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# Air Quality Impact Assessment Report for Proposed Harmony West Wits Reclamation and Deposition Project

Project done on behalf of **Environmental Impact Management Services**


**Report Compiled by**
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| | | |

## Competency Profiles

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She has worked across Africa and has considerable experience in the many aspects of air quality management, including impact- and health risk screening assessments, dispersion modelling simulations, and emissions quantification for a variety of source types. Hanlie has been involved in a few United Nations Environmental Programme (UNEP) projects and served as the project manager on numerous innovative air quality management plan (AQMP) developments. She also participates actively in the National Association for Clean Air (NACA) and the International Union of Air Pollution Prevention and Environmental Protection Associations (IUAPPA). She served as an external examiner for various MSc and PhD dissertations and lectured at air quality management courses.

# Executive Summary

Randfontein Estates Limited (a subsidiary of Harmony Gold Mining Company) (hereafter referred to as the applicant) has appointed Environmental Impact Management Services (Pty) Ltd (EIMS) as the Environmental Assessment Practitioner (EAP) to assist with undertaking the required authorisation processes and to compile and submit the required documentation in support of application for the proposed new Deelkraal II Tailings Storage Facility (TSF) project and associated infrastructure on a site located approximately 13 km southwest of Carletonville in the Merafong City Local Municipality, West Rand District Municipality, Gauteng Province (i.e. the Proposed Harmony West Wits Reclamation and Deposition Project).

The Applicant requires additional deposition capacity for West Wits region's operations. The applicant plans on constructing the Deelkraal II TSF to cater for the additional future capacity. This TSF will receive residue from Kusasalethu, and Savuka plants and will also assist in returning process water for reclaiming the existing Deelkraal 1 TSF and Kusasalethu TSF for processing at Kusasalethu plant. Additional planned infrastructure includes slurry, potable, sewage and return water pipelines, access roads, pump stations, a return water dam and a power line. Proposed upgrades to the existing Kusasalethu plant are also proposed as part of the project.

Airshed Planning Professionals (Pty) Ltd was appointed by Environmental Impact Management Services Pty Ltd (EIMS) to undertake an Air Quality Study as part of the proposed changes at the Deelkraal and Kusasalethu mines. Although the focus of the study is on the significance in impact changes of the proposed Deelkraal Facility (TSF) and upgrades at the Kusasalethu processing plant, the Savuka and Mponeng Mine operations are included in the baseline to provide for a semi-cumulative assessment.

*Study Approach and Methodology*

The investigation followed the methodology required for a specialist report as prescribed in the Environmental Impact Assessment (EIA) Regulations (Government Notice 517 in Government Gazette 44701 of 11 June 2021).

*Baseline Assessment*

The baseline study encompassed the analysis of meteorological data and analysis of dustfall results.

- Simulated Weather Research and Forecasting Model (WRF) meteorological data (including wind speed, wind direction and temperature) was used for the period 2022 to 2024.
- The Savuka and Mponeng dustfall network comprise of 15 single Dustfall Monitoring Units (DMU) in accordance with ASTM D1739 (1970), with ten (10) units at the Savuka operations and five (5) at the Mponeng operations. Dustfall results for the period January 2023 to July 2025 were made available for inclusion into this report.
- The Kusasalethu dust fallout comprising of 7 single Dustfall Monitoring Units (DMU) in accordance with ASTM D1739 (1970). Five (5) of these DMUs are screened against the NDCR non-residential limit of 1 200 mg/m²/day, with the remaining two (2) units regarded as residential (screened against the NDCR residential limit of 600 mg/m²/day). Dustfall rates for the Kusasalethu DMUs for the period January 2020 to June 2025.

*Impact Assessment Criteria*

Particulates represent the main pollutants of concern in the assessment of operations from the project. Daily and annual PM2.5 (particulate matter with diameter of less than 2.5 µm) and PM10 (particulate matter with diameter of less than 10 µm) ground level concentrations and dust deposition rates were assessed. The simulated impacts were assessed against published National Ambient Air Quality Standards (NAAQS) and National Dust Control Regulations (NDCR).

*Emissions Inventory*

Emissions inventories provide the source input required for the simulation of ambient air concentrations. Fugitive source emissions as a result of wind erosion from the existing sources (surrounding TSFs and marginal ore dumps) and the proposed Deelkraal II TSF were quantified. Point source emissions from the stacks was provided by the client and based on MES limits.

*Impact Prediction Study*

Particulate matter concentrations and deposition rates due to the current and future operations were simulated using the AERMET/AERMOD dispersion modelling suite. Ambient concentrations were simulated to ascertain daily and annual averaging levels occurring as a result of the project operations.

*Management of Uncertainties*

Data limitations and assumptions associated with this project are as follows:

- Use was made of simulated Weather Research and Forecasting Model data for a point at the Savuka site, and this is regarded as representative of the project area for Mponeng.
- The quantification of sources of emission was restricted to the project activities and operations within the study domain only. Although other background sources were identified, such sources could not be quantified. The current mining and processing operations at Mponeng and Savuka were modelled to reflect the cumulative PM concentrations in the area, specifically at the nearby receptors.
- Information required for the calculation of emissions from dust sources for the project operations was supplied by EIMS with the baseline activities taken from a previous study conducted for West Wits operations. The assumption was made that this information was accurate and correct.
- Routine emissions from the operations were estimated and modelled.
- Emissions from the Construction phase were estimated as area wide construction emissions and could not be modelled since the actual plans of individual construction processes were not available. Impacts from construction operations are however usually lower than operational phase due to their temporary nature and duration, and the likelihood that these activities will not occur concurrently at all portions of the site.

*Main Findings*

The main findings of the receiving environment assessment are:

- AQSRs near the Deelkraal and Kusasalethu operations include individual households and residential areas: Deelkraal, Elandsrand and Wedela communities.
- AQSRs near the Savuka and DF5 TSFs include individual households and residential areas: Elandsridge, Western Deep Levels, The Village, Southdene communities.
- The main sources associated with the proposed operations likely to contribute to baseline PM emissions include mining and reclaiming operations, processing operations, vehicle entrained dust from roads, vehicle exhaust and windblown dust from exposed areas on existing TSFs and WRDs.
- Other sources of PM within the area include other companies mining, transport and processing activities, farm activities, occasional biomass burning, household fuel burning in the residential areas, vehicle entrained dust from public roads and vehicle exhaust.
- The wind field is dominated by winds from the northerly sector with the strongest winds (>6 m/s) mostly from the north-northeasterly sector. The predominant northerly wind field remains similar throughout the seasons.
- Dust fallout results from the five (7) DMUs at Kusasalethu for the period January 2020 to June 2025 show compliance with the NDCR at both the residential and non-residential sites with one residential exceedance in November 2020.
- Dust fallout results from the five (12) DMUs at Savuka for the period January 2023 to July 2025 show compliance with the NDCR at both the residential and non-residential sites.

The main findings of the impact assessment for current and future operations are as follows:

- The simulated $PM_{2.5}$ 24-hour concentrations indicate compliance with the NAAQS at all the AQSRs, for both current and future operations. The annual $PM_{2.5}$ concentrations for current and future operations are also likely to be within compliance with the NAAQS. The additional emission due to the Deelkraal II TSF and Kusasalethu plant would result on average in a 29% increase in daily GLCs at the various AQSRs, and a 14% increase annually when taking existing sources from Savuka and Mponeng.
- The simulated $PM_{10}$ 24-hour GLCs indicate compliance with the NAAQS all the AQSRs, for both current and future operations. The annual $PM_{10}$ concentrations for current and future operations are also likely to be within compliance with the NAAQS. The additional emission due to the Deelkraal II TSF and Kusasalethu plant would result on average in a 29% increase in daily GLCs at the various AQSRs, and a 14 % increase annually increase when taking exiting sources from Savuka and Mponeng into account but likely still within compliance with the NAAQS.
- The simulated daily average dustfall rates with the current operations project no exceedances of the NDCR limit for residential areas (600 mg/m²-day). The limit for agricultural areas was projected to be exceeded up to 1.7 km to the south-southwest from the existing dormant TSF at Deelkraal and up to 1.95 km south-southwest from the inactive TSF at Kusasalethu. The simulated daily average dustfall rates for the future operations show similar impact areas to the current operations but with exceedance of the agricultural limit for up to 4.7 km from the proposed Deelkraal II TSF, and average increase of 56% when taking exiting sources from Savuka and Mponeng into account.
- The environmental risk due to unmitigated future operations is classified as **Medium** based om the Deelkraal and Kusasalethu operations**,** with minor spatial and temporal cumulative change**.** With mitigation (80% CE through grassing of TSF side slopes and wet slurry deposition) the risk is classified as **Low**.

*Recommendations*

With the potential impacts from windblown dust from the active TSFs, especially for the proposed Deelkraal II TSF, the following recommendations are proposed:

- Dustfall monitoring continues to ensure dustfall rates are in compliance with the NDCR limits;
- Dust fallout monitor DK 1 should be moved to south-western boundary if the nearby Deelkraal town.
- A new dust fallout monitor be placed on the south-western boundary of the proposed Deelkraal II TSF
- Mitigation measures aimed at reducing wind erosion from the active TSFs, i.e. the vegetation of TSF side slopes, with dust suppression on the surface of the TSF in the form of wet deposition and water sprays.
- Further dust suppression should include regular water sprays on unpaved surface roads, preferably combined with chemical.

In conclusion, it is the specialist opinion that the project may be authorised provided that the recommended air quality management measures are implemented

# Table of Contents


1 Introduction ..... 12

1.1 Background ..... 12

1.2 Scope of Work ..... 13

1.3 Pollutants of Interest ..... 14

1.4 Methodology ..... 14

1.4.1 Potential Air Emissions from the Project ..... 15

1.4.2 Regulatory Requirements and Assessment Criteria ..... 15

1.4.3 Description of the Baseline Environment ..... 15

1.4.4 Existing Ambient Air Quality ..... 15

1.4.5 Emissions Inventory ..... 15

1.4.6 Atmospheric Dispersion Modelling ..... 15

1.4.7 Uncertainty of Modelled Results ..... 17

1.4.8 Management of Uncertainties ..... 17

1.4.9 Impact Assessment Report ..... 18

2 Regulatory Requirements and Assessment Criteria ..... 19

2.1 Emissions Standards ..... 19

2.2 Atmospheric Emissions Reporting Regulations ..... 19

2.3 Atmospheric Dispersion Modelling Regulations ..... 20

2.4 National Ambient Air Quality Standards (NAAQS) ..... 21

2.5 National Dust Control Regulations (NDCR) ..... 21

2.6 Screening criteria for animals and vegetation ..... 22

3 Description of the Receiving Environment ..... 23

3.1 Affected Environment ..... 23

3.2 Atmospheric Dispersion Potential ..... 23

3.2.1 Local Wind Field ..... 23

3.2.2 Ambient Temperature ..... 27

3.2.3 Atmospheric Stability ..... 28

3.2.4 Precipitation and Relative Humidity ..... 29

4 Status Quo of Ambient Air Quality in the Area ..... 30

4.1 Existing Sources of Air Pollution ..... 30

4.2 Sampled Dustfall Rates ..... 30

4.2.1 Kusasalethu Mine ..... 30

4.2.2 Savuka and Mponeng ..... 38

5 Air Quality Impact Assessment ..... 45
5.1 Description of Current Operations in the West Wits area ..... 45
5.1.1 Ventilation shafts ..... 45
5.1.2 Deelkraal and Kusasalethu Gold Plants ..... 45
5.1.3 Tailings Storage Facilities ..... 45
5.1.4 Waste Rock Dumps ..... 46
5.1.5 Vehicles operations ..... 46
5.2 Project Activities from an Air Quality Perspective ..... 46
5.3 Emissions Quantification ..... 47
5.3.1 Construction Phase ..... 47
5.3.2 Operational Phase ..... 52
5.4 Simulation Results ..... 54
5.4.1 Respirable particulate matter ($PM_{2.5}$) ..... 54
5.4.2 Inhalable particulate matter ($PM_{10}$) ..... 60
5.4.3 Fallout Dust ..... 66
5.5 Impact Significance Rating ..... 69
6 Dust Management Plan ..... 71
6.1 Objectives and Targets ..... 71
6.2 Dust Management Measures ..... 71
6.2.1 Wind Erosion ..... 71
6.3 Performance Indicators ..... 72
6.3.1 Ambient Air Quality Monitoring ..... 72
6.3.2 Periodic Inspections and Audits ..... 73
6.3.3 Liaison Strategy for Communication with Interested and Affected Parties (I&APs) ..... 73
7 Main Findings and Recommendations ..... 75
7.1 Main Findings ..... 75
7.2 Recommendations ..... 76
8 References ..... 77
9 Appendix A: Specialist Curriculum Vitae ..... 78
10 Appendix B – Impact Significance Rating Methodology ..... 85
11 Appendix C – Cumulative Future Scenario Emissions ..... 90

