Case Study: Silica Exposure at Sibanye Stillwater

Andre du Plessis

MINERALS COUNCIL
SOUTH AFRICA

Biography

Andre du Plessis started his mining career as a Learner official in 1985. During the next few years, he was privileged to work at places such as Rooiberg Tin, Greenside collieries, Okiep Copper, Deelkraal, Kloof and Driefontein.

Andre obtained, amongst others, his certificate in Mine Environmental Control, a Radiation Protection Officer certificate as well as a Mine Managers Certificate.

He left the Environmental Engineering field for some 12 years to do hard rock mining as a Shiftboss, Mine Overseer and eventually a Mining Manager. He saw the light and in 2018 transferred back to Environmental Engineering.

Andre is currently the Environmental Engineering Manager for Sibanye Stillwater, Gold Division.

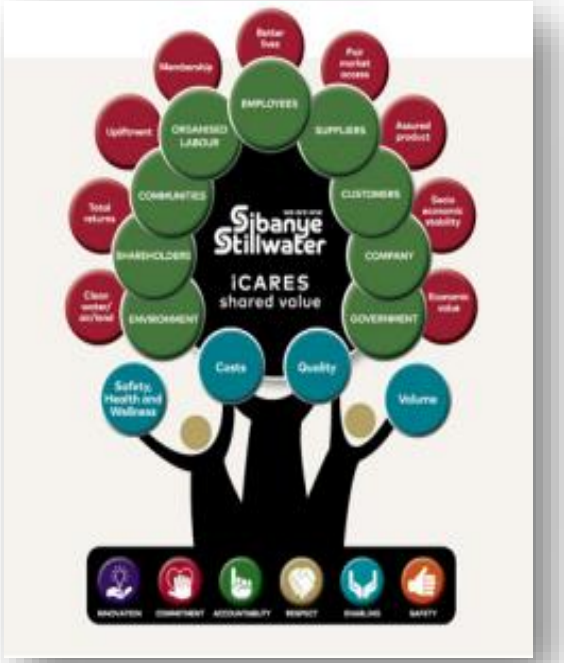
Current practices to reduce silica exposure at Sibanye Stillwater Gold Operations

21 June 2024

Andre du Plessis

Agenda

- Sibanye Stillwater Gold Operations - Introduction
- Brief Overview of the Au Operations
- MHSC Milestones
- Hierarchy of control vs Business value
- Performance against 1st MHSC Milestone - 2013
- Interventions
- Case Studies
- Dust Blitz Audits
- Summary
- Acknowledgements
- Questions



We represent our business ethos through the indigenous South African Umdoni tree

- our values are the fundamental roots of our organisation, which provide a solid basis for the way we do business
- the trunk of the tree (our people) represents the material strength of the company
- the leaves on the branches represent all our stakeholders
- the tree's seeds and fruits signify the varying benefits and value that our success will bring to those stakeholders

Our roots, our iCARES values, are at the heart of all that we do, the decisions we make and how we conduct our business. These values are enshrined in our Code of ethics and form the basis of the organisational growth and culture rejuvenation programme currently underway.

iCARES VALUES

INNOVATION
We intentionally find new ways to do things better. We will all understand the need to innovate, develop innovators, encourage innovation, invite everyone to innovate; and we recognise innovation.

COMMITMENT
We are committed to the protection of life, health and the environment; to operational excellence, to high standards of governance, to ethical conduct and regulatory compliance, and to adhering to best practice industry disclosure and reporting standards.

ACCOUNTABILITY
We are accountable to our stakeholders for delivering on our key operational targets and strategic objectives; for identifying, managing and mitigating the risks inherent in our business; and for maximising the return on capital deployed.

RESPECT
We treat people fairly, respect each other, value the richness of human diversity and support employees in realising their full potential.

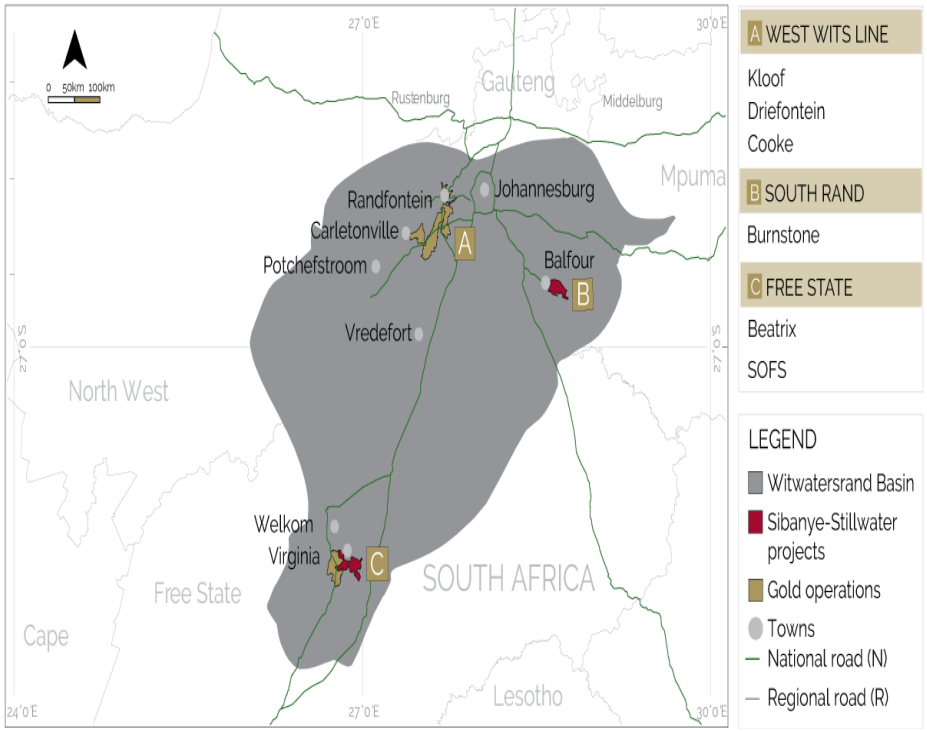
ENABLING
We enable prosperous and sustainable operations by engaging with our stakeholders, empowering our employees in their professional development, and offering doorstep communities skills and resources to thrive post-mining.

SAFETY
We acknowledge that working at depth, with heavy machinery, presents risks to life and limb; therefore we prioritise all practical, technical and behavioural measures to reduce safety and health risks to near zero.

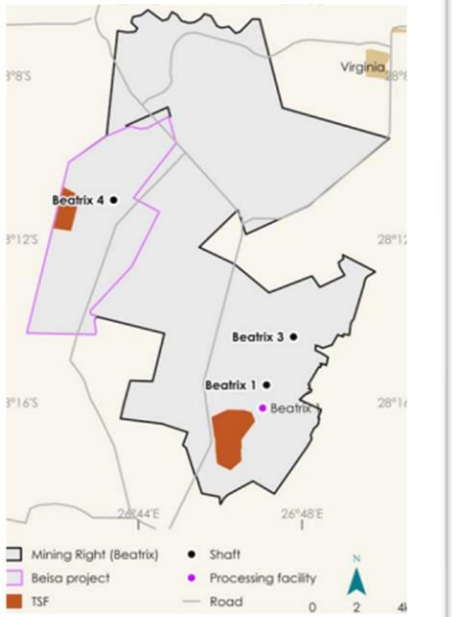
Sibanye Stillwater Gold Operations - Introduction

Geological setting Gold occurs in quartz-pebble conglomeritic units (or reefs) in a thick succession of metamorphosed sediments in the Witwatersrand Basin.
The basin is geographically located in the central-north to north-eastern part of South Africa and extends from Johannesburg in the north to some 40km south of Welkom and covers an area of approximately 70,000km².

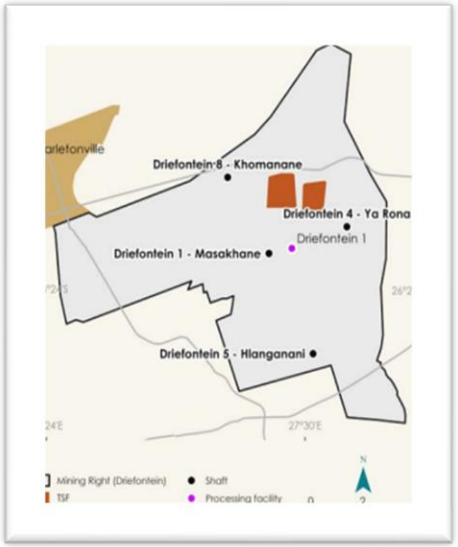
More than 150 mines have operated in the basin since gold was first discovered in 1886, primarily producing gold. Uranium has been intermittently produced, often as a by-product, since the early 1950s.



