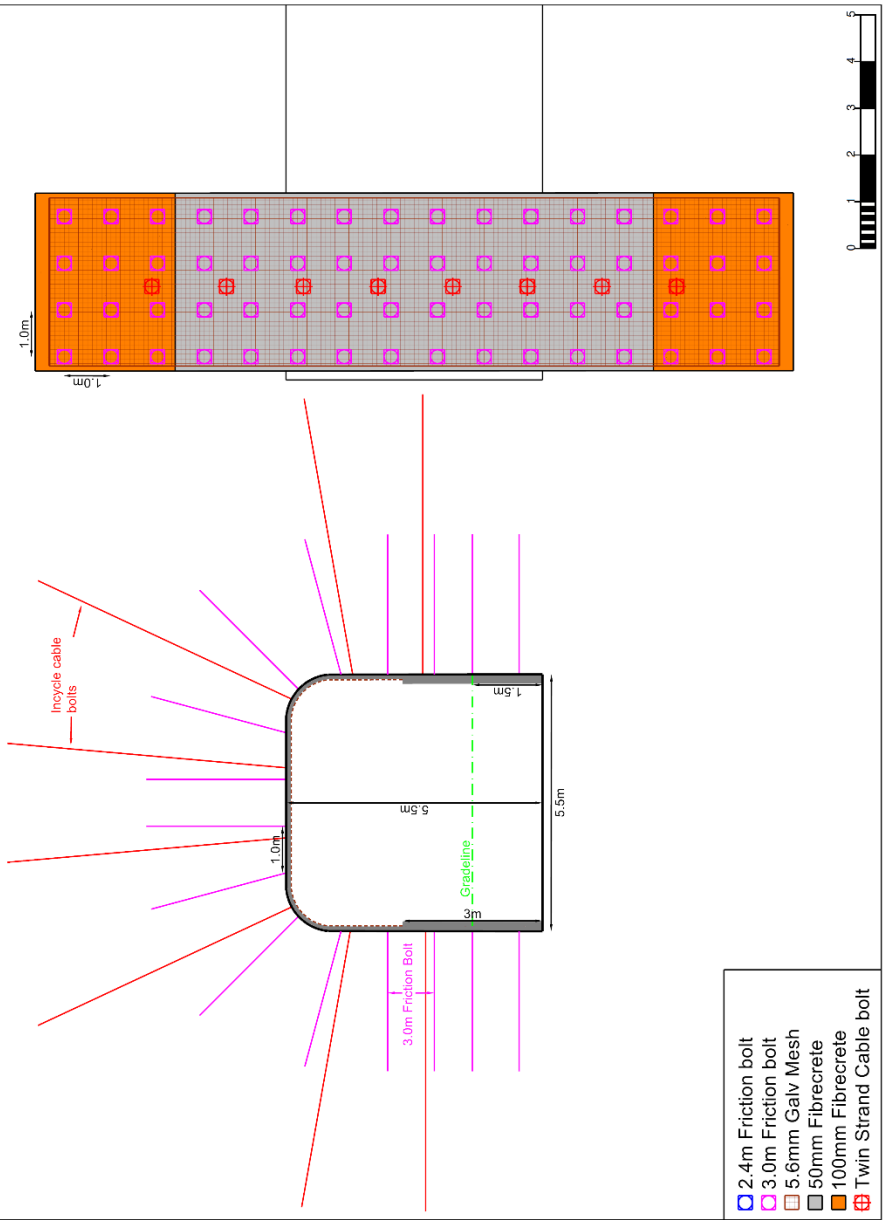


- 2.4m Friction bolt
- 3.0m Friction bolt
- 5.6mm Galv Mesh
- 50mm Fibrecrete
- 100mm Fibrecrete
- Twin Strand Cable bolt

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Stockpile Internal - Support Type S3

Stockpile Support - Poor Ground - Maximum drive dimensions 5.5mWx5.5mH



Support Elements

- 50mm fibrecrete floor to floor
- Galvanised mesh from floor to floor, after shotcrete
- Rings of 3.0m split set bolts from floor to floor with 1.0m bolt spacing
- 1.0m between rings
- Incycle cable bolts at 1.5m bolt spacing, lowest hole must not be higher than 2.5m off floor
- 2.5m between cable bolt rings
- maintain 1.5m cable bolt spacing if overbreak is encountered eg. a 8mHx6mW drive requires a minimum 11 cable bolts
- minimum cable bolt lenth 6m, extend cable bolt length untill 2m of solid ground is encountered
- drive dimensions greater than 8mH/7mW require minimum 8m cables
- Additional 50mm fibrecrete after bolt, mesh and cable bolts on walls from floor to 3.0m
- Install at least one pull collar on split sets or MD bolts per cut

Support Notes

- No person is to work under unsupported ground
- All cablebolts must be grouted and plated before firing the next cut
- All rockbolts to be installed at 90°±20° to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Stockpiles development in poor ground shall be avoided if practicable
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Stockpile Loading - Support Type SL1

Support Elements

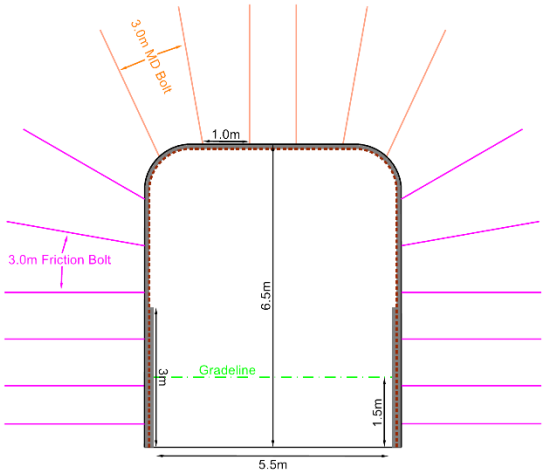
- 50mm fibrecrete floor to floor
- Galvanised mesh from floor to floor, after shotcrete
- Rings of 3.0m split set bolts from floor to shoulder with 1.0m bolt spacing
- Rings of 3.0m MD bolts from shoulder to shoulder with 1.0m bolt spacing (overbreak will require addidtional MD's Shoulder to shoulder)
- 1.0m between rings
- Additional 50mm fibrecrete after bolt and mesh on walls from floor to 3.0m
- Install at least one pull collar on split sets or MD bolts per cut

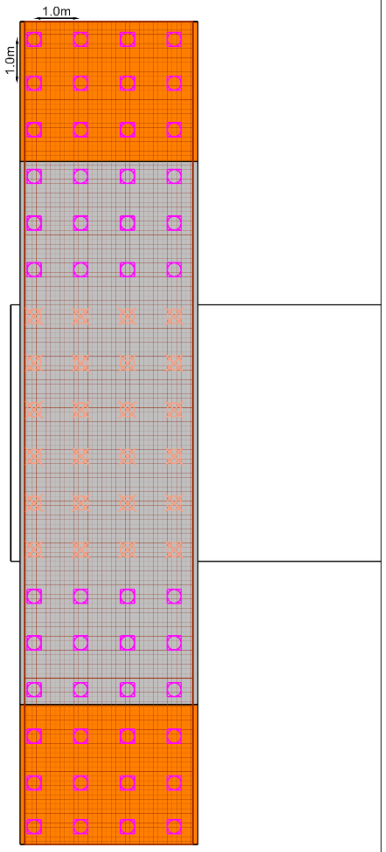
Support Notes

- No person is to work under unsupported ground
- All rockbolts to be installed at 90°±20° to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Stockpile Loading Support - Good Ground - Maximum Drive Dimensions 6.5mHx5.5mW



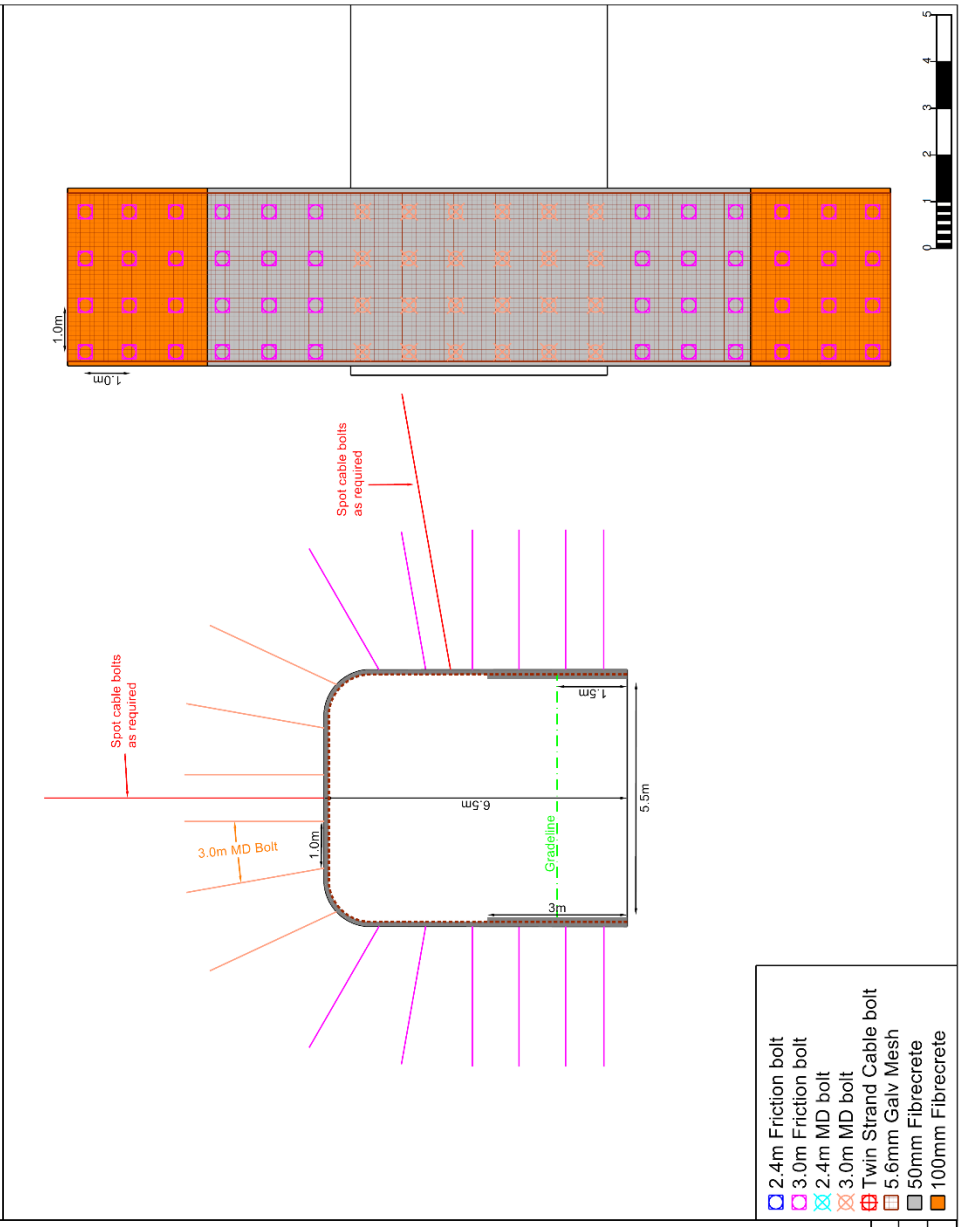


- 2.4m Friction bolt
- 3.0m Friction bolt
- 2.4m MD bolt
- 3.0m MD bolt
- Twin Strand Cable bolt
- 5.6mm Galv Mesh
- 50mm Fibrecrete
- 100mm Fibrecrete

0 1 2 3 4 5

Stockpile Loading - Support Type SL2

Stockpile Loading Support - Fair Ground - Maximum Drive Dimensions 6.5mHx5.5mW



Support Elements

- 50mm fibrecrete floor to floor to face
- Galvanised mesh from floor to floor, after shotcrete
- Rings of 3.0m split set bolts from floor to shoulder with 1.0m bolt spacing
- Rings of 3.0m MD bolts from shoulder to shoulder with 1.0m bolt spacing (overbreak will require addidtional MD's Shoulder to shoulder)
- 1.0m between rings
- Additional 50mm fibrecrete after bolt and mesh on walls from floor to 3.0m
- Spot cable bolts at operations or geotechnical instruction
- Install at least one pull collar on split sets or MD bolts per cut

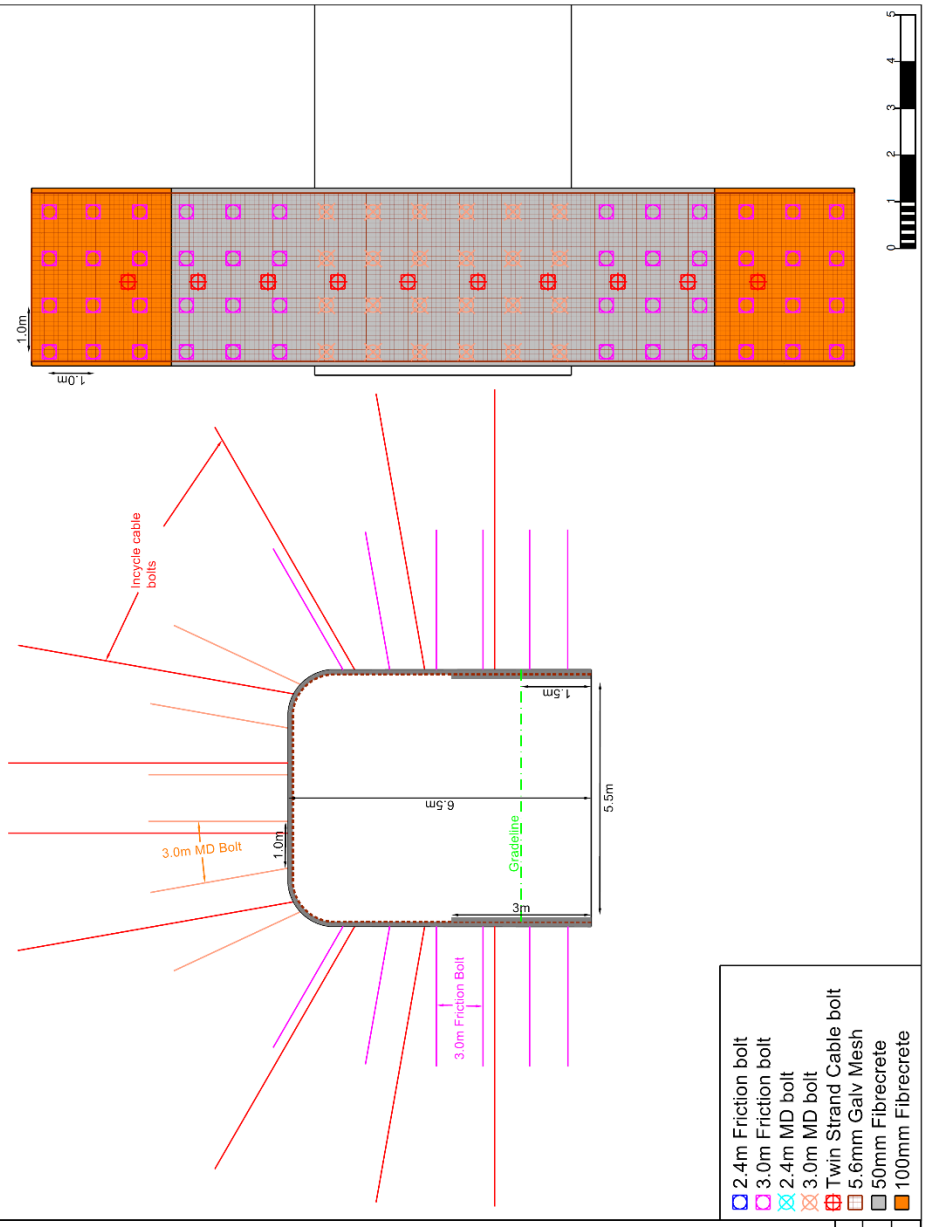
Support Notes

- No person is to work under unsupported ground
- All cablebolts must be grouted and plated before firing the next cut
- All rockbolts to be installed at 90°±20° to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Stockpile Loading - Support Type SL3

Stockpile Loading Support - Poor Ground - Maximum Drive Dimensions 6.5mHx5.5mW



Support Elements

- 50mm fibrecrete floor to floor to face
- Galvanised mesh from floor to floor, after shotcrete
- Rings of 3.0m split set bolts from floor to shoulder with 1.0m bolt spacing
- Rings of 3.0m MD bolts from shoulder to shoulder with 1.0m bolt spacing (overbreak will require additional MD's Shoulder to shoulder)
- 1.0m between rings
- Incycle cable bolts at 1.5m bolt spacing, lowest hole must not be higher than 2.5m off floor
- 2.5m between cable bolt rings
- maintain 1.5m bolt spacing if overbreak is encountered eg. a 8mHx6mW drive requires a minimum 11 cable bolts
- minimum cable bolt lenth 6m, extend cable bolt length untill 2m of solid ground is encountered
- drive dimensions greater than 8mH/7mW require minimum 8m cables
- Additional 50mm fibrecrete after bolt, mesh and cable bolts on walls from floor to 3.0m
- Install at least one pull collar on split sets or MD bolts per cut

Support Notes

- No person is to work under unsupported ground
- All cablebolts must be grouted and plated before firing the next cut
- All rockbolts to be installed at 90°±20° to the planned profile
- All rockbolts to be installed with a combi plate
- Any faulty rockbolts must have a replacement bolt installed beside it
- Stockpiles development in poor ground shall be avoided if practicable
- Last row of bolts must be installed to the face, shotcrete no further than 0.5m from face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement - additional support may be installed at the operators discretion

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Intersection Support - Support Type I1

Support Elements

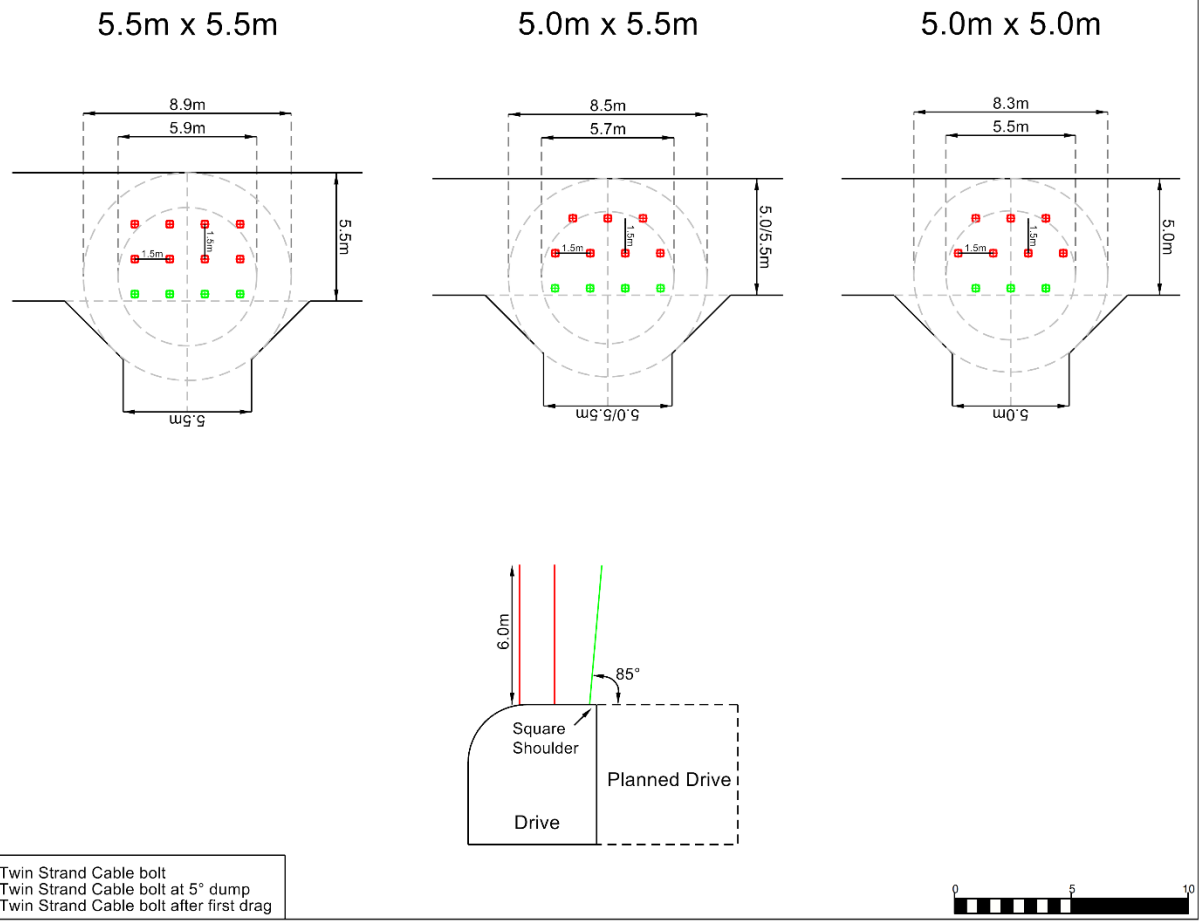
- Rock support to be installed as per standard from one of the P, T, C,S or SL support types
- Where 5.5mW meets 5.5mW
 --12 x 6m cablebolts - 4/4/4
- Where 5mW meets 5.5mW
 --11 x 6m cablebolts - 3/4/4
- Where 5mW meets 5mW
 --10 x 6m cablebolts - 3/4/3
- Additional cables can be added at operations or geotechnical discrecion
- If cables clostest to the drag are impracticable to install without damage then two stage installiation required with final cables installed after first drag