# List of Tables

Table 1: National Ambient Air Quality Standards....21
Table 2: Acceptable dustfall rates....21
Table 3: Monthly temperature summary (WRF data, January 2022 to December 2024)....27
Table 4: Site description and location of Kusasalethu Dustfall Monitoring Units (DMU)....31
Table 5: Site description and location of Savuka and Mponeng Dustfall Monitoring Units (DMU)....39
Table 6: Activities and associated air pollutants from the Deelkraal and Kusasalethu Operations....46
Table 7: Areas affected by Construction activities....48
Table 8: Deelkraal II Construction Emission estimation techniques and parameters....50
Table 9: Emissions in tonnes per annum (tpa) for the various scenarios....52
Table 10: Emission estimation techniques and parameters....53
Table 11: Simulated $PM_{2.5}$ concentrations at the AQSRs....55
Table 12: Simulated $PM_{10}$ concentrations at the AQSRs....61
Table 13: Simulated dustfall rates at the AQSRs....66
Table 14: Significance rating for potential air quality impacts due to the current operations....69
Table 15: Significance rating for potential air quality impacts due to future operational phase with Kusasalethu upgrades and Deelkraal II receiving process tailings....70
Table 16: Recommended dust fallout monitoring locations....73
Table 17: Criteria for determining impact consequence....85
Table 18: Probability scoring....86
Table 19: Determination of Significance....87
Table 20: Significance classes....87
Table 21: Criteria for determining prioritisation....88
Table 22: Determination of prioritisation factor....88
Table 23: Final environmental significance rating....89
Table 24: Cumulative Emissions Emission estimation techniques and parameters....90

# List of Figures

Figure 1: Location of sensitive receptor areas surrounding the current Deelkraal, Kusasalethu, Savuka and Mponeng mining operations ..... 24
Figure 2: Topography for the study area ..... 25
Figure 3: Period, day- and night-time wind roses (WRF data, January 2022 to December 2024) ..... 26
Figure 4: Seasonal wind roses (WRF data, January 2022 to December 2024) ..... 26
Figure 5: Monthly temperatures (WRF data, January 2022 to December 2024) ..... 27
Figure 6: Diurnal temperature profile (WRF data, January 2022 to December 2024) ..... 28
Figure 7: Diurnal atmospheric stability (WRF data, January 2022 to December 2024) ..... 29
Figure 8: Kusasalethu Dustfall Monitoring Units (DMU) ..... 32
Figure 9: Kusasalethu DMU Dustfall rates from January 2020 to December 2020 for Non-Residential sites ..... 33
Figure 10: Dustfall rates from January 2020 to December 2020 for Residential sites ..... 33
Figure 11: Dustfall rates from January 2021 to September 2021 for Non-Residential sites ..... 34
Figure 12: Dustfall rates from January 2021 to September 2021 for Residential sites ..... 34
Figure 13: Dustfall rates from April 2022 to August 2022 for Non-Residential sites ..... 35
Figure 14: Dustfall rates from April 2022 to August 2022 for Residential sites ..... 35
Figure 15: Dustfall rates from January 2023 to December 2023 for Non-Residential sites ..... 36
Figure 16: Dustfall rates from January 2023 to December 2023 for Residential sites ..... 36
Figure 17: Dustfall rates from January 2024 to December 2024 for Non-Residential sites ..... 37
Figure 18: Dustfall rates from January 2024 to December 2024 for Residential sites ..... 37
Figure 19: Dustfall rates from January 2025 to June 2025 for Non-Residential sites ..... 38
Figure 20: Dustfall rates from January 2025 to June 2025 for Residential sites ..... 38
Figure 21: Savuka and Mponeng Dustfall Monitoring Units (DMU) ..... 40
Figure 22: Savuka DMU Dustfall rates from January 2022 to December 2022 for Residential sites ..... 41
Figure 23: Dustfall rates from January 2022 to December 2022 for Non-Residential sites ..... 41
Figure 24: Dustfall rates from January 2023 to December 2023 for Residential sites ..... 42
Figure 25: Dustfall rates from January 2023 to December 2023 for Non-Residential sites ..... 42
Figure 26: Dustfall rates from January 2024 to December 2024 for Residential sites ..... 43
Figure 27: Dustfall rates from January 2024 to December 2024 for Non-Residential sites ..... 43
Figure 28: Dustfall rates from January 2025 to July 2025 for Residential sites ..... 44
Figure 29: Dustfall rates from January 2025 to July 2025 for Non-Residential sites ..... 44
Figure 30: Simulated area of exceedance of the 24-hour $PM_{2.5}$ NAAQS as a result of current and future operations with mitigation measures applied ..... 57
Figure 31: Simulated annual average $PM_{2.5}$ concentrations as a result of current operations ..... 58
Figure 32: Simulated annual average $PM_{2.5}$ concentrations as a result of future operations ..... 59
Figure 33: Simulated area of exceedance of the 24-hour $PM_{10}$ NAAQS as a result of current and future operations ..... 63
Figure 34: Simulated annual average $PM_{10}$ concentrations as a result of current operations ..... 64
Figure 35: Simulated annual average $PM_{10}$ concentrations as a result of future operations ..... 65
Figure 36: Simulated average daily dustfall rates as a result of current operations ..... 67
Figure 37: Simulated average daily dustfall rates as a result of future operations ..... 68
Figure 38: Prosed locations of new dust fallout monitors at Deelkraal and Kusasalethu ..... 74

## List of Abbreviations

| | |
|---|---|
| **AEL** | Atmospheric Emissions Licence |
| **Airshed** | Airshed Planning Professionals (Pty) Ltd |
| **APPA** | Atmospheric Pollution Prevention Act |
| **CO** | Carbon monoxide |
| **DM** | District Municipality |
| **EIA** | Environmental Impact Assessment |
| **EIMS** | Environmental Impact Management Services Pty Ltd |
| **FEL** | Front-end-Loader |
| **GLC** | Ground level concentration |
| **GLCC** | Global Land Cover Characterisation |
| **I&APs** | Interested and Affected Parties |
| **LM** | Local Municipality |
| **LOM** | Life of Mine |
| **MES** | Minimum Emission Limits |
| **MOD** | Marginal Ore Dump |
| **NMES** | National Minimum Emission Standards |
| **NAAQS** | National Ambient Air Quality Standards |
| **NDCR** | National Dust Control Regulations |
| **NEMA** | National Environmental Management Act |
| **NEM:AQA** | National Environmental Management: Air Quality Act |
| **NO** | Nitrogen oxide |
| **$NO_2$** | Nitrogen dioxide |
| **$NO_x$** | Oxides of nitrogen |
| **$O_3$** | Ozone |
| **PM** | Particulate matter |
| **$PM_{10}$** | Particulate matter with diameter of less than 10 µm |
| **$PM_{2.5}$** | Particulate matter with diameter of less than 2.5 µm |
| **SAAQIS** | South African Air Quality Information System |
| **$SO_2$** | Sulphur dioxide |
| **SRTM** | Shuttle Radar Topography Mission |
| **TSF** | Tailings Storage Facility |
| **US EPA** | United States Environmental Protection Agency |
| **WHO** | World health Organisation |
| **WRF** | Weather Research and Forecasting Model |

## Units

| | |
|---|---|
| **°C** | Degree Celsius |
| **km** | kilometre |
| **kPa** | kilo pascal |
| **m** | metres |
| **mm** | millimetre |
| **$mg/m^2/day$** | milligram per metre squared per day |
| **t** | ton |
| **tpa** | tons per annum |
| **tpm** | tons per month |
| **$µg/m^3$** | microgram per cubic metre |
| **%** | percent |

# Glossary

**Air pollution**: means any change in the composition of the air caused by smoke, soot, dust (including fly ash), cinders, solid particles of any kind, gases, fumes, aerosols and odorous substances.

**Atmospheric emission**: means any emission or entrainment process emanating from a point, non-point or mobile sources that result in air pollution.

**Averaging period**: This implies a period of time over which an average value is determined.

**Dust:** Solid materials suspended in the atmosphere in the form of small irregular particles, many of which are microscopic in size.

**Frequency of Exceedance**: A frequency (number/time) related to a limit value representing the tolerated exceedance of that limit value, i.e. if exceedances of limit value are within the tolerances, then there is still compliance with the standard.

**Particulate Matter (PM):** These comprise a mixture of organic and inorganic substances, ranging in size and shape and can be divided into coarse and fine particulate matter. The former is called Total Suspended Particulates (TSP), whilst $PM_{10}$ and $PM_{2.5}$ fall in the finer fraction referred to as Inhalable particulate matter.

**TSP:** Total suspended particulates refer to all airborne particles and may have particle sizes as large as 150 µm, depending on the ability of the air to carry such particles. Generally, suspended particles larger than 75 to 100 micrometre (µm) do not travel far and deposit close to the source of emission.

**$PM_{10}$:** Thoracic particulate matter is that fraction of inhalable coarse particulate matter that can penetrate the head airways and enter the airways of the lung. $PM_{10}$ consists of particles with a mean aerodynamic diameter of 10 µm or smaller, and deposit efficiently along the airways. Particles larger than a mean size of 10 µm are generally not inhalable into the lungs. These $PM_{10}$ particles are typically found near roadways and dusty industries.

**$PM_{2.5}$:** Respirable particulate fraction is that fraction of inhaled airborne particles that can penetrate beyond the terminal bronchioles into the gas-exchange region of the lungs. Also known as fine particulate matter, it consists of particles with a mean aerodynamic diameter equal to or less than 2.5 µm ($PM_{2.5}$) that can be inhaled deeply into the lungs. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries and automobiles react in the air.

**Point sources:** are discrete, stationary, identifiable sources of emissions that release pollutants to the atmosphere (International Finance Corporation (IFC), 2007).

**Vehicle entrainment:** This is the lifting and dropping of particles by the rolling wheels leaving the road surface exposed to strong air current in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed.

# 1 INTRODUCTION

## 1.1 Background

Randfontein Estates Limited (a subsidiary of Harmony Gold Mining Company) (hereafter referred to as the applicant) has appointed Environmental Impact Management Services (Pty) Ltd (EIMS) as the Environmental Assessment Practitioner (EAP) to assist with undertaking the required authorisation processes and to compile and submit the required documentation in support of application for the proposed new Deelkraal II Tailings Storage Facility (TSF) project and associated infrastructure on a site located approximately 13 km southwest of Carletonville in the Merafong City Local Municipality, West Rand District Municipality, Gauteng Province (i.e. the Proposed Harmony West Wits Reclamation and Deposition Project).

The Applicant requires additional deposition capacity for West Wits region's operations. The applicant plans on constructing the Deelkraal II TSF to cater for the additional future capacity. This TSF will receive residue from Kusasalethu, and Savuka plants and will also assist in returning process water for reclaiming the existing Deelkraal 1 TSF and Kusasalethu TSF for processing at Kusasalethu plant. Additional planned infrastructure includes slurry, potable, sewage and return water pipelines, access roads, pump stations, a return water dam and a power line. Proposed upgrades to the existing Kusasalethu plant are also proposed as part of the project.

