MINING INDUSTRY
OCCUPATIONAL
SAFETY & HEALTH

MINERALS COUNCIL
SOUTH AFRICA

LEDGING PLANNING, EXECUTION AND MONITORING LEADING PRACTICE (LEDGING LP) CASE STUDY

"Rowland Shaft commenced with the Ledging LP adoption on 28 May 2019."

INTRODUCTION AND BACKGROUND OF LEDGING LP ADOPTION AT ROWLAND SHAFT

Rowland Shaft commenced with the Ledging LP adoption on 28 May 2019. The mine's adoption journey was characterised by several successes which accelerated its progress in the first phase of the adoption, and a few challenges which resulted in the mine's journey being stagnant for significant periods of time. These challenges were addressed by the piloting of a small section. In addition to this, the Mining Industry Occupational Safety and Health (MOSH) Fall of Ground (FOG) Team timeously hosted meetings and offered individual guidance, which assisted the Rowland Shaft adoption team in regaining momentum in their adoption journey.

This ledging success story documents the journey of Rowland Shaft during the 14th step of adoption (i.e. the trial or pilot stage of the Ledging LP) which assisted the mine to:

a) Demonstrate how the Ledging LP would be applied at Rowland Shaft (i.e. testing practicality of the leading practice)

b) Assist the mine to check its alignment to the full Ledging Leading Practice Adoption Guide

c) Document the success story of this trial or pilot to help other mines to understand its importance. It will also give lagging and future adopters an idea of how a leading practice is piloted

The pilot was designed to simulate the full Ledging LP as stipulated in the Leading Practice Adoption Guide from the start (planning) to the end (post-ledge audit). This would also help the mine to ensure that their procedures were practical and effective.

OVERVIEW

Mining company

Sibanye-Stillwater

Commodity

Platinum

Operation/Mine

Marikana – Rowland Shaft

Health and safety case study

Ledging planning, execution and monitoring leading practice (Ledging LP)

Number of employees affected by the health and safety case study

897

Stakeholders consulted

Full-time health and Safety structures

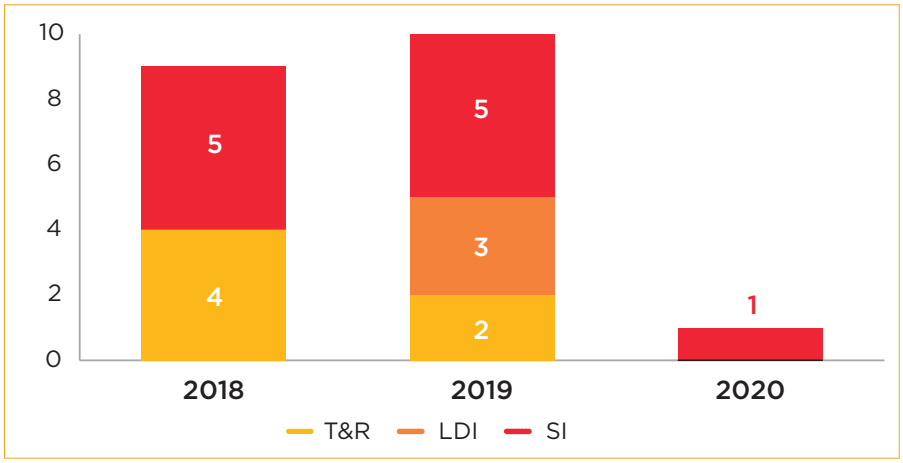
Occupations affected/benefited

Mine manager, production and technical service personnel, all 69 stoping crews at Rowland Shaft

FULL DESCRIPTION OF THE RISK ADDRESSED BY THE LEDGING LP

At the end of 2020, Rowland Shaft had 9,184,046 (FOG) fatality-free shifts. The last FOG fatality on the mine occurred on 15 April 2013. Figure 1 shows the fall of ground injury data for Rowland Shaft from 2018 to 2020.