Support Notes

- No person is to work under unsupported ground
- Shoulder needs to be squared off where intersection will occur
- Cables shall be installed at 90° (Red) except those cloest to the planned drag, which shall be installed at 5°. Where necessary, cables may be offset by applying a 5° inclination for each 0.5 m of offset required to a maximum of 15°
- Cable bolts to be tensioned to 7t
- Any faulty cable bolts must have a replacement cable bolt installed beside it
- All cable bolts to be plated and tensioned before firing the next face/drag
- Cable bolts must be installed as close as possible to the wall where drag will occur
- Survey to mark up cable bolts for drilling
- Every intersection requires geotechnical inspection before developing
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Intersection Support - Good Ground



- Twin Strand Cable bolt
- Twin Strand Cable bolt at 5° dump
- Twin Strand Cable bolt after first drag

Intersection Support - Support Type I2

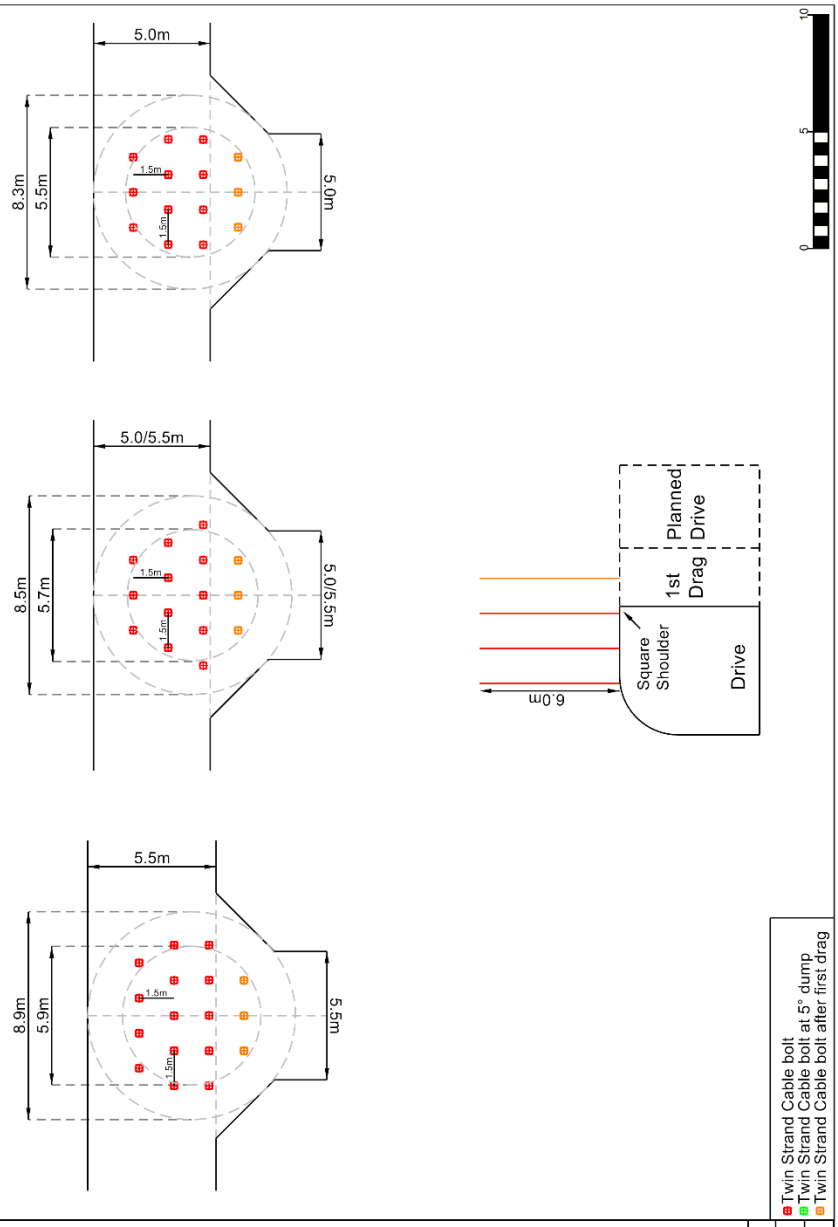
Intersection Support - Fair Ground

Support Elements

- Rock support to be installed as per standard from one of the P, T, C,S or SL support types
- Where 5.5mW meets 5.5mW
--17 x 6m cablebolts - 4/5/5/3
- Where 5mW meets 5.5mW
--15 x 6m cablebolts - 3/4/5/3
- Where 5mW meets 5mW
--14 x 6m cablebolts - 3/4/4/3
- Additional cables can be added at operations or geotechnical discrecion
- If cables clostest to the drag are impracticable to install without damage then two stage installiation required with final cables installed after first drag

Support Notes

- No person is to work under unsupported ground
- Shoulder needs to be squared off where intersection will occur
- Cables shall be installed at 90° except where necessary, cables may be offset by applying a 5° inclination for each 0.5 m of offset required to a maximum of 15°
- Cable bolts to be tensioned to 7t
- Any faulty cable bolts must have a replacement cable bolt installed beside it
- All cable bolts to be plated and tensioned before firing the next face/drag
- Cable bolts must be installed as close as possible to the wall where drag will occur
- Survey to mark up cable bolts for drilling
- Every intersection requires geotechnical inspection before developing
- These rules are the minimum support requirement – additional support may be installed at the operators discretion



Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Intersection Support - Support Type I3

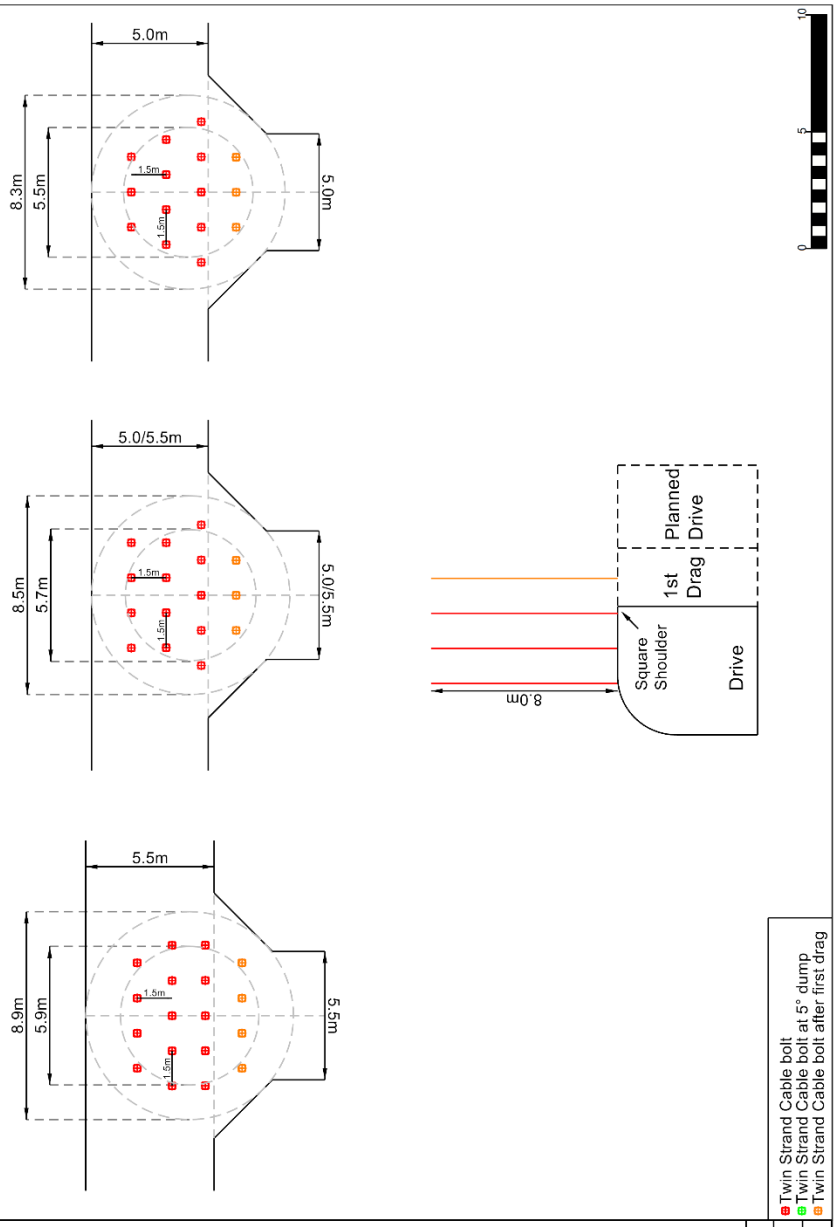
Intersection Support - Poor Ground/Strategic Openings

Support Elements

- Rock support to be installed as per standard from one of the P, T, C,S or SL support types
- Where 5.5mW meets 5.5mW
--18 x 8m cablebolts - 4/5/5/4
- Where 5mW meets 5.5mW
--16 x 8m cablebolts - 4/4/5/3
- Where 5mW meets 5mW
--15 x 8m cablebolts - 3/4/5/3
- Additional cables can be added at operations or geotechnical discrecion
- If cables clostest to the drag are impracticable to install without damage then two stage installiation required with final cables installed after first drag

Support Notes

- No person is to work under unsupported ground
- Shoulder needs to be squared off where intersection will occur
- Cables shall be installed at 90° except where necessary, cables may be offset by applying a 5° inclination for each 0.5 m of offset required to a maximum of 15°
- Cable bolts to be tensioned to 7t
- Any faulty cable bolts must have a replacement cable bolt installed beside it
- All cable bolts to be plated and tensioned before firing the next face/drag
- Cable bolts must be installed as close as possible to the wall where drag will occur
- Survey to mark up cable bolts for drilling
- Every intersection requires geotechnical inspection before developing
- Intersection in poor ground shall be avoided if practicable
- These rules are the minimum support requirement – additional support may be installed at the operators discretion



Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Intersection Development Angled - Support IA1

Support Elements

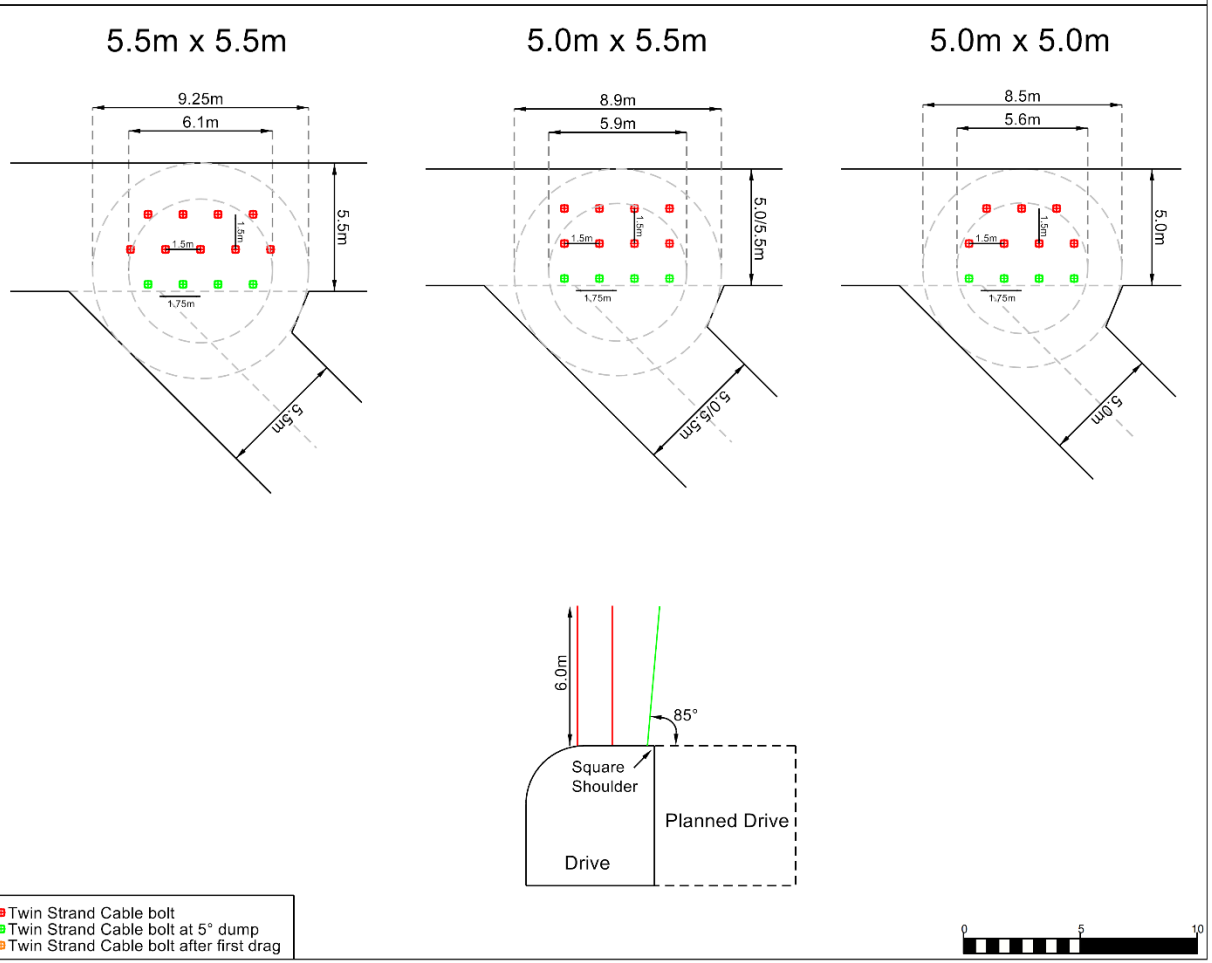
- Rock support to be installed as per standard from one of the P, T, C,S or SL support types
- Where 5.5mW meets 5.5mW
 --13 x 6m cablebolts - 4/5/4
- Where 5mW meets 5.5mW
 --12 x 6m cablebolts - 4/4/4
- Where 5mW meets 5mW
 --11 x 6m cablebolts - 3/4/4
-Additional cables can be added at operations or geotechnical discrecion
- If cables clostest to the drag are impracticable to install without damage then two stage installiation required with final cables installed after first drag

Support Notes

- No person is to work under unsupported ground
- Shoulder needs to be squared off where intersection will occur
- Cables shall be installed at 90° (Red) except those cloest to the planned drag, which shall be installed at 5°. Where necessary, cables may be offset by applying a 5° inclination for each 0.5 m of offset required to a maximum of 15°
- Cable bolts to be tensioned to 7t
- Any faulty cable bolts must have a replacement cable bolt installed beside it
- All cable bolts to be plated and tensioned before firing the next face/drag
- Cable bolts must be installed as close as possible to the wall where drag will occur
- Survey to mark up cable bolts for drilling
- Every intersection requires geotechnical inspection before developing
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Intersection Support Angled - Good Ground



Intersection Development Angled - Support IA2

Support Elements

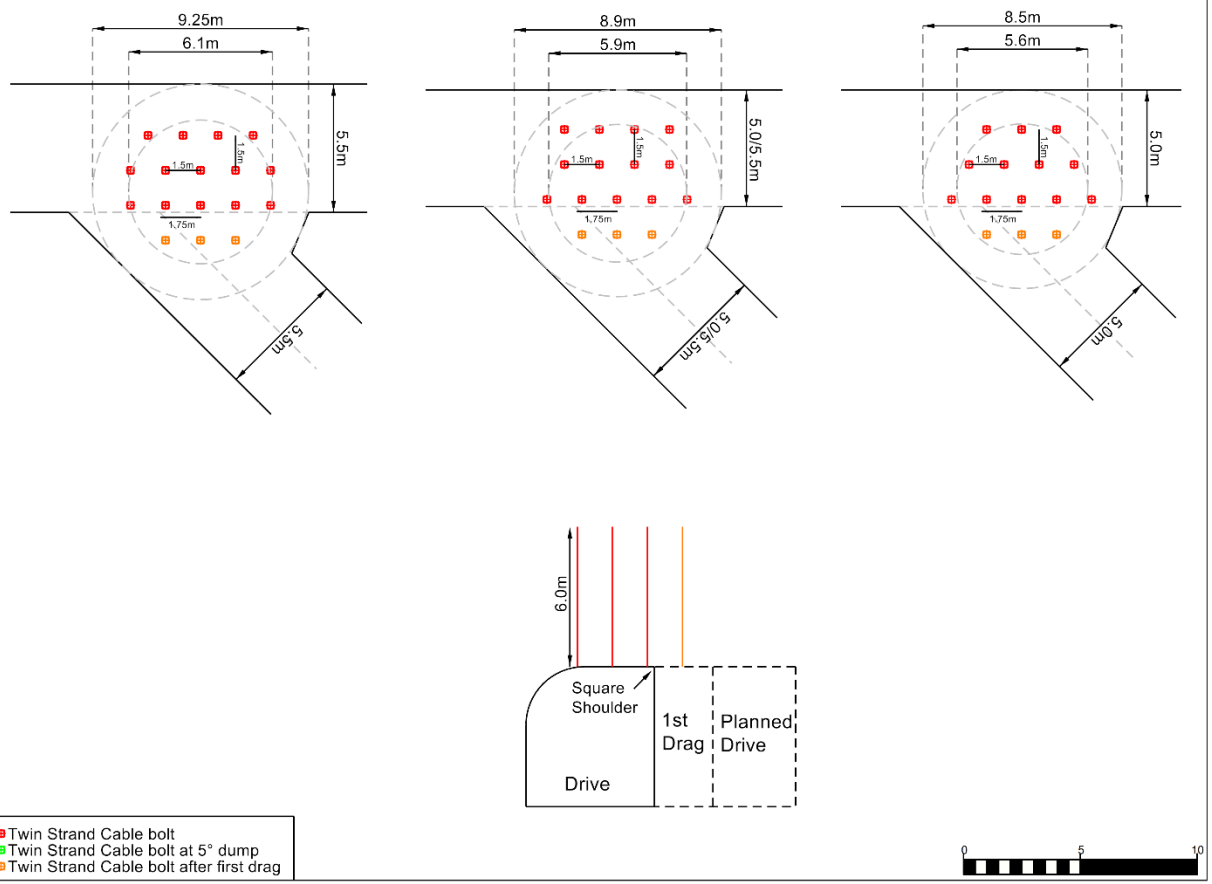
- Rock support to be installed as per standard from one of the P, T, C,S or SL support types
- Where 5.5mW meets 5.5mW
 --17 x 6m cablebolts - 4/5/5/3
- Where 5mW meets 5.5mW
 --16 x 6m cablebolts - 4/4/5/3
- Where 5mW meets 5mW
 --15 x 6m cablebolts - 3/4/5/3
- Additional cables can be added at operations or geotechnical discrecion
- If cables clostest to the drag are impracticable to install without damage then two stage installiation required with final cables installed after first drag

