

DEVELOPING A NARROW-REEF ROCK BORING SYSTEM FOR NEAR-HORIZONTAL SLOTS BASED ON TUNNELLING EXPERIENCE

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MAKING A DIFFERENCE IN THE MINING INDUSTRY

AGENDA

- Introduction
- Scope / Requirement
- PHASE 1: Desktop study
- PHASE 2A & 3A: Disc Cutter Test on UG2
- PHASE 2B & 3B: Design of Novel Equipment
- PHASE 3C: Procure and Build of Novel Equipment
- PHASE 3D: Surface Testing of PHASE 3C Equipment
- PHASE 4A & 4B: Design, Procure & Build Complete System
- PHASE 4C: Surface Commissioning and Testing
- PHASE 4D: Machine Underground Trail
- Conclusion
- Acknowledgements



INTRODUCTION

- Partnership between African Rainbow Minerals and Master Drilling
 - Master Drilling – Innovative global mining drilling specialists
 - African Rainbow Minerals - diversified mining and minerals company
- Developed a MRE (Mechanized Rock Excavation) Oct 2020
 - Narrow-reef/ore bodies
- Phased Development approach
 - Focused development on Novel Equipment
 - Risk reduction in development cost
 - Longer development time



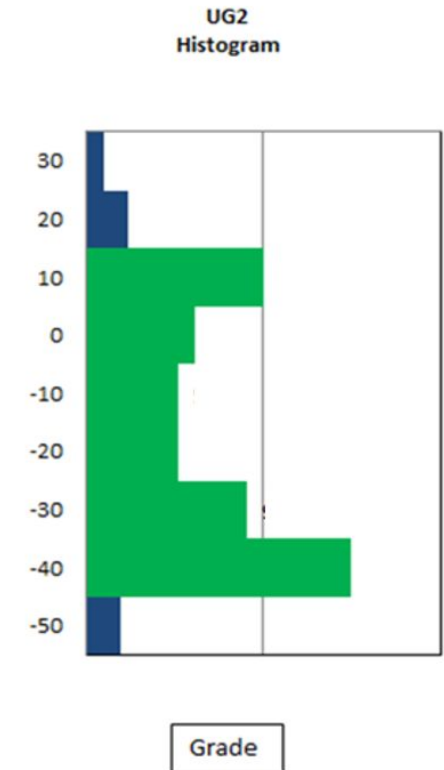
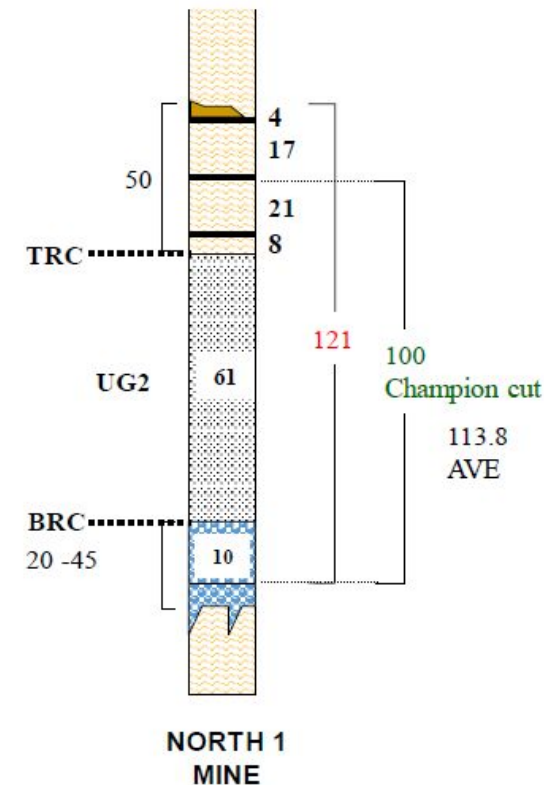
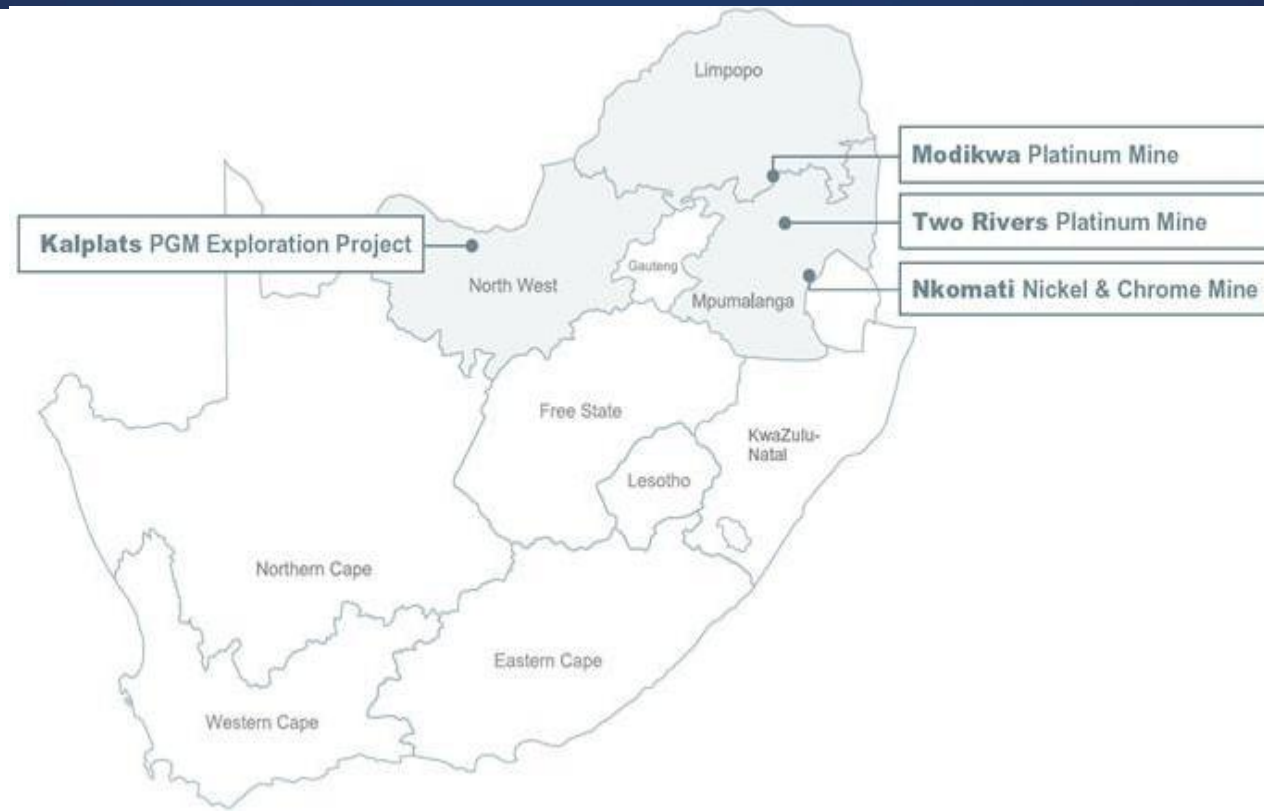
SCOPE/REQUIREMENT