Sibanye Stillwater Gold Operations – Brief Overview



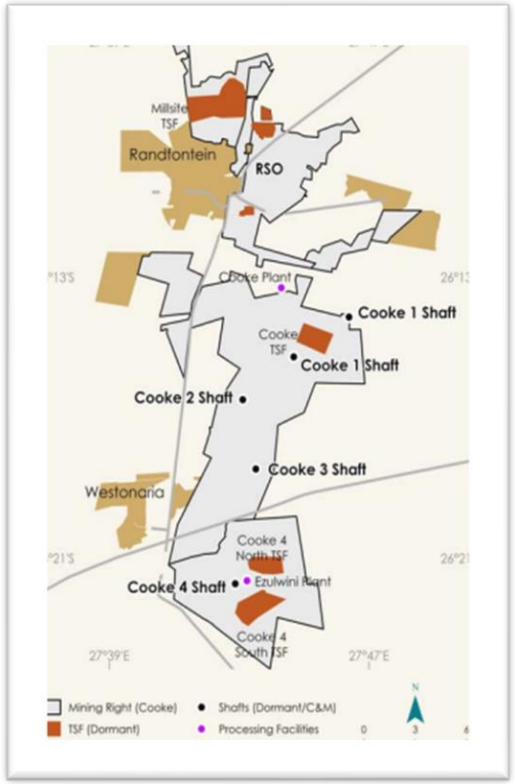
The **Beatrix** operation is a mature, shallow to intermediate level underground gold operation. It is located near the towns of Welkom and Virginia, approximately 280km south-west of Johannesburg, in the Free State province of South Africa. The Beatrix operation is a conventional mining operation, consisting of two operating shafts: No. 1 shaft and No. 3 shaft. The ore-body is accessed using a vertical shaft system, down to 26 level (the lowest working level at No. 3 shaft), approximately 1,350m below surface.



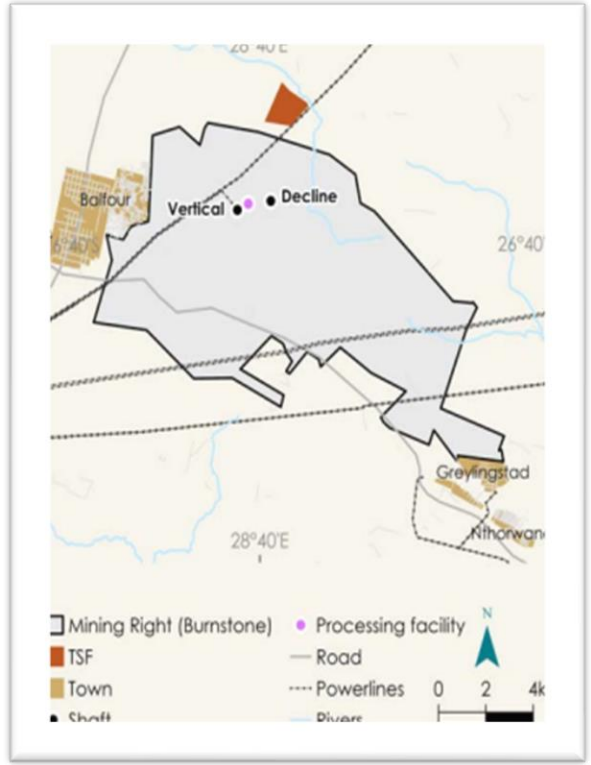
The **Driefontein** operation is a mature, intermediate to ultra-deep level gold mine, located near Carletonville, approximately 70km west of Johannesburg, in the Gauteng province of South Africa. It consists of four vertical operating shafts, No. 1 shaft, No. 4 shaft, No. 5 shaft and No. 8 shaft, extending down to 50 level (the lowest working level) at No. 5 shaft, approximately 3,300m below surface.

The **Kloof** operation is an intermediate to ultra-deep level gold mining complex, situated in the West Wits Line of the Witwatersrand Basin, near the towns of Randfontein and Westonaria, approximately 60km west of Johannesburg, in the Gauteng province of South Africa.
The Kloof operation consists of three producing vertical shafts, namely No.1 shaft, No. 7 shaft and No. 8 shaft. The reef horizon is accessed the deepest (40 level is currently the deepest working level) at No. 7 shaft, approximately 3,200m below surface.

Sibanye Stillwater Gold Operations



The **Cooke** operation is situated in the West Wits Line of the Witwatersrand Basin, near the town of Randfontein, approximately 35km south-west of Johannesburg, in the Gauteng province of South Africa. It was previously a large underground mining complex, consisting of four vertical production shafts, but the final underground workings were placed on care and maintenance during 2017. Current operations comprise the Randfontein surface operation (RSO), which mines and re-treats historic tailings through the Cooke gold plant.



The **Burnstone** project is a shallow gold development project, situated near Balfour in the Mpumalanga province, South Africa, 80km south-east of Johannesburg. The Burnstone project intends mining the UK9A Kimberley reef to produce approximately 140kozpa over a 23-year LoM and was scheduled for steady state production by 2031.

A Healthy Worker is a Safe and Productive Worker

Milestones

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2014 MHSC Milestones

NEW MHSC MILESTONES

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Industry Target: Zero rate of fatalities and injuries

- Every Fatality is one too many, we will eliminate fatalities by December 2020.
- Every mining company must have a target of ZERO FATALITIES.
- Up to December 2016, 20% reduction in Serious Injuries (SI) per year
- From January 2017, 20% reduction in Lost Time Injuries (LTI) per year.

Industry Target: Elimination of Silicosis

- By December 2024, 95% of all exposure measurement results will be below the milestone level for respirable crystalline silica of 0.05 mg/m3 *(these are individual readings - not average results).*
- Using present diagnostic techniques, no new cases of silicosis will occur amongst previously unexposed individuals *("These are those unexposed to mining dust prior to December 2008 I.e. equivalent to a new persons who entered the industry in 2009)*

Industry Target: Elimination of Noise Induced Hearing Loss (NIHL)

- By December 2024, the total operational or process noise emitted by any equipment must not exceed a milestone sound pressure level of 107 dB(A). *(This milestone of the sound pressure levels will be verified by initiatives under the CoE and MOSH and reviewed in 2016)*
- By December 2016, no employee's Standard Threshold Shift (STS) will exceed 25 dB from the baseline when averaged at 2000, 3000 and 4000 Hz in one *or both ears*

OUR VISION Superior value creation for all our stakeholders…through a culture of **CARE**