Figure 1: Rowland FOG injury data: 2018-2020



Ledging related FOG incident at Rowland Shaft

On 18 August 2019, a few months after the mine had registered to adopt the Ledging LP, (i.e. during the administration stages of adoption) a FOG occurred in a ledging panel between the blasting time and night shift re-entry period.

Upon investigation, the following causative factors were identified:

- The FOG was observed to be triggered by the intersection of a low angle joint with sub-vertical jointing causing wedge failure
- Non-compliance to systematic support installation - the ledge had advanced up-dip with non-adherence to the systematic ledging support procedure
- Geological triggers that were identified but not supported as required by the standard

A significant number of tendon support units were not installed according to the standard operating procedure i.e. the units were not tensioned and with poor installation angles. This incident reaffirmed the need for the mine to adopt the Ledging LP.

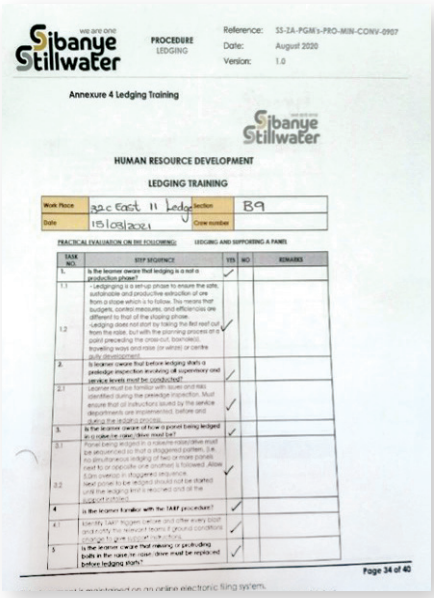
Rowland Shaft ledging LP trial

At Rowland Shaft a ledge is defined as an excavation where the initial cut of the reef is undertaken from the raise (breast), slusher or stope preparation drive (SPD) in (up-dip & down-dip) mining to establish a robust centre gully/ SPD/slusher, to set up and equip for the stoping phase to follow. Many of the Rowland Shaft ore reserves are extracted using an up-dip/down-dip mining method, however, the future of Rowland Shaft is headed towards breast mining. The pilot of the Ledging LP was conducted in an up-dip layout, where ledging would commence up-dip from a slusher.

The trial commenced on 15 March 2021 and was conducted at Section B9 (UG2 Section). To kickstart the pilot, Section B9 held their monthly planning meeting and manager's review simultaneously. During this meeting, Ledge 32c East 11 was discussed in detail. The planning and review session was attended by all relevant mining and service department personnel (as required in the Ledging Leading Practice Adoption Guide). The aim of this initial ledging planning meeting was to produce a ledging startup risk assessment which focused on planning a pre-ledge inspection, the training plan for the ledging crews, the mine overseer's induction material, as well as setting up a system and generating reports to communicate ledging instructions and their risks.

Following the planning meeting, a startup risk assessment notification was sent out to all the relevant service departments who then conducted an underground assessment together with the mining department (as per the Ledging LP requirement). During this assessment, the training officers conducted ledging training with the crews using the Human Resource Department Ledging Training Document shown in Figure 2. It is important to note that the ledging training document presented below was developed at another Sibanye-Stillwater platinum mine in Rustenburg during its leading practice adoption. This training document together with the ledging procedure were then rolled out to the other company operations such as Rowland Shaft.