Support Notes

- No person is to work under unsupported ground
- Shoulder needs to be squared off where intersection will occur
- Cables shall be installed at 90° except where necessary, cables may be offset by applying a 5° inclination for each 0.5 m of offset required to a maximum of 15°
- Cable bolts to be tensioned to 7t
- Any faulty cable bolts must have a replacement cable bolt installed beside it
- All cable bolts to be plated and tensioned before firing the next face/drag
- Cable bolts must be installed as close as possible to the wall where drag will occur
- Survey to mark up cable bolts for drilling
- Every intersection requires geotechnical inspection before developing
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Intersection Support Angled - Fair Ground



- Twin Strand Cable bolt
- Twin Strand Cable bolt at 5° dump
- Twin Strand Cable bolt after first drag

Intersection Development Angled - Support IA3

Support Elements

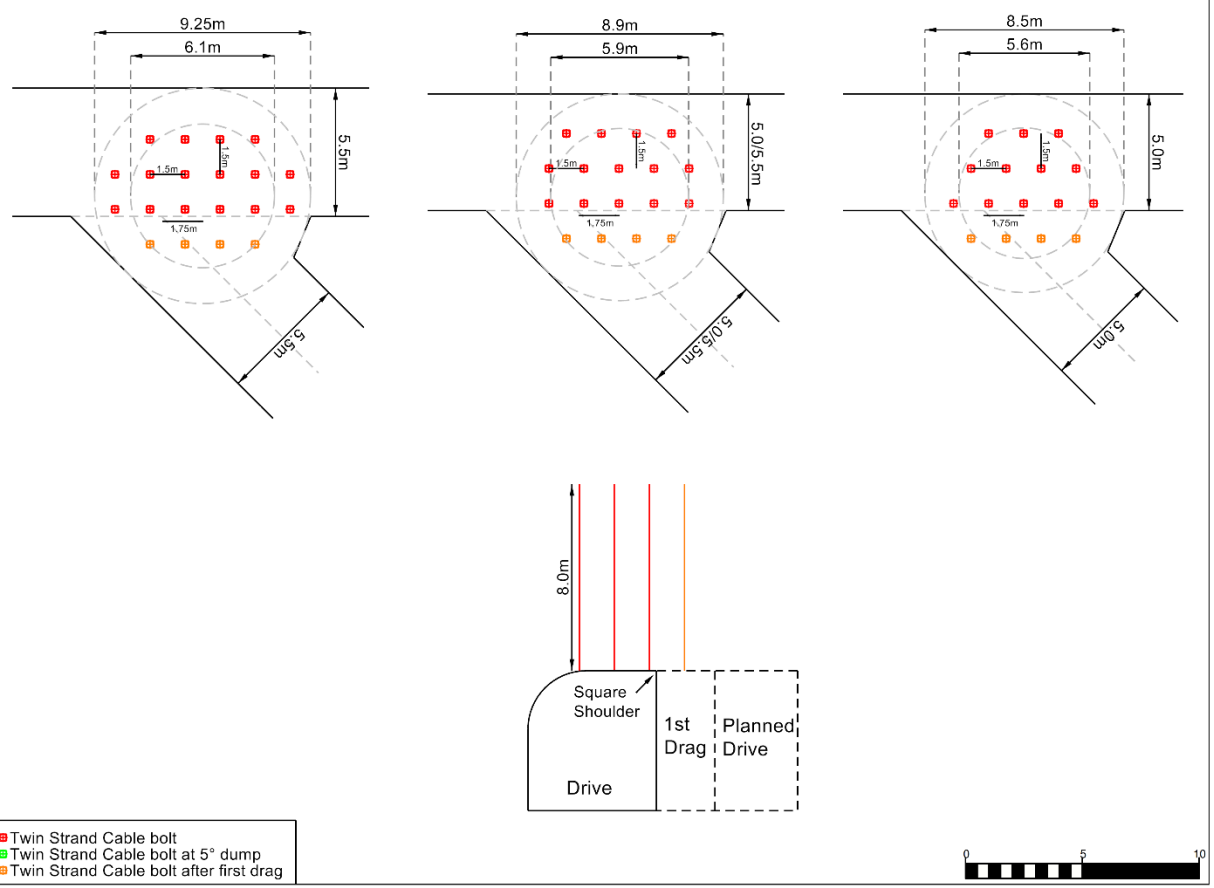
- Rock support to be installed as per standard from one of the P, T, C,S or SL support types
- Where 5.5mW meets 5.5mW
 --20 x 6m cablebolts - 4/6/6/4
- Where 5mW meets 5.5mW
 --18 x 6m cablebolts - 4/5/5/4
- Where 5mW meets 5mW
 --16 x 6m cablebolts - 3/4/5/4
- Additional cables can be added at operations or geotechnical discrecion
- If cables clostest to the drag are impracticable to install without damage then two stage installiation required with final cables installed after first drag

Support Notes

- No person is to work under unsupported ground
- Shoulder needs to be squared off where intersection will occur
- Cables shall be installed at 90° except where necessary, cables may be offset by applying a 5° inclination for each 0.5 m of offset required to a maximum of 15°
- Cable bolts to be tensioned to 7t
- Any faulty cable bolts must have a replacement cable bolt installed beside it
- All cable bolts to be plated and tensioned before firing the next face/drag
- Cable bolts must be installed as close as possible to the wall where drag will occur
- Survey to mark up cable bolts for drilling
- Every intersection requires geotechnical inspection before developing
- Intersection in poor ground shall be avoided if practicable
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Intersection Support Angled - Poor Ground/Strategic Openings



- Twin Strand Cable bolt
- Twin Strand Cable bolt at 5° dump
- Twin Strand Cable bolt after first drag

Wide Span Development - Support Type W

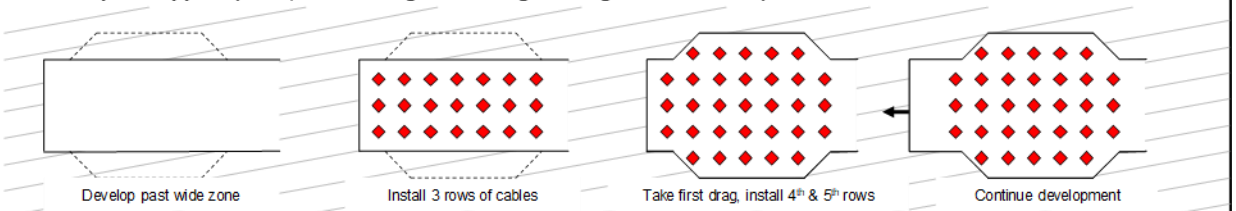
Wide Span Support (> 6m, non-strategic and height not greater than 6m)

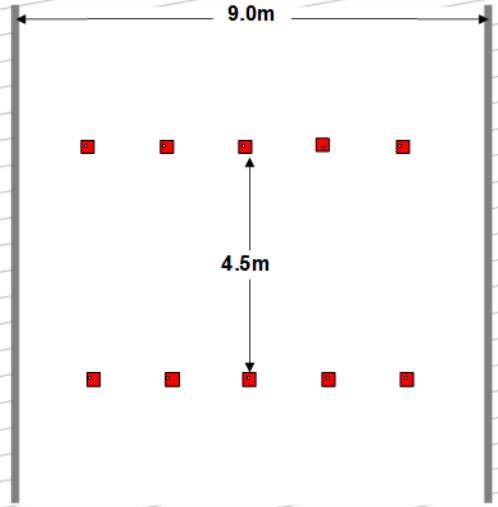
Support Elements

- Rock support to be installed as per standard from one of the P, T or S support types
- 1.0m between rings
- + spot bolts as required
- + spot cablebolts as required
- Split sets may be used in the lower walls to augment the standard pattern
- Pattern cable bolting as specified by the geotechnical engineer – based off support calculation tables (Rosengren, 2006)

Support Notes

- No person is to work under unsupported ground
- All rock bolts to be installed at 90º±10º to the planned profile
- All rock bolts to be installed with a combi plate
- Any faulty rock bolts must have a replacement bolt installed beside it
- Last row of bolts must be no further than 1m from the face
- All CT bolts to be grouted before firing the next face
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- All cable bolts to be plated and tensioned before firing the *next* face





Span	Ring Spacing (m)					Minimum Cable Length (m)
	2/ring	3/ring	4/ring	5/ring	6/ring	
7	2.9	4.4	5.9	7.4	8.8	5.3
8	2.3	3.4	4.5	5.6	6.8	5.7
9	1.8	2.7	3.6	4.5	5.3	6.0
10	1.4	2.2	2.9	3.6	4.3	6.3
11	1.2	1.8	2.4	3.0	3.6	6.7
12	1.0	1.5	2.0	2.5	3.0	7.0

** Rosengren, 2006*

****All cablebolts must be grouted and plated before firing drag****

OCEANAGOLD

Ground Control Management Plan
Standard Ground Support Designs

Support Type W: These rules are the minimum support requirement – additional support may be installed at the operators discretion	Designed:	Anthony Jones
	Approved:	James Isles

- 50mm fibre reinforced shotcrete
- 100mm fibre reinforced shotcrete
- 2.4m CT/DCP Bolt
- 2.4m or 3.0m split set
- Cablebolt
- Mesh
- Mesh
- Mesh strap
- W strap

Intersection Pillar Angled - Support Type IPA1

Support Elements

50mm fibre reinforced shotcrete from floor to shoulders
Rock support to be installed as per current standard from one of the P, T, C,S or SL support types
2 x 6m long Osro Straps installed per pillar
4 x 6m long cable bolts installed in nose pillar, located within osro straps
2 x 6m long cable bolts installed in opposite pillar, located within the osro straps

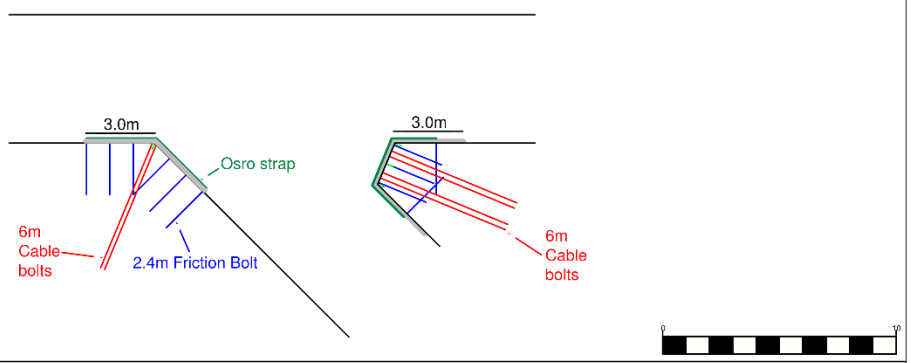
Support Notes

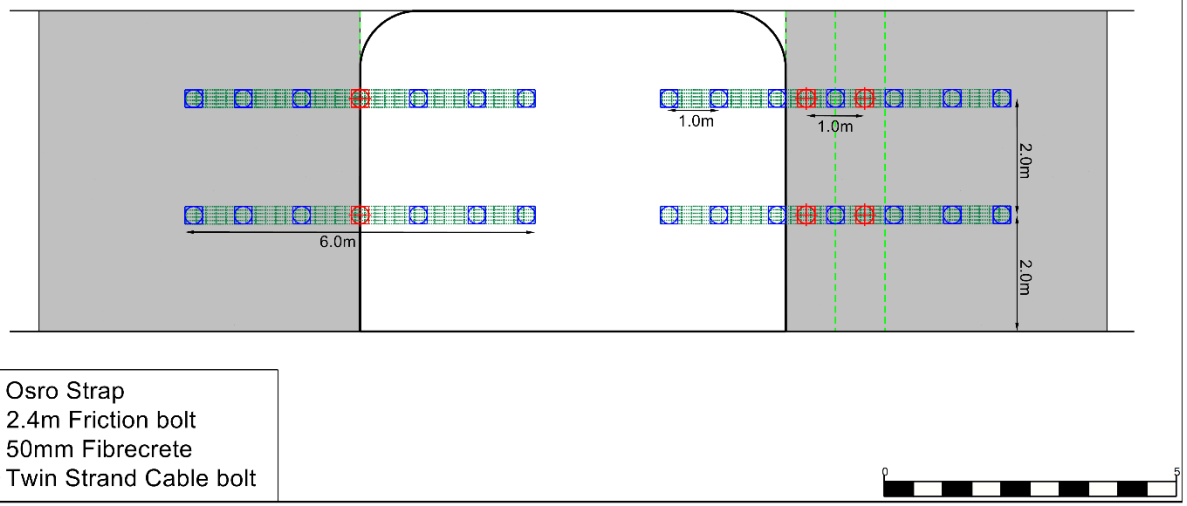
- No person is to work under unsupported ground
- Shoulder needs to be squared off where intersection will occur
- All cable bolts to be installed at 90º±20º to the planned profile
- Cable bolts to be tensioned to 7t
- Any faulty cable bolts must have a replacement cable bolt installed beside it
- All cable bolts to be plated and tensioned

Minimum Fibrecrete Volume Required	
Drive height	Volume
5.0mH	4.9m3
5.5mH	5.4m3
6.0mH	5.9m3
6.5mH	6.4m3
7.0mH	6.9m3

Designed By	M.McCulloch
Approved By	James Isles
Date	30/08/2023

Intersection Pillar Angled - Low Traffic Pillars





Intersection Pillar Angled - Support Type IPA2

Support Elements

Intersections creating high risk pillars should be avoided if practicable
100mm fibre reinforced shotcrete from floor to shoulders
Rock support to be installed as per current standard from one of the P, T, C,S or SL support types
2 x 6m long Osro Straps installed per pillar
4 x 6m long cable bolts installed in nose pillar, located within osro straps
2 x 6m long cable bolts installed in opposite pillar, located within the osro straps

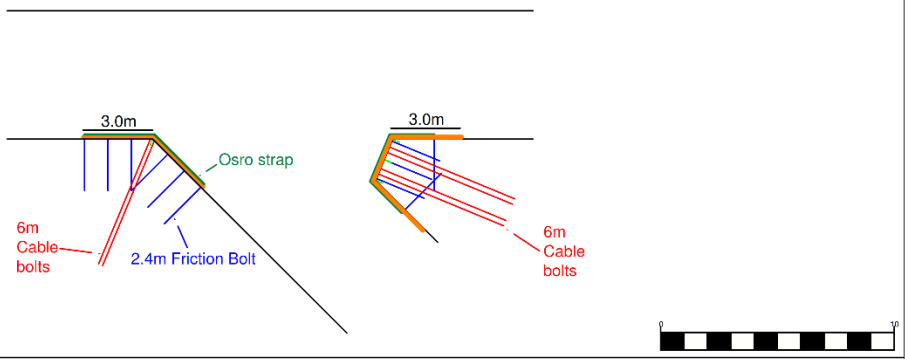
Support Notes

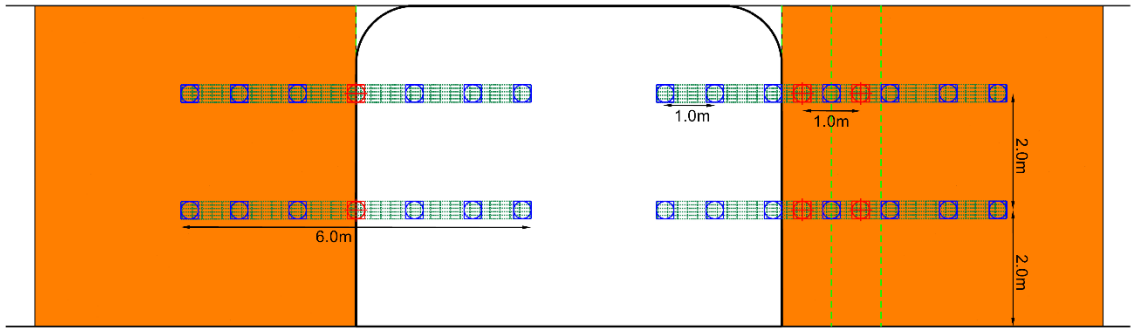
- No person is to work under unsupported ground
- Shoulder needs to be squared off where intersection will occur
- All cable bolts to be installed at 90º±20º to the planned profile
- Cable bolts to be tensioned to 7t
- Any faulty cable bolts must have a replacement cable bolt installed beside it
- All cable bolts to be plated and tensioned

Minimum Fibrecrete Volume Required	
Drive height	Volume
5.0mH	9.8m3
5.5mH	10.8m3
6.0mH	11.8m3
6.5mH	12.7m3
7.0mH	13.7m3

Designed By	M.McCulloch
Approved By	James Isles
Date	30/08/2023

Intersection Pillar Angled - High Traffic Pillars





- Osro Strap
- 2.4m Friction bolt
- 50mm Fibrecrete
- Twin Strand Cable bolt

Intersection Pillar - Support Type IP1

Support Elements

50mm fibre reinforced shotcrete from floor to shoulders
Rock support to be installed as per current standard from one of the P, T, C,S or SL support types
2 x 6m long Osro Straps installed per pillar
4 x 6m long cable bolts installed per pillar, located within osro straps

Support Notes

- No person is to work under unsupported ground
- Shoulder needs to be squared off where intersection will occur
- All cable bolts to be installed at 90º±20º to the planned profile
- Cable bolts to be tensioned to 7t
- Any faulty cable bolts must have a replacement cable bolt installed beside it
- All cable bolts to be plated and tensioned

Minimum Fibrecrete Volume Required

Drive height	T intersection	X intersection
5.0mH	5.3m3	10.5m3
5.5mH	5.8m3	11.6m3
6.0mH	6.3m3	12.6m3
6.5mH	6.8m3	13.7m3
7.0mH	7.4m3	14.7m3