The Savuka Plant treats tailings from the Savuka Dormant TSFs (Old North TSFs) at a rate of 330 000 tpm and deposits the subsequent tailings on Savuka 5 & 7 TSFs. Harmony plans on remining Deelkraal 1 Dormant TSF and Kusasalethu TSF amongst other potential future sources. These TSFs will be processed through the Kusasalethu Plant at 500 000 tpm. The planned Life of Mine (LOM) for the West Wits region exceed the available deposition capacity of the existing TSFs. Therefore, additional deposition capacity is required.

The Kusasalethu Plant will accommodate future reclamation operations and will therefore need site/s to deposit the tailings. Harmony owns ground, located adjacent to the Deelkraal 1 Dormant TSF, that can be used i.e. for the proposed Deelkraal II TSF. The Deelkraal 1 Dormant TSF and adjacent virgin ground footprint combined geometry will accommodate the future reclamation operations deposition rate and capacity. The proposed TSF will cover an area of approximately 430 ha.

In addition to the Deelkraal II TSF, additional infrastructure is also proposed, as follows:

- A new Return Water Dam in the vicinity of the Deelkraal II TSF;
- Upgrades to the existing Kusasalethu plant including new/upgrade of gold and new uranium sections;
- Slurry pipelines:
    - Reclaimed Slurry from Deelkraal 1 to Kusasalethu (~10.6 km);
    - Kusasalethu Barren Tailings to Deelkraal II and booster pump station (~10.2 km);
    - Reclaimed Slurry from Kusasalethu TSF to Kusasalethu Plant (~2 km);
    - Slurry pipeline from Kusasalethu Plant to Savuka TSF (~4.97 km); and
    - Slurry pipeline from Savuka plant to DF5 TSF (~2.9 km).
- Process Water Pipelines:
    - Process Water Feed from Kusasalethu Plant to Deelkraal Reclamation (~9.54 km) –
    - Return Water Feed to Kusasalethu Process Water Tank (~9.58 km); -
    - Driefontein DP2 Pump Station to North Boundary Dam (~4.78 km); -
    - DP2 feed to Tau Tona Reverse Osmosis Plant (~0.1 km); -
    - Nursery Pumpstation #3 to Kusasalethu Process Water Tank (~9 km); and
    - Process Water pipelines from Kusasalethu Plant to Savuka White Tanks (~8 km).
- Powerlines (all powerlines will be 22 kV or lower):
    - Powerline from Kusasalethu Plant to the existing Deelkraal TSF (~9.2 km);
    - Powerline from Kusasalethu Plant to the Kusasalethu TSF (~1.8 km);

    - Powerline from Savuka shaft to Kusasalethu Plant (~8.1 km).
- Potable Water pipeline from Rand Water supply point to the Deelkraal TSF (~8.52 km).
- Deelkraal 1 TSF Reclamation Pump Station.
- Kusasalethu TSF Reclamation Pump Station.
- New Access Roads (2 x 3.5 m double road) adjacent to pipeline routes/OH lines and around Deelkraal II TSF (where no access road is already in place).
- Topsoil Stockpiles and overburden stockpiles.
- Ancillary construction infrastructure including workshops and laydown areas.

Airshed Planning Professionals (Pty) Ltd was appointed by Environmental Impact Management Services Pty Ltd (EIMS) to undertake an Air Quality Study as part of the proposed changes at the Deelkraal and Kusasalethu mines. Although the focus of the study is on the significance in impact changes of the proposed Deelkraal Facility (TSF) and upgrades at the Kusasalethu processing plant, the Savuka and Mponeng Mine operations are included in the baseline to provide for a semi-cumulative[1] assessment.

## 1.2 Scope of Work

The scope of work for the AQIA includes the following:

- Identifying potential areas sensitive to air pollution in the project area, as well as the site dispersion potential including meteorological conditions, topography and surface characteristics (land use);
- Estimate particulate matter (PM) emissions associated with the current Kusasalethu, as well as the PM emission due the upgraded Kusasalethu processing plant.
- Estimate particulate matter (PM) emissions associated with the proposed TSF at Deelkraal;
- Undertake atmospheric dispersion modelling including all the current and future sources of particulate matter (PM) emissions at Kusasalethu operations;
- Undertake atmospheric dispersion modelling including all the current and future sources of particulate matter (PM) emissions associated with the proposed TSF at Deelkraal;
- Assess the impact of the current and future operations on human health and biota by screening the modelling outputs ($PM_{10}$ and $PM_{2.5}$ concentrations and dustfall rates) against the National Ambient Air Quality Standards (NAAQS), National Dust Control Regulations (NDCR) and limits for biota from available literature;
- Compile an air quality specialist report; and,
- Model sources of radionuclides and radon gas (modelled as a unit release) that would contribute to the radiological impact of the proposed operations as input for the Radiological Impact Assessment to be undertaken by AquiSim Consulting (Pty) Ltd.

[1] The semi-cumulative assessment includes the Mponeng and Savuka operations but excludes other mining operations in the region.

## 1.3 Pollutants of Interest

Airborne PM is the most significant pollutant of concern from the proposed gold and uranium reclamation at Kusasalethu and Deelkraal mines.

The impact of particles on human health is largely dependent on: (i) particle characteristics, particularly particle size and shape, and chemical composition; and (ii) the duration, frequency and magnitude of exposure. The potential of particles to be inhaled and deposited in the lung is a function of the particle size, shape and density. Airborne particulate matter may range from relatively uniform soil particles (e.g. during dust storms) to very complex mixtures of extremely small organic and inorganic particles and liquid droplets (e.g. industrial sites). These particles could be made up of several components, including salts and acids (such as sulfates and nitrates), organic chemicals, metals and radionuclides, and soil or dust particles. The nasal openings permit large dust particles (less than few mm's) to enter the nasal region, along with much finer airborne particulates. Larger particles are deposited in the nasal region by impaction on the hairs of the nose or at the bends of the nasal passages.

Smaller particles, typically less than 10 µm, pass through the nasal region and are deposited in the tracheobronchial and pulmonary regions. Particles are removed by impacting with the wall of the bronchi when they are unable to follow the gaseous streamline flow through subsequent bifurcations of the bronchial tree. As the airflow decreases near the terminal bronchi, the smallest particles (less than 2.5 µm) are removed by Brownian motion, which pushes them to the alveolar membrane (CEPA/FPAC Working Group, 1998; Dockery & Pope, 1994).

Ambient air pollution PM can therefore be divided into three classes based on their size:

- *Inhalable coarse particulate matter* ($PM_{10}$) consists of particles with a diameter between 2.5 and 10 micrometres (µm) that deposit efficiently along the airways. Particles larger than 10 µm are generally not inhaled into the lungs. These particles are typically found near roadways and dusty industries.
- *Fine particulate matter* ($PM_{2.5}$) consists of particles with a diameter less than 2.5 µm and can be inhaled deeply into the lungs. These particles can be directly emitted from sources such as vegetation fires, or they can form when gases emitted from power plants, industries and automobiles react in the air.
- *Ultrafine particles* ($PM_1$) consist of particles with a diameter smaller than 0.1 µm and have widespread deposition within the respiratory tract. These particles are typically a result of secondary chemical reactions in the atmosphere.

Air quality standards and guidelines for airborne particulates are given for various particle size fractions, including total suspended particulates (TSP), and thoracic ($PM_{10}$) and respirable ($PM_{2.5}$) particulates.

PM comprises a mixture of organic and inorganic substances. From gold mining and processing facilities the radioactive particles in the form of radionuclides and radon releases are of concern. These are addressed in a separate radiation study conducted by AquiSim Consulting (Pty) Ltd.

## 1.4 Methodology

The methodology followed in the assessment to quantify the air quality impacts associated with the project is discussed below. The general tasks included:

- The establishment of the baseline air quality (based on available information); and

- Preliminary qualitative assessment of the significance of the impact through the comparison of current dustfall rates with the National Dust Control Regulations (NDCR), and the potential impact from the proposed Project.

### *1.4.1 Potential Air Emissions from the Project*

With the focus of the study on the potential impacts from the reclamation of both the Deelkraal and Kusasalethu TSFs where windblown dust is the main source of air pollution, particulates are the main pollutant of concern. Gaseous emissions such as sulfur dioxide ($SO_2$), oxides of nitrogen (NOx), carbon monoxide (CO), and Total Organic Compounds (TOC) are pollutants that would result from vehicles, ventilation shafts and operational equipment, but at much lower quantities compared to PM emissions.

Airborne PM impacts are assessed based on the varying size, with $PM_{10}$ and $PM_{2.5}$ associated with health impacts, and TSP associated with nuisance caused by dust fallout (Colls, 2002).

### *1.4.2 Regulatory Requirements and Assessment Criteria*

In the evaluation of air emissions and ambient air quality impacts reference is made to Minimum Emission Limits (MES) as part of the Listed Activities, NAAQS and the NDCR as set out in the National Environmental Management Air Quality Act (Act No. 39 of 2004) (NEMAQA). These standards apply only to common air pollutants, collectively known as criteria pollutants ($SO_2$, $NO_2$, CO, PM, benzene, ozone and lead).

### *1.4.3 Description of the Baseline Environment*

An understanding of the atmospheric dispersion potential of the area is essential to an air quality impact assessment. While there is an on-site meteorological station at Mponeng, no recent data was available. Use was therefore made of modelled Weather Research and Forecasting Model (WRF) meteorological data for an on-site location for the period 1 January 2022 to 31 December 2024.

### *1.4.4 Existing Ambient Air Quality*

No data was provided on the current ambient $PM_{10}$ and $PM_{2.5}$ concentrations. Dustfall measurements were available for the Savuka mine from January 2023 to June 2025 and for the Kusasalethu mine from January 2020 to July 2025.

### *1.4.5 Emissions Inventory*

The establishment of a comprehensive emission inventory forms the basis for the assessment of the air quality impacts from the project operations. The proposed Project operations will result in windblown particulate emissions.

Fugitive emissions refer to emissions that are spatially distributed over a wide area. In the quantification of fugitive dust, use was made of emission factors which associate the quantity of a pollutant to the activity associated with the release of that pollutant.

### *1.4.6 Atmospheric Dispersion Modelling*

#### *1.4.6.1 Dispersion model selection*

Dispersion models compute ambient pollutant concentrations as a function of source configurations, emission strengths and meteorological characteristics, thus providing a useful tool to ascertain the spatial and temporal patterns in the ground level

concentrations arising from the emissions from various sources. Increasing reliance has been placed on concentration estimates from models as the primary basis for environmental and health impact assessments, risk assessments and emission control requirements.

The US Environmental Protection Agency's (US EPA) approved regulatory model – AERMOD – was selected for this study. It is one of the models recommended for Level 2 assessments, for near-source (less than 50 km from source) applications in all terrain types, in the South African Regulations Regarding Air Dispersion Modelling (Government Gazette No. 37804, 11 July 2014).

AERMOD is an advanced new-generation model. It is designed to predict pollution concentrations from continuous point, flare, area, line, and volume sources. AERMOD offers new and potentially improved algorithms for plume rise and buoyancy, and the computation of vertical profiles of wind, turbulence and temperature however retains the single straight-line trajectory limitation. AERMET is a meteorological pre-processor for AERMOD. Input data can come from hourly cloud cover observations, surface meteorological observations and twice-a-day upper air soundings. Output includes surface meteorological observations and parameters and vertical profiles of several atmospheric parameters. AERMAP is a terrain pre-processor designed to simplify and standardise the input of terrain data for AERMOD. Input data includes receptor terrain elevation data. The terrain data may be in the form of digital terrain data. The output includes, for each receptor, location, and height scale, which are elevations used for the computation of air flow around hills.

A disadvantage of the model is that spatial varying wind fields, due to topography or other factors cannot be included. Input data types required for the AERMOD model include: source data, meteorological data (supplied in the required format with the WRF data), terrain data, information on the nature of the receptor grid and pre-development or background pollutant concentrations or dustfall rates.

#### *1.4.6.2 Meteorological Data Requirements*

AERMOD requires two specific input files generated by the AERMET pre-processor. AERMET is designed to be run as a three-stage processor and operates on three types of data (upper air data, on-site measurements, and the national meteorological database). Use was made of simulated WRF data for the period 2022 to 2024.