Figure 2: Ledging training documents for crews

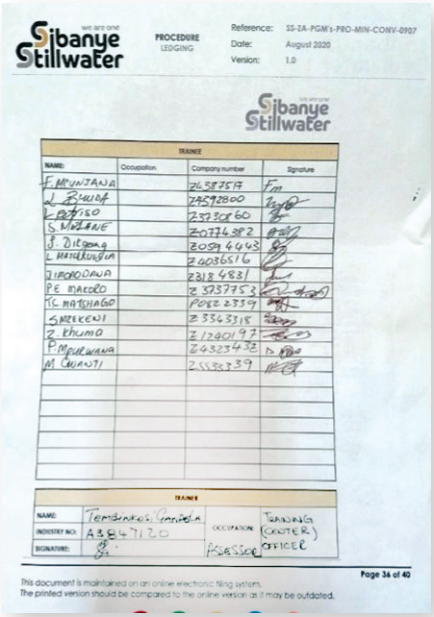

Sibanye Stillwater

PROCEDURE LEDGING

Annexure 4 Ledging Training

HUMAN RESOURCE DEVELOPMENT

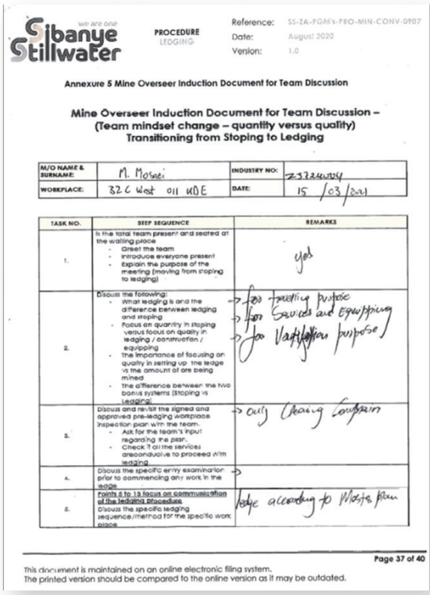
LEDGING TRAINING


Sibanye Stillwater

PROCEDURE LEDGING

Since Rowland does not have dedicated ledging crews, the crew selected to ledge this excavation rotated between stoping and ledging. Because of this rotation, the planning team saw it necessary to induct the crew into ledging (in addition to the training). This would help to facilitate the required change from a stoping to a ledging mindset. To achieve this objective, the mine created a ledging induction programme. The contents of the induction are shown in Figure 3.

Figure 3: Mine overseer's induction documents



Sibanye Stillwater — PROCEDURE LEDGING

Reference: SS-ZA-PGM's-PRO-MIN-CONV-0907
Date: August 2020
Version: 1.0

Annexure 5 Mine Overseer Induction Document for Team Discussion

Mine Overseer Induction Document for Team Discussion – (Team mindset change – quantity versus quality) Transitioning from Stoping to Ledging

M/O NAME & SURNAME	M. Mosaei	INDUSTRY NO:	[illegible]
WORKPLACE:	32 C West 011 UDE	DATE:	15/03/2021

TASK NO.	STEP SEQUENCE	REMARKS
1.	Is the total team present and seated at the waiting place • Greet the team • Introduce everyone present • Explain the purpose of the meeting (moving from stoping to ledging)	yes
2.	Discuss the following: • What ledging is and the difference between ledging and stoping • Focus on quantity in stoping versus focus on quality in ledging / construction / equipping • The importance of focusing on quality in setting up the ledge vs the amount of ore being mined • The difference between the two bonus systems (Stoping vs Ledging)	→ for travelling purpose → for Services and Equipping → for Ventilation purpose
3.	Discuss and revisit the signed and approved pre-ledging workplace inspection plan with the team. • Ask for the team's input regarding the plan. • Check if all the services are conducive to proceed with ledging	→ only cleaning [illegible]
4.	Discuss the specific entry examination prior to commencing any work in the ledge	→
5.	**Points 5 to 13 focus on communication of the ledging procedure** Discuss the specific ledging sequence/method for the specific work place	ledge according to Master plan

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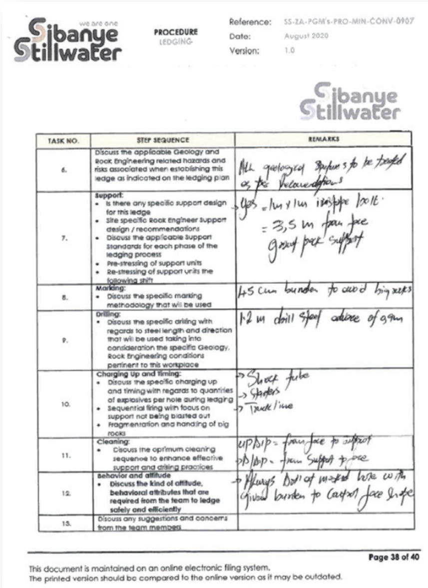
The printed version should be compared to the online version as it may be outdated.