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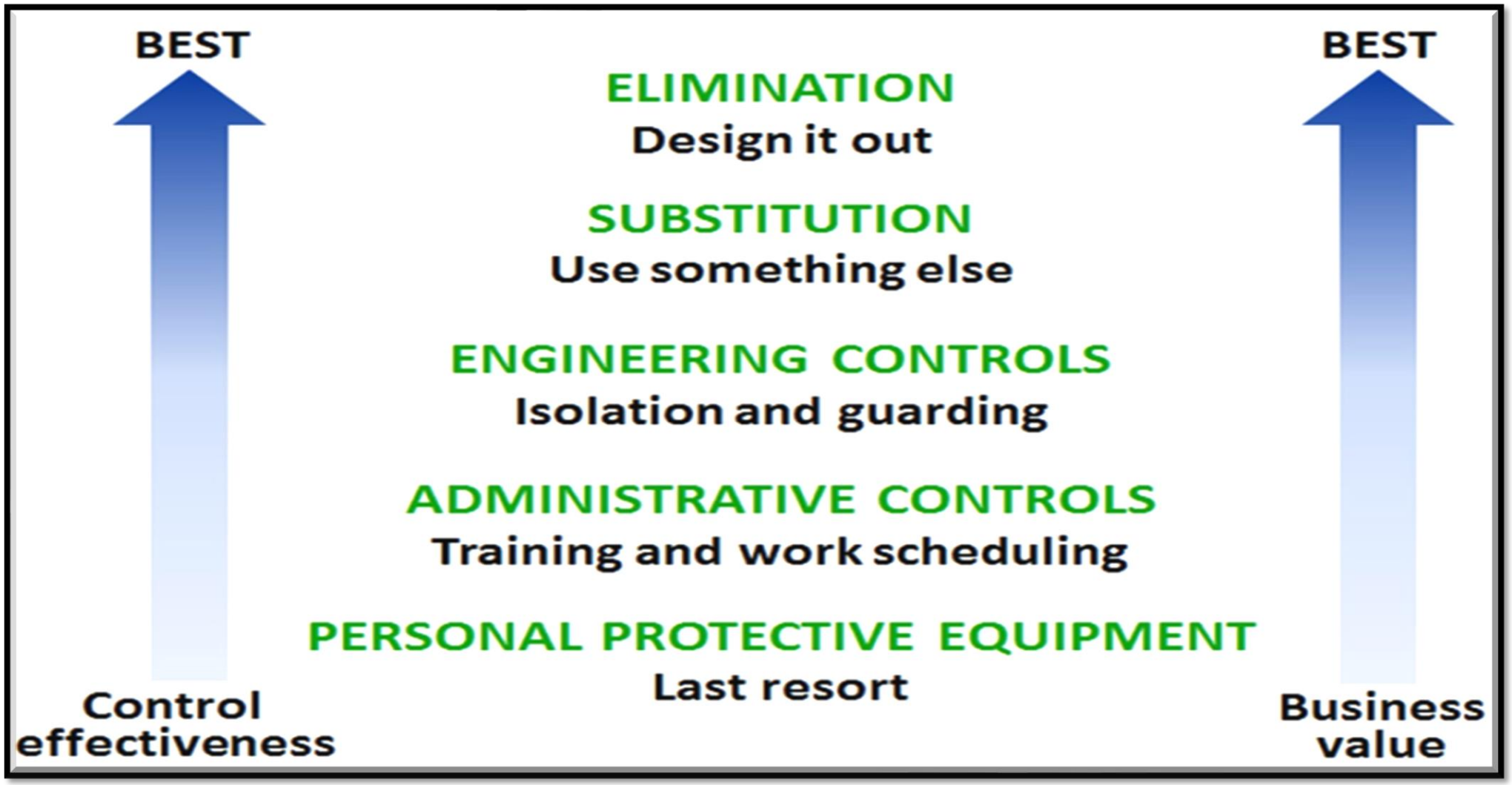
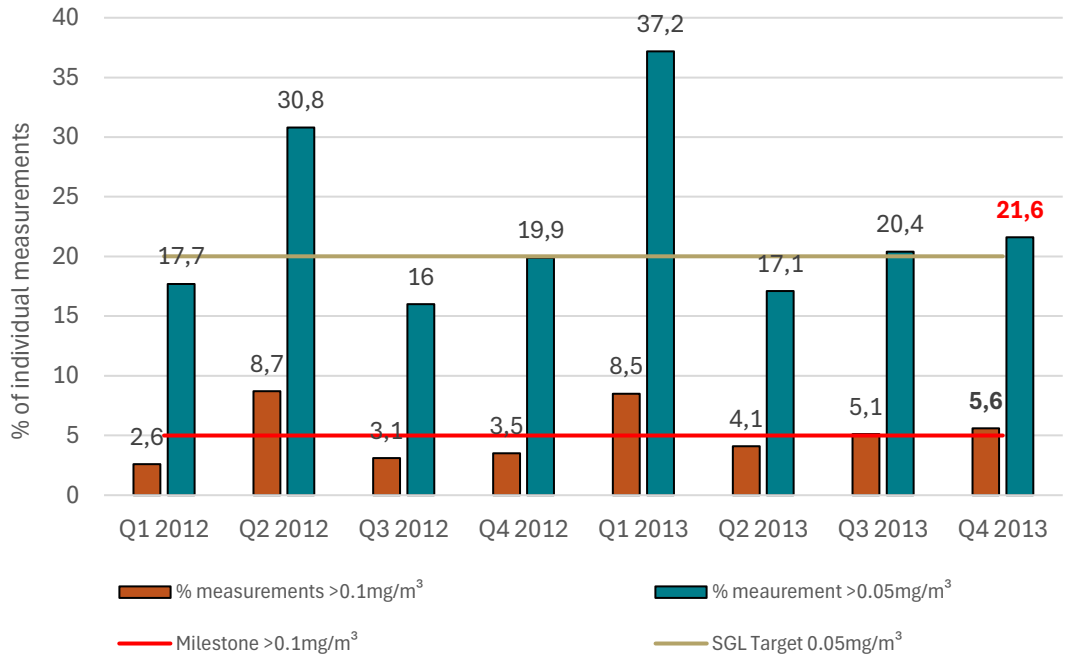
Hierarchy of Control vs Business Value



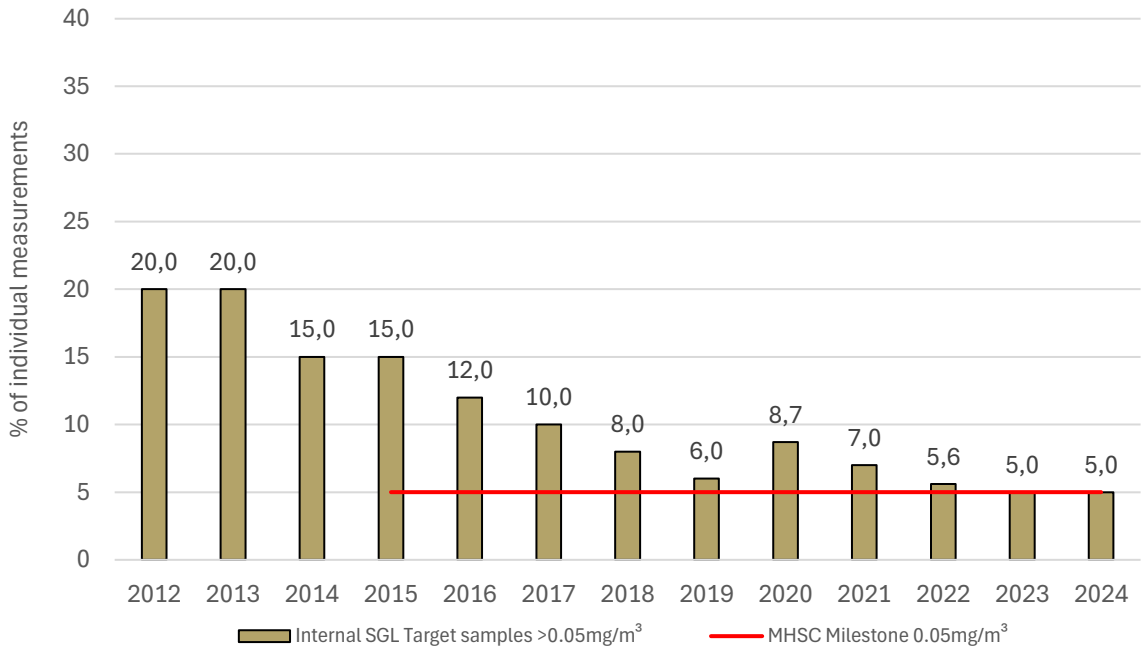
Performance against the 1st MHSC Milestone

Exposures in 2013



- Almost achieved the 2003 Silica Exposure Milestone of no more than 5% of samples > 0.1 mg/m³
- At the start of 2014, we were at 21.6% of sample > 0.05 mg/m³ – a huge challenge to achieving the next milestone·

Step down approach adopted to achieve 2014 Milestone



- Achieving the new (2014) Milestone – no more than 5% of samples to be >0.05 mg/m³

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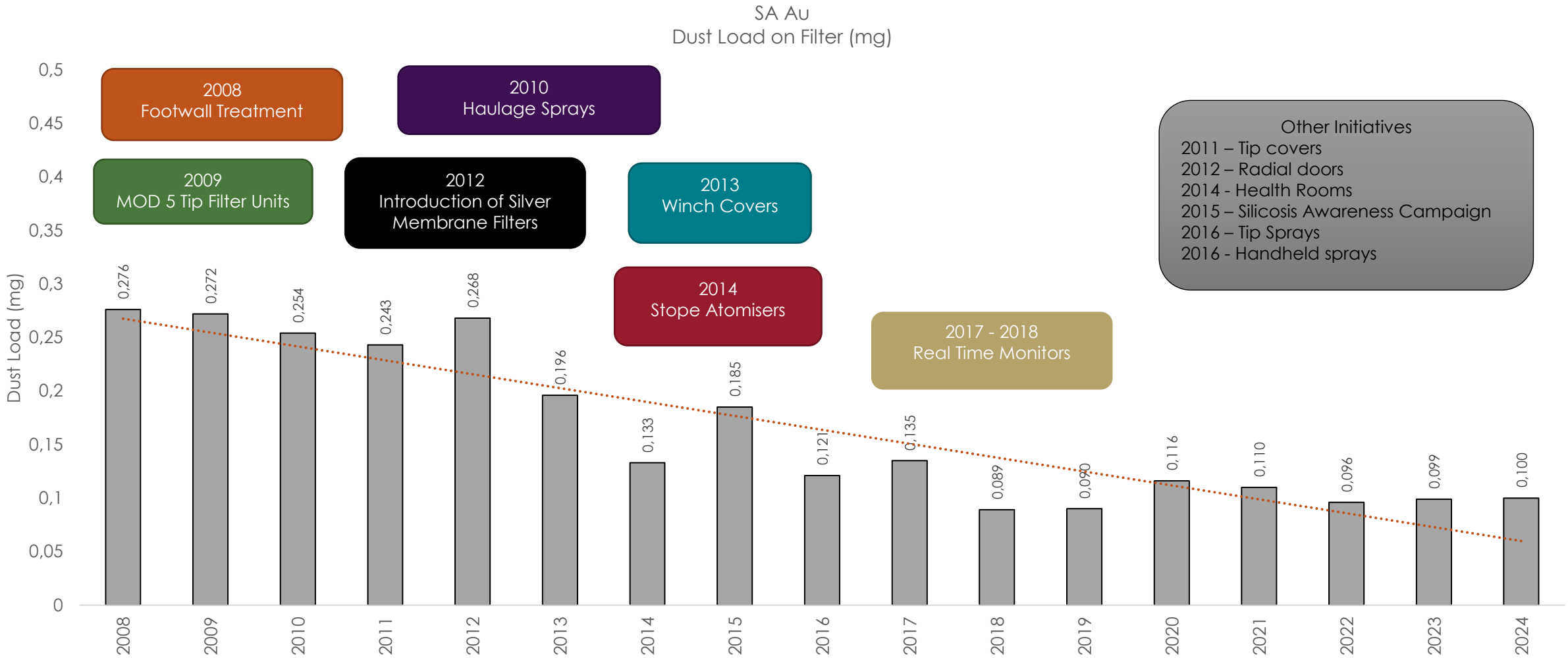
Initiatives that Sibanye Stillwater invested in over time