#### *1.4.6.3 Source Data Requirements*

The AERMOD model can model point, area, volume and line sources. The windblown dust from the TSFs and Marginal Ore Dumps (MODs) were modelled as area sources, with the vents and stacks modelled as point sources. Version 11.0.0.10 of AERMOD and its pre-processors were used in the study, with the US EPA 22112 AERMOD executable.

#### *1.4.6.4 Modelling Domain*

The dispersion of pollutants will be modelled for an area covering 20 km (east-west) by 20 km (north-south) for the project site. The modelling domain was selected on the basis of the sources of emissions and potential impact areas. This area was divided into a grid with a resolution of 200 m (east-west) by 200 m (north-south). AERMOD simulates ground-level concentrations for each of the receptor grid points. The receptors were modelled at 1.5 m above ground.

#### *1.4.6.5 Topographical and Land Use Data*

The readily available terrain and land use data will be obtained from the United States Geological Survey (USGS) via the Earth Explorer website (U.S. Department of the Interior, U.S. Geological Survey, 2026). Use will be made of Shuttle Radar Topography Mission (SRTM) (30 m, 1 arc-sec) data and Global Land Cover Characterisation (GLCC) data for Africa.

#### 1.4.6.6 Dispersion results

The dispersion model uses the specific input data to run various algorithms to estimate the dispersion of pollutants between the source and receptor. The model output is in the form of a simulated time-averaged concentration at the receptor. These simulated concentrations will be compared against the relevant ambient air quality standards. The post-processing of air concentrations at discrete receptors as well as the regular grid points includes the calculation of various percentiles, specifically the 99$^{th}$ percentile, which corresponds to the requirements of the NAAQS.

Ground level concentration (GLC) isopleth plots will be presented to depict interpolated values from the concentrations simulated by AERMOD for each of the receptor grid points specified. Plots reflecting daily averaging periods contain only the 99$^{th}$ percentile of simulated ground level concentrations, for those averaging periods, over the entire period for which simulations were undertaken. It is therefore possible that even though a high daily average concentration is simulated at certain locations, this may only be true for one day during the period. Typically, NAAQS apply to areas where the Occupational Health and Safety regulations do not apply, thus outside the operational areas boundaries (fences). Ambient air quality guidelines and standards are therefore not occupational health indicators but applicable to areas where the public has access.

### 1.4.7 Uncertainty of Modelled Results

The main steps of uncertainty management are to:

- identify and understand uncertainties;
- understand whether uncertainties matter for decisions being made at the time;
- if they do matter, decide what to do about them; and,
- recommend a way forward.

Managing uncertainties attempts to eliminate the source of technical disagreements and failure to understand them often leads to a conclusion that all uncertainties need to be eliminated before project decisions can be made. The first decision about how to manage uncertainties relates to their significance given the decision being addressed. In the current context, the different parts of the investigation were grouped into similar uncertainty regimes, namely:

- dispersion model uncertainties;
- input data uncertainties;
- the methodology of validating model results; and,
- the methodology of expressing the modelled scenarios.

Modelled results are considered valid when they fall within the generally accepted (US EPA, 2005) “factor of two” accuracy of dispersion models. In quantifying the uncertainty of the modelled results for this assessment, measured ambient data was required which was not available for this study.

### 1.4.8 Management of Uncertainties

The Deelkraal II TSF and Kusasalethu plant upgrade is a proposed operation, and certain assumptions had to be made around the construction and operational phases of the project. It is important to understand these constraints specifically when interpreting the simulated results. Data limitations and assumptions associated with this project are as follows:

- Use was made of simulated Weather Research and Forecasting Model data for a point at the Savuka site, and this is regarded as representative of the project area for Mponeng.
- The quantification of sources of emission was restricted to the project activities and operations within the study domain only. Although other background sources were identified, such sources could not be quantified. The current

mining and processing operations at Mponeng and Savuka were modelled to reflect the cumulative PM concentrations in the area, specifically at the nearby receptors.

- Information required for the calculation of emissions from dust sources for the project operations was supplied by EIMS with the baseline activities taken from a previous study conducted for West Wits operations. The assumption was made that this information was accurate and correct.
- Routine emissions from the operations were estimated and modelled.
- Emissions from the Construction phase were estimated as area wide construction emissions and could not be modelled since the actual plans of individual construction processes were not available. Impacts from construction operations are however usually lower than operational phase due to their temporary nature and duration, and the likelihood that these activities will not occur concurrently at all portions of the site.

### *1.4.9 Impact Assessment Report*

An air quality impact assessment report, including the methodology, analysis, results and proposed recommendations, will be submitted in support of the EIA being conducted.

# 2 REGULATORY REQUIREMENTS AND ASSESSMENT CRITERIA

Prior to assessing the impact of proposed activities on human health and the environment, reference needs to be made to the air quality regulations governing the calculation and impact of such operations i.e. reporting requirements, emission standards, ambient air quality standards and dust control regulations.

Emission standards are generally provided for point sources, specify the amount of the pollutant acceptable in an emission stream and are often based on proven efficiencies of air pollution control equipment. Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality standards and guideline values indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Air quality guidelines and standards are normally given for specific averaging or exposure periods.

This section summarises legislation for PM concentrations and dustfall rates. The National Environmental management: Air Quality Act (NEM:AQA) Section 21 Listed Activities and Minimum Emissions Standards (MES), National Atmospheric Emission Reporting Regulations, Regulations regarding Air Dispersion Modelling, NAAQS and NDCR are relevant to the project and are discussed below.

## 2.1 Emissions Standards

The NEM:AQA (Act No. 39 of 2004 as amended) mandates the Minister of Environment to publish a list of activities which result in atmospheric emissions and consequently cause significant detrimental effects on the environment, human health and social welfare, economic conditions, ecological conditions or cultural heritage. All scheduled processes as previously stipulated under the Air Pollution Prevention Act (APPA) are included as listed activities with additional activities added to the list. The updated Listed Activities and MES were published in 2013 (Government Gazette [GN] 893, No. 37054 as amended by GN 551, 12 June 2015; GN 1207, 81 October 2018; GN 687, 22 May 2019; and GN 421, 27 March 2020).

## 2.2 Atmospheric Emissions Reporting Regulations

The National Atmospheric Emission Reporting Regulations (GN R283 in Government Gazette No. 38633) came into effect on 2 April 2015. The purpose of the regulations is to regulate the reporting of data and information from an identified point, non-point and mobile sources of atmospheric emissions to an internet-based National Atmospheric Emissions Inventory System (NAEIS). The NAEIS is a component of the South African Air Quality Information System (SAAQIS). Its objective is to provide all stakeholders with relevant, up to date and accurate information on South Africa's emissions profile for informed decision making.

Emission sources and data providers are classified according to groups. Kusasulethu mining operations would be classified under Group A ("Listed activity published in terms of section 21(1) of the Act") and is required to report emissions. Emission reports from this group must be made in the format required for NAEIS and should be in accordance with the AEL requirements.

The required information for the preceding calendar year must be submitted onto NAEIS by 31 March[2] of each year. Records of data submitted must be kept for a period of 5 years and must be made available for inspection by the relevant authority.

The relevant authority must request a data provider, in writing to verify the information submitted if the information is incomplete or incorrect. The data provider then has 60 days to verify the information. If the verified information is incorrect or incomplete the relevant authority must instruct a data provider, in writing, to submit supporting documentation prepared by an independent person. The relevant authority cannot be held liable for cost of the verification of data. A person guilty of an offence in terms of section 13 of these regulations is liable for penalties.

### 2.3 Atmospheric Dispersion Modelling Regulations

Air dispersion modelling provides a cost-effective means for assessing the impact of air emission sources, the major focus of which is to determine compliance with the relevant ambient air quality standards. Dispersion modelling provides a versatile means of assessing various emission options for the management of emissions from existing or proposed installations. Regulations regarding Air Dispersion Modelling were promulgated in GN 533, in Government Gazette No. 37804; 11 July 2014, and recommend a suite of dispersion models to be applied for regulatory practices as well as guidance on modelling input requirements, protocols and procedures to be followed. The Regulations regarding Air Dispersion Modelling are applicable –

(a) in the development of an air quality management plan, as contemplated in *Chapter 3* of the NEMAQA;
(b) in the development of a priority area air quality management plan, as contemplated in *Section 19* of the NEMAQA;
(c) in the development of an AIR, as contemplated in *Section 30* of the NEMAQA; and,
(d) in the development of a specialist air quality impact assessment study, as contemplated in *Chapter 5* of the NEMAQA.

Three *Levels of Assessment* are defined in the Regulations. The three levels are:

- Level 1: where worst-case air quality impacts are assessed using simpler screening models
- Level 2: for assessment of air quality impacts as part of license application or amendment processes, where impacts are the greatest within a few kilometres downwind (less than 50km)
- Level 3: require more sophisticated dispersion models (and corresponding input data, resources and model operator expertise) in situation:
    - where a detailed understanding of air quality impacts, in time and space, is required;
    - where it is important to account for causality effects, calms, non-linear plume trajectories, spatial variations in turbulent mixing, multiple source types & chemical transformations;
    - when conducting permitting and/or environmental assessment process for large industrial developments that have considerable social, economic and environmental consequences;
    - when evaluating air quality management approaches involving multi-source, multi-sector contributions from permitted and non-permitted sources in an air-shed; or,
    - when assessing contaminants resulting from non-linear processes (e.g. deposition, ground-level O3, particulate formation, visibility).

The first step in the dispersion modelling exercise requires a clear objective of the modelling exercise and thereby gives clear direction to the choice of the dispersion model most suited for the purpose. Accordingly, Level 2 was deemed appropriate.

[2] Currently the submission date is 30 June 2025 due to manual submission requirements by the DFFE.

## 2.4 National Ambient Air Quality Standards (NAAQS)

Criteria pollutants are considered those pollutants most found in the atmosphere, that have proven detrimental health effects when inhaled and are regulated by ambient air quality criteria. These generally include CO, $NO_2$, $SO_2$, $PM_{10}$, $PM_{2.5}$, and ground level ozone ($O_3$).

The initial NAAQS were published for comment in the Government Gazette on 9 June 2007. The revised NAAQS were subsequently published for comment in the Government Gazette on 13 of March 2009. The final revised NAAQS were published in the Government Gazette on 24 of December 2009 (GN 1210, Government Gazette 32816) and additional standards for particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$) were published on 29 June 2012 (GN 486, Government Gazette no. 35463). SA NAAQSs for the criteria pollutants assessed in this study are listed in **Table 1.**

**Table 1: National Ambient Air Quality Standards**

| Pollutant | Averaging Period | Concentration (µg/m³) | Permitted Frequency of Exceedance | Compliance Date |
|---|---|---|---|---|
| **$PM_{2.5}$** | 24-hour | 40 | 4 | 1 January 2016 till 31 December 2029 (currently enforceable) |
| | 24-hour | 25 | 4 | 1 January 2030 |
| | 1 year | 20 | - | 1 January 2016 till 31 December 2029 (currently enforceable) |
| | 1 year | 15 | - | 1 January 2030 |
| **$PM_{10}$** | 24-hour | 75 | 4 | Currently enforceable |
| | 1 year | 40 | - | Currently enforceable |

## 2.5 National Dust Control Regulations (NDCR)

The NDCR were published on 1 November 2013 (GN R827 in Government Gazette No. 36974). The purpose of the regulations is to prescribe general measures for the control of dust in all areas including residential and non-residential areas. The standard for acceptable dustfall rates for residential and non-residential areas is set out in **Table 2.** According to these regulations the dustfall at the boundary or beyond the boundary of the premises where it originates cannot exceed 600 mg/m²- day in residential and light commercial areas; or 1 200 mg/m²-day in areas other than residential and light commercial areas.

**Table 2: Acceptable dustfall rates**

| Restriction Area | Dust-fall rate (D) (mg/m²-day, 30-day average) | Permitted frequency of exceeding dust fall rate |
|---|---|---|
| **Residential** | D < 600 | Two within a year, not sequential months |
| **Non-residential** | 600 < D < 1 200 | Two within a year, not sequential months |

In addition to the dust fall limits, the NDCR prescribe monitoring procedures and reporting requirements. This will be based on the measuring reference method ASTM 01739 averaged over 30 days.