Sibanye Stillwater — PROCEDURE LEDGING

Reference: SS-ZA-PGM's-PRO-MIN-CONV-0907
Date: August 2020
Version: 1.0

TASK NO.	STEP SEQUENCE	REMARKS
6.	Discuss the applicable Geology and Rock Engineering related hazards and risks associated when establishing this ledge as indicated on the ledging plan	All geological structures to be treated as per recommendations
7.	**Support:** • Is there any specific support design for this ledge • Site specific Rock Engineer support design / recommendations • Discuss the applicable support standards for each phase of the ledging process • Pre-stressing of support units • Re-stressing of support units the following shift	→ yes - 1m x 1m in-stope bolt = 3,5 m from face grout pack support
8.	**Marking:** • Discuss the specific marking methodology that will be used	45 cm burden to avoid big rocks
9.	**Drilling:** • Discuss the specific drilling with regards to steel length and direction that will be used taking into consideration the specific Geology, Rock Engineering conditions pertinent to this workplace	1.2 m drill steel [illegible]
10.	**Charging Up and Timing:** • Discuss the specific charging up and timing with regards to quantities of explosives per hole during ledging • Sequential firing with focus on support not being blasted out • Fragmentation and handling of big rocks	→ Shock tube → Starters → Trunk line
11.	**Cleaning:** • Discuss the optimum cleaning sequence to enhance effective support and drilling practices	up dip - from face to support → dip - from support to face
12.	**Behavior and attitude** • **Discuss the kind of attitude, behavioral attributes that are required from the team to ledge safely and efficiently**	→ Always drill of marked hole with given burden to control face shape
13.	Discuss any suggestions and concerns from the team members	

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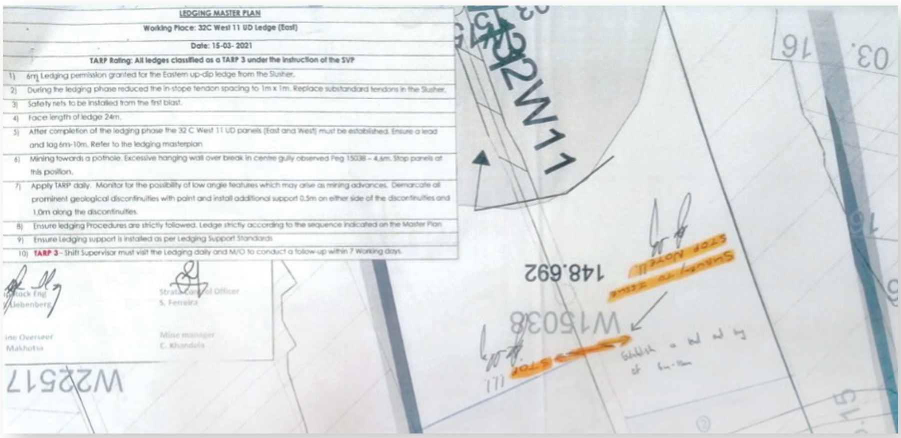
In the next step of the pilot, the survey department provided the planning team with a 1:200 scale masterplan plan. On this plan all the information (including crew input), instructions and strategy were plotted. The plan also included the required geological information. The mine also created a system to capture non-compliance instances. Reports were generated and close-out actions assigned and completed. The crew was also briefed on the close-out report and requested to sign it to acknowledge receipt. This was done to involve them in the process and communicate the actions that were assigned. Following this step, the rock engineering department obtained the master ledging plan from the survey department and the ledging sequence was specified as shown in Figure 4.