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Interventions

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Case Studies - interventions to reduce exposure levels

Several interventions introduced by the Sibanye–Stillwater Gold Operations

- Footwall Treatment
- MOD 5 Filtration Units
- Haulage Sprays
- Stope Atomiser Sprays
- Dust Blitz Audit's
- Winch Covers
- Silicosis awareness

Footwall treatment

This is an engineering control that involves the wetting of underground haulage surfaces (footwall and sidewalls) with water or a combination of water and surfactants by spray cars that are pulled by an underground locomotive, spraying the solution onto the footwalls and sidewalls to consolidate the dust particles and prevent them from becoming airborne.

Footwall Treatment

–

Reduce the liberation of dust into intake airways

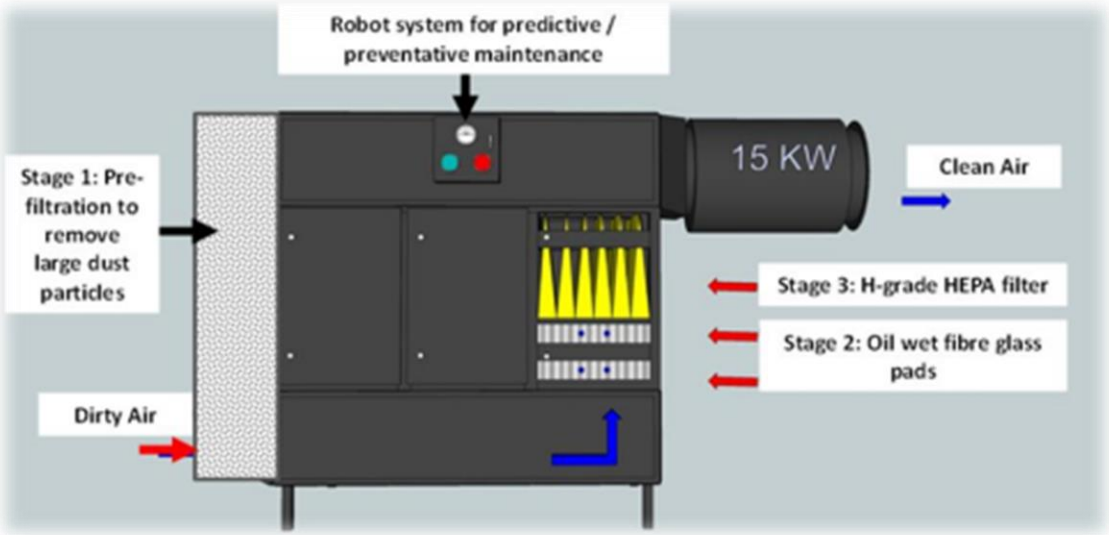
Activity	Before Footwall Treatment (Aerosols <10µ)	After Footwall Treatment (Aerosols <10µ)	Percentage reduction
Empty hoppers from station	0.478mg/m³	0.190mg/m³	**60%**
Hoppers with rock to station	0.442mg/m³	0.355mg/m³	**19.7%**
Empty material cars passing	0.517mg/m³	0.244mg/m³	**52.8%**
Employees passing	0.322mg/m³	0.076mg/m³	**76.3%**
Explosive cars from station	0.385mg/m³	0.055mg/m³	**85.7%**

Installation of MOD 5 Filtration Units

Multi-stage filtration systems have been recognised as a primary dust control in intake airways.

Following the installation of the multi-stage filtration units an average reduction of 71% in the dust load was observed.

MOD 5 Filtration Units



Haulage sprays

Haulage Sprays

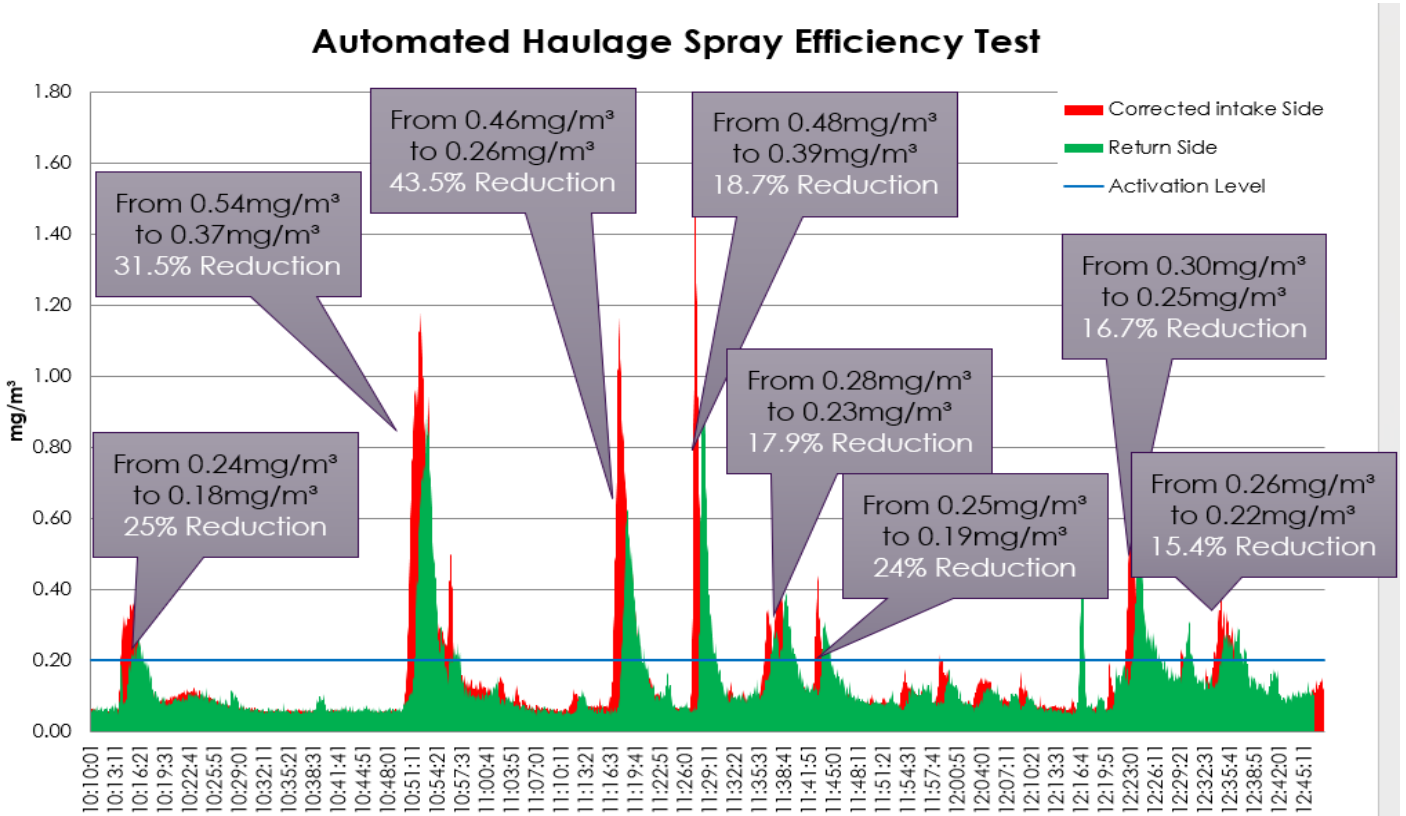
The Haulage spray system is a water-based dust engineering control that is either used to water down and suppress dust or to facilitate the airborne capture of dust particles. It is the deployment of the technology that is based on the principle that fine water droplets will bond with dust particles and thus enhance the application of water for dust control.
The practice is founded on the following principles:

- Site specific design
- Nozzle size, pressure and surfactant specifications

There are various types of spray systems installed across the Au Operations where specific needs have been identified. These sprays are mostly used in intake airways where high velocities have the tendency to remove moisture from the footwall resulting in the liberation of dust into the atmosphere. Regular checks and maintenance of this system are required to ensure effectiveness.
The decision as to whether haulage sprays are required and installed is dependent on the outcome of a risk assessment.