The regulation also specifies that the method to be used for measuring dustfall and the guideline for locating sampling points shall be American Standard Testing Method (ASTM, 1970)[3], or equivalent method approved by any internationally recognised body. It is important to note that dustfall is assessed for nuisance impact and not inhalation health impact.

The currently enforceable NDCR are expected to be repealed and replaced as noted in the draft NDCR published on 25 May 2018 (Gazette No. 41650, No. 517) and more recently published on 8 March 2024 (Notice 4475 GG 50272). Under the 2024 draft NDCR, the definitions of Residential area and non-residential area have changed to:

- "Residential area" means any area where the land is used for the purposes as prescribed under schedule 2 of the Spatial Planning and Land Use Management Act, 2013 (Act No. 16 of 2013), excluding the land that is scheduled for agriculture, industrial and mining purposes.
- "Non-residential area" means any area that's its land is scheduled for agriculture, industrial and mining purposes as prescribed under schedule 2 of the Spatial Planning and Land Use Management Act, 2013 (Act No. 16 of 2013).

## 2.6 Screening criteria for animals and vegetation

Limited information is available on the impact of dust on vegetation and grazing quality. While there is little direct evidence of the impact of dustfall on vegetation in the South African context, a review of European studies has shown the potential for reduced growth and photosynthetic activity in sunflower and cotton plants exposed to dust fall rates greater than 400 mg/m²- day (Farmer, 1993). In addition, there is anecdotal evidence to indicate that over extended periods, high dustfall levels in grazing lands can soil vegetation and this can impact the teeth of livestock (Farmer, 1993).

[3] ASTM 1739:70 is a previous version of ASTM 1739 which did not prescribe a wind shield around the opening of the bucket; the addition of a wind shield is intended to deflect wind away from the lip of the container, allowing for a more laminar flow across the top of the collecting container (Kornelius *et al*., 2015). SANS 1929-2004 does however refer to ASTM 1739-98 (ASTM, 1998), which has a wind shield.

# 3 DESCRIPTION OF THE RECEIVING ENVIRONMENT

## 3.1 Affected Environment

Deelkraal and Kusasalethu is located approximately 14 kilometres (km) southwest and 9 km, south of Carletonville respectively. Other neighbouring towns include Fochville and Potchefstroom, situated 19 km and 34 km to the east-southeast and southwest of the Kususalethu operations respectively. The Savuka and the DS5 TSFs are located approximately 4.5 km and 8km northwest of the Kusasalethu respectively (**Figure 1**).

The land use in the area comprises primarily of mining and agriculture. The topography is characterised by undulating hills ranging from 1 500 to 1 700 metres above mean sea level (mamsl) as shown in **Figure 2**.

## 3.2 Atmospheric Dispersion Potential

In the assessment of the possible impacts from air pollutants on the surrounding environment and human health, a good understanding of the regional climate and local air dispersion potential of a site is essential. Meteorological characteristics of a site govern the dispersion, transformation, and eventual removal of pollutants from the atmosphere (Pasquill and Smith, 1983; Godish, 1990). The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer.

Dispersion comprises vertical and horizontal components of motion. The vertical component is defined by the stability of the atmosphere and the depth of the surface mixing layer. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness.

The wind direction and the variability in wind direction, determine the general path pollutants will follow, and the extent of crosswind spreading (Shaw and Munn, 1971; Pasquill and Smith, 1983; Oke, 1990).

Pollution concentration levels fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field. Spatial variations, and diurnal and seasonal changes, in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales (Goldreich and Tyson, 1988). Atmospheric processes at macro- and meso-scales need therefore be considered to accurately parameterise the atmospheric dispersion potential of a particular area.

Use was made of three years (2022 – 2024) of simulated WRF hourly sequential data, for a location at Savuka and Kusasulethu mines. This data was used to construct wind roses, general climatic information such as diurnal temperature variations, atmospheric stability estimates and for dispersion modelling.

### *3.2.1 Local Wind Field*

The wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses below, reflect the different categories of wind speeds; the yellow area, for example, representing winds between 5 and 7 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s are also indicated.

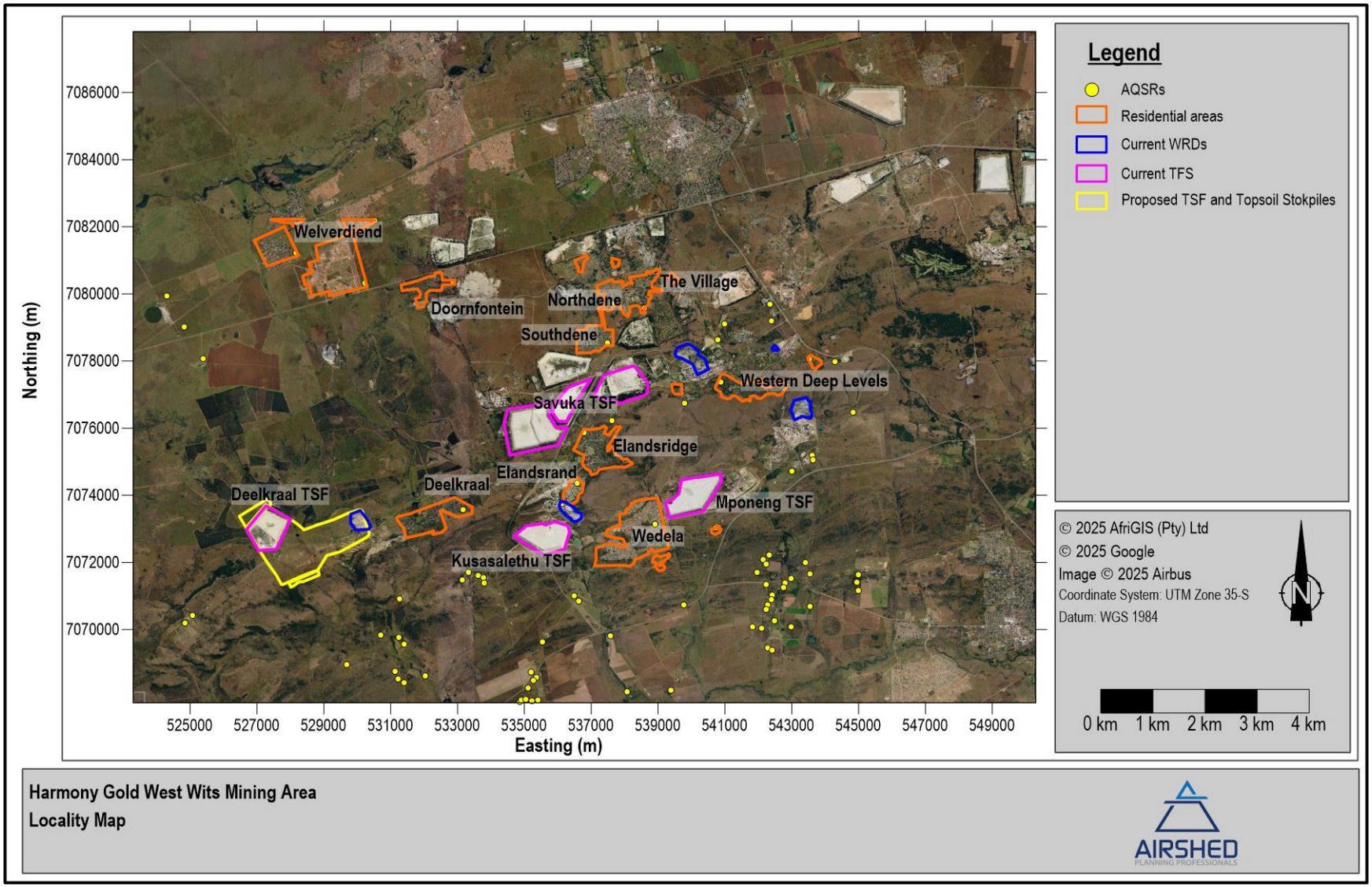



**Figure 1: Location of sensitive receptor areas surrounding the current Deelkraal, Kusasalethu, Savuka and Mponeng mining operations**

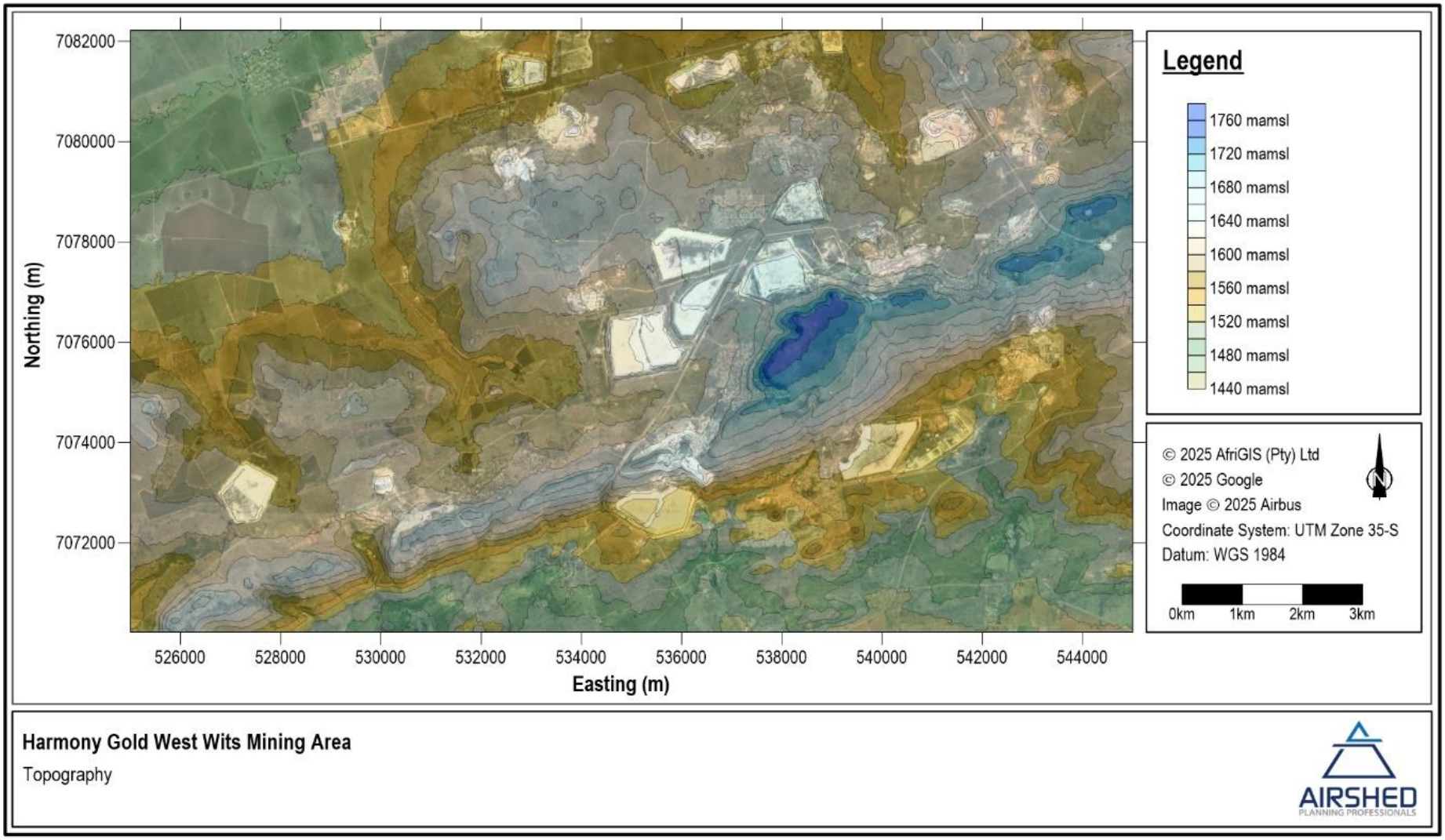



**Figure 2: Topography for the study area**

The period wind field and diurnal variability in the wind field are shown in **Figure** 3, while the seasonal variations are shown in Figure 4. The wind field is dominated by winds from the northerly sector. The strongest winds (>6 m/s) occurred mostly from the north-northeasterly sector. Calm conditions occurred 3.5% of the time, with the average wind speed over the period of 3.63 m/s. Both daytime and night-time show dominant northerly wind fields, with calm conditions 4.4% during the day, and 2.52% during the night.