ORE BODIES

- UG2 Chromitite: 650 - 750mm Height.
- Maximize ore extraction.
- Minimize ore dilution and waste development.
- Conventional absolute minimum stope 117cm

ROCK CHARECTERISTICS

- Pyroxenite top and bottom waste rock
140 - 180 MPa UCS
10 MPa Tensile
- UG2 Ore rock
80 - 110 MPa UCS
7 MPa Tensile



PHASE 1 DESKTOP STUDY

CUTTING METHODE

- Circular overcut
- Circular standard cut
- Rectangular excavation

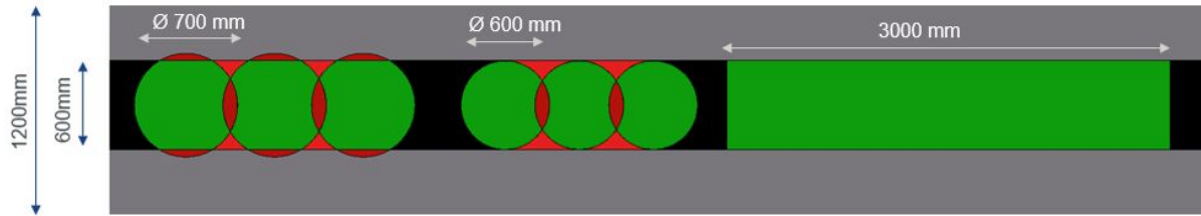


Figure 4: Extraction calculations

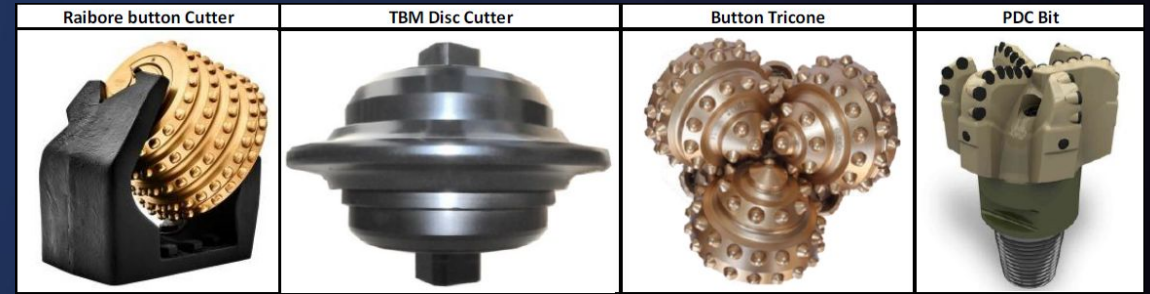
Table 3: Extraction calculations

	3 x Ø 700mm	3 x Ø 600mm	3000mm x 600mm
Panel Area	1,14 m ²	0,96 m ²	1,8 m ²
Excavated area	1,15 m ²	0,85 m ²	1,8 m ²
Excavated reef	1,03 m ²	0,80 m ²	1,8 m ²
Reef left behind	0,07 m ²	0,12 m ²	0 m ²
Reef left behind [%]	6%	12,5%	0 %
Estimate advance rate [hour]	10 m/hour	13 m/hour	3 m/hour

- From the calculations in **table 3** above, the rectangular excavation shape is superior to round excavations in terms of material dilution as well as advance rates. The Ø700mm drilled holes can excavate more reef per hole than the Ø600mm drilled holes, but waste rock will be included in the excavated chromitite ore.

AVAILABLE TECHNOLOGIES

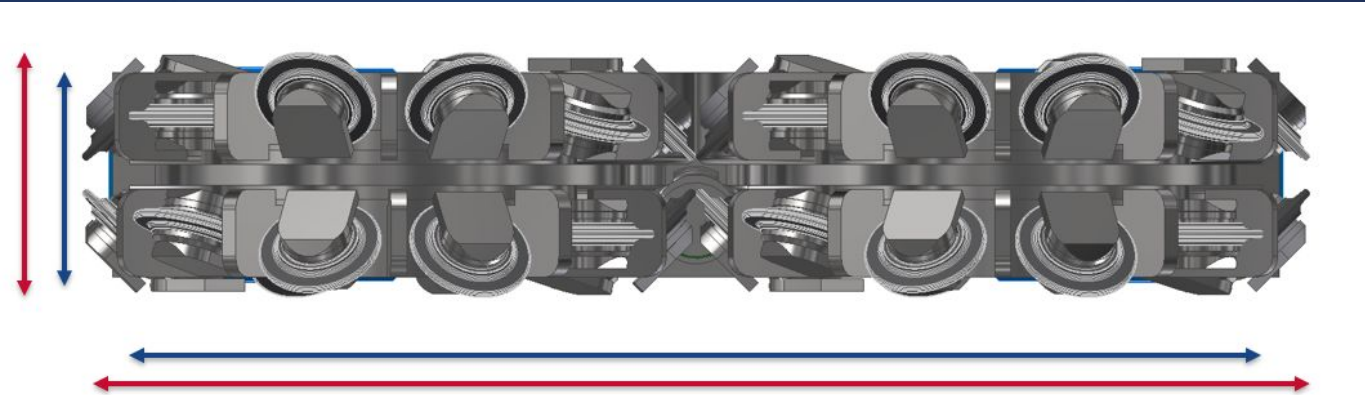
- Looked at available technologies and maturity
- Cutter types and penetration rates



		Bauer diaphragm wall		Atlas Copco Slot Borer	
					
Criteria	Weight	Score	Weighted	Score	Weighted
Cost	4	3	12	1	4
Conceptual risk	5	2	10	2	10
Rock cutting hardness	4	3	12	3	12
kW required	5	3	15	3	15
Cutting face size	4	3	12	2	8
Mass and Size	4	2	8	1	4
Human Resources	3	3	9	2	6
Automation	3	2	6	2	6
Guidance System	4	2	8	2	8
Business case	5	3	15	3	15
Reef extraction/dilution	4	3	12	2	8
Personel removed from inside	3	3	9	3	9
Equipment Handling	2	3	6	3	6
Penetration	4	2	8	2	8

PHASE 1 DESKTOP STUDY

TECHNICAL CONCEPT – NEW MACHINE DEVELOPMENT



Cutting (hole) Dimensions:

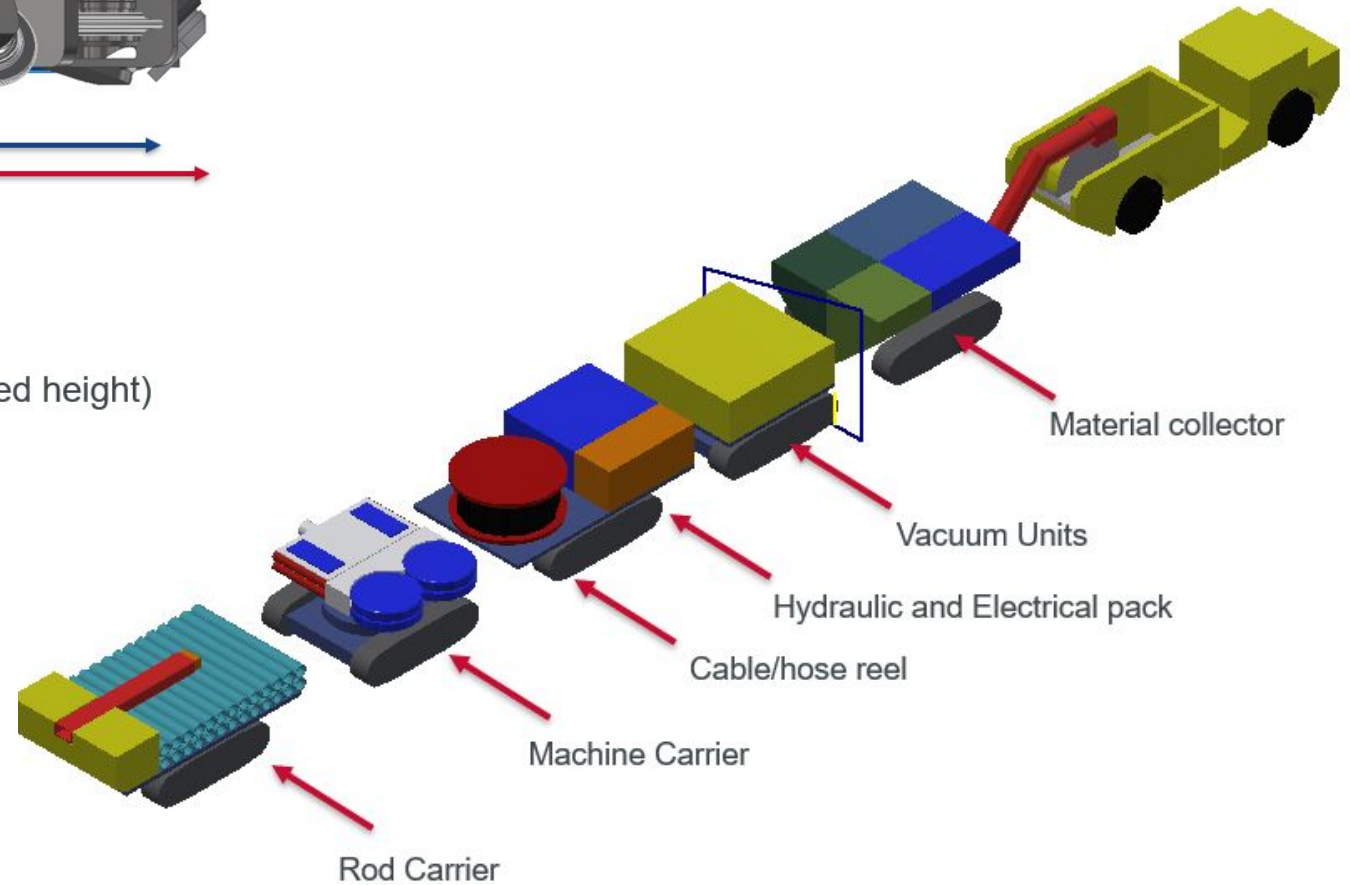
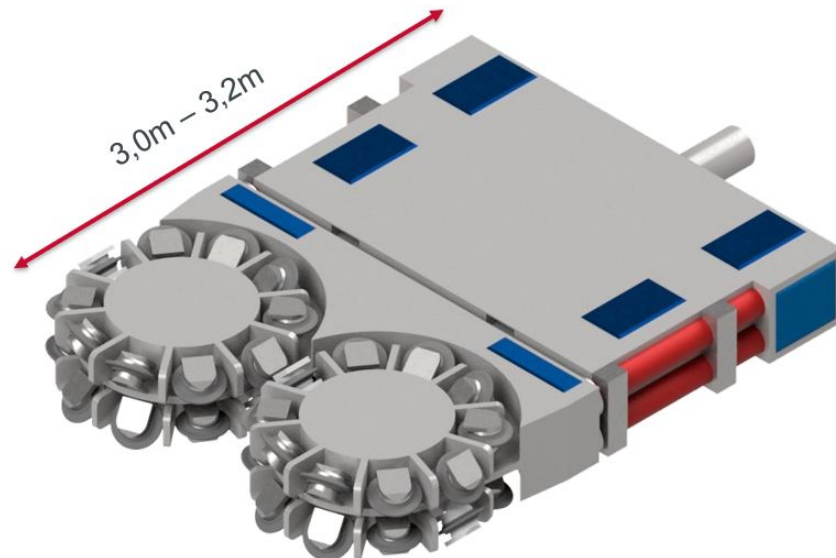
Width = +/- 3000mm

Height = 600mm (fixed height)

Machine Dimensions:

Width = +/- 2800mm

Height = max 500mm (fixed height)



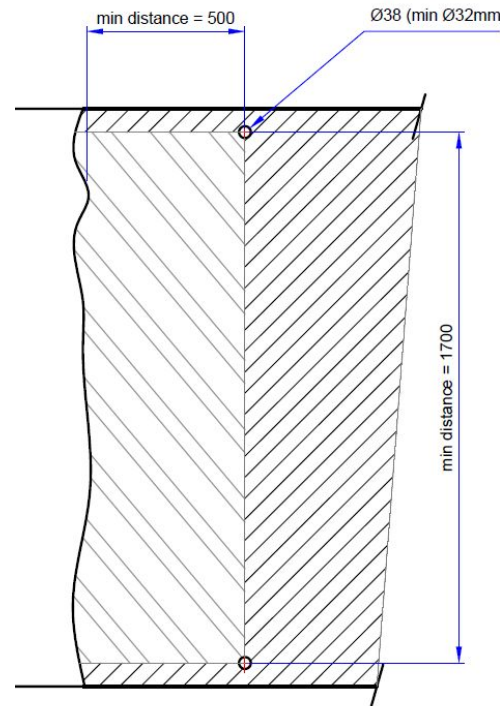
PHASE 2A & 3A: DISC CUTTER TEST

DISC CUTTER DATA ON UG2 ORE

- Disc cutter size and types
 - Regular, Ballistic, Raise Borer Button Embedded Button, Hard Faced
- 10" disc cutter - Regular