Automated Haulage Sprays

Haulage Sprays



Before spray mg/m³	0.24	0.54	0.46	0.48	0.28	0.25	0.30	0.26
After spray mg/m³	0.18	0.37	.026	0.39	0.23	0.19	0.25	0.22
Reduction %	25.0	31.5	43.5	12.7	17.9	24.0	16.7	15.4

Overall - 24.0% Reduction

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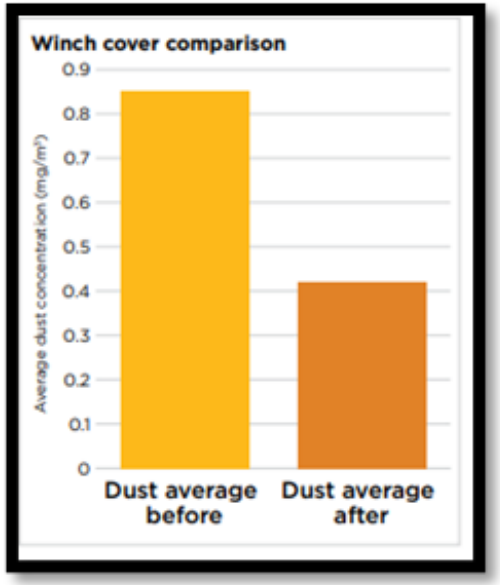
Winch Covers – Simple Leading Practice

Winch Covers

50% reduction in aerosol particles (total dust) in the breathing zone of winch operators was observed. The risk of silicosis to winch operators, the employees who are most at risk, is significantly reduced.



In stope Atomiser Sprays – effectiveness study

In-stope Atomiser Sprays

The effectiveness of the atomiser spray was evaluated by comparing personal respirable dust exposure levels of different occupations of in-stope workers before and after the installation of the atomiser sprays.

Personal exposure monitoring was conducted on both the day shift and night shift using gravimetric sampling pumps.

Monitoring focused on the occupations that are mostly deployed in the stoping faces, strike gullies, centre gullies and back area sweepings.

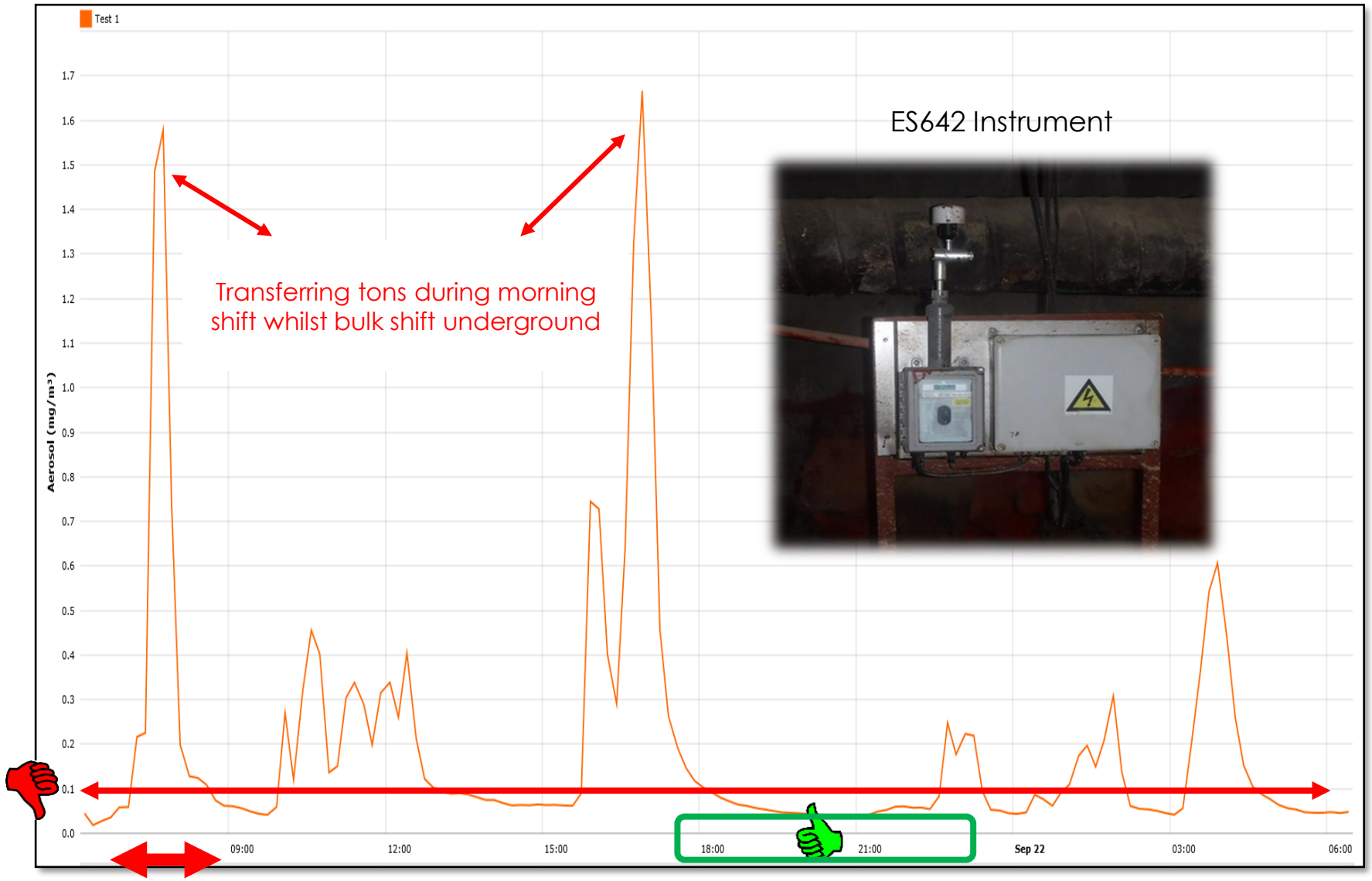
Team leaders, winch drivers, stope teams and rock drill operators were measured and observed during the study period.

A total of 20 personal exposure samples were collected over the 8-week period.

Occupation	Before concentration (mg/m^3)	After concentration (mg/m^3)	Exposure reduction (%)
RDO	1.163	0.231	**80.1**
Winch operator	1.358	0.200	**85.3**
Stope team	1.450	0.317	**78.1**