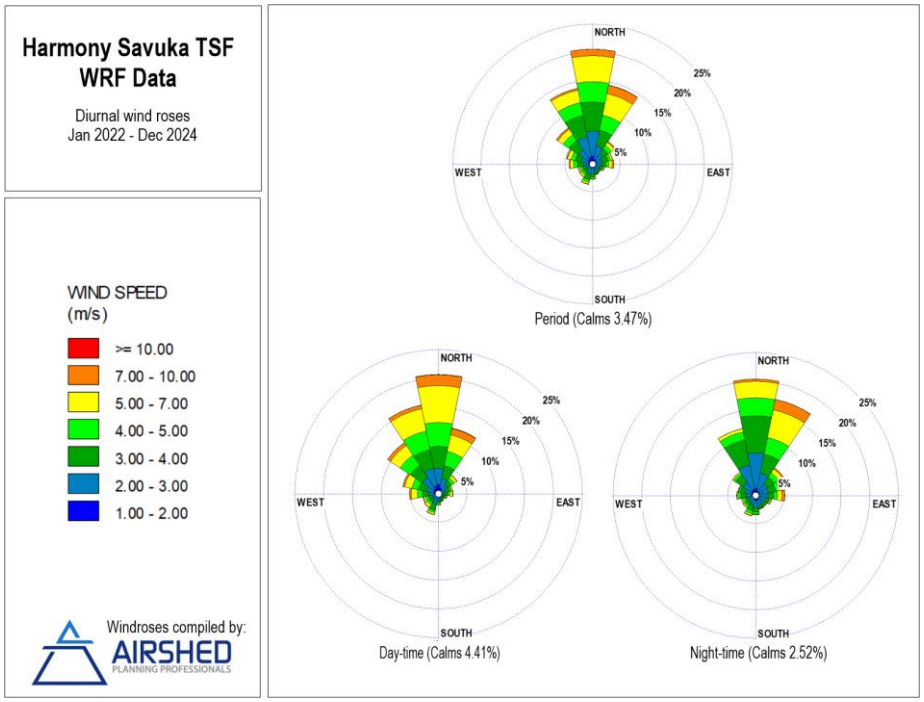



**Figure 3: Period, day- and night-time wind roses (WRF data, January 2022 to December 2024)**

The dominant northerly winds prevail throughout the seasons, with an increase in wind speeds during the spring months **(Figure 4).**

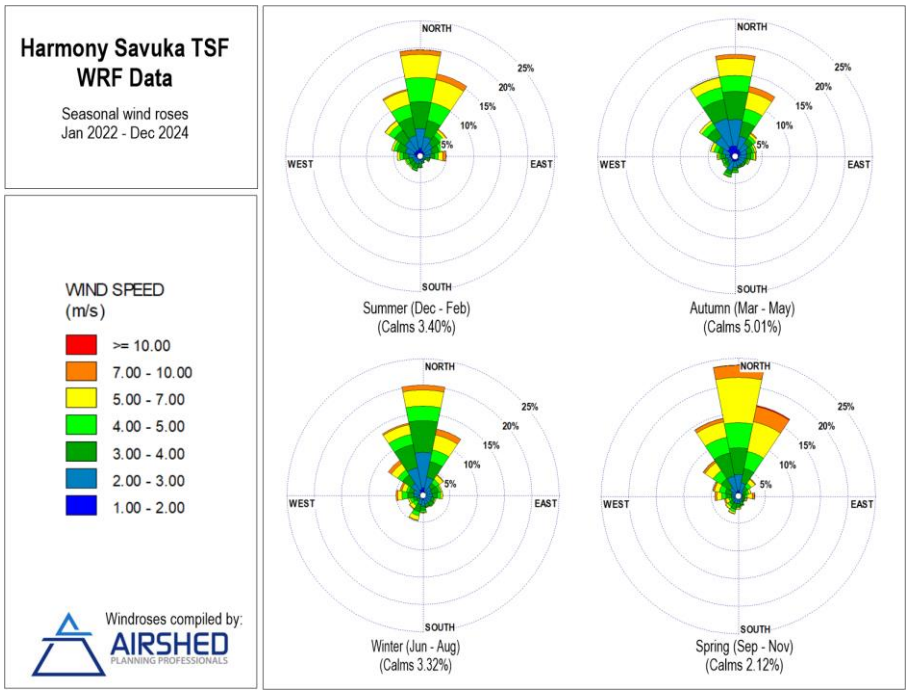



**Figure 4: Seasonal wind roses (WRF data, January 2022 to December 2024)**

### 3.2.2 *Ambient Temperature*

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the emissions plume and the ambient air, the higher the plume can rise), and determining the development of the mixing and inversion layers.

Monthly mean, maximum and minimum temperatures are given in **Table 3** and **Figure 4**. Diurnal temperature variability is presented in **Figure 5**. Temperatures ranged between -2°C and 35°C. The highest temperature occurred in January and the lowest in July. During the day, temperatures increase to reach maximum at around 14:00 in the afternoon. Ambient air temperature decreases to reach a minimum at around 06:00 i.e. just before sunrise.

**Table 3: Monthly temperature summary (WRF data, January 2022 to December 2024)**

| Minimum, Average and Maximum Temperatures (°C) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| **Monthly Average** | 23 | 23 | 22 | 18 | 16 | 12 | 12 | 15 | 19 | 21 | 22 | 24 |
| **Hourly Maximum** | 33 | 35 | 33 | 29 | 27 | 23 | 23 | 28 | 30 | 33 | 34 | 34 |
| **Hourly Minimum** | 11 | 14 | 13 | 8 | 5 | 1 | -2 | 1 | 4 | 3 | 7 | 13 |

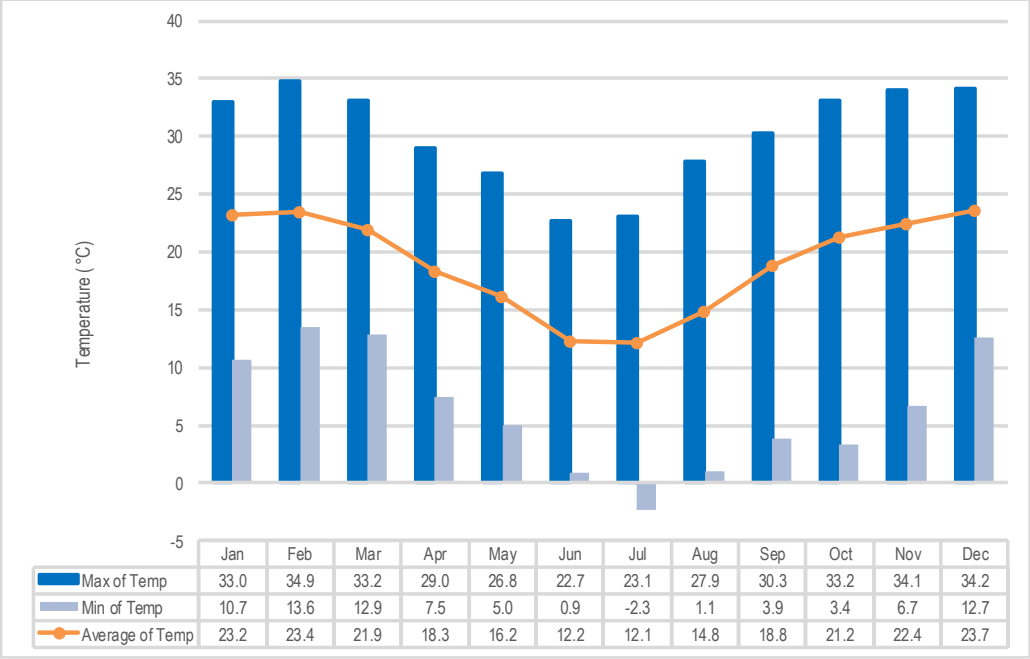



**Figure 5: Monthly temperatures (WRF data, January 2022 to December 2024)**

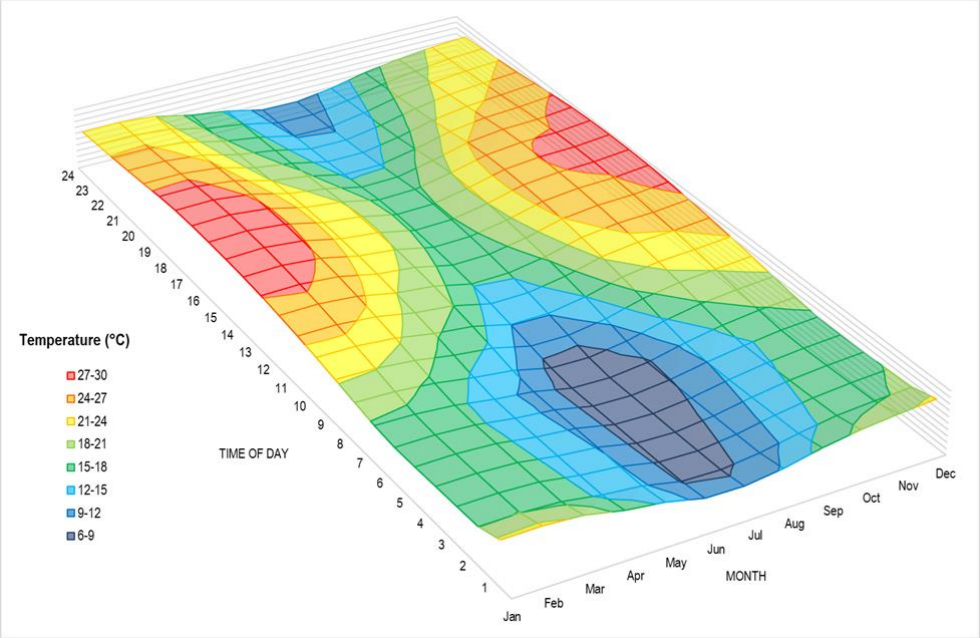



**Figure 6: Diurnal temperature profile (WRF data, January 2022 to December 2024)**

### *3.2.3 Atmospheric Stability*

The new generation air dispersion models differ from the models traditionally used in a number of aspects, the most important of which are the description of atmospheric stability as a continuum rather than discrete classes. The atmospheric boundary layer properties are therefore described by two parameters; the boundary layer depth and the Obukhov length (often referred to as the Monin-Obukhov length).

The Obukhov length ($L_{Mo}$) provides a measure of the importance of buoyancy generated by the heating of the ground and mechanical mixing generated by the frictional effect of the earth's surface. Physically, it can be thought of as representing the depth of the boundary layer within which mechanical mixing is the dominant form of turbulence generation (CERC, 2004). The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. During daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface. Night-times are characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds and lower dilution potential.

Diurnal variation in atmospheric stability, as calculated from measured data, and described by the inverse Obukhov length and the boundary layer depth is provided in **Figure 7**. The highest concentrations for ground level, or near-ground level releases from non-wind dependent sources would occur during weak wind speeds and stable (night-time) atmospheric conditions. For elevated releases, unstable conditions can result in very high concentrations of poorly diluted emissions close to the stack. This is called *looping* (Figure 7(c)) and occurs mostly during daytime hours. Neutral conditions disperse the plume fairly equally in both the vertical and horizontal planes and the plume shape is referred to as *coning* (Figure 7(b)). Stable conditions prevent the plume from mixing vertically, although it can still spread horizontally and is called *fanning* (Figure 7(a)) (Tiwary & Colls, 2010). For ground level releases such as fugitive dust the highest ground level concentrations will occur during stable night-time conditions.