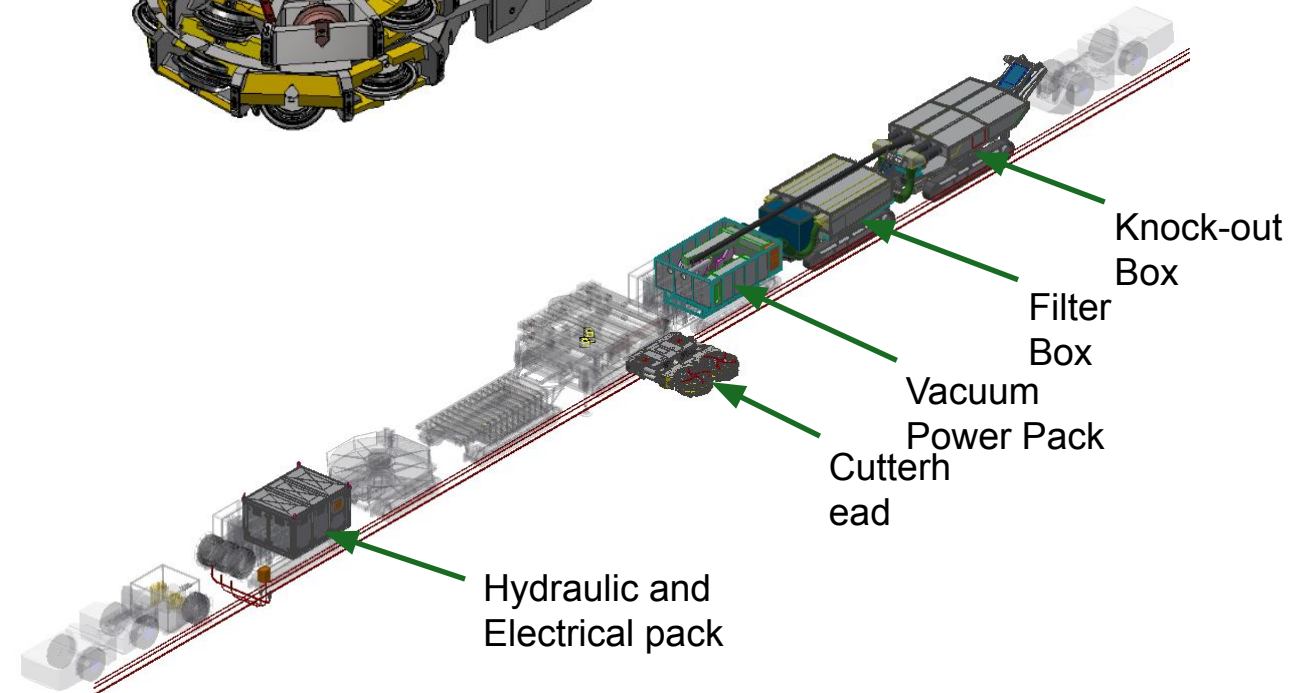
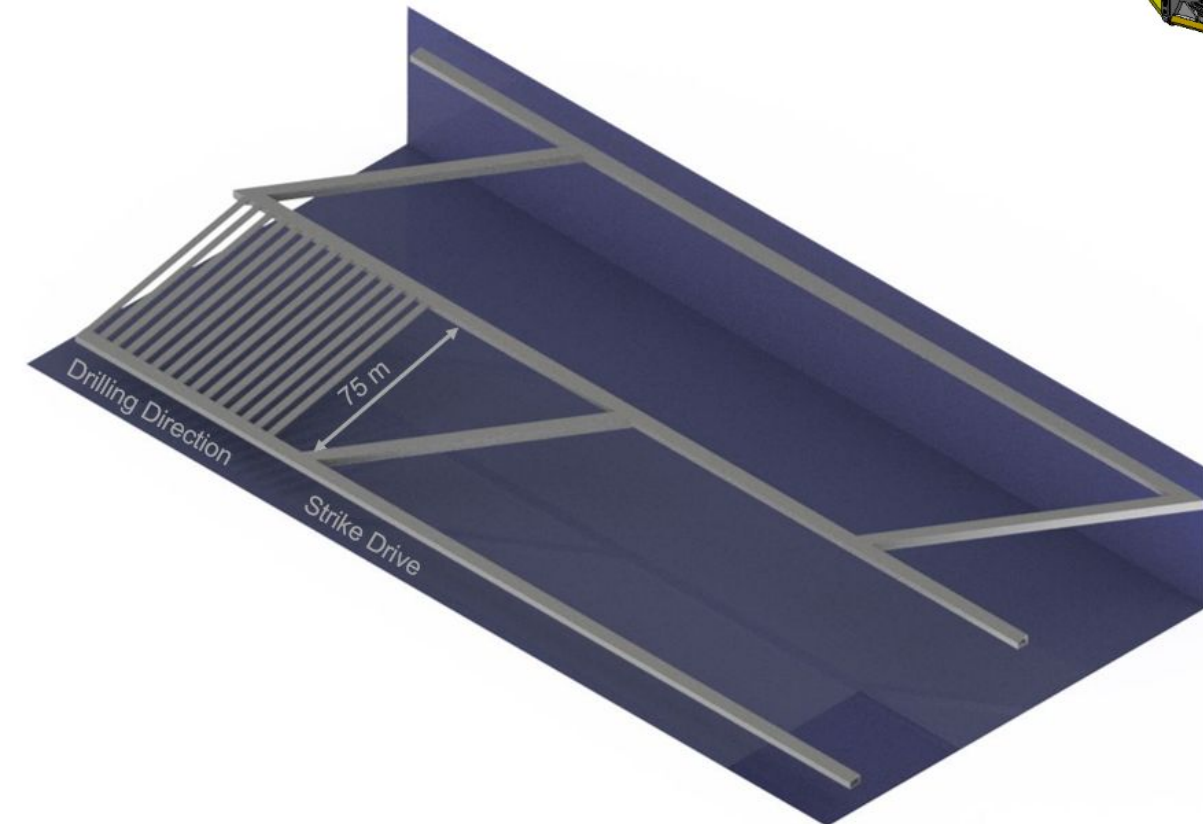
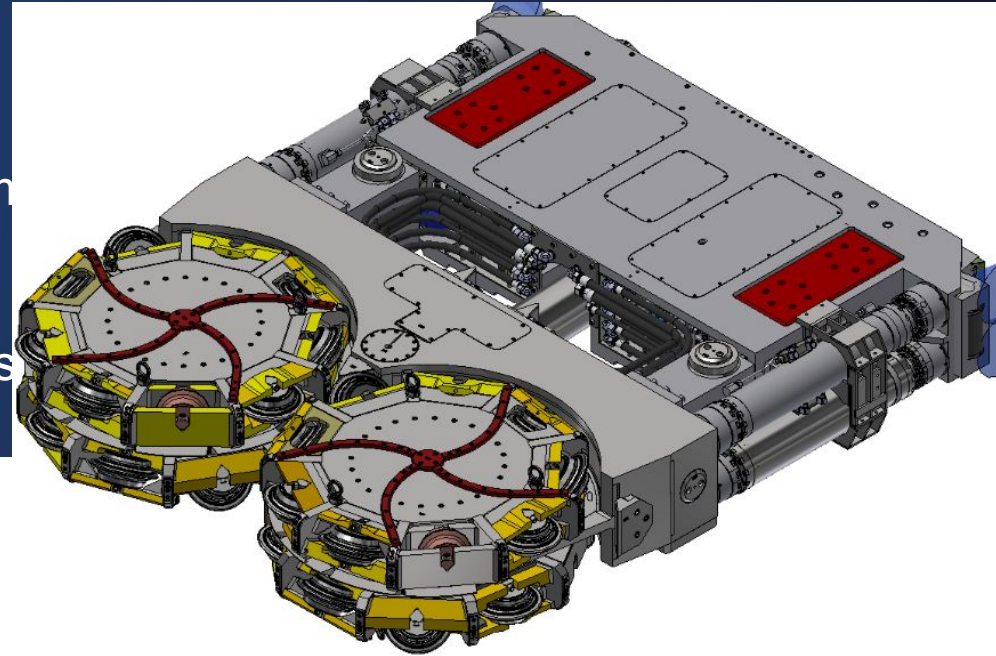
TESTING METHOD