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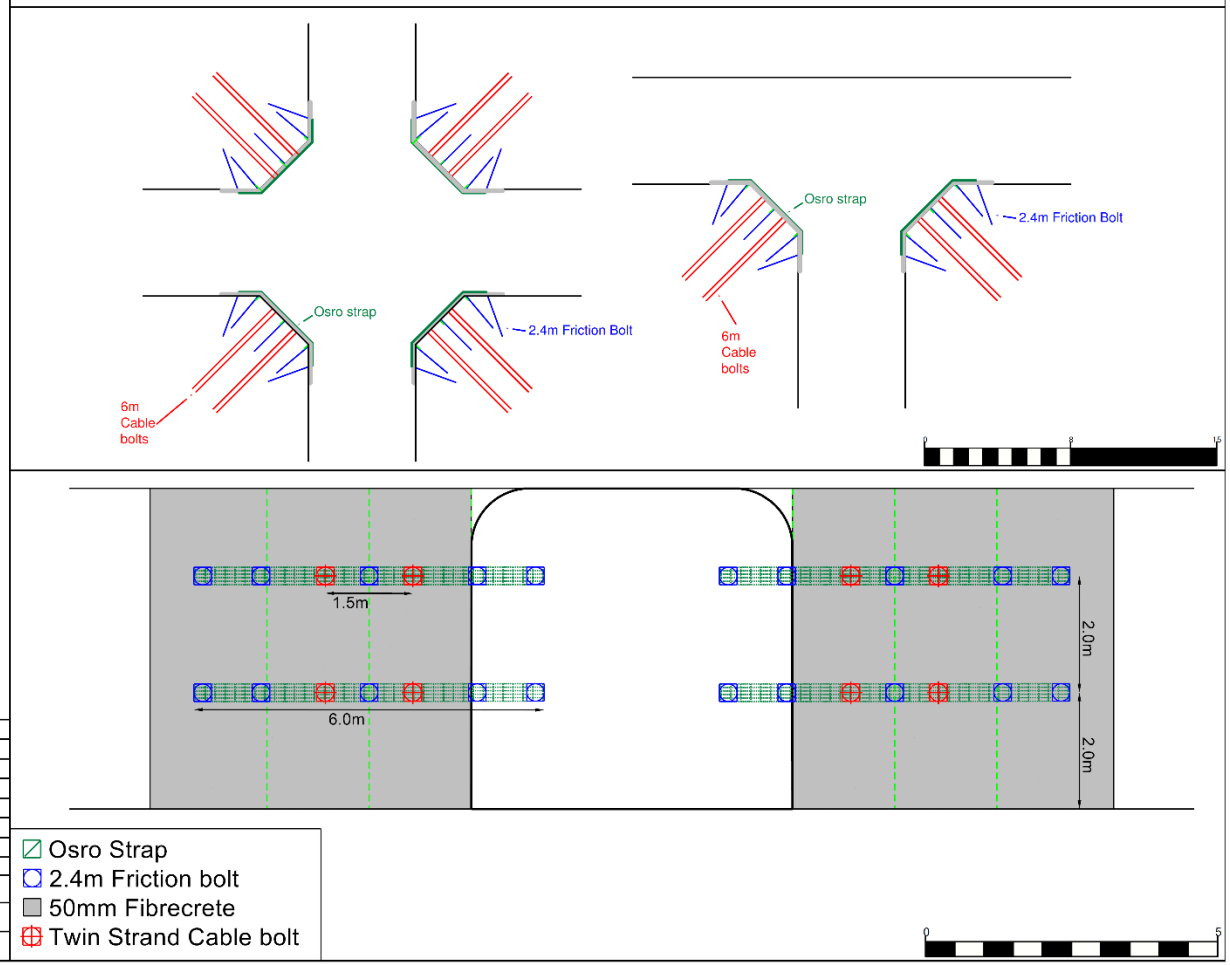
Approved By	James Isles
Date	30/08/2023

Intersection Pillar - Low Traffic Pillars



Intersection Pillar - Support Type IP2

Support Elements

Intersections creating high risk pillars should be avoided if practicable
100mm fibre reinforced shotcrete from floor to shoulders
Rock support to be installed as per current standard from one of the P, T, C,S or SL support types
2 x 6m long Osro Straps installed per pillar
4 x 6m long cable bolts installed per pillar, located within osro straps

Support Notes

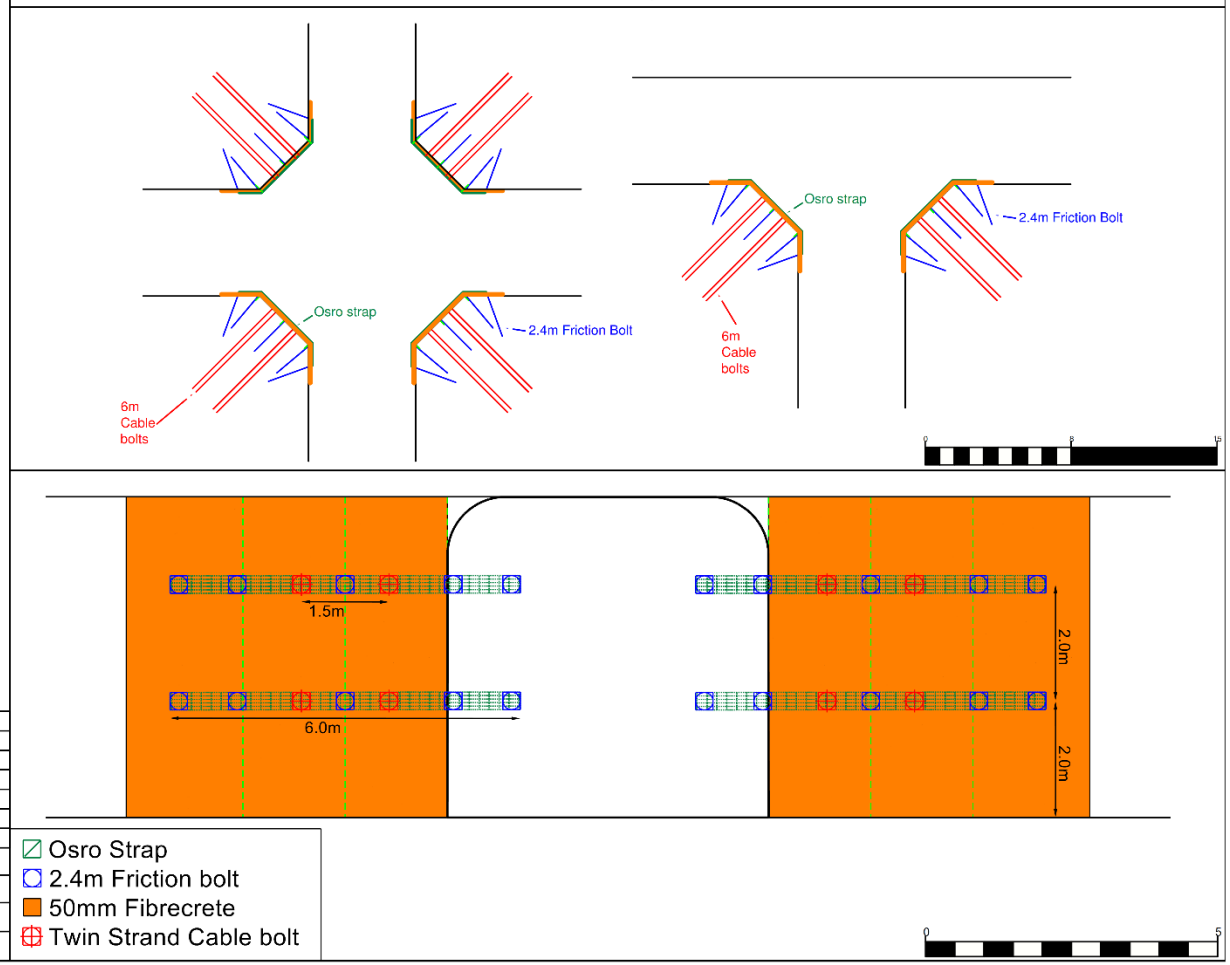
- No person is to work under unsupported ground
- Shoulder needs to be squared off where intersection will occur
- All cable bolts to be installed at 90º±20º to the planned profile
- Cable bolts to be tensioned to 7t
- Any faulty cable bolts must have a replacement cable bolt installed beside it
- All cable bolts to be plated and tensioned

Minimum Fibrecrete Volume Required

Drive height	T intersection	X intersection
5.0mH	10.5m3	21.0m3
5.5mH	11.6m3	23.1m3
6.0mH	12.6m3	25.2m3
6.5mH	13.7m3	27.3m3
7.0mH	14.7m3	29.4m3

Designed By	M.McCulloch
Approved By	James Isles
Date	30/08/2023

Intersection Pillar - High Traffic Pillars



Intersection Pillar Angled - Support Type IPA1a

Support Elements

50mm fibre reinforced shotcrete from floor to shoulders
Rock support to be installed as per current standard from one of the P, T, C,S or SL support types
2 x 6m long Osro Straps installed per pillar
4 x 6m long SDAs installed in nose pillar, located within osro straps
2 x 6m long SDAs installed in opposite pillar, located within the osro straps

Support Notes

- No person is to work under unsupported ground
- Shoulder needs to be squared off where intersection will occur
- All SDAs to be installed at 90°±20° to the planned profile
- Any faulty SDAs must have a replacement bolt installed beside it
- All SDAs to be plated and tensioned

Minimum Fibrecrete Volume Required	
Drive height	Volume
5.0mH	4.9m3
5.5mH	5.4m3
6.0mH	5.9m3
6.5mH	6.4m3
7.0mH	6.9m3

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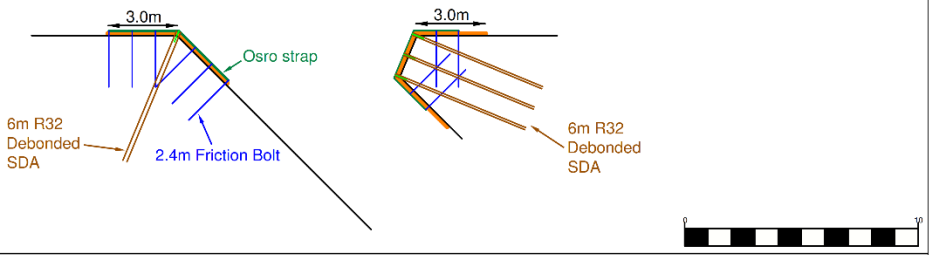
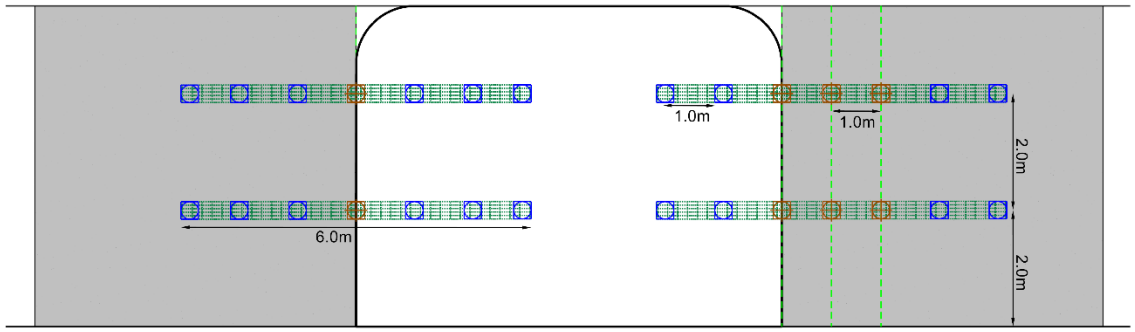
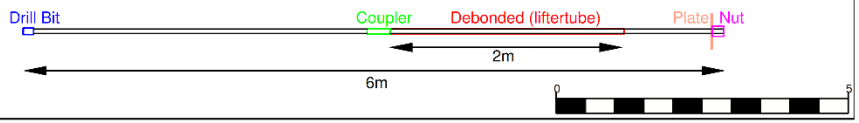
Approved By	Jolyon Jardine
Date	27/11/2024

Intersection Pillar Angled - Low Traffic Pillars





- Osro Strap
- 2.4m Friction bolt
- 50mm Fibrecrete
- 6m R32 Debonded SDA



Intersection Pillar Angled - Support Type IPA2a

Support Elements

Intersections creating high risk pillars should be avoided if practicable
100mm fibre reinforced shotcrete from floor to shoulders
Rock support to be installed as per current standard from one of the P, T, C,S or SL support types
2 x 6m long Osro Straps installed per pillar
4 x 6m long SDAs installed in nose pillar, located within osro straps
2 x 6m long SDAs installed in opposite pillar, located within the osro straps

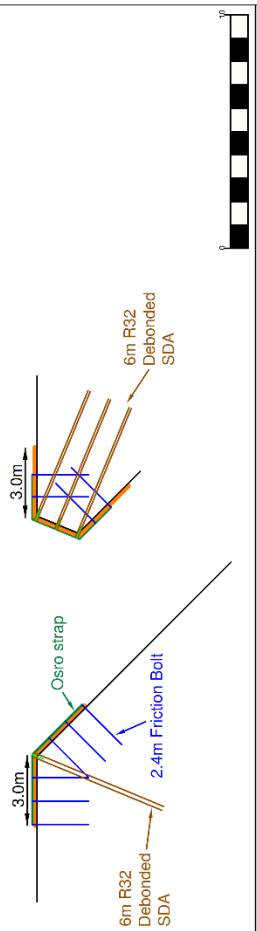
Support Notes

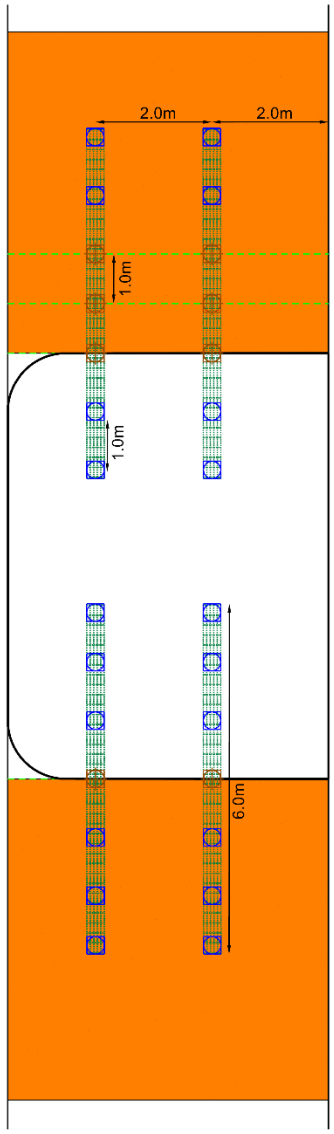
- No person is to work under unsupported ground
- Shoulder needs to be squared off where intersection will occur
- All SDAs to be installed at 90º±20º to the planned profile
- Any faulty SDAs must have a replacement bolt installed beside it
- All SDAs to be plated and tensioned

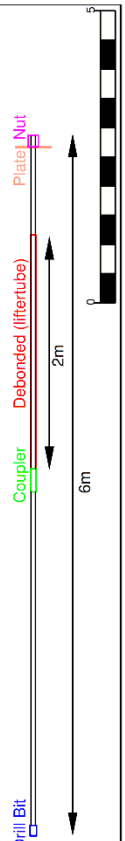
Minimum Fibrecrete Volume Required	
Drive height	Volume
5.0mH	9.8m3
5.5mH	10.8m3
6.0mH	11.8m3
6.5mH	12.7m3
7.0mH	13.7m3

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Intersection Pillar Angled - High Traffic Pillars







Osro Strap
2.4m Friction bolt
100mm Fibrecrete
6m R32 Debonded SDA

Intersection Pillar - Support Type IP1a

Support Elements

50mm fibre reinforced shotcrete from floor to shoulders
Rock support to be installed as per current standard from one of the P, T, C,S or SL support types
2 x 6m long Osro Straps installed per pillar
4 x 6m long SDAs installed per pillar, located within osro straps

Support Notes

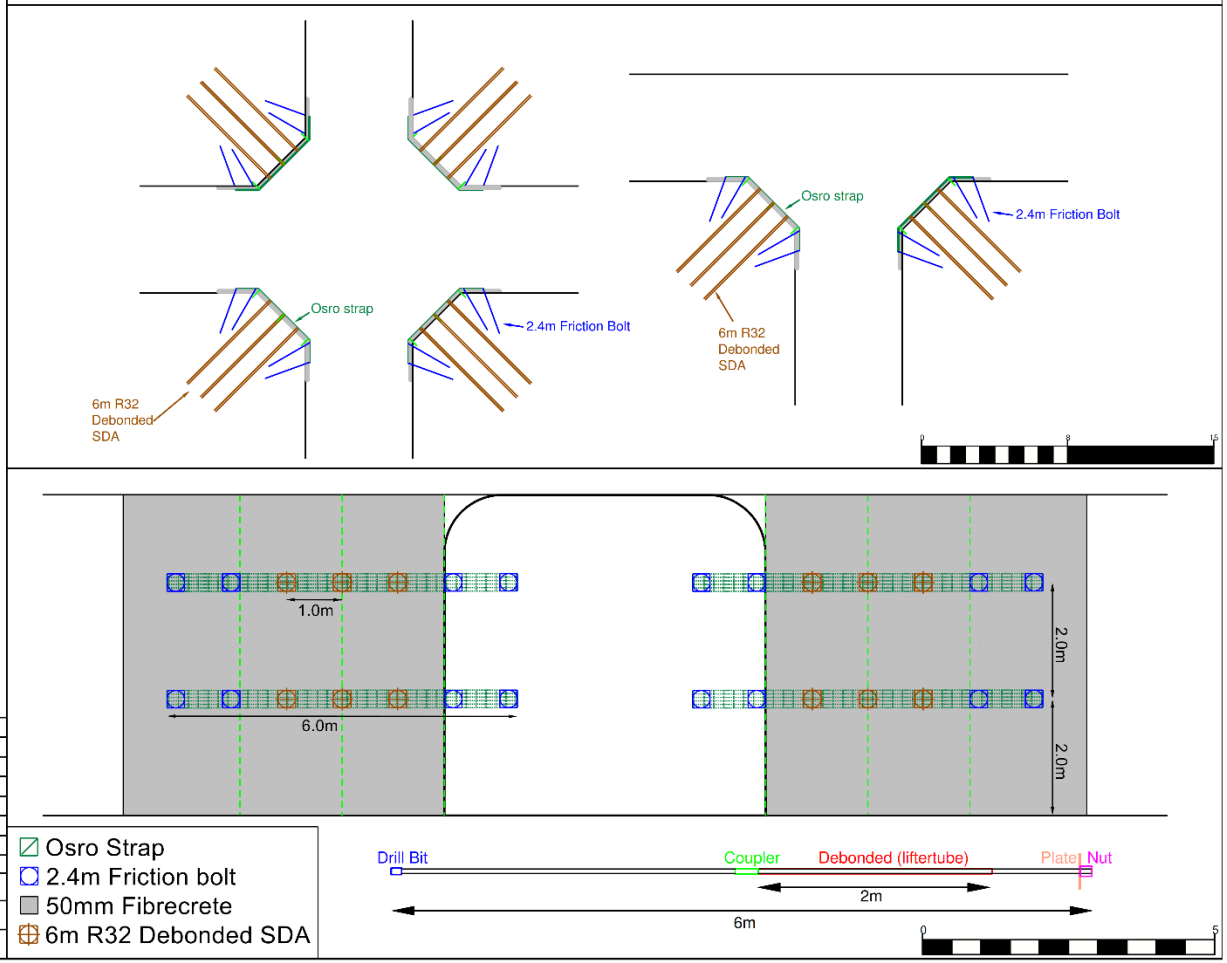
- No person is to work under unsupported ground
- Shoulder needs to be squared off where intersection will occur
- All SDAs to be installed at 90°±20° to the planned profile
- Any faulty SDAs must have a replacement bolt installed beside it
- All SDAs to be plated and tensioned

Minimum Fibrecrete Volume Required

Drive height	T intersection	X intersection
5.0mH	5.3m3	10.5m3
5.5mH	5.8m3	11.6m3
6.0mH	6.3m3	12.6m3
6.5mH	6.8m3	13.7m3
7.0mH	7.4m3	14.7m3

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Intersection Pillar - Low Traffic Pillars



Intersection Pillar - Support Type IP2a

Support Elements

Intersections creating high risk pillars should be avoided if practicable
100mm fibre reinforced shotcrete from floor to shoulders
Rock support to be installed as per current standard from one of the P, T, C,S or SL support types
2 x 6m long Osro Straps installed per pillar
4 x 6m long debonded SDAs installed per pillar, located within osro straps