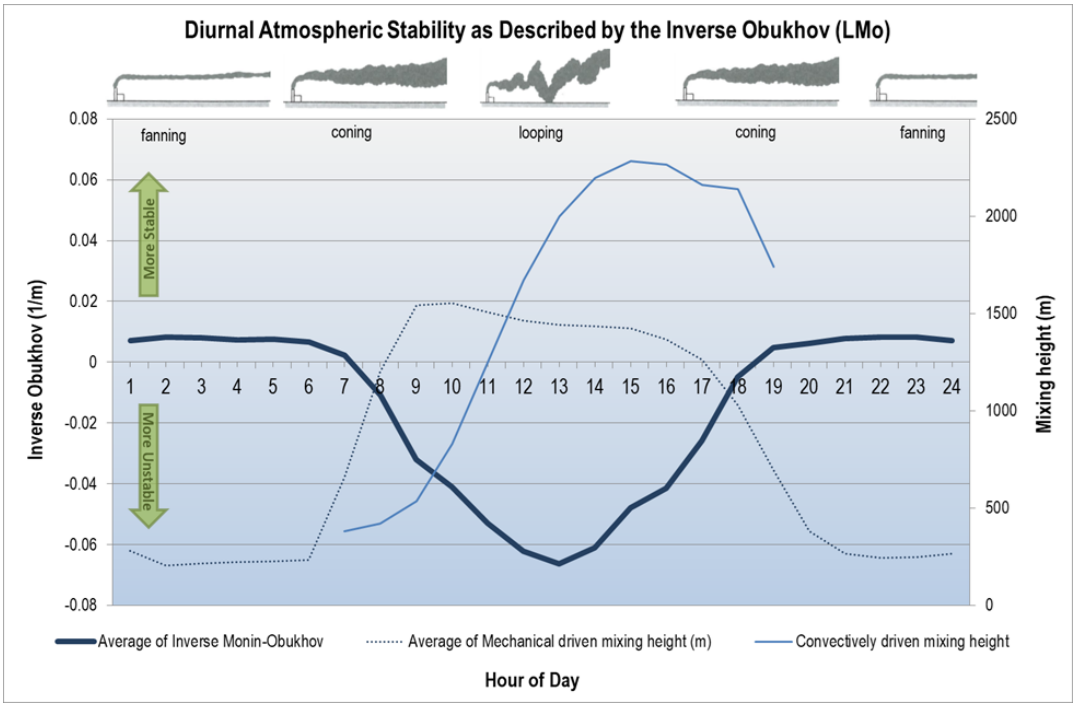



**Figure 7: Diurnal atmospheric stability (WRF data, January 2022 to December 2024)**

### *3.2.4 Precipitation and Relative Humidity*

Rainfall is important to air pollution studies since it represents an effective removal mechanism of atmospheric pollutants. Monthly rainfall obtained from the on-site data did not appear to be accurate. Rainfall in this area occurs mostly during the summer months although it also rains during spring and autumn while the winter months are dry even through the relative humidity is greater during the winter period than other seasons. Colder air can hold less moisture than warmer air and thus the percentage saturation is higher at a lower moisture quantity resulting in higher relative humidity during colder periods than warmer periods.

# 4 STATUS QUO OF AMBIENT AIR QUALITY IN THE AREA

## 4.1 Existing Sources of Air Pollution

The current air quality in the study area is mostly influenced by mining, deposition and reclamation activities at Deelkraal, Kusasalethu and Savuka and other companies' mining operations, as well as farming activities, domestic fires, vehicle exhaust emissions and dust entrained by vehicles. These emission sources vary from activities that generate relatively course airborne particulates (such as farmland preparation, dust from paved and unpaved roads, and the mine sites) to fine PM such as that emitted by vehicle exhausts, diesel power generators and processing operations.

Domestic households are known to have the potential to be one the most significant sources that contribute to poor air quality within residential areas. Individual households are low volume emitters, but their cumulative impact is significant. It is likely that households within the local communities or settlements utilize coal, paraffin and/or wood for cooking and/or space heating (mainly during winter) purposes. Pollutants arising from the combustion of wood include respirable particulates, CO and $SO_2$ with trace amounts of polycyclic aromatic hydrocarbons (PAHs), in particular benzo(a)pyrene and formaldehyde. Particulate emissions from wood burning have been found to contain about 50% elemental carbon and about 50% condensed hydrocarbons.

Biomass burning includes the burning of evergreen and deciduous forests, woodlands, grasslands, and agricultural lands. Within the project vicinity, crop-residue burning and wildfires (locally known as veld fires) may represent significant sources of combustion-related emissions. The frequency of wildfires in the grasslands varies between annual and triennial. Biomass burning is an incomplete combustion process (Cachier, 1992), with carbon monoxide, methane and nitrogen dioxide gases being emitted. Approximately 40% of the nitrogen in biomass is emitted as nitrogen, 10% is left in the ashes, and it may be assumed that 20% of the nitrogen is emitted as higher molecular weight nitrogen compounds (Held, et al., 1996). The visibility of the smoke plumes is attributed to the aerosol (particulate matter) content.

Emissions from unpaved roads constitute a major source of emissions to the atmosphere in the South African context. When a vehicle travels on an unpaved road the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong turbulent air shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. Dust emissions from unpaved roads vary in relation to the vehicle traffic and the silt loading on the roads. Unpaved roads in the region are mainly haul and access roads. Emissions from paved roads are significantly less than those originating from unpaved roads, however they do contribute to the particulate load of the atmosphere. Particulate emissions occur whenever vehicles travel over a paved surface. The fugitive dust emissions are due to the re-suspension of loose material on the road surface. Paved roads in the region include the N12 to the south, the R501 to the north and R500 to the east.

## 4.2 Sampled Dustfall Rates

### *4.2.1 Kusasalethu Mine*

Dust fallout sampling has been undertaken around the Kusasalethu operations since January 2019 by Aquatico Scientific and includes a network comprising of 7 single Dustfall Monitoring Units (DMU) in accordance with ASTM D1739 (1970) (**Figure 8**). Five (5) of these DMUs are screened against the NDCR non-residential limit of 1 200 mg/m²/day, with the remaining two (2) units regarded as residential (screened against the NDCR residential limit of 600 mg/m²/day). These are listed in **Table 4.**

**Table 4: Site description and location of Kusasalethu Dustfall Monitoring Units (DMU)**

| Mine | DMU | Location | | Classification | Status 2025 |
|---|---|---|---|---|---|
| | | Longitude | Latitude | | |
| Harmony - Kusasalethu Mine | DK1 - Deelkraal Dust Bucket 1 | 27.29529 | -26.4662 | Non-residential | Active |
| | DK2 - Deelkraal Dust Bucket 2 | 27.29628 | -26.47259 | Non-residential | Active |
| | ER3 - Eandsrand Dust Bucket 3 | 27.35774 | -26.45294 | Non-residential | Active |
| | ER4 - Eandsrand Dust Bucket 4 | 27.36715 | -26.46905 | Non-residential | Active |
| | ER5 - Eandsrand Dust Bucket 5 | 27.35284 | -26.47134 | Non-residential | Active |
| | DK6 - Deelkraal Dust Bucket 6 | 27.3695 | -26.43636 | Residential | Active |
| | ER7 - Eandsrand Dust Bucket 7(ER Village Dust Station) | 27.37885 | -26.43591 | Residential | Active |

Dustfall rates for the Kusasalethu DMUs for the period January 2020 to June 2025 were made available for inclusion into this report and shown in **Figures 9 and 10** for 2020, **Figures 11 and 12** for 2021, **Figures 13 and 14** for 2022, **Figures 15 and 16** for 2023, **Figures 17 and 18** for 2024 and **Figures 19 and 20** for 2025.

During the five and half years (January 2020 – July 2025) for both the residential and non-residential locations the dustfall rates were below the respective NDCRs with one exceedance of the residential limit recorded at DK6 in November 2020.