- Pillar Preparation
- Test Frame setup
- Testing method



PHASE 2B & 3B: DESIGN OF NOVEL EQUIPMENT FOR SURFACE TEST

- Cutterhead
- Vacuum System
 - Knock-out Box, Filter Box, Vacuum Power Pack
- Aux Equipment required for test
 - Hydraulic & Electrical Power packs
- Mining Layout



PHASE 2B & 3B: DESIGN OF NOVEL

EQUIPMENT REEF SENSING EQUIPMENT

- Ground Penetrating Radar
- Reef Recognition

3RD PARTY VERIFICATION

- Colorado School of Mines
- 3RD Party Tunnel Supplier – Conceptual Design

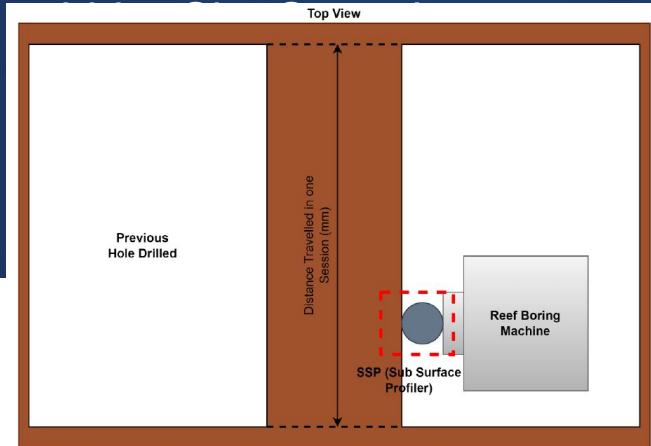
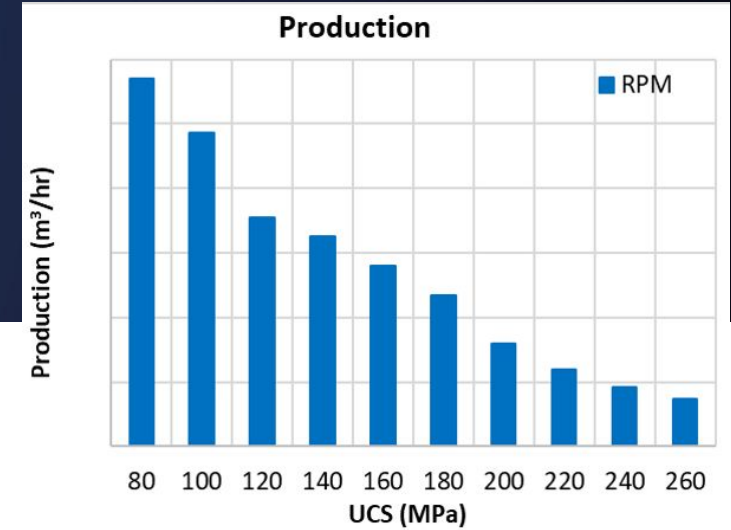
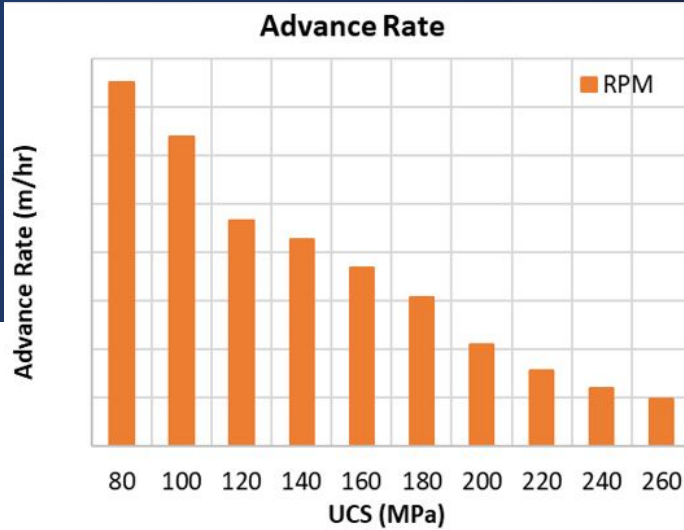
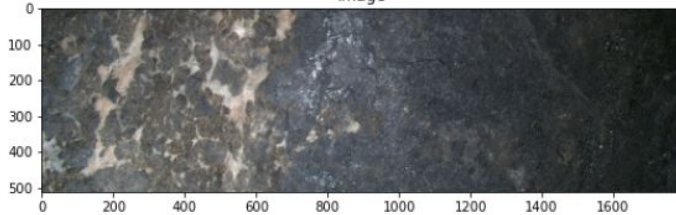


Figure 1: Distance travelled by SSP in one Survey (Outcome)