Support Notes

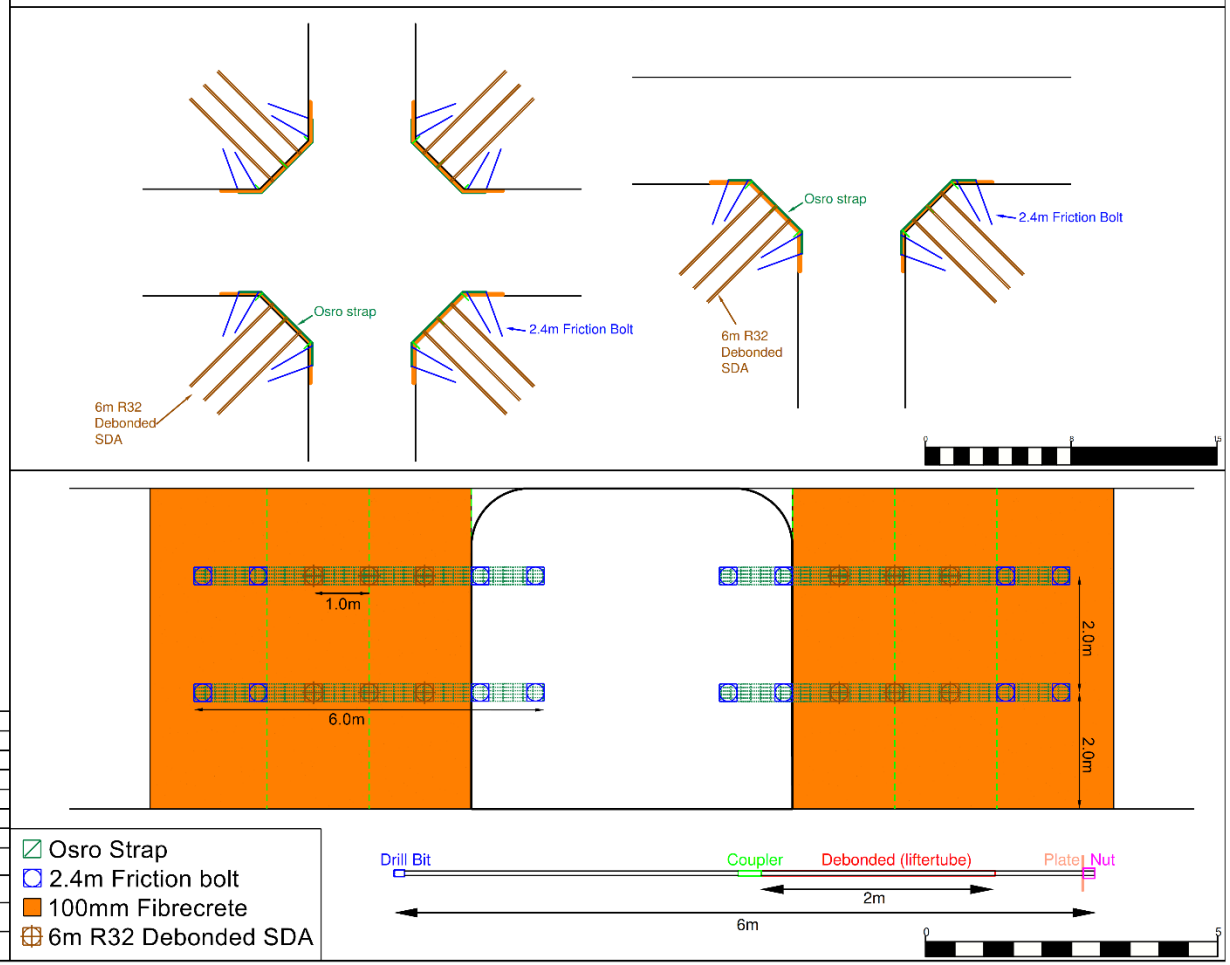
- No person is to work under unsupported ground
- Shoulder needs to be squared off where intersection will occur
- All SDAs to be installed at 90º±20º to the planned profile
- Any faulty SDAs must have a replacement bolt installed beside it
- All SDAs to be plated and tensioned

Minimum Fibrecrete Volume Required

Drive height	T intersection	X intersection
5.0mH	10.5m3	21.0m3
5.5mH	11.6m3	23.1m3
6.0mH	12.6m3	25.2m3
6.5mH	13.7m3	27.3m3
7.0mH	14.7m3	29.4m3

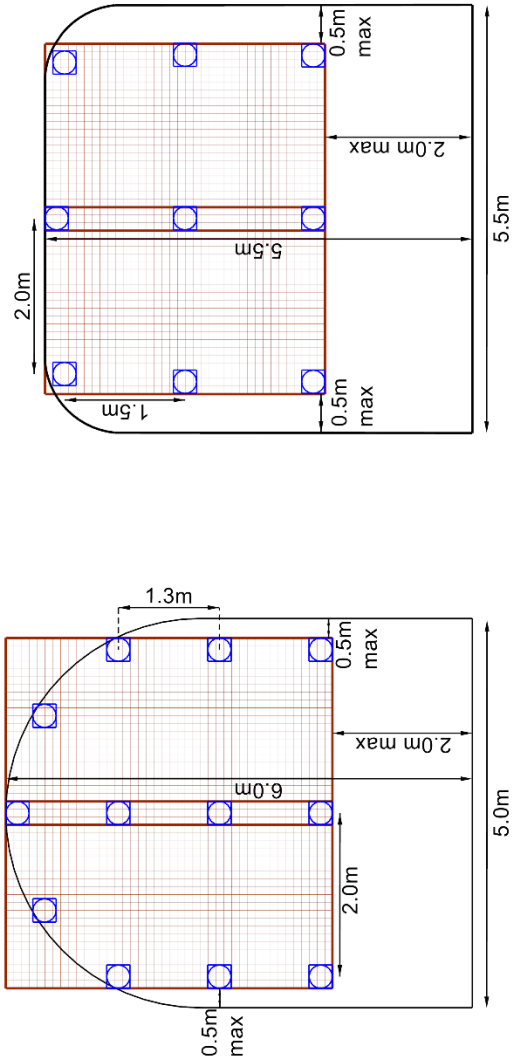
Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Intersection Pillar - High Traffic Pillars



Face - Support Type F1

Face Support - Good Ground



Support Elements

- Galvanised mesh sheets installed no higher than 2m above the floor to the backs and no more than 0.5m to each wall
- Black 2.4m Split set bolts on a 1.5m x 2m Bolt Spacing drives less than 5.5mH
- Black 2.4m Split set bolts on a 1.3m x 2m bolt Spacing for drives greater than 5.5mH

Support Notes

- Ensure face is scaled thoroughly from top to bottom
- No person is to approach the face until it is fully supported
- All rockbolts to be installed with a combi plate
- Any faulty bolts must have a replacement bolt installed beside it
- Face mesh sheets should not be pinned to long term support
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

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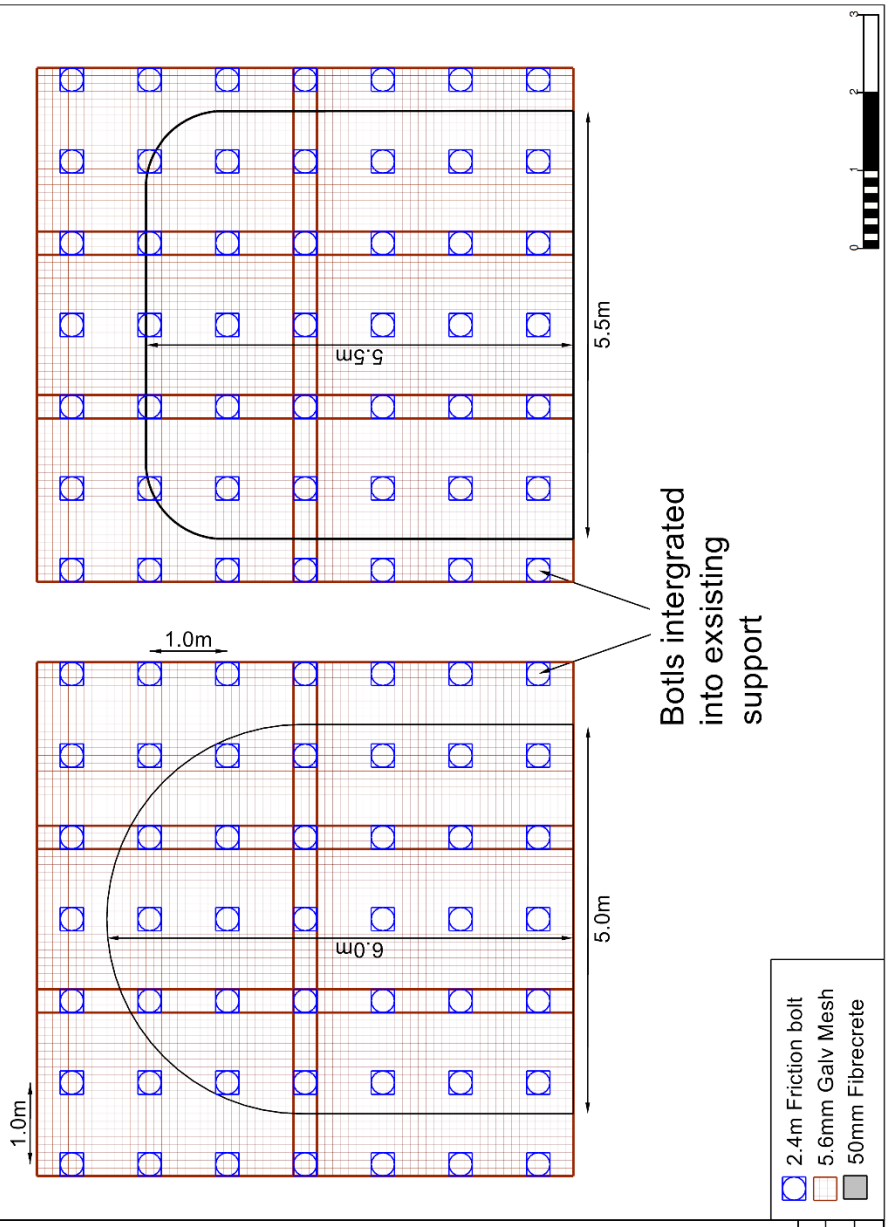
Approved By	Jolyon Jardine
Date	27/11/2024

Face - Support Type F2

Face Support - Poor Ground/Final Faces



Support Elements

- Galvanised mesh sheets installed from floor to backs
- Black 2.4m Split set bolts on a 1.0m x 1.0m bolt spacing

Support Notes

- Ensure face is scaled thoroughly from top to bottom
- No person is to approach the face until it is fully supported
- All rockbolts to be installed with a combi plate
- Any faulty bolts must have a replacement bolt installed beside it
- Face mesh sheets must be integrated into long term support
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

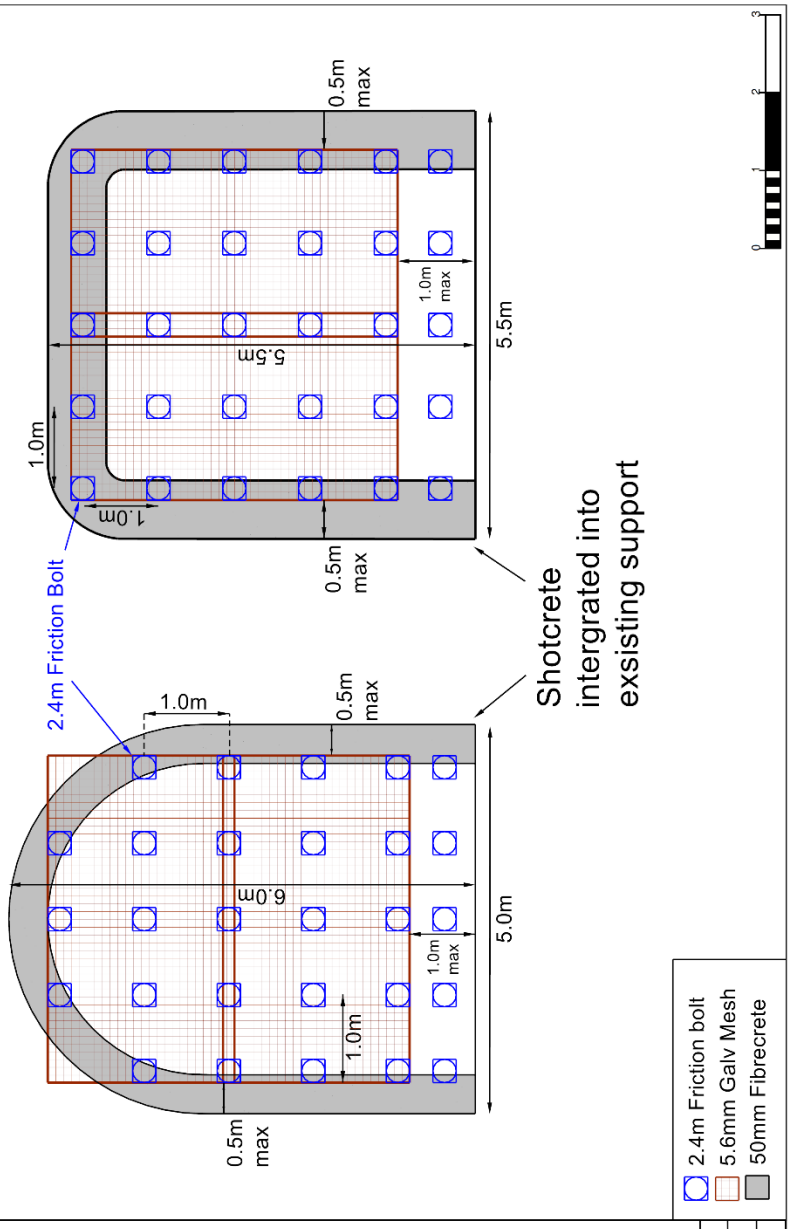
Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Face - Support Type F2.5

Support Elements

- Galvanised mesh sheets installed no higher than 1m above the floor to the backs and no more than 0.5m to each wall
- Black 2.4m Split set bolts on a 1.0m x 1.0m bolt spacing from floor to backs
- 50mm fibrecrete floor to backs integrates face support into exsisting ground support

Face Support - Diamond Drilling Location



Support Notes

- Ensure face is scaled thoroughly from top to bottom
- No person is to approach the face until it is fully supported
- All rockbolts to be installed with a combi plate
- Any faulty bolts must have a replacement bolt installed beside it
- Face mesh sheets must be integrated into long term support
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Face - Support Type F3

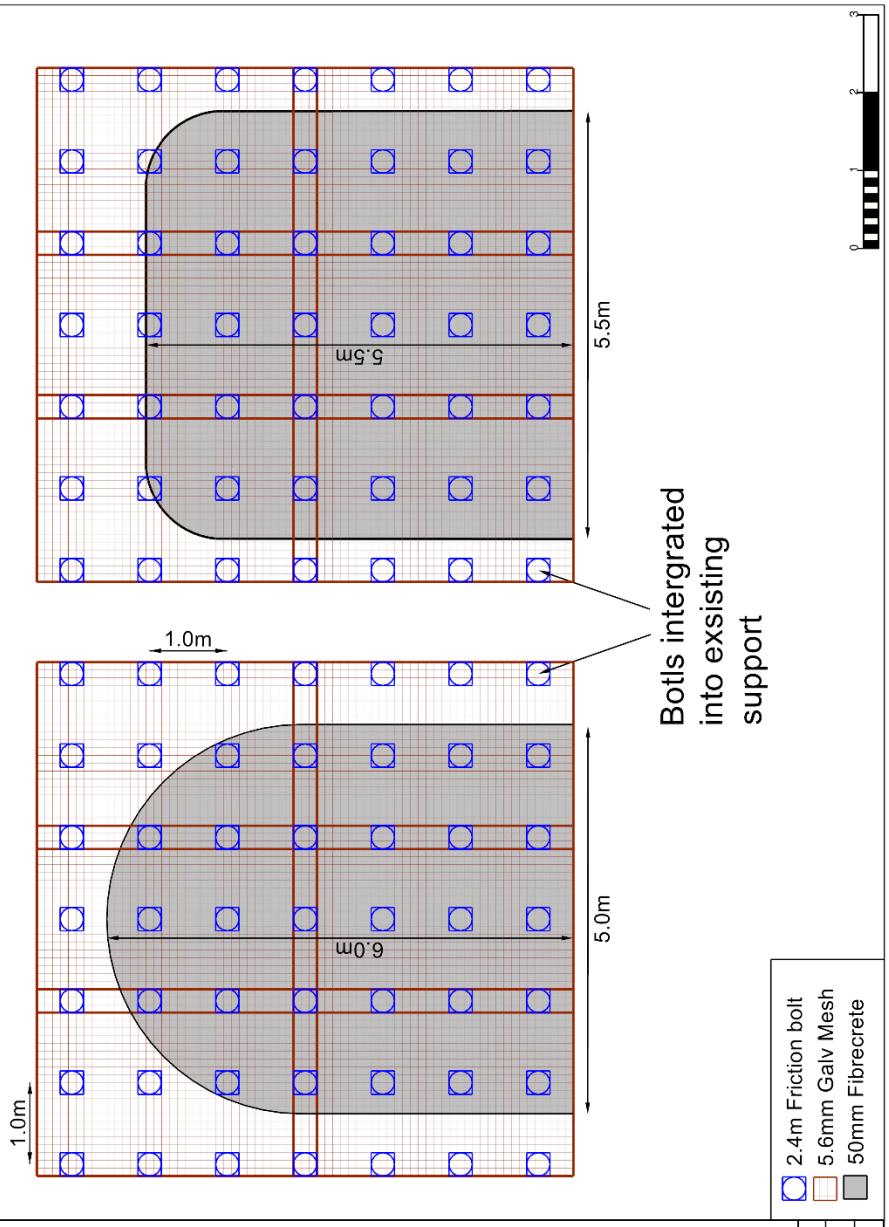
Face Support - Very Poor Ground/Stockpile Final Faces

Support Elements

- 50mm fibrecrete floor to backs
- Galvanised mesh sheets installed from floor to backs and no more integrated into exsisting support
- 2.4m Split set bolts on a 1.0m x 1.0m bolt spacing

Support Notes

- Ensure face is scaled thoroughly from top to bottom
- No person is to approach the face until it is fully supported
- All rockbolts to be installed with a combi plate
- Any faulty bolts must have a replacement bolt installed beside it
- Face mesh sheets must be integrated into long term support
- All sheets of mesh are to overlap by at least 3 squares, with the bolt in the middle (2nd row) of the overlap
- These rules are the minimum support requirement – additional support may be installed at the operators discretion



Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Spiling Bar - Support Type SB1