Fixed Location – Continuous Real Time Monitors

Continuous Real Time Monitor

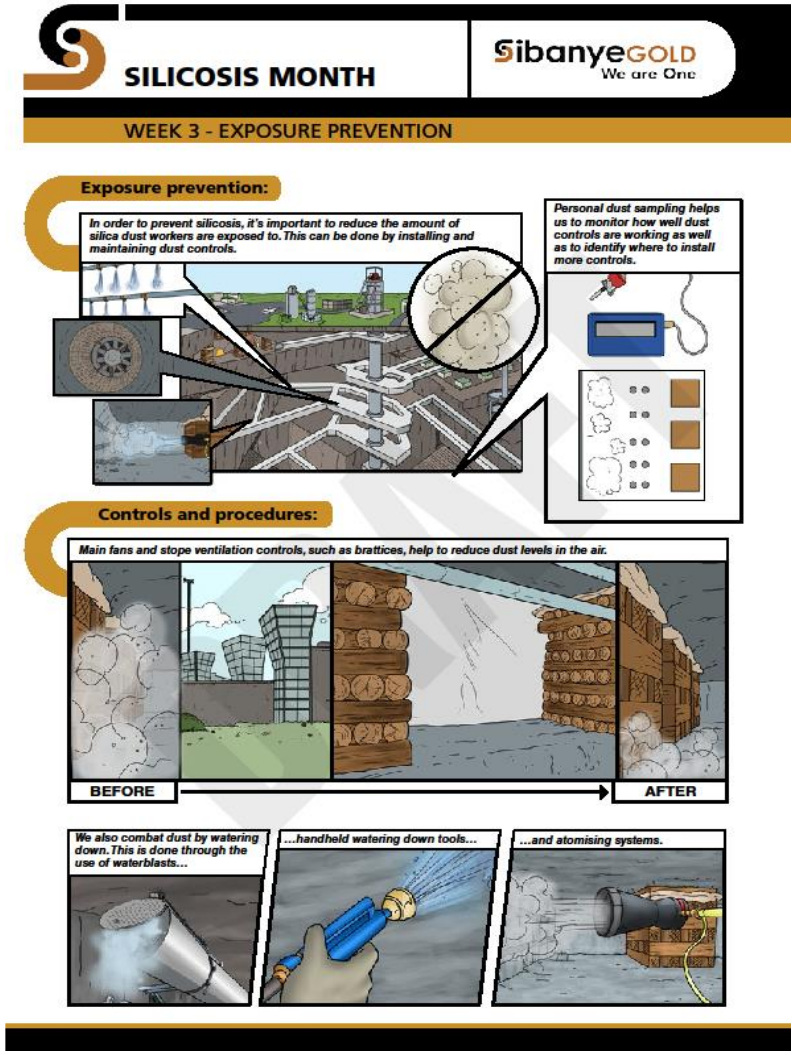


Silicosis Awareness

Health Rooms

- Consultation with Employees
- Weekly topics
- Multiple/common languages
- Discussed at safety meetings
- Health Room discussion (below)

Health Promotion
Risk communication



Dust Blitz Audits

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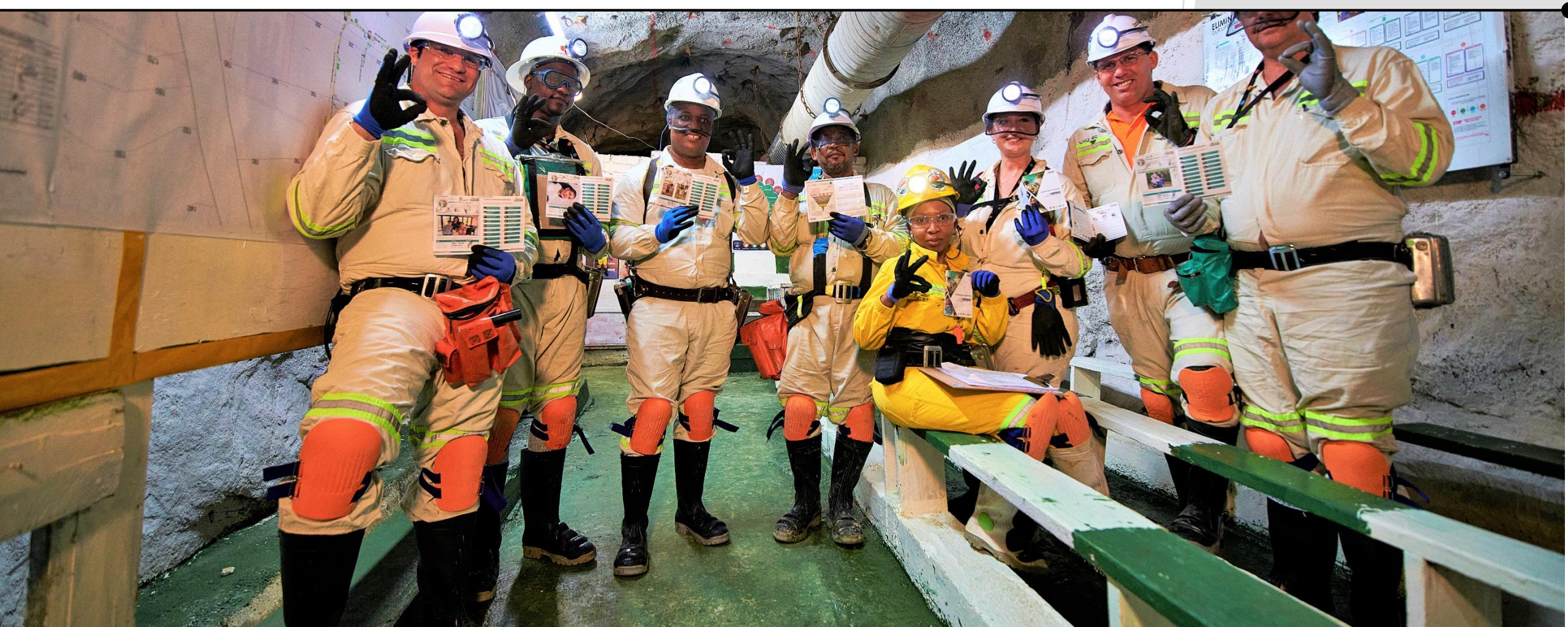


Dust Blitz Audits

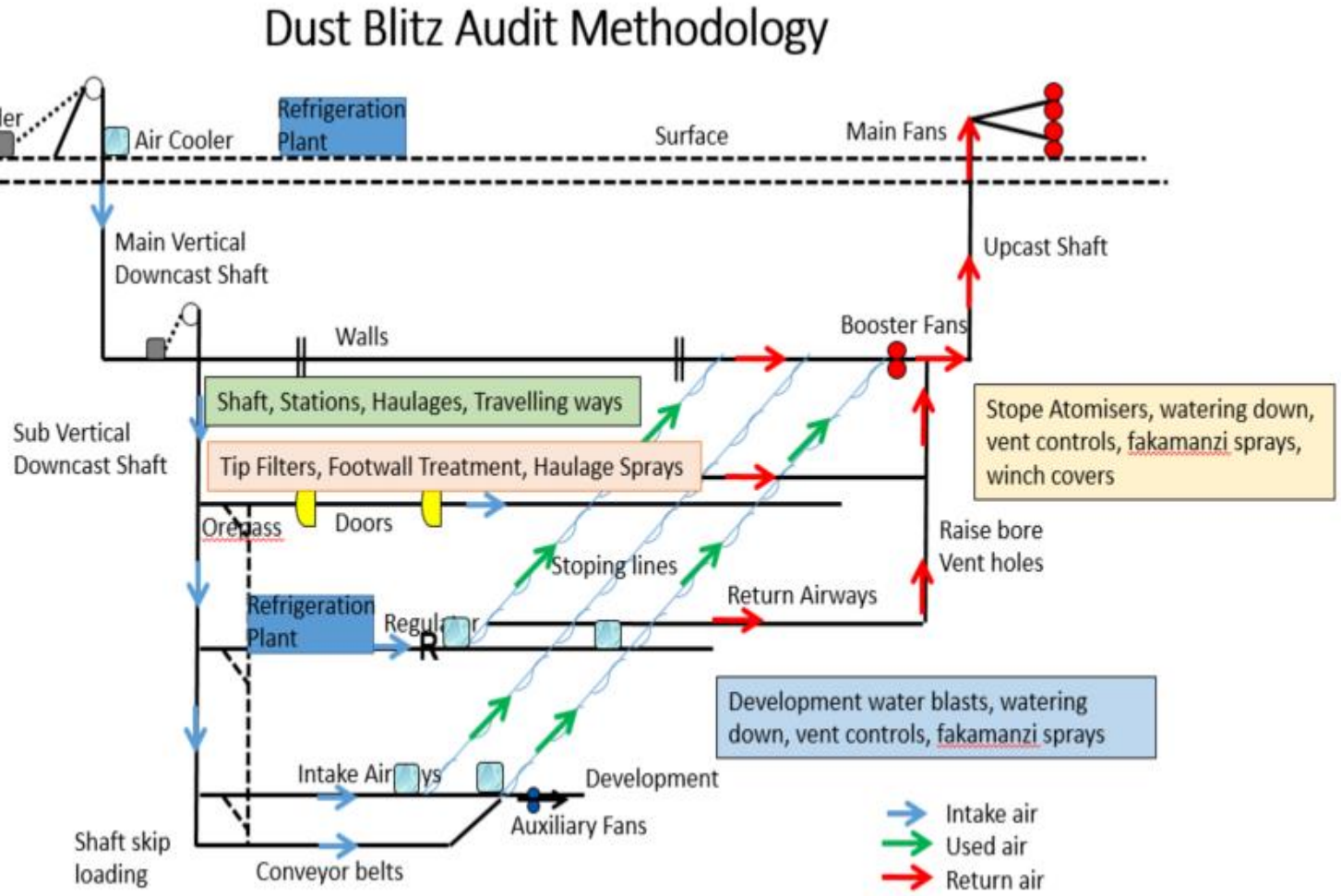
Dust Blitz Audits

Audit Team Environmental Engineering staff & Safety Officers

Issued with gravimetric sampling instruments, hand-held aerosol monitors, camera's

Gravimetric sampling instruments were issued to employees working in the work places on the same day.