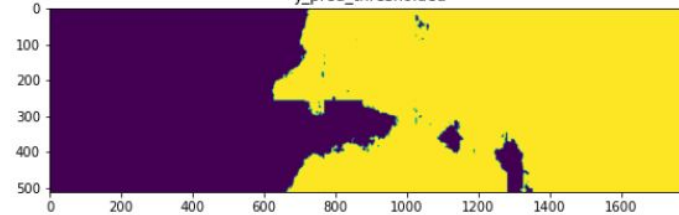


Reef coverage 0.5676694597516742

Image

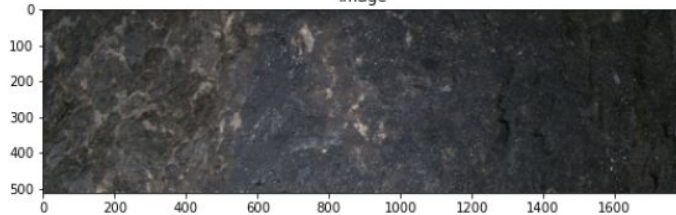


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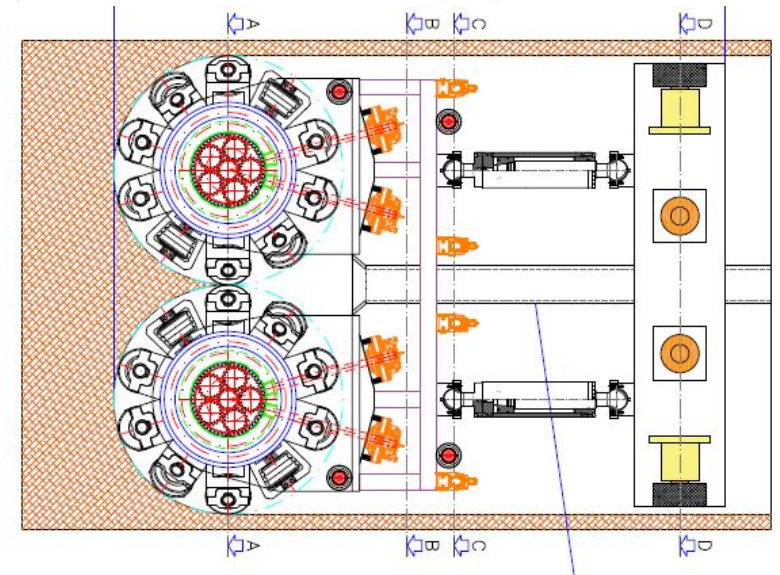
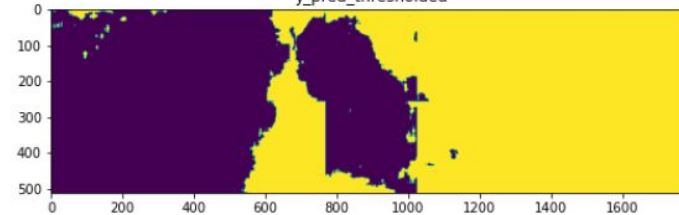


Reef coverage 0.5440128871372768

Image



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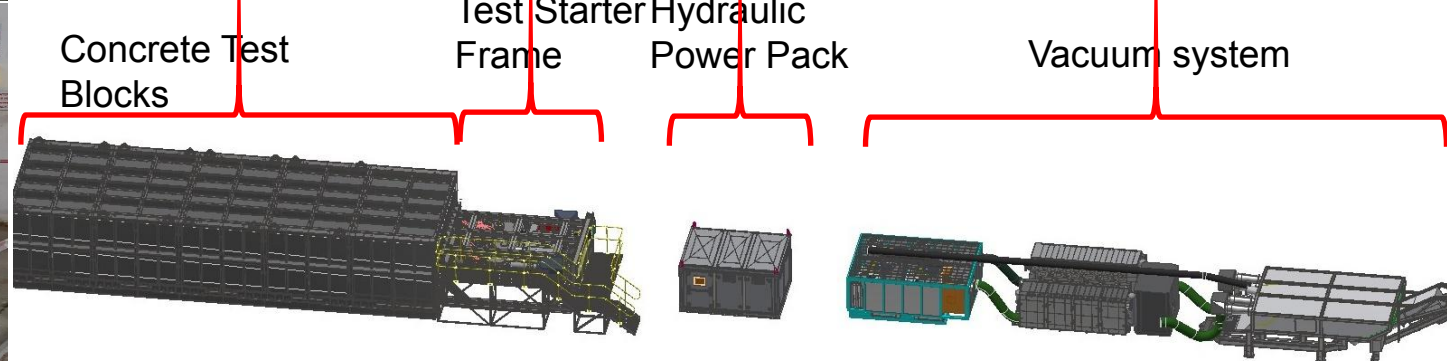
PHASE 3C: PROCURE AND BUILD OF NOVEL

EQUIPMENT FOR SURFACE TESTING

- Cutterhead
- Vacuum Power Pack
- Filterbox & Knock-Out -Box
- Hydraulic Power Pack
- Operator Cabin

SURFACE TEST SITE PREPARTION

- Site Establishment and Layout
- Concrete Test Blocks



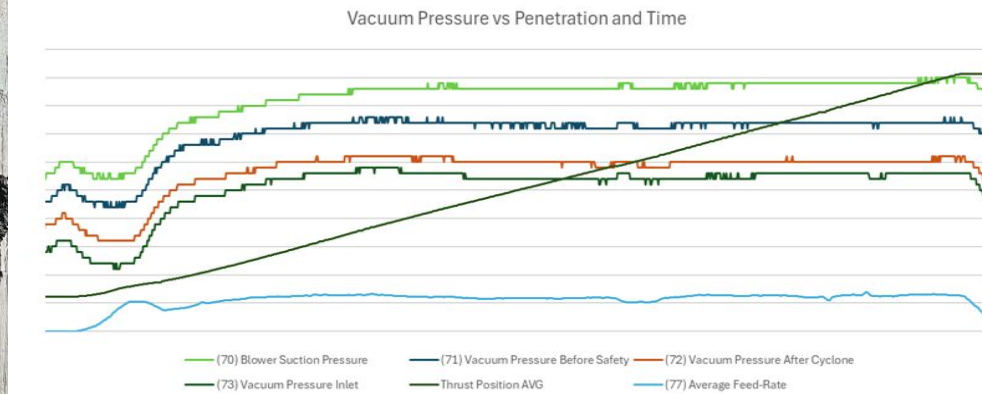
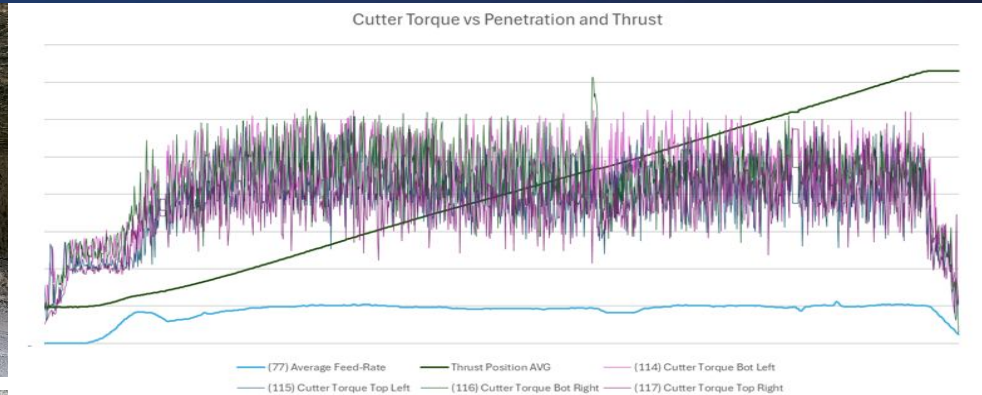
PHASE 3D: SURFACE TESTING OF PHASE 3C