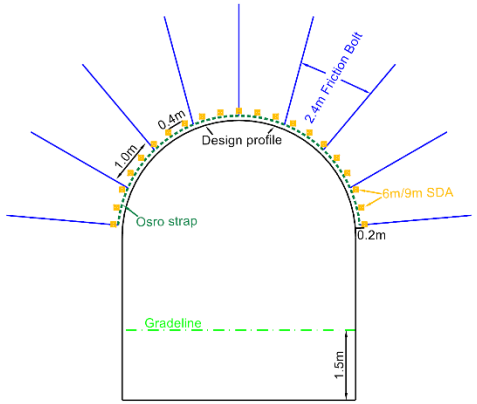
Support Elements

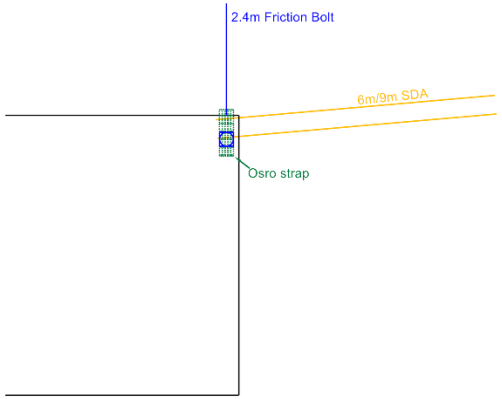
- R32 SDAs from shoulder to shoulder on 400mm spacing
- Tails of the SDAs to be pinned to the back with a 6m osro strap and 2.4m Split set bolts
- Rock support to be installed as per current standard from one of the P, T, C,S or SL support types

Support Notes

- No person is to work under unsupported ground
- SDAs to be installed 200mm above the design profile
- SDAs shall be a minimum of 6m length
- Install additional rod to make 9m length if poor ground is still encountered at the end of the 6m hole
- SDAs shall be fully encapsulated with GP cement grout or resin.
- Grout shall be allowed to cure a minimum 12 hours before advancing the face
- Resin shall be allowed to cure a minimum 1 hour before advancing the face
- SDAs shall run parallel to the drive gradient
- Maximum cut length is 2m advance
- Minimum 2m of spiling bar embedment required from end of development face
- These rules are the minimum support requirement – additional support may be installed at the operators discretion
- Refer to Design and Instillation of Spiling SOP for further details

Spiling Bar Support - Poor Ground





Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

- 2.4m Friction bolt
- Low Pressure Encapsulation R32 SDA
- Osro Strap

0 5

Spiling Bar - Support Type SB2

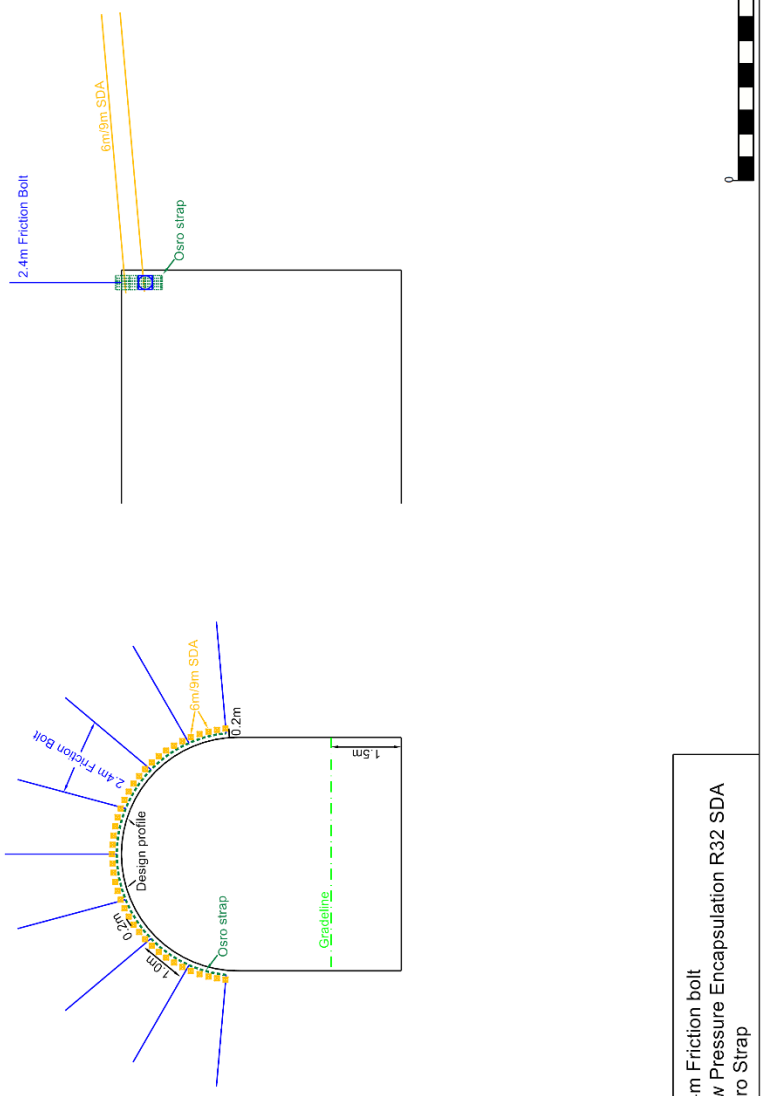
Support Elements

- R32 SDAs from shoulder to shoulder on 200mm spacing
- Tails of the SDAs to be pinned to the back with a 6m osro strap and 2.4m Split set bolts
- Rock support to be installed as per current standard from one of the P, T, C,S or SL support types

Support Notes

- No person is to work under unsupported ground
- SDAs to be installed 200mm above the design profile
- SDAs shall be a minimum of 6m length
- Install additional rod to make 9m length if poor ground is still encountered at the end of the 6m hole
- SDAs shall be fully encapsulated with GP cement grout or resin.
- Grout shall be allowed to cure a minimum 12 hours before advancing the face
- Resin shall be allowed to cure a minimum 1 hour before advancing the face
- SDAs shall run parallel to the drive gradient
- Maximum cut length is 2m advance
- Minimum 2m of spiling bar embedment required from end of development face
- These rules are the minimum support requirement – additional support may be installed at the operators discretion
- Refer to Design and Instillation of Spiling SOP for further details

Spiling Bar Support - Very Poor Ground



Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

- 2.4m Friction bolt
- Low Pressure Encapsulation R32 SDA
- Osro Strap

Spiling Bar - Support Type SB3

Support Elements

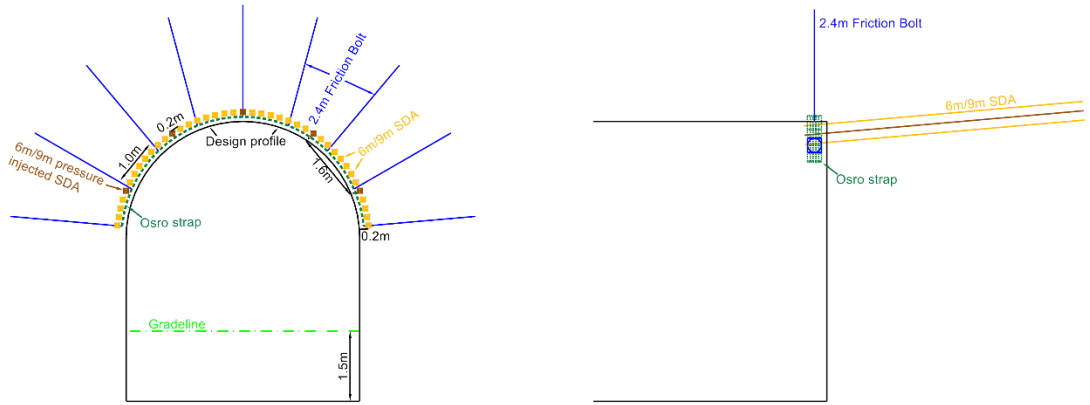
- R32 SDAs from shoulder to shoulder on 200mm spacing
- 5 pressure injected SDAs at 1.6m spacing
- Tails of the SDAs to be pinned to the back with a 6m osro strap and 2.4m Split set bolts
- Rock support to be installed as per current standard from one of the P, T, C,S or SL support types

Support Notes

- No person is to work under unsupported ground
- SDAs to be installed 200mm above the design profile
- SDAs shall be a minimum of 6m length
- Install additional rod to make 9m length if poor ground is still encountered at the end of the 6m hole
- SDAs shall be fully encapsulated with GP cement grout or resin.
- Grout shall be allowed to cure a minimum 12 hours before advancing the face
- Resin shall be allowed to cure a minimum 1 hour before advancing the face
- SDAs shall run parallel to the drive gradient
- Maximum cut length is 2m advance
- Minimum 2m of spiling bar embedment required from end of development face
- These rules are the minimum support requirement – additional support may be installed at the operators discretion
- Refer to Design and Instillation of Spiling SOP for further details

Designed By	M.McCulloch
Approved By	Jolyon Jardine
Date	27/11/2024

Spiling Bar Support - Extremely Ground



- 2.4m Friction bolt
- Round 1 Pressure Injected R32 SDA
- Round 2 Low Pressure Encapsulation R32 SDA
- Osro Strap

0 5

Temporary Development - Support Type B1

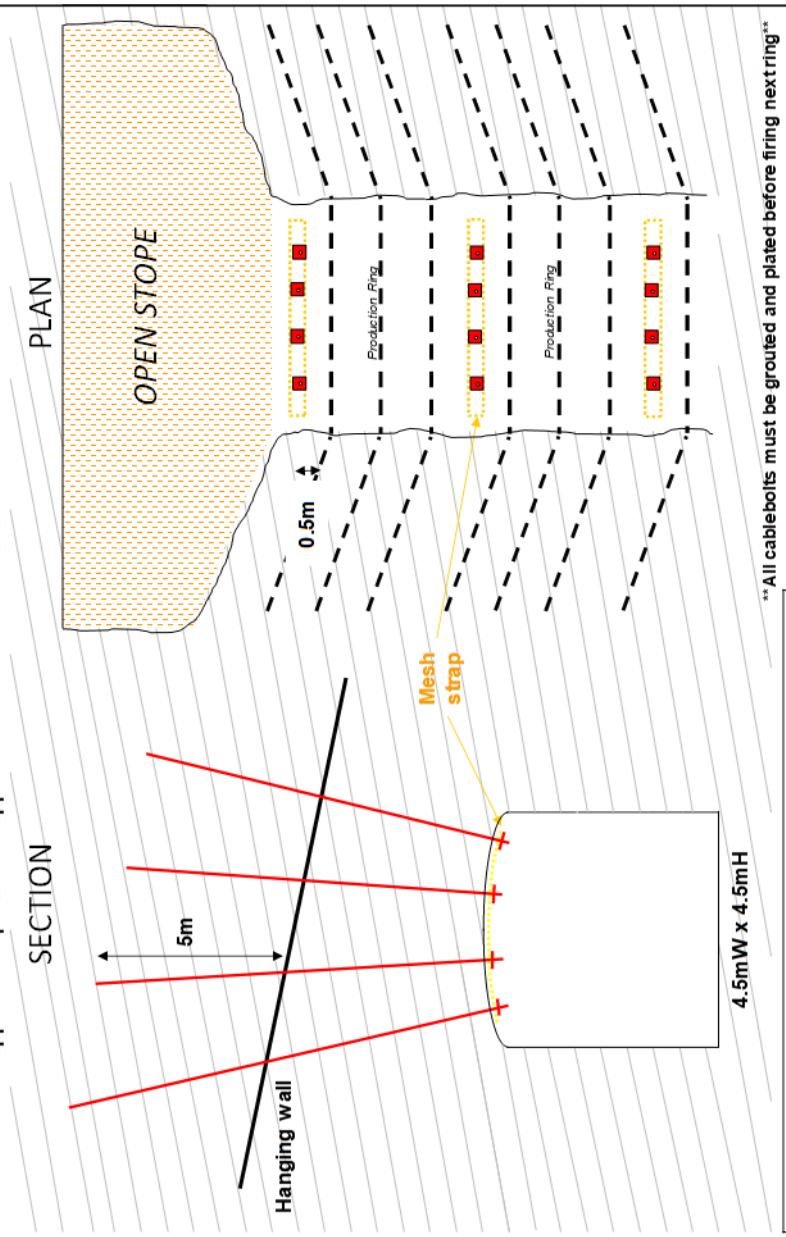
Ground Support – Stope Brow Support in Good to Fair Ground

Support Elements

- Rings of 4 twin strand cable bolts 0.7m back from every brow position, with a minimum of 5m embedment above the hanging wall
- Mesh strap running across each brow position, tied into cable bolts with tensioned cable bolt plates

Support Notes

- Open stopes are non-entry
- No person is to work under unsupported ground
- All cable bolts/rock bolts to be installed at 90º±20º to the planned profile
- Any faulty cable bolts must have a replacement bolt installed beside it
- All mesh straps to be held in place by cable bolt plates
- All cable bolts to be tensioned to 7t
- A minimum of two complete sets of brow support must be fully installed at all times during stoping. Three rows of complete brow support are required prior to firing the next rings



OCEANAGOLD

Ground Control Management Plan
Standard Ground Support Designs

Support Type B1: These rules are the minimum support requirement – additional support may be installed at the operators discretion	Designed:	Anthony Jones
	Approved:	James Isles

Temporary Development - Support Type B2

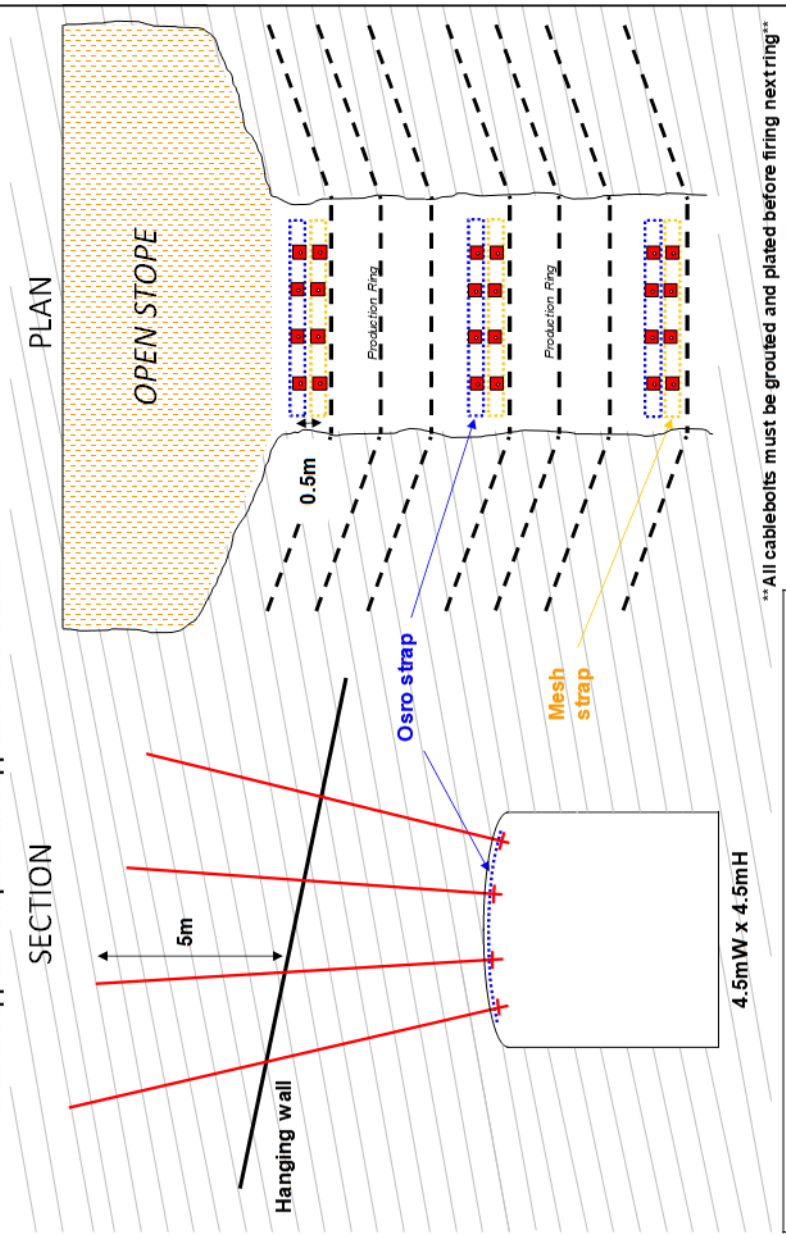
Ground Support – Stope Brow Support in Poor Ground

Support Elements

- Front ring of 4 twin strand cable bolts 0.7m back from every brow position, with a minimum of 5m embedment above the hanging wall
- A second ring of twin strand cable bolts positioned 0.5m behind the first ring of cable bolts
- Osro strap running across the front ring of brow cable bolts, tied into cable bolts with tensioned cable bolt plates
- Mesh strap running across the second ring of brow cable bolts, tied into cable bolts with tensioned cable bolt plates

Support Notes

- Open stopes are non-entry
- No person is to work under unsupported ground
- All cable bolts to be installed at 90° ±20° to the planned profile
- Any faulty cable bolts must have a replacement bolt installed beside it
- All brow straps to be held in place by cable bolt plates
- All cable bolts to be tensioned to 7t
- A minimum of two complete sets of brow support must be fully installed at all times during stoping. Three rows of complete brow support are required prior to firing the next rings



OCEANAGOLD **Ground Control Management Plan** Standard Ground Support Designs		
Support Type B2: These rules are the minimum support requirement – additional support may be installed at the operators discretion	Designed:	Anthony Jones
	Approved:	James Isles

Temporary Development - Support Type ICB

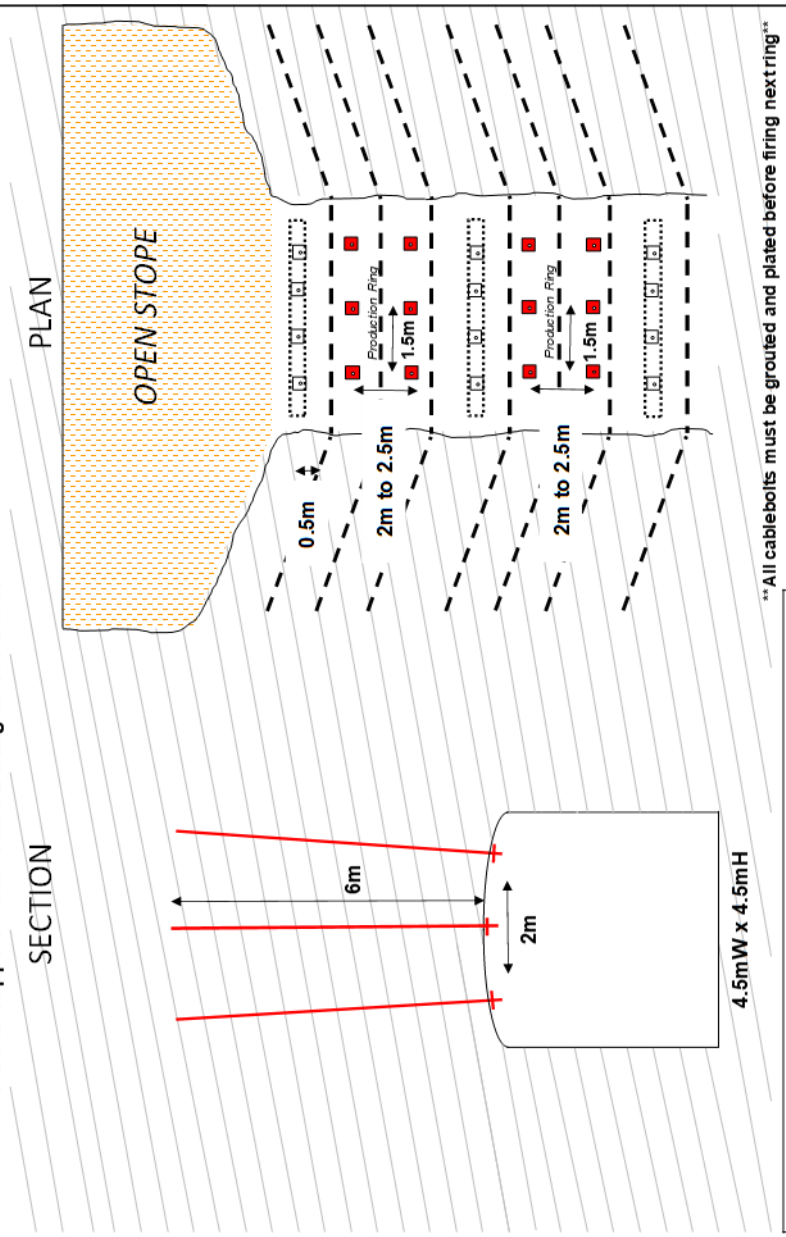
Ground Support – Infill Cable Bolting in Ore Drives