Figure 4: Ledging master plan with sequence



LEDGING MASTER PLAN

Working Place: 32C West 11 UD Ledge (East)

Date: 15-03- 2021

TARP Rating: All ledges classified as a TARP 3 under the instruction of the SVP

1) 6m Ledging permission granted for the Eastern up-dip ledge from the Slusher.
2) During the ledging phase reduced the in-stope tendon spacing to 1m x 1m. Replace substandard tendons in the Slusher.
3) Safety nets to be installed from the first blast.
4) Face length of ledge 24m.
5) After completion of the ledging phase the 32 C West 11 UD panels (East and West) must be established. Ensure a lead and lag 6m-10m. Refer to the ledging masterplan
6) Mining towards a pothole. Excessive hanging wall over break in centre gully observed Peg 15038 – 4,6m. Stop panels at this position.
7) Apply TARP daily. Monitor for the possibility of low angle features which may arise as mining advances. Demarcate all prominent geological discontinuities with paint and install additional support 0.5m on either side of the discontinuities and 1,0m along the discontinuities.
8) Ensure ledging Procedures are strictly followed. Ledge strictly according to the sequence indicated on the Master Plan
9) Ensure Ledging support is installed as per Ledging Support Standards
10) TARP 3 – Shift Supervisor must visit the Ledging daily and M/O to conduct a follow-up within 7 Working days.

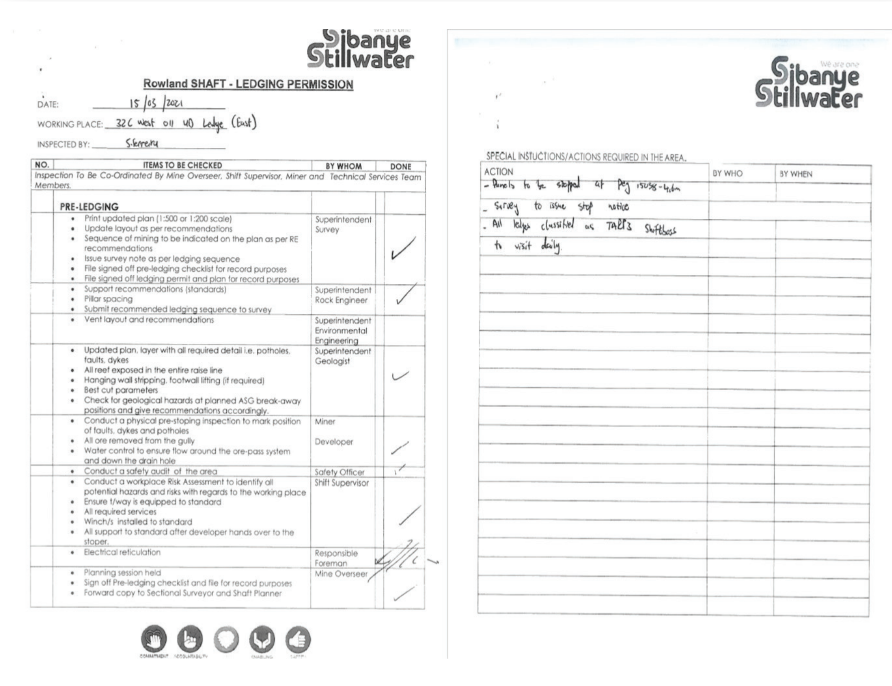
Rock Eng — Liebenberg
Strata Control Officer — S. Ferreira
Mine Overseer — Makhotsa
Mine manager — C. Khandela

On completion of the risk assessment, an underground ledging task or checklist is compiled as part of the master plan. This list is shown in Figure 5 . When the checklist is complete, the permit to ledge document is compiled and approved. This ledging permit is issued once all the service departments provide their specific reports and the required actions are closed out and complete. During the trial it was found that the mine's ledging permit document was outdated. The adoption of the Ledging LP also helped the mine to update the ledging permit and align it with the new system.

The induction was designed to be facilitated by the ledging mine overseer and assist the crew to focus less on the the quantity of ore extracted in the ledge, and more on the quality of the ledge construction. The induction was also designed to help the crew to mentally prepare for other general changes that are involved when transitioning from stoping to ledging.