Audit team carried out inspection from the shaft through to the stope / development end. Inspecting all controls along the way.

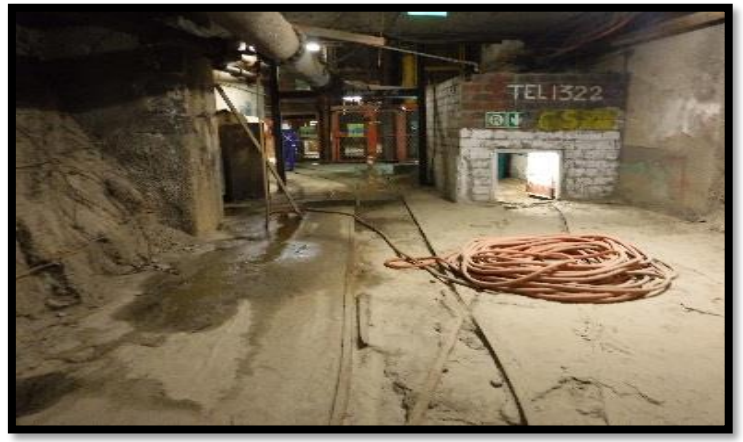


Dust Blitz Audits

Dust Blitz Audits

12 Level Belt section – dust & ore accumulation under and around the belts

Before



28 Level towards the fridge plant – dusty station areas

12 Level Belt section – dust & ore accumulation removed under and around the belts

After Clean-up

28 Level towards the fridge plant – dusty station areas washed daily

Dust Blitz Audits

Dust Blitz Audits

3E Panel – Watering down with an open-ended hose

3E B/Gully – Atomiser working
Fakamanzi tool hanging on the sidewall – not in use