Support Elements

- 3 x 6m twin strand cable bolts, with a 1.5m bolt spacing
- Ring spacing between 2m to 2.5m

Support Notes

- Open stopes are non-entry
- No person is to work under unsupported ground
- All cable bolts to be installed at 90° ±20° to the planned profile
- Any faulty cable bolts must have a replacement bolt installed beside it
- All cable bolts to be tensioned to 7t



OCEANAGOLD **Ground Control Management Plan** Standard Ground Support Designs		
Support Type ICB: These rules are the minimum support requirement – additional support may be installed at the operators discretion	Designed:	Anthony Jones
	Approved:	James Isles

13.2 Trigger Action Response Plans

OCEANAGOLD	Development Ground Conditions - Active TARP			
	Triggers			
Question:	**Green - Level 1**	**Yellow - Level 2**	**Orange - Level 3**	**Red - Level 4**
Scaling	hard <0.5 if fall out past design profile	0.5-1.0m of fall out past design profile	soft 1.-1.4m of fall out past design profile	excessive causing major fallout 1.5m+ past design profile
Overbreak	less than 0.5m past design profile	0.5-1.0m of fall out past design profile	1.-1.4m of fall out past design profile	1.5m+ of fall out past design profile
Feed Pressure	constant pressure	adjusted pressure	reduced pressure	minimum pressure
Rods Bogging	none	rare	intermittent	frequent
Bolting Splitsets	positive restistance, 15-20 second install time	positive restistance, 15-20 second install time	little pressure required for three or more and less than 15 second install time	no precussion required when installing 3 or more splitsets and less than 15 second install time
Bolting MDs	All Anchor	All Anchor	Two or less mds not anchoring	Three or more MDs not anchoring
Voids	None present	No Notable	Minor (<=0.3m)	Significant (>0.3m)
Ground Water	None	Damp	Wet	Pouring
Ground Noise	No Noise	No Noise	Isolated non regular noise occuring at more than 15 minute intervals	Noise at regular intervals (more than every 15 minutes)
Plates popping in previous three cuts?	None Popped	None Popped	1 x Popped bolt	More than one popped
Bolt and Mesh deformation in previous three cuts?	None	None	Visible	Bagging behind mesh or mesh strands breaking
Shotcrete cracking in previous three cuts?	No shotcrete cracks	Hairline fractures	Cracks up to 5mm thick	Cracks greater than 5mm thick
Trigger Actions Responses for Above Triggers (Responsibilities)				
Operators (jumbo, solo, production)	• Continue with minimum support standard – Level 1	• Upgrade ground support standard to level 2 • Note change in conditions on SIMBIO Reports	• Upgrade ground support standard to level 3 • Note change in conditions on SIMBIO Reports • Inform Shift supervisor	• Immediately barricade affected area • Immediately inform shift supervisor
Shift Supervisor	• No action required	• Inspect heading and ensure support is adequate	• Inform geotechnical department • Inspect heading and ensure support is adequate	• Inform geotechnical department • Inspect heading and ensure area is made safe, ground support can be installed if safe to do so. • Photograph walls/backs/face before shotcrete application if applicable • Development advance to halt until geotechnical assessment completed

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Rehabilitation Ground Conditions - Active TARP

Question:	Triggers		
	Green - Level 1	Orange - Level 2	Red - Level 3
Scaling	<1.0m of fall out	soft 1.-1.5m of fall out	excessive causing major fallout >1.5m
Feed Pressure	constant to adjusted pressure	reduced pressure	minimum pressure
Rods Bogging	none	intermittent	frequent
Bolting Splitsets	positive restistance, 15-20 second install time	little pressure required for three or more over a single cut and less than 15 second install time	no precussion required when installing 3 or more splitsets and less than 15 second install time
Bolting MDs	All Anchor	Three or less mds not anchoring over a single cut	Four or more MDs not anchoring over a single cut
Voids	None present	Minor <=0.3m	Significant >0.3m
Ground Water	None to wet	None to wet	Pouring
Ground Noise	None	Isolated non regular noise occuring at more than 5 minute intervals	Noise at regular intervals (less than every 5 minutes)
Cable Bolts Condition	none or Isolated stressed cable bolts	Isolated popped or stressed cable bolts >3m apart	Multiple popped cable bolts within 3m of one another
Trigger Actions Responses for Above Triggers (Responsibilities)			
Jumbo Operator	• Continue with current rehab plan	• Note change in conditions on SIMBIO Reports • Inform Shift supervisor • Paint up areas of concern	• Immediately barricade affected area • Immediately inform shift supervisor
Geotechnical Department	• Inspect area once rehab is completed and check completion to plan	• Inspect area and create plan for additional ground support as required	• Inspect area and created rehab plan that ensures that the appropriate support is installed before advancing
Shift Supervisor and Mining Superintendent	• Inspect area once rehab is completed and check completion to plan before opening area to other personnel	• Inspect area and ensure appropiate support is being installed for ground conditions • Inspect area once rehab is completed and check completion to plan before opening area to other personnel	• Ensure area remains barricaded and personnel are made aware of the hazards • Inspect heading and ensure area is made safe, ground support can be installed if safe to do so.

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OCEANAGOLD	Development Face Conditions - Active TARP				
	Triggers				
Question:	**Blue - Level 1**	**Green - Level 2**	**Yellow - Level 3**	**Orange - Level 4**	**Red - Level 5**
Feed Pressure	Constant pressure	Adjusted pressure	Adjusted pressure	Reduced pressure	Minimum pressure
Rods Bogging	None	Rare	Rare	Intermittent	Frequent
Bolting Splitsets	Positive restistance, 15-20 second install time	Positive restistance, 15-20 second install time	Positive restistance, 15-20 second install time	Little pressure required for three or more and less than 15 second install time	No precussion required when installing 3 or more splitsets and less than 15 second install time
Voids	None present	No Notable	No Notable	Minor (<=0.3m)	Significant (>0.3m)
Ground Water	None to wet	None to wet	None to wet	None to wet	Pouring
Face Position	Continued development planned	Final non stockpile face, no more planned development	Continued development planned but diamond drilling planned from current face position	Final stockpile face, no more planned development	N/A
Trigger Actions Responses for Above Triggers (Responsibilities)					
Operators (jumbo, solo, production)	Continue with minimum support standard Level 1	Upgrade ground support standard Level 2	Upgrade ground support standard to level 2.5	Upgrade ground support standard to level 3	• Immediately Barricade affected area • Immediately inform shift supervisor • Senior technical personnel to inspect before re-entry
Shift Supervisor	• No action required	• Inspect heading and ensure support is adequate	• Inspect heading and ensure support is adequate	• Inform geotechnical department • Inspect heading and ensure support is adequate	• Inform geotechnical department • Inspect heading and ensure area is made safe, ground support can be installed under JHA. • Photograph face before shotcrete application if applicable • Development to halt until geotechnical assessment completed

OCEANAGOLD	Development Spiling - Active TARP				
	Triggers				
Question:	**Blue - Level 1**	**Green - Level 2**	**Yellow - Level 3**	**Orange - Level 4**	**Red - Level 5**
Development Ground Conditions	Green or yellow level on development ground conditions TARP	Orange level on development ground conditions TARP	Orange level on development ground conditions TARP	Orange level on development ground conditions TARP	Red level on development ground conditions TARP
Face Ground Conditions	Blue level on face conditions TARP	Green or yellow level on face conditions TARP	Orange level on face ground TARP	Red level on face conditions TARP	Red level on face conditions TARP
Face Period	Face been less than a month	Face has been sitting for more than a month	N/A	N/A	N/A
Trigger Actions Responses for Above Triggers (Responsibilities)					
Operator -	• No spiling required	• Upgrade support standard to Level 1	• Upgrade ground support standard to level 2	• Upgrade ground support standard to level 3	• Inform geotechnical department • Development to halt until geotechnical assessment completed

OCEANAGOLD	Open Stope Stability - Active Production TARP		
	Triggers		
Question:	**Green - Level 1**	**Orange - Level 2**	**Red - Level 3**
Pillar Condition and Rock Fall/Noise	No signs of potential or actual pillar failures from CMS or observation **and;** No unexplained and continuous rock fall/noise occurring in stope	Signs of potential or actual pillar failures from CMS or observation **or;** Unexplained and continuous rock fall/noise occurring in stope	Signs of potential or actual pillar failures from CMS or observation **and;** Unexplained and continuous rock fall/noise occurring in stope
Bunding	Sufficient catchment between bund and any rill material **and;** bund built to standard	Insufficient catchment between bund and any rill material **or;** bund not built to standard (size and position)	No Bund (unless brow choked)
Trigger Actions Responses for Above Triggers (Responsibilities)			
All UG personnel	• Check stope status board daily • Standard Production procedures to be followed • Any hazardous changes in open stope conditions report to your shift supervisor and change the sign to orange or red	• Check stope status board daily • Get permission from shift supervisor if entry is required – understand any hazards • Continuously check for any open stope condition triggers • Any hazardous changes in open stope conditions leave area, change sign to red and report to your shift supervisor immediately	• Check stope status board daily • Stay out of barricaded area unless mine manager has given permission • If authorized by mine manager, inform shift supervisor before and after entering area
Technical Personnel or Shift Boss	• Update stope status board with any new information or hazards • Inspect open stopes daily • Ensure correct signage and traffic light is in place	• Update stope status board with any new information or hazards • Inspect open stope before any work commences in drive • Conduct regular inspections throughout shift • Ensure correct signage and traffic light is in place	• Update stope status board with any new information or hazards • Stay out of barricaded area unless authorized by mine manager • If authorized by mine manager, inform shift supervisor before and after entering area

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OCEANAGOLD	Production Drive Stability - Active Production TARP		
	Triggers		
Question:	**Green - Level 1**	**Orange - Level 2**	**Red - Level 3**
Ground Movement	Ground movement rate < 5mm/day	Ground movement rate > 5mm/day	Ground movement rate longer installed to the c likely to lead to any rocl Ground movement >15r
Ground Support	Ground support remains installed to the correct standard	Ground support is no longer at the correct standard but at a level not likely to lead to any rock fall	Ground support is no lo could lead to a rock fall
Plates Popping	none or Isolated stressed or popped plates > 5m apart not replaced by a rehab bolt	Isolated plates popping < 5m apart not replaced by a rehab bolt	> 3 popped plates in a s bolt or multiple plates p
Rock Noise	No active ground noise	Isolated non regular noise occurring at more than 5 minute intervals	Isolated non regular noi intervals
Production Holes	No closure of holes	<25% of holes collapsed or cut off	>25% of holes collapsed
Rock Build up Behind in Mesh	Minimal or no loose rock behind mesh – no "bagging"	Loose rock building up behind mesh, some areas beginning to "bag"	Severe "bagging" in the
Drill Holes	All drill holes are open	Drill holes are partially closed, some holes completely closed	All or most drill holes ar
Water	No new water coming from rock	change in water coming from rock	severe change in water
	Trigger Actions Responses for Above Triggers (Responsibilities)		
All UG personnel	• Check stope status board daily • Standard Production procedures to be followed • Any hazardous changes in open stope conditions report to your shift supervisor and change the sign to orange or red	• Check stope status board daily • Change traffic light to Orange and ensure chain is located to isolate the hazard • Get permission from shift supervisor if entry is required – understand any hazards • Continuously check for any open stope condition triggers • Any hazardous changes in open stope conditions leave area, change sign to red and report to your shift supervisor immediately	• Check stope status bo • Change traffic light to isolate the hazard • Stay out of barricaded given permission • If authorized by mine before and after enterir
Technical Personnel or Shift Supervisor	• Update stope status board with any new information or hazards • Inspect open stopes daily • Ensure correct signage and traffic light is in place	• Update stope status board with any new information or hazards • Inspect open stope before any work commences in drive • Conduct regular inspections throughout shift • Ensure correct signage and traffic light is in place	• Update stope status b hazards • Stay out of barricaded manager • If authorized by mine before and after enterir

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Brow Stability - Active Production TARP

Triggers

Question:	Green - Level 1	Orange - Level 2	Red - Level 3
Brow Cables	Brow cable bolts unstressed and fully confined	Brow cable bolts are stressed but confined **or;** Brow cable bolts are not stressed but partially unconfined	Brow cable bolts are badly stressed or "popped" **or;** Brow cable bolts are stressed and partially unconfined **or;** Brow cable bolts are fully unconfined
Wall stability	No wall failure or wedges at brow	Minor wall failure or wedges at stope brow effecting front ring of next blast	Significant wall failure or wedges at stope brow effecting front 2 rings of next blast
Trigger Actions Responses for Above Triggers (Responsibilities)			
All UG personnel	• Check stope status board daily • Standard Production procedures to be followed • Any hazardous changes in open stope conditions report to your shift supervisor and change the sign to orange or red	• Check stope status board daily • Change traffic light to Orange at safe brow location • Get permission from shift supervisor if entry is required – understand any hazards • Continuously check for any open stope condition triggers • Any hazardous changes in open stope conditions leave area, change sign to red and report to your shift supervisor immediately	• Check stope status board daily • Stay out of barricaded area unless mine manager has given permission • If authorized by mine manager, inform shift supervisor before and after entering area • Production loading can occuer with shift supervisor review if deemed safe to do so
Technical Personnel or Shift Supervisor	• Update stope status board with any new information or hazards • Inspect open stopes daily • Ensure correct signage and traffic light is in place	• Update stope status board with any new information or hazards • Inspect open stope before any work commences in drive • Conduct regular inspections throughout shift • Ensure correct signage and traffic light is in place	• Update stope status board with any new information or hazards • Stay out of barricaded area unless authorized by mine manager • If authorized by mine manager, inform shift supervisor before and after entering area

OCEANAGOLD	Pre-Production Ground Conditions - Stope Design TARP			
	Triggers			
Question:	**Green - Level 1**	**Yellow - Level 2**	**Orange - Level 3**	**Red - Level 4**
Profile	less than 0.5m past design profile	0.5-1.0m of fall out past design profile	1.-1.4m of fall out past design profile	1.5m+ of fall out past design profile
Water	None	Damp	Wet	Pouring
Structures	No major structures (faults, jointing)	Minor structures present in backs or walls	Major structures present in backs or walls but could be managed by ground support	Major structures are present in backs or walls and not easily managed by ground support
Ground Stress	No visible ground stress (plates "popping", rock noise)	Minor visible ground stress (plates "popping", rock noise)	Ground is stressed, some plates are popping in the area, some isolated rock noise	Ground is stressed, multiple plates popping, regular ground noise
Predicted Ground Stress	No predicted ground stress	No predicted ground stress	Area is predicted to come under ground stress	Area is predicted to come under significant ground stress
Trigger Actions Responses for Above Triggers (Responsibilities)				
Geotechnical Department	Continue with minimum support standard – Level 1	Upgrade brow support standard to level 2	Upgrade brow support standard to level 2 Infill cable bolts required Reposition brow if practicable or create specific brow support.	Not suitable to be a brow position

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OCEANAGOLD	Convergence Monitoring - Active TARP				
	Triggers				
Question:	**Blue - Level 1**	**Green - Level 2**	**Yellow - Level 3**	**Orange - Level 4**	**Red - Level 5**
Monitoring	<1mm per day convergence	Between 0.1 – 2mm/day convergence **or;** Between 0-2mm/day convergence in the golden point fault zone	Between 2 – 5mm/day convergence **or;** Between 2 - 4mm/day convergence in the golden point fault zone	Between 5 – 15mm/day convergence **or;** 4-6mm/day convergence in the golden point fault zone	>15mm/day convergence **or;** >5mm/day and ground support no longer installed to the correct standard but at a level not likely to lead to any rock fall **or;** >6mm/day in the golden point fault zone
Trigger Actions Responses for Above Triggers (Responsibilities)					
All UG Personnel	Report changes in ground conditions to shift supervisor and on workplace inspections	Report changes in ground conditions to shift supervisor and on workplace inspections	Report any changes in ground conditions to shift supervisor and on workplace inspections	Every person entering drive to conduct full drive inspection before starting work Report any changes in ground conditions to shift supervisor and on workplace inspections	Stay out of barricaded areas unless the correct authorisation has been granted
Shift Supervisor and Superintendent	N/A	N/A	N/A	Inspect area when geotechnical engineers are unavailable	Ensure area remains barricaded and all personnel are made aware of the hazards
Geotechnical Department	Three monthly measurements and visual inspections	Monthly measurements and visual inspections, review total movement	Two weekly measurements and visual inspections, review total movement	Weekly measurements and visual inspections, add to hazard board and inform workforce, review total movement	Daily measurements and visual inspections, (if required and safe to do so), add to hazard board, determine level of barricade, review total movement
Underground Mine Manager	N/A	N/A	N/A	N/A	Enforce No Entry procedure on area

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OCEANAGOLD	Development Pull Testing Friction and MD Bolts- Active TARP			
	Triggers			
Question:	**Green - Level 1**	**Yellow - Level 2**	**Orange - Level 3**	**Red - Level 4**
Pull Testing Results	Pull test achieves at least 90 percent design load (7.2t Friction bolt) (16.2t MD bolt)	Pull test failure between 80 to 90 percent of bolt strength (6.4-7.2t Friction bolt) (14.4 -16.2t MD bolt) **and;** Level 1 ground support installed	Pull test failure between 50 and 80 percent of bolt strength (4.0 - 6.4t Friction Bolt) (9.0-14.4t MD bolt) **and;** Level 1 or level 2 ground support installed	Pull test failure less than 50 percent of bolt strength (< 4.0t Friction bolt) (< 9t MD bolt)
Trigger Actions Responses for Above Triggers (Responsibilities)				
Person Pull Testing	• Record pull test results and install information tag on tested bolt • Report results to Geotechnical department	• Record pull test results and install information tag on tested bolt • Conduct additional tests on nearest pull rings to failure • Notify Shift Supervisor and Geotechnical Engineer	• Record pull test results and install information tag on tested bolt • Conduct additional tests on nearest pull rings to failure • Notify Shift Supervisor and Geotechnical Engineer	• Immediately inform shift supervisor • Record pull test results and install information tag on tested bolt • Conduct additional tests on nearest pull rings to failure • Notify shift supervisor and Geotechnical Engineer
Geotechnical Department	• Report results quarterly	• Report results quarterly • Inspect area of pull test failure and determine cause of failure • Ensure at least level 2 ground support or greater is installed or effective spot cable bolting is installed	• Report results quarterly • Inspect area of pull test failure and determine cause of failure • Ensure at least level 3 ground support or effective spot cable bolting is installed	• Report results quarterly • Inspect area of pull test failure and determine cause of failure • Design specific rehab plan for safe recovery • Conduct investigation into failure and develop corrective actions to prevent recurrence • Report failure to Mine Manager
Shift Supervisor	• No action required	• Ensure extra ground support is installed as instructed by geotechnical engineer	• Ensure extra ground support is installed as instructed by geotechnical engineer	• Barricade area off and restrict personnel entry • Ensure extra ground support is installed as instructed by geotechnical engineer