As part of this induction, the mine overseer was also required to discuss the ledging planning minutes with the crew. The crew was encouraged to give their input and suggestions for the plan (bottom-up planning) to be incorporated into the master plan. All the relevant service departments were required to take note of the crew's input and include these suggestions or recommendations in their final ledging startup report and the ledging master plan.

Figure 5: Ledging planning checklist



Sibanye Stillwater

Rowland SHAFT - LEDGING PERMISSION

DATE: 15/05/2021

WORKING PLACE: 32C West 011 UD Ledge (East)

INSPECTED BY: S.Smelu

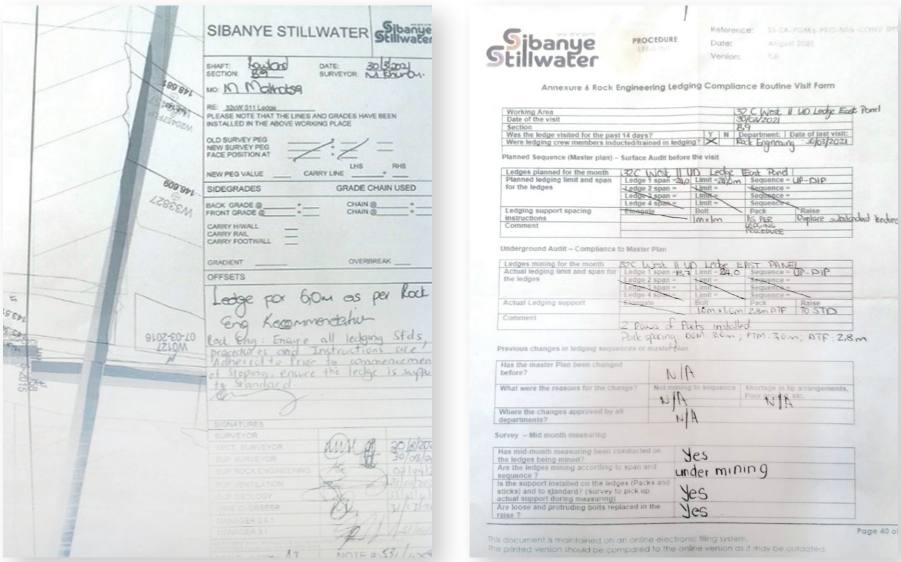
NO.	ITEMS TO BE CHECKED	BY WHOM	DONE
	Inspection To Be Co-Ordinated By Mine Overseer, Shift Supervisor, Miner and Technical Services Team Members.		
	PRE-LEDGING		
	• Print updated plan (1:500 or 1:200 scale) • Update layout as per recommendations • Sequence of mining to be indicated on the plan as per RE recommendations • Issue survey note as per ledging sequence • File signed off pre-ledging checklist for record purposes • File signed off ledging permit and plan for record purposes	Superintendent Survey	✓
	• Support recommendations (standards) • Pillar spacing • Submit recommended ledging sequence to survey	Superintendent Rock Engineer	✓
	• Vent layout and recommendations	Superintendent Environmental Engineering	
	• Updated plan, layer with all required detail i.e. potholes, faults, dykes • All reef exposed in the entire raise line • Hanging wall stripping, footwall lifting (if required) • Best cut parameters • Check for geological hazards at planned ASG break-away positions and give recommendations accordingly	Superintendent Geologist	✓
	• Conduct a physical pre-stoping inspection to mark position of faults, dykes and potholes • All ore removed from the gully • Water control to ensure flow around the ore-pass system and down the drain hole	Miner / Developer	✓
	• Conduct a safety audit of the area	Safety Officer	✓
	• Conduct a workplace Risk Assessment to identify all potential hazards and risks with regards to the working place • Ensure t/way is equipped to standard • All required services • Winch/s installed to standard • All support to standard after developer hands over to the stoper.	Shift Supervisor	✓
	• Electrical reticulation	Responsible Foreman	✓
	• Planning session held • Sign off Pre-ledging checklist and file for record purposes • Forward copy to Sectional Surveyor and Shaft Planner	Mine Overseer	✓

SPECIAL INSTUCTIONS/ACTIONS REQUIRED IN THE AREA.