EQUIPMENT

- Penetration Rates
 - Instantaneous 75 - 105mm/min
- Vacuum Inlet Blockage
 - Changed the design and retested
- Vacuum Power Pack - 3RD Party design
 - Unit running sound 125 dB
 - Structural issue with sound & vibration
 - Pressure losses over vacuum

VACUUM SYSTEM

- Filter Box – 3RD Party design
 - Structural design flaw
 - Filter blockage – pulse and clean every 750mm
 - Fines < 200 μ m cause filter build-up
- Knock-Out Box - 3RD Party design
 - Structural design flaw
 - Screw discharge rate



PHASE 4A & 4B: DESIGN, PROCURE & BUILD

COMPLETE SYSTEM

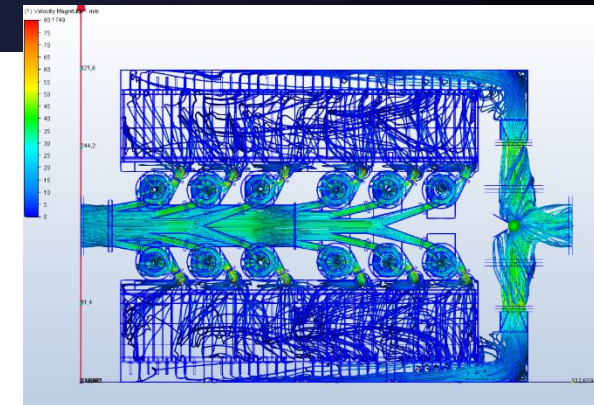
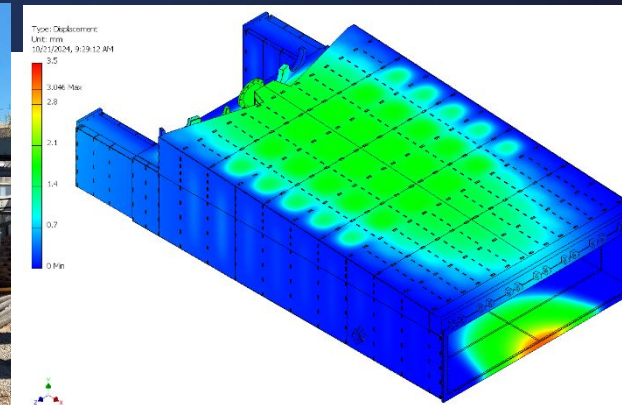
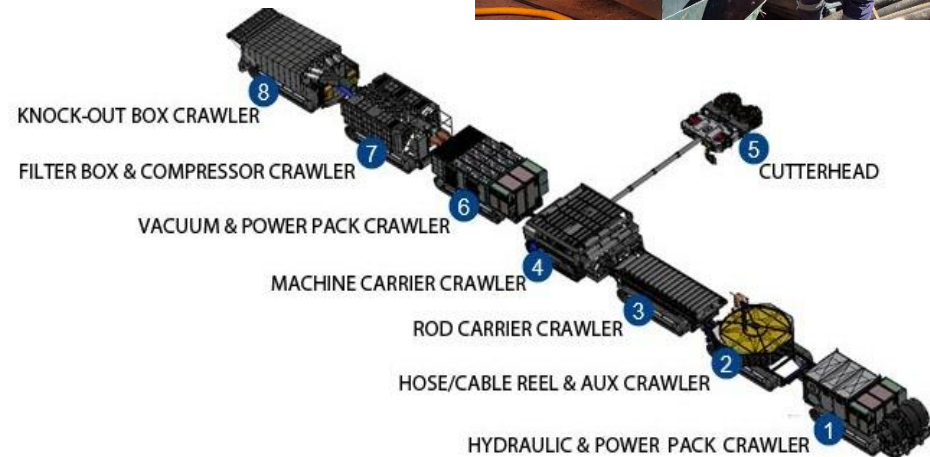
- Added Tracks to Units
- Hydraulic Pack Crawler
- Hose Reel Crawler
- Drill Rod Crawler
- Starter Frame Crawler (Machine Carrier)
- Vacuum System Crawler

COMPLETE SYSTEM UNITS

- Filter Box Crawler Mark2 – Redesign
- Knock-Out Box Crawler Mark2 - Redesign
- Motivator Crawler
- 3RD Party Equipment
 - Auto Steering Equipment
 - Lidar Scanning Drilled Slots



Complete Reef Borer System



PHASE 4C: SURFACE COMMISSIONING AND TEST

EQUIPMENT TESTED

- Complete System
 - Vacuum/Drill rod present to Machine Carrier
 - Vacuum/Drill rod loading Semi-Auto
 - Hose Reel functionality
- Filterbox Crawler
 - Filter performance 4m before