3E Gully – watered down using an open-ended hose

Winch Cover in place

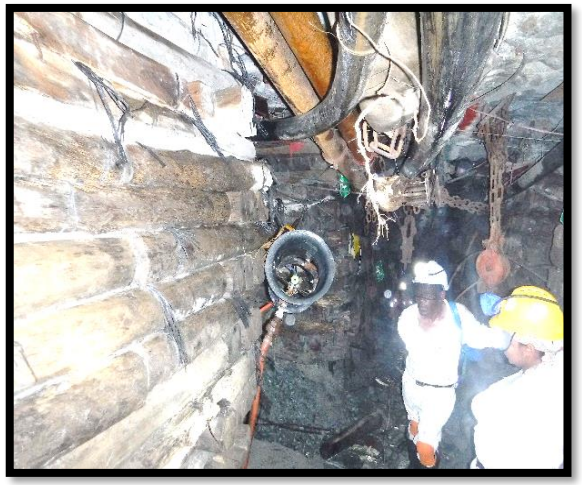
Dust Blitz Audits

Dust Blitz Audits

Travel way to Tertiary Shaft washed down

Station Area washed

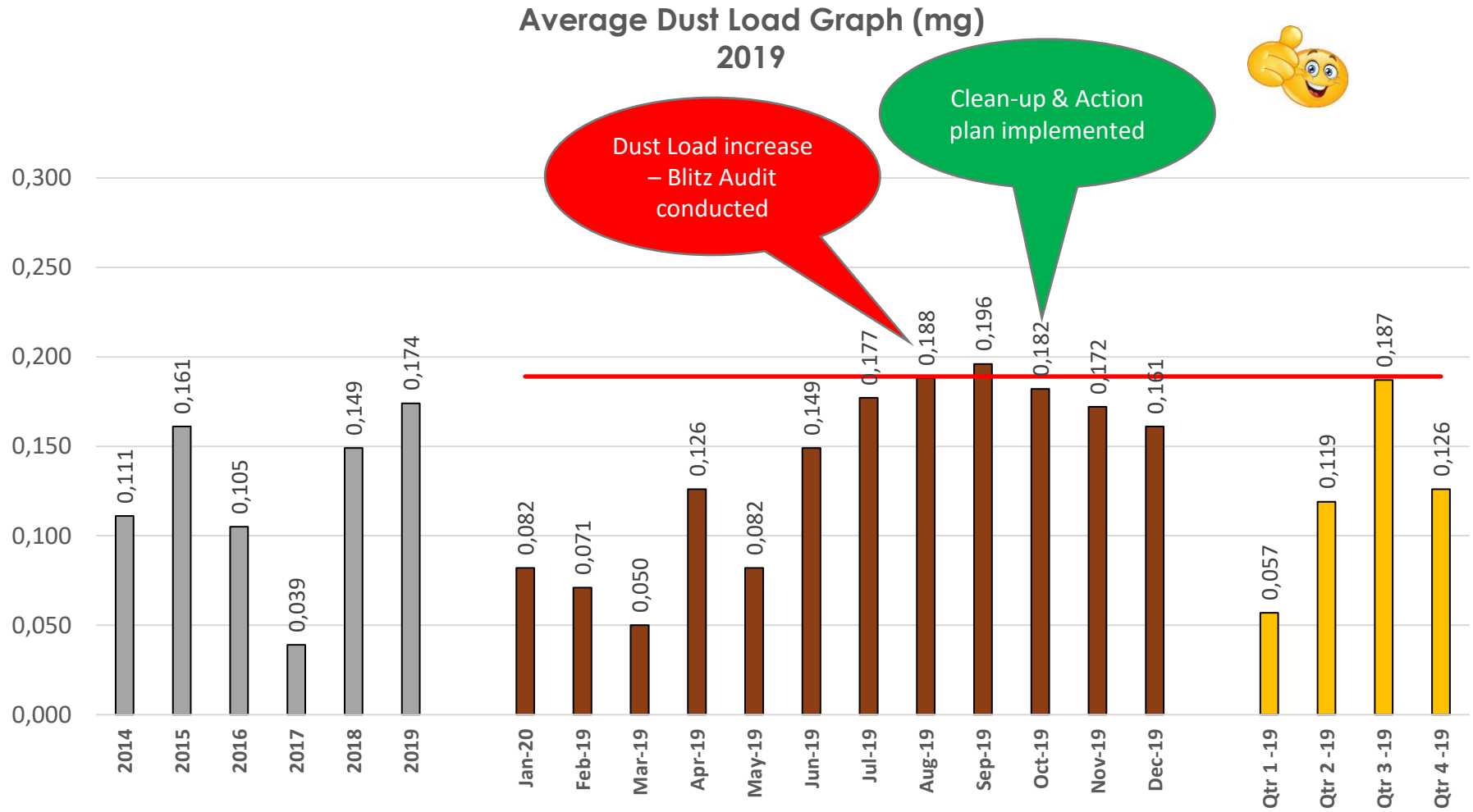
1E Centre Gully – watered down



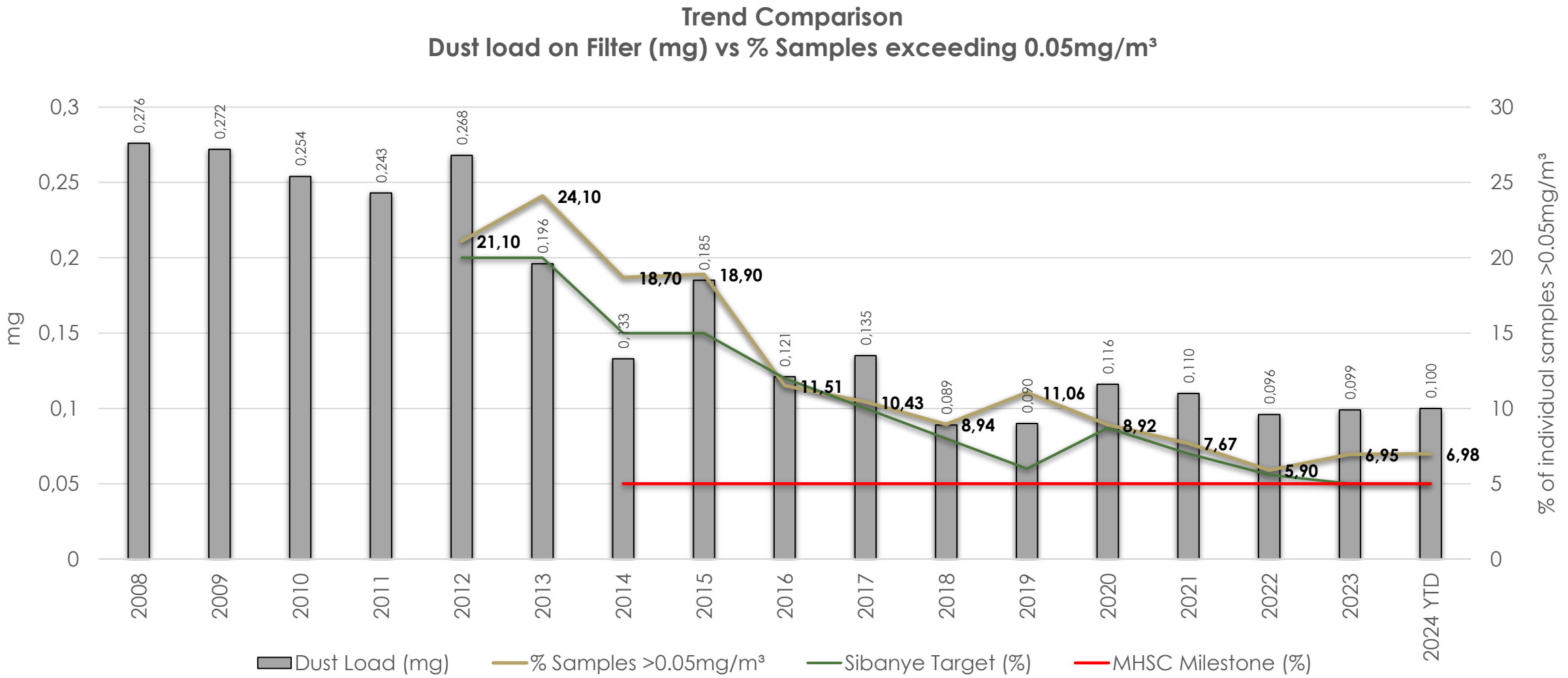
Dust atomizer in place and connected up

Dust Blitz Audits

Dust Blitz Audits



Overall Effectiveness of Technological & Administrative Practices



Summary

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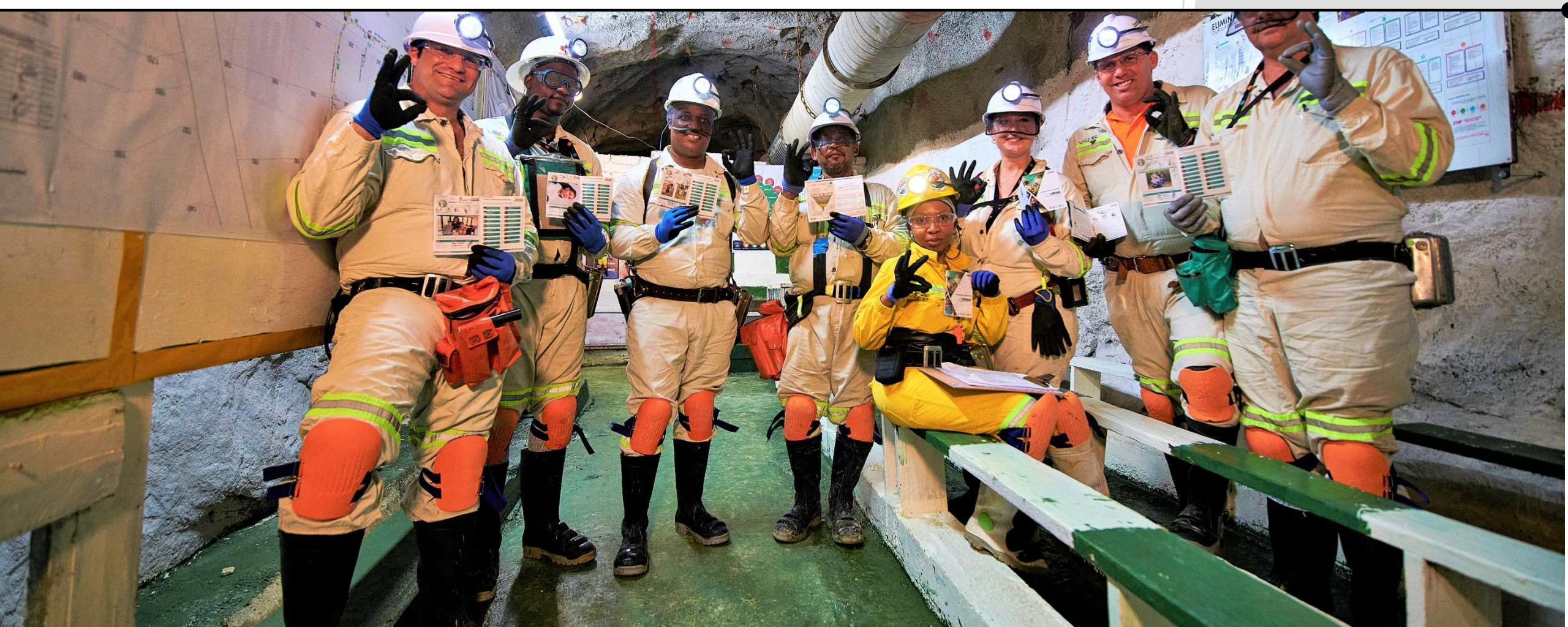
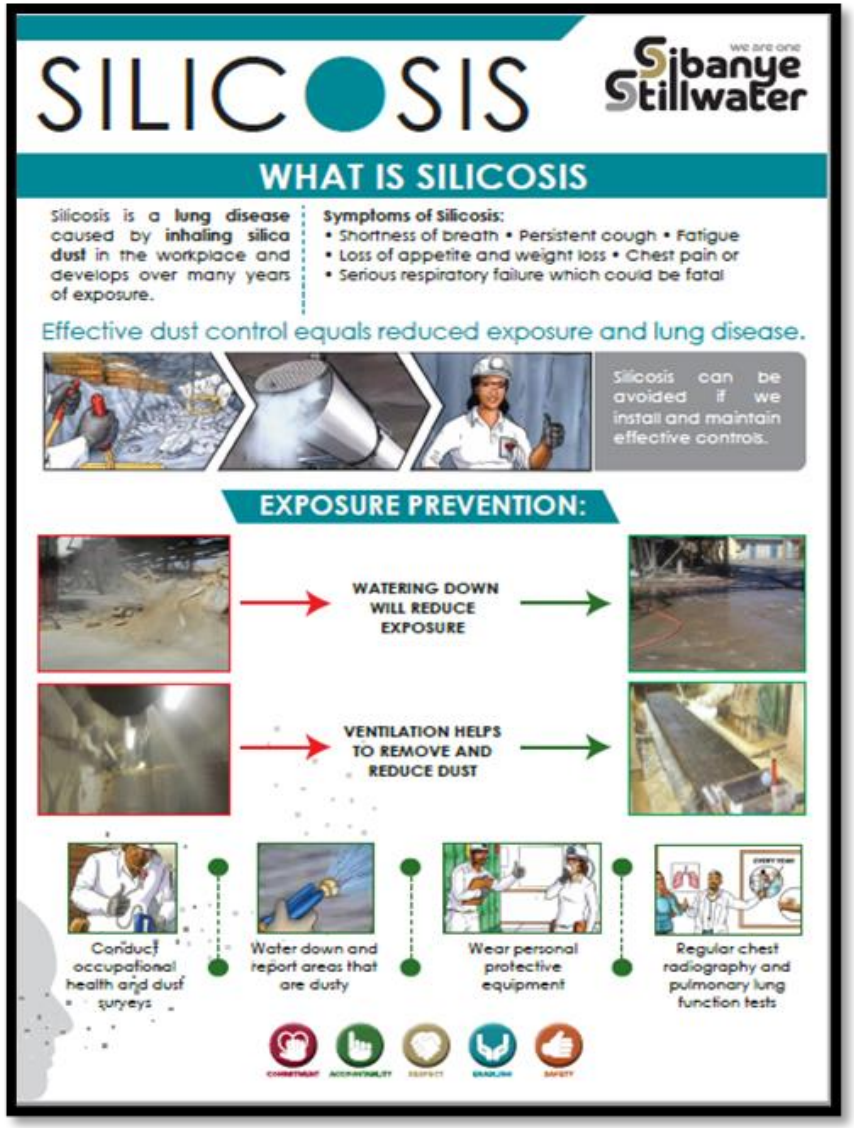


Effective dust control (prevention) equates to reduced exposure and lung disease

- Line Management / leadership is critically important in dust prevention and control.
- Direct correlation between dust load on filter & level of exposure – **the lower the dust load the lower the potential for over exposure**
- Vitally important that all controls from the shaft to the working face are in place, maintained to standard and operating at all times – dust load can be reduced by keeping all intake airways clean.
- Maintenance of existing controls
- All spillage (e.g. backfill), accumulation of dust needs to be removed and areas cleaned and kept damp at all times to reduce exposure levels within the workplaces.
- Good Housekeeping is essential
- Dry backfill, dry mud bags , dry ore spillage increases the dust load.



Acknowledgements

Recognition and a special word of “Thanks” to everyone that assisted with the case studies and implementation of the various interventions across the Au Operations.

Questions?