ACTION	BY WHO	BY WHEN
- Panels to be stopped at peg		
- Survey to issue stop notice		
- All ledges classified as TARPS Shaftboss to visit daily		

After the ledging begins, the service departments monitor and evaluate the ledge on a regular basis to ensure that the production team is compliant with the design, standards and procedures, and the health and safety requirements. As part of the monitoring and evaluation the survey department conducts mid-month, measuring and all service departments scrutinize the note for compliance. The rock engineering department conducts a post-ledge inspection once the ledge reaches the required limit of 6m. The post-ledge inspection documents are shown in Figure 6.

Figure 6: Post ledge inspection



SIBANYE STILLWATER

SHAFT: Rowland DATE: 30/8/2021

SECTION: B9 SURVEYOR:

MO: N Makhosa

RE: 32cW 011 Ledge

PLEASE NOTE THAT THE LINES AND GRADES HAVE BEEN INSTALLED IN THE ABOVE WORKING PLACE

OFFSETS

Ledge for 6.0m as per Rock Eng Recommendation

Annexure 6 Rock Engineering Ledging Compliance Routine Visit Form

Working Area: 32 C West 11 UD Ledge East Panel

Has mid month measuring been conducted on the ledges being mined? Yes

Are the ledges mining according to span and sequence? under mining

Is the support installed on the ledges (Packs and sticks) and to standard? Yes

Are loose and protruding bolts replaced in the raise? Yes

In addition to the procedure followed in this trial, The following documents (forming part of our portfolio of evidence) were submitted to the MOSH FOG Team:

- The Sibanye-Stillwater Marikana Conventional Production Ledging Procedure which was revised to align with the ledging leading practice
- Permit to commence ledging (unsigned copy)
- Human Resource Development for Ledging (training material) (unsigned copy)
- Mine overseer induction document for team discussion (unsigned copy)
- Rock engineering ledging compliance routine visit form
- The bonus memo which indicates that the ledging crews have a different bonus structure from the stoping crews, which motivates that the crews will be paid for quality and not quantity
- Rowland Shaft managerial instructions which indicate that its management is constantly communicating and making improvements and adjustments to improve safety in ledging both in its procedural approach as well as to its standards and that these are communicated from top-down (leadership behavior competencies).
- Rowland Shaft's 2021 budget plan, indicating the plan of three ledging-specific crews and the ledging efficiencies

The flow process of the ledging planning at Rowland Shaft (as per the trial) is summarised in Figure 7.

Figure 7: Flow of ledging process during trial

OPERATION'S STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS (SWOT) ANALYSIS

As a requirement for the COPA engagements and presentations, the operation summarised their Ledging LP adoption with the following SWOT analysis, and the content has paved the way for other mines in the group to adopt this leading practice.

SWOT ANALYSIS

STRENGTHS

- Buy in and involvement from management, union and safety structures
- Proactive interpretation and implementation of best practice guidelines

WEAKNESSES

- Co-ordinating the Adoption Process in a challenging production environment
- Not communicating the portfolio of evidence to the MOSH FOG Team regularly
- Inability to evidence that current systems and practices align with the Leading Practice

OPPORTUNITIES

- The best practice guidelines assisted in motivating the inclusion of three ledging specific crews in the 2021 shaft budget
- We have bottom-up alignment and participation, and have equipped ourselves with ledging specific training

THREATS

- A change or removal of any of the driving factors i.e. change in the ledging bonus structure, change in management, change in the key role players

CONCLUSION

The trial conducted at Rowland Shaft was successful and it proved that the systems, standards and procedures required to conduct safe ledging are indeed practical and achievable. It also proved that the new ledging planning and execution systems are aligned to the MOSH Ledging Leading Practice. The new ledging procedure from the onset requires discipline and involvement from all departments to achieve the goal of safe ledging in our environment. Rowland Shaft, upon satisfaction from the MOSH team, rolled out the new system of ledging shaft wide and enforced all the relevant procedures, standards and learning material.

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