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OCEANAGOLD	Development Pillar Conditions - Active TARP		
	Triggers		
Question:	**Green - Level 1**	**Orange - Level 2**	**Red - Level 3**
Ground Conditions	Green TARP level on development ground conditions TARP	Yellow TARP level on development ground conditions TARP	Orange or Red TARP level on development ground conditions TARP
Geological Structures	None	Minor and not directly stricking through pillar	Major **or;** minor and striking through pillar
Ground movement	Not likely to experience significant ground movement	Expected to experience significant ground movement	N/A
Traffic	Not a high traffic area	High traffic pillar	N/A
Trigger Actions Responses for Above Triggers (Responsibilities)			
Geotechnical Department	Continue with minimum support standard Level 1	Upgrade ground support standard to level 2	Area not suitable for a development pillar **or;** Specific ground support design required

OCEANAGOLD	Development Intersection - Active TARP			
	Triggers			
Question:	**Green - Level 1**	**Yellow - Level 2**	**Orange - Level 3**	**Red - Level 4**
Ground Conditions	Green level on development ground conditions TARP 6m either side of the planned centreline	Yellow level on development ground conditions TARP 6m either side of the planned centreline	Yellow level on development ground conditions TARP 6m either side of the planned centreline	Orange or Red level on development ground conditions TARP 6m either side of the planned centreline
Geological Structures	None	Minor <100mm and not likely to cause significant overbreak	Moderate <200mm likely to cause moderate overbreak	Major >200mm or likely to cause significant overbreak
Wedge Development	None or minor (<5t) wedge in planned intersection	minor to moderate (5-20t) wedge in planned intersection	Moderate to significant (20-50t) wedge in planned intersection	Major (>50t) wedge in planned intersection
Development Type	General access	General access	Strategic openings	N/A
Trigger Actions Responses for Above Triggers (Responsibilities)				
Geotechnical Department	• Review geological and geotechnical information • Continue with minimum support standard Level 1	• Review geological and geotechnical information • Upgrade ground support standard to level 2	• Review geological and geotechnical information • Upgrade ground support standard to level 3 **and;** • Consider moving intersection location	• Review geological and geotechnical information • Area not suitable for a development intersection **or;** • Specific ground support design required

OCEANAGOLD	Corrosion - Active TARP				
	Triggers				
Question:	**Blue - Level 1**	**Green - Level 2**	**Yellow - Level 3**	**Orange - Level 4**	**Red - Level 5**
Visible corrosion	No visible corrosion	Minor visible corrosion	Moderate visible corrosion	High visible corrosion	Very high visible corrosion
Loss of Ground Support	No loss of mesh cross-sectional area	<10% loss of mesh cross-sectional area	10-25% loss of mesh cross-sectional area	10-25% loss of mesh cross-sectional area	>25% loss of mesh cross sectional area
Air Condition	Air is fresh or return but not foggy	Air is fresh or return but not foggy	Air is fresh or return but not foggy	air is foggy, stagnant or condensation evident on ground support	N/A
Ground Support Age	Black ground support <1 year installed	Black ground support 1-1.5 year installed	Black ground support 1.5-1.75 year installed	Black ground support >1.75 year installed	Black ground support >2 year installed
Trigger Actions Responses for Above Triggers (Responsibilities)					
All UG Personnel	Report changes in corrosion conditions or changes in air quality to shift supervisor and on workplace inspections	Report changes in corrosion conditions or changes in air quality to shift supervisor and on workplace inspections	Report changes in corrosion conditions or changes in air quality to shift supervisor and on workplace inspections	Report changes in corrosion conditions or changes in air quality to shift supervisor and on workplace inspections	Stay out of barricaded areas unless the correct authorisation has been granted
Supervisor and Mining Superintendent	N/A	N/A	N/A	N/A	Ensure area remains barricaded and all personnel are made aware of the hazards
Geotechnical Department	Assess any changes in corrosion level	12 monthly geotechnical corrosion assessment	6 monthly geotechnical corrosion assessment	3 Monthly geotechnical corrosion assessment	• Ensure that drive is immediately barricaded with no entry • Manage no entry system including risk assessment • Conduct geotechnical assessment and report findings to all personnel

G:\Geotechnical Engineering\Ground control Management Plan

OCEANAGOLD	Geotechnical Visual Inspection - Active TARP			
	Triggers			
Question:	**Green - Level 1**	**Yellow - Level 2**	**Orange - Level 3**	**Red - Level 4**
Shotcrete	Minor cracking <30mm	Moderate cracking 30-50mm	Major cracking 50-100mm	Severe cracking >100mm
Ground Support	Ground support in place and at the required standard	Ground support in place and not to the required standard, but not likely to lead to a fall of ground	Ground support in place, but not to the required standard and could lead to a fall of ground	Ground support not in place
Mesh bagging	No bagging of mesh or shotcrete	Minor bagging of mesh	Moderate bagging of mesh	Major bagging of mesh
Corrosion	None to high	None to high	None to high	Major
Ground Type	Galv or black <2 years old	black 1.5-2 years old	N/A	Black >2 year old
Ground water	Dry to moderate explained flow	N/A	N/A	Significant unexplained inflow of water
Rock bolts	Isolated stressed split set, MD or DCS bolts	Isolated stressed or popped split set, MD or DCS bolts	More than 10 popped split set, MD **or** DCS bolts within 10m **or;** Multiple popped along a single mesh join **or;** clusters of more than 4 popped adjacent bolts	Rock bolts compromised to the point a fall of ground is imminent
Cable bolts	None present or no signs of stress	Isolated popped or stressed cable bolts	Multiple stressed and popped cable bolts	Multiple popped cable bolts within 3m of one another
Geotechnically Unstable Ground	Significant structures present (Soft/Weak Fault zones) and adequately supported with longer support (SDA/Cables) and support intact.	Significant structures present (Soft/Weak Fault zones) but adequately supported with longer support (SDA/Cables) and support stressed or damaged.	Significant structures present (Soft/Weak Fault zones) and adequately supported with longer support (SDA/Cables), but support is compromised.	Significant structures present (Soft/Weak Fault zones) and not adequately supported with longer support (SDA/Cables).
Trigger Actions Responses for Above Triggers (Responsibilities)				
Geotechnical Department	• Continue development inspections as per schedule • Fill out inspections sheets	• Develop rehab plans, risk assessment and schedule work • Update development inspection schedule • Fill out inspections sheets	• Ensure that drive is immediately barricaded with no unauthorised entry and unsupported ground • Develop rehab plans, risk assessment and schedule work • Update development inspection schedule • Fill out inspections sheets	• Ensure that drive is immediately barricaded with no entry • Manage no entry system including risk assessment • Conduct geotechnical assessment and report findings to all personnel • Develop rehab plans, risk assessment and schedule work • Update development inspection schedule • Fill out inspections sheets
UG Supervisor and Mining Superintendent	• Report any changes in ground conditions to the geotechnical department	• Report any changes in ground conditions to the geotechnical department • Ensure that hazard is communicated to crews and hazard board updated • Allow resources so that rehabilitation is completed in the appropriate time frame	• Report any changes in ground conditions to the geotechnical department • Ensure that hazard is communicated to crews and hazard board updated • Ensure that personnel stary out of barricaded area unless authorised to do so • Allow resources so that rehabilitation is completed in the appropriate time frame	• Report any changes in ground conditions to the geotechnical department • Ensure that hazard is communicated to crews and hazard board updated • Ensure that personnel stary out of barricaded area unless authorised to do so • Allow resources so that rehabilitation is completed in the appropriate time frame

13.3 Shotcrete and General Purpose Concrete Mix Designs

OceanaGold Frasers Underground 40MPa Shotcrete Mix Design

Per m3

Cement (HES)	451kg
Silica Fume	30kg
7mm Aggregate	184kg
Sand	1487kg
Water	180L
W/C Ratio	0.4
Glenium 79	3.75L
Delvocrete	1L
Fibres	6kg
Ideal Spraying Slump	170mm +/- 20mm

OceanaGold Frasers Underground 35MPa General Purpose Mix Design

Per m3

Cement (HES)	355kg
13mm Aggregate	570kg
19mm Aggregate	610kg
Sand	773kg
Water	125L
W/C Ratio	0.35
Glenium 79	Carry on agi to adjust slump if required
Delvocrete	Add 1L per cube if delayed
Ideal Slump	100mm

13.4 No Entry Authorisation Forms

NO ENTRY AUTHORISATION FORM

Date: .....

"No Entry" Area / Location: .....

Reason "No Entry" sign placed: Report Name.....

Reason for re-entry: .....

LIKELIHOOD	CONSEQUENCES				
	First Aid	MTI	LTI	Permanent Injury	Fatality
Almost Certain	11	16	20	23	25
Likely	7	12	17	21	24
Possible	4	8	13	18	22
Unlikely	2	5	9	14	19
Rare	1	3	6	10	15

Low (Risk Score 1-5): *Managed by routine procedures such as Stop and Think.*

Medium (Risk Score 6-12): *Supervisor must sign off on task. A procedure or JHA is required.*

High (Risk Score 13-20): *JHA required with Superintendent or Manager sign off. A PHMP must be in place.*

Extreme (Risk Score 21-25): *Alternative methods of work must be considered. Risk needs to be lowered to a more acceptable level.*

Existing Scenario			Controlled Scenario	
Hazard Identified	Existing Controls	Risk	Additional Controls Identified	Risk

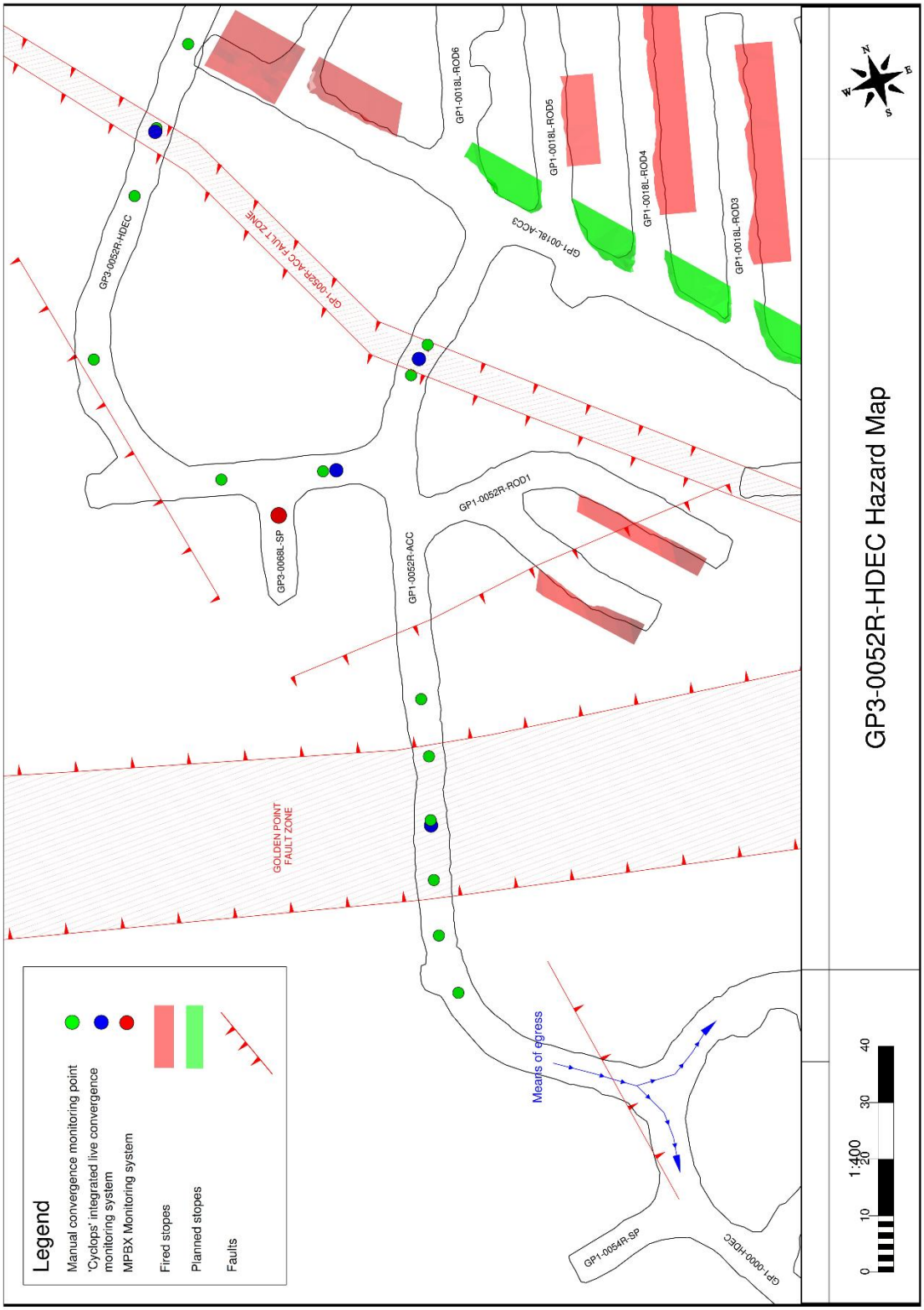
	Name	Signature	Date
Shift Supervisor:			
Mine Manager Authorisation:			
Authorisation For:			

MAC-440-FOR-022

13.5 Rockbolt and Cable Bolt Grout Mix Guidelines

Water to Cement Ratio	Grout Characteristics at Grout hose	Grout Characteristic When Handled	Next Steps
<0.30	Dry stiff structure	Tube fractures when bent and is too dry to stick to the glove. Can be rolled into balls	Too dry Add water
0.30	Moist tube structure, which melts slightly with time.	Tube of grout is fully flexible, and grout will stick to the glove. Rolls into soft wet balls.	Too dry Add water
0.35	Wet tube structure that melts away with time.	Grout sticks readily to the glove when upturned.	Ideal Mixture for cable bolter
0.40	Tube structure is lost immediately, to form a pancake.	Grout sticks to the glove but can be shaken free	Ideal Mixture for hand installed bolts
>0.40	Grout flows readily and splashes on impact.	Grout will drip from the glove	Too wet Add cement

13.6 Example of Hazard Map



13.7 Ground Condition Rating (GCR)

The Ground Condition Rating (GCR) is a rock mass rating scale (1-5) developed specifically for Macraes underground operations The definitions below can be used to assign GCR based either on geological face mapping observations, blast hole drilling, or rock bolting:

GCR	Face Mapping Observations	Rock Bolting-Drill Observations	Equiv. Q	Equiv. RMR	PSM Rock Mass Class	Equiv. GSI	Equiv. RQD
1 Very Strong	Intact or massive psammite, can only be chipped with rock hammer, joints are widely spaced and not very prominent, joint surfaces are rough and undulating, tight with no or very little joint alteration. No faulting. Hanging wall is not present in face or backs.	Good consistent drilling in hard ground	10 + Good	65 + Good to Very Good	**A** Lithified rock with frequent defects and rare shearing	65 (55-75)	100% Excellent
2 Strong	Blocky, requires several blows to fracture with rock hammer. Joints spaced 0.3m to 1m, not polished or slickensided, infill < 5 mm.. This is better than average ground, solid with no obvious faults or close jointing, more common in stockwork headings in between Hanging Wall and Lower zone lodes.	Softer ground, but not bogging steels.	4-10 Fair	55-65 Fair to Good			75-90% Good
3 Fair	Blocky/disturbed, joints are closely spaced (>0.3 m) with smooth and planar surfaces, some joint alteration present. May be several obvious joint sets. Some small faults may be present (<10 mm thick) but the face looks hard with no major features or softer than normal rock. Minimal overbreak.	Ground drills on low pressure with occasional/rare bogged steel.	1-4 Poor	40-60 Fair	**B** Fractured rock with frequent defects and some shearing	55 (45-65)	50-75% Fair
4 Very Weak	Disintegrated, rock crumbles when hit. Joints closely spaced, unfavourably oriented, open, altered, or slickensided. Faults common with gouge thickness 10-100 mm. Seepage flow may be present. These faces usually have either a rock unit that is softer than average for that lithology; or a fault or joint where rock has fallen out below creating overbreak.	Very poor ground with frequent bogging of rods. Bolts/splitsets hammer in twice as fast as they would in competent ground.	0.1-1 Very Poor	20-40 Poor	**C** Fractured to fragmented rock with frequent shearing	30 (20-40)	25-50% Poor
5 Extremely Weak	Laminated/highly sheared rock mass, intense alteration (rotten), open fractures, multiple large continuous and persistent faults (thickness > 100 mm) or significant fault zone. Seepage flows common. Significant overbreak (metres) may be present in backs or walls. Face needs extensive scaling prior to sampling and will often be supported.	Drill steels need to be manually feathered (to avoid bogging). Bolts feed in with no percussion and may fall out.	< 0. 1 Extremely Poor	< 20 Very Poor	**D** Fragmented / sheared rock	20 (10-30)	< 15% Very Poor

13.8 Wide Spans and Intersection Cablebolt Design Guidelines

The following design guidelines were determined by Kevin Rosengren (2006) using the parabolic arch design theory. They are based on a rock bulk density of 2.65 t/m^3, assumes 0.5 m overbreak on either side and twin strand cablebolts. All calculations us a factor of safety of 1.8.

13.8.1 Wide Spans

Span (m)	Type A			Type B		
	Mass (t/m)	No. of Cables/m	Min. Length	Mass (t/m)	No. of Cables/m	Min. Length
6	22.4	0.54	5.0	33.6	0.81	6.0
7	30.5	0.73	5.4	45.7	1.10	6.5
8	39.8	0.96	5.7	59.7	1.43	7.0
9	50.4	1.21	6.0	75.6	1.81	7.5
10	62.2	1.49	6.3	93.3	2.24	8.0
11	75.3	1.81	6.7	112.9	2.71	8.5
12	89.6	2.15	7.0	134.4	3.22	9.0
13	105.2	2.52	7.3	157.7	3.78	9.5
14	122.0	2.93	7.7	182.9	4.39	10.0
15	140.0	3.36	8.0	210.0	5.04	10.5

13.8.2 Intersections

Dia. of Inscribed Circle (m)	Type A			Type B		
	Mass (t)	No. of Cables	Min. length	Mass (t)	No. of Cables	Min. Length
6	79	1.9	5.0	119	2.9	6.0
7	126	3.0	5.4	189	4.5	6.5
8	188	4.5	5.7	281	6.8	7.0
9	267	6.4	6.0	401	9.6	7.5
10	367	8.8	6.0	550	13.2	8.0
11	488	11.7	6.7	732	17.6	8.5
12	633	15.2	7.0	950	22.8	9.0
13	805	19.3	7.3	1208	29.0	9.5
14	1006	24.3	7.7	1509	36.2	10.0
15	1237	29.7	8.0	1856	44.5	10.5

13.9 Corrosion assessment form

Geotechnical Corrosion assessment

Name……

Date……

Location……

Mesh type (Black or Galv)……

Date bolts installed……

Air type Fresh Return Foggy

Moisture on GS Running water Damp Dry

Level of visible corrosion: None Minor Moderate High Very High

Is the galvanisation still intact? YES NO

If galvanisation not intact then calliper measurements are required.

Calliper measurements taken on an adequate range of mesh samples, mesh to be cleared of any corrosion or surface material with a wire brush:

location	measurement	location	measurement	location	measurement

Insert calliper measurements into the corrosion database located:

\\corporate.oceanagold.com\OGNZFiles\Macraes\Frasers Underground\05. Geotechnical\Ground Support\Corrosion\Corrosion assessment.xlsx

If the ground support is compromised to the point that could lead to a fall of ground the drive is required to be chained off.

Comments:

\\corporate.oceanagold.com\OGNZFiles\Macraes\Frasers Underground\05. Geotechnical\Ground Support\Corrosion\Corrosion assessment sheet.docx

OUR VALUES: **RESPECT** | **ONE TEAM** | **CONTRIBUTE** | **KNOWLEDGE**

Page 1 of 1