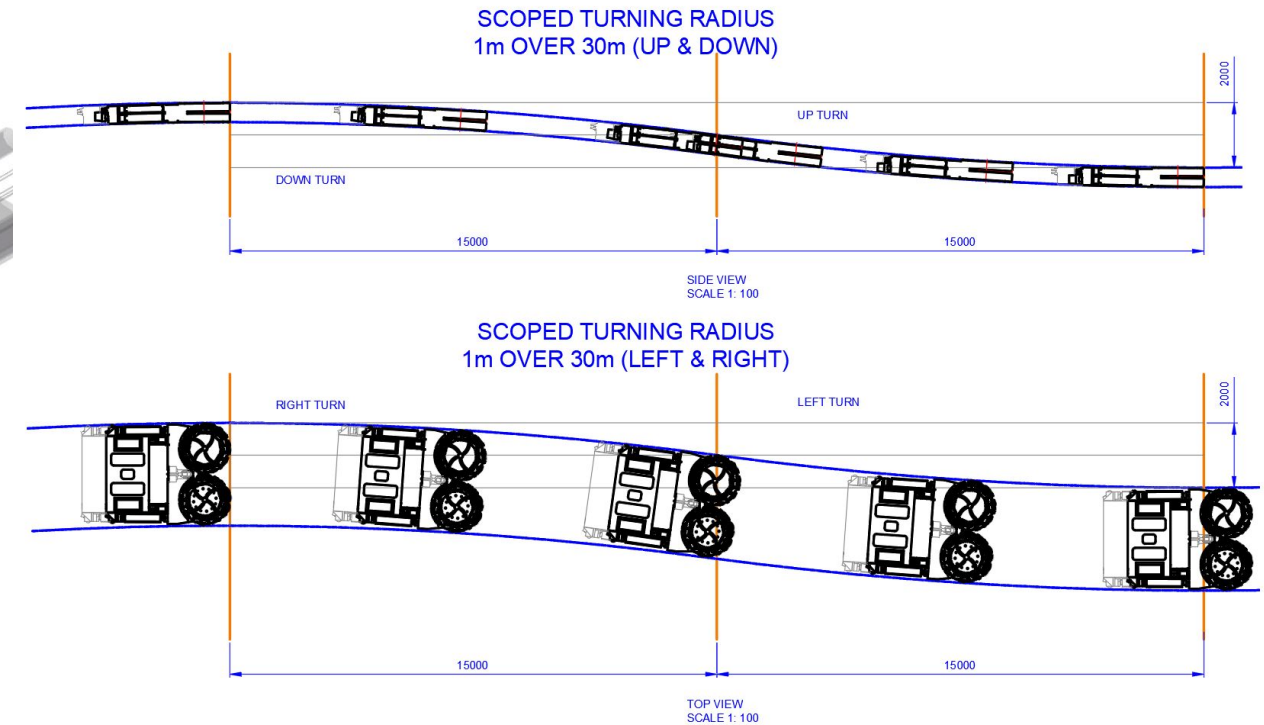
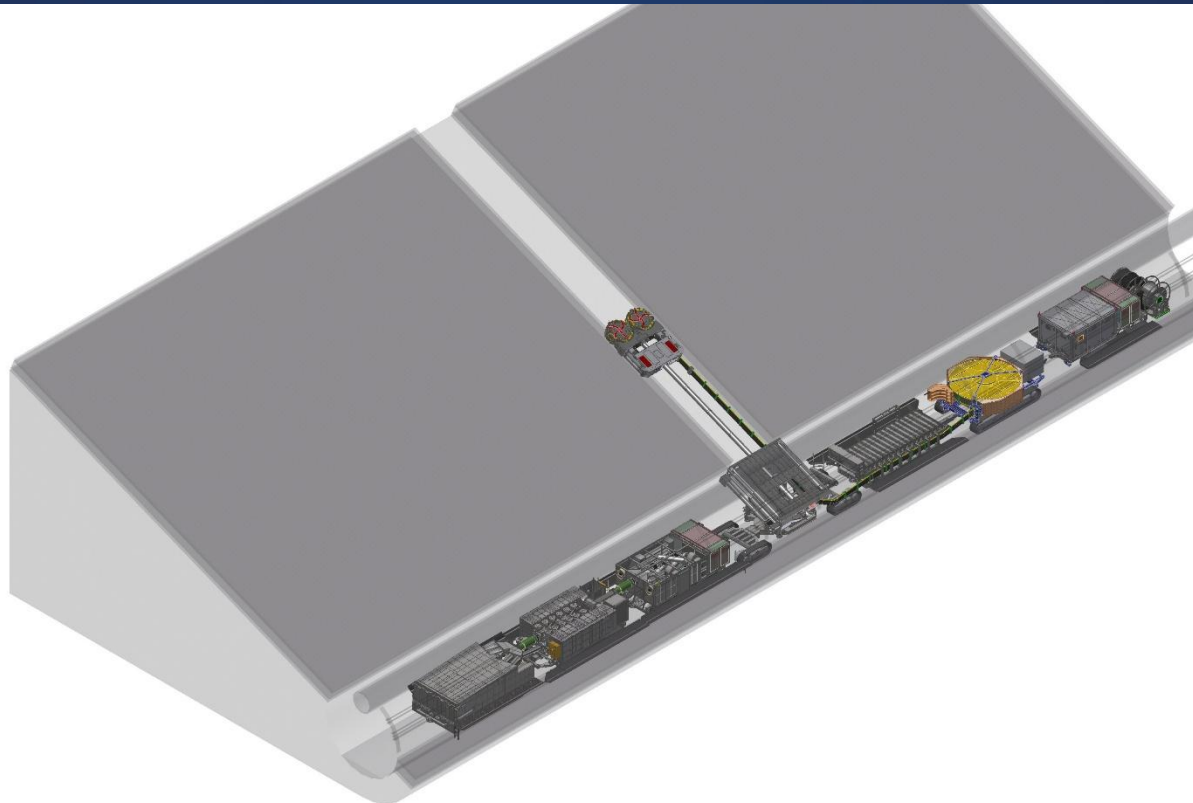
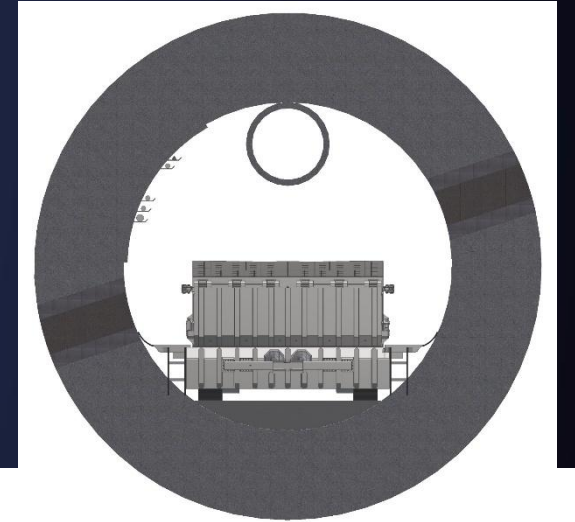
- Knock-Out Box Crawler
 - Discharge cycle down to 7minutes



PHASE 4D: MACHINE UNDERGROUND TRAIL

BOKONI WINTERSVELDT PROJECT

- Assemble and move machine underground.
- Drill 2 x 30m Slots, 1 x 60m slot
- Do verification and testing, production rates, steering capabilities, system functionality.
- Test Steering of the machine between Slot and in strike drives
- Remote operation from surface Control Room



CONCLUSION

- Phased Summary:
 - PHASE 1 – OCT 2020 – FEB 2021
 - PHASE 2 – FEB 2021 – DEC 2021
 - PHASE 3 – JAN 2022 – OCT 2023
 - PHASE 4 – OCT 2023 - CURRENT
- What Next - 2026
 - Underground trail end test
 - Further Improvement and development
 - Preparing Resources for Operational Drilling



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ACKNOWLEDGEMENTS

- African Rainbow Minerals
 - Support local skill and industry capacity building
 - Been pivotal in the support of this development**Jacques van der Bijl**
- Master Drilling
 - Appetite to invest and look at alternative mining technologies**Koos Jordaan**



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THANK YOU

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