**Figure 8: Kusasalethu Dustfall Monitoring Units (DMU)**

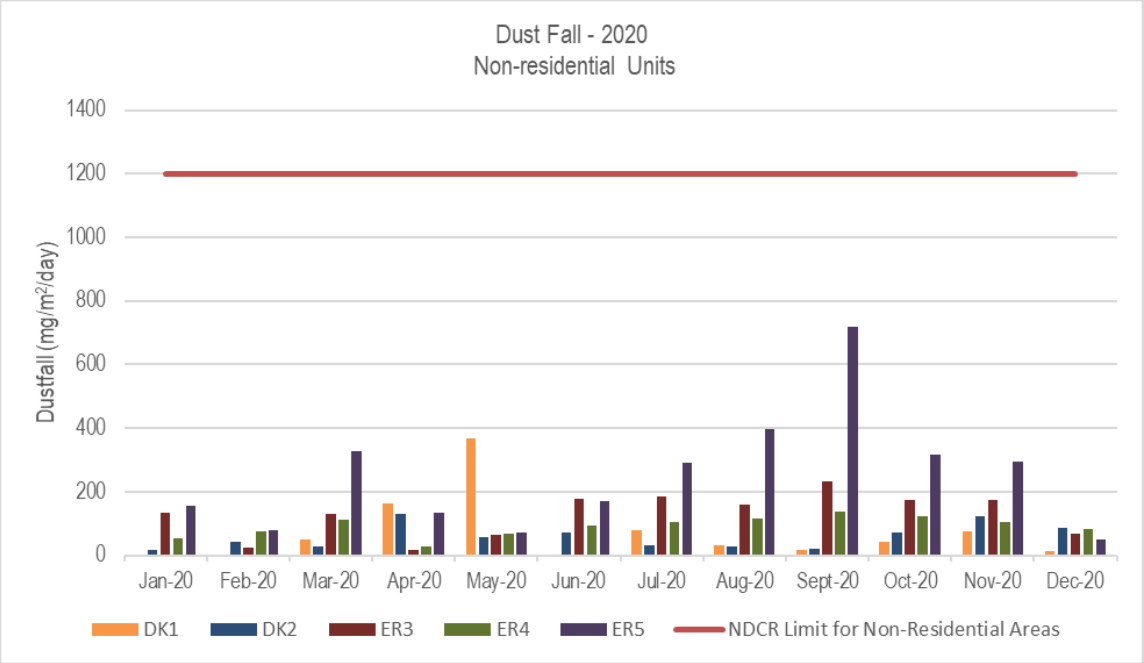



**Figure 9: Kusasalethu DMU Dustfall rates from January 2020 to December 2020 for Non-Residential sites**

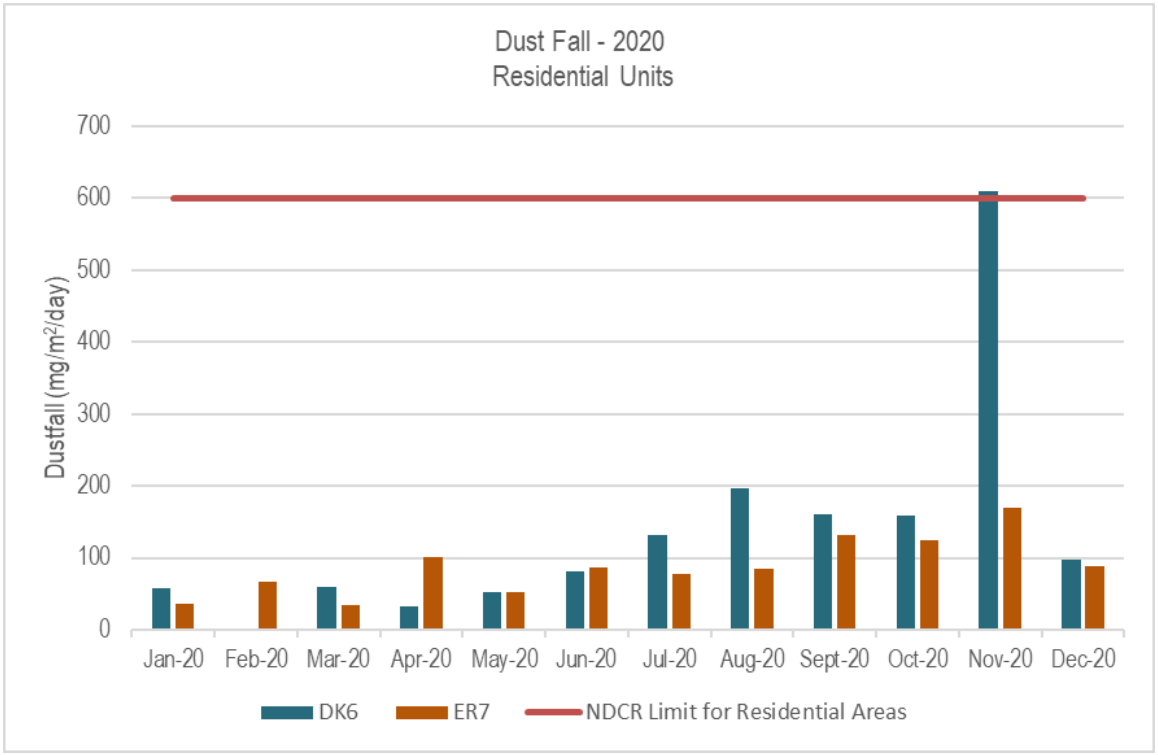



**Figure 10: Dustfall rates from January 2020 to December 2020 for Residential sites**

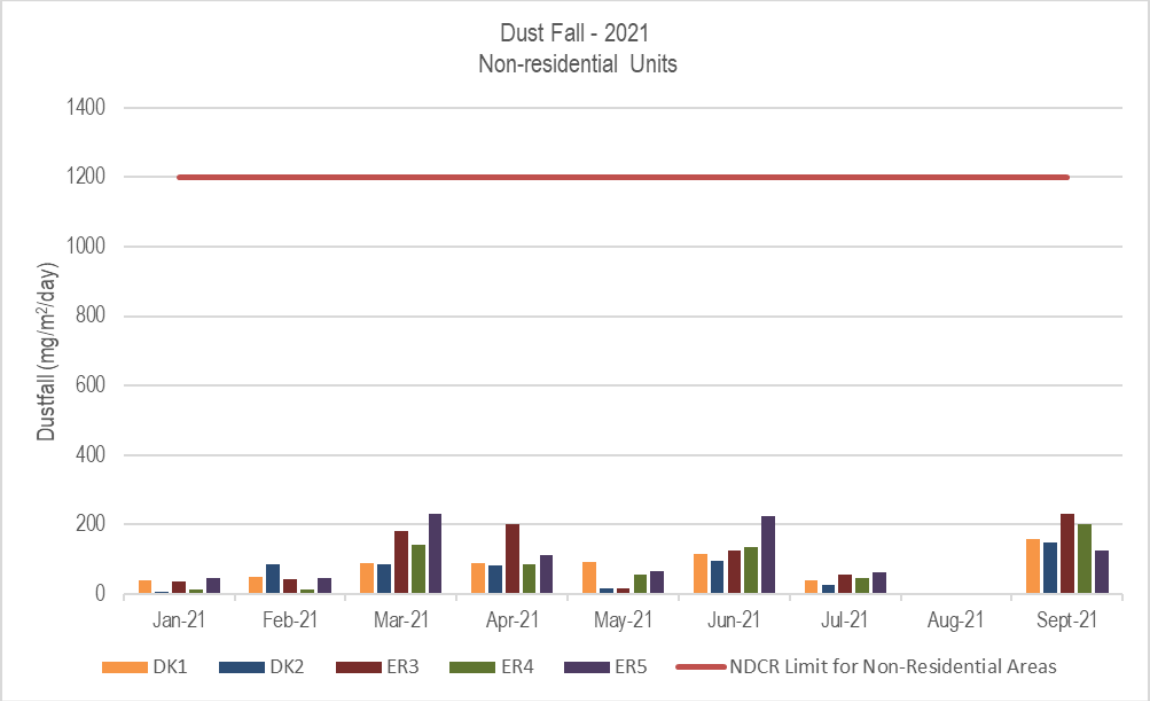



**Figure 11: Dustfall rates from January 2021 to September 2021 for Non-Residential sites**

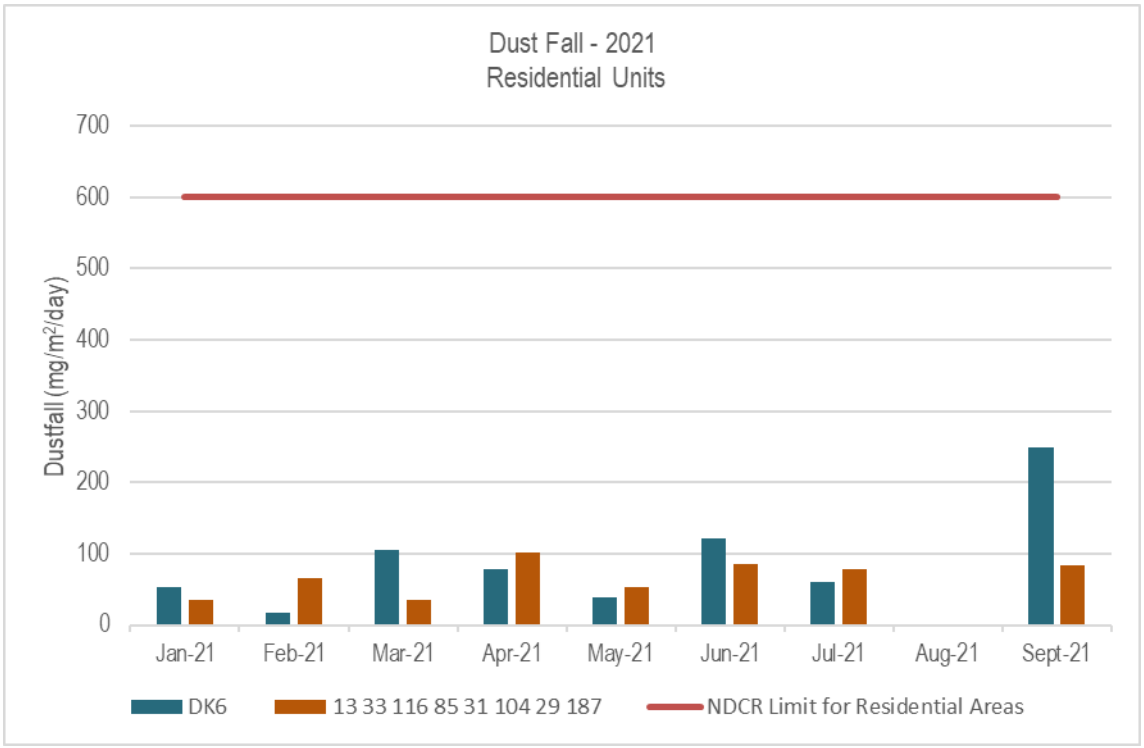



**Figure 12: Dustfall rates from January 2021 to September 2021 for Residential sites**

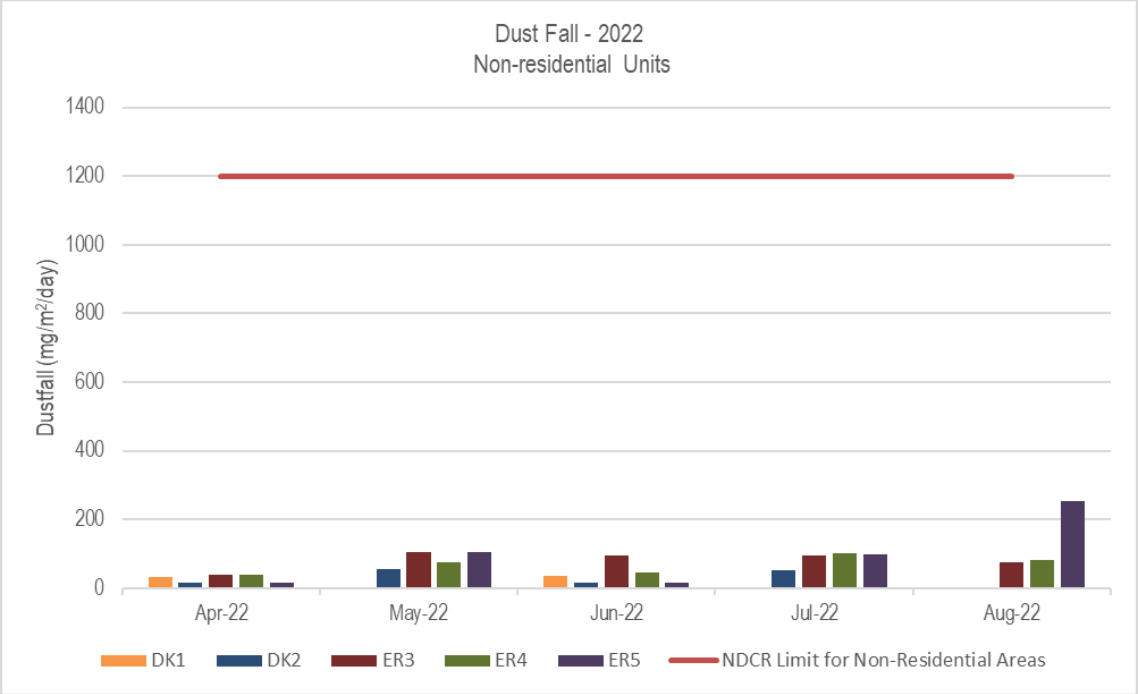



**Figure 13: Dustfall rates from April 2022 to August 2022 for Non-Residential sites**

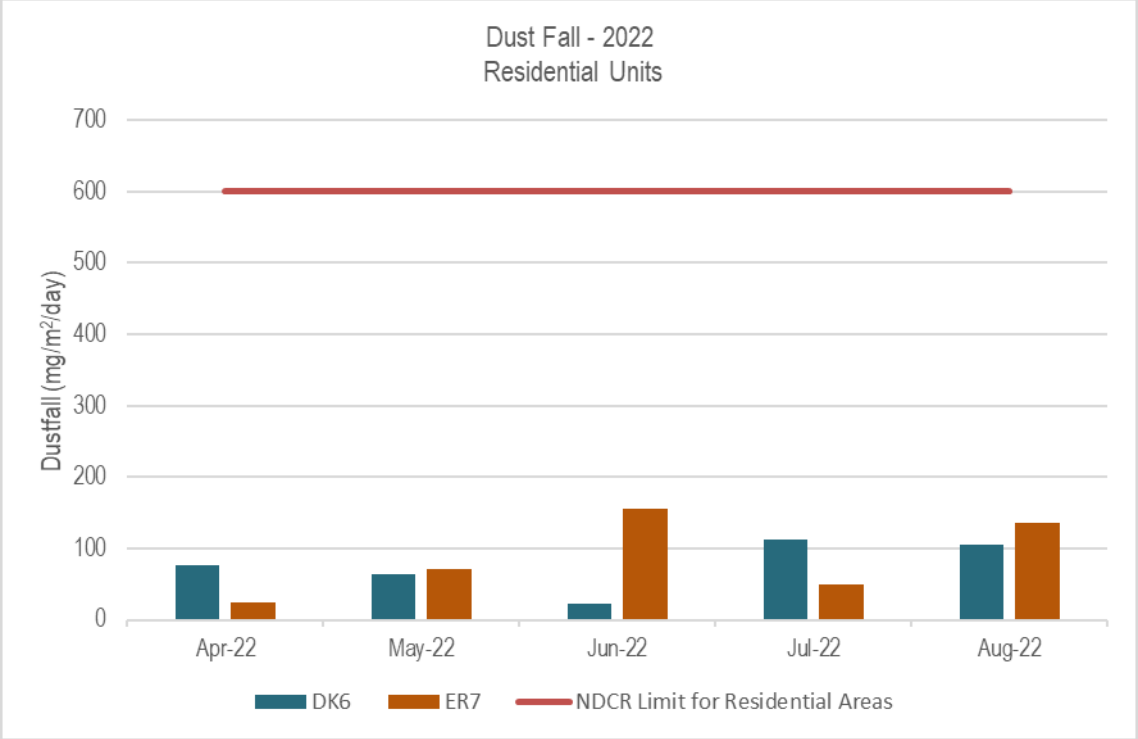



**Figure 14: Dustfall rates from April 2022 to August 2022 for Residential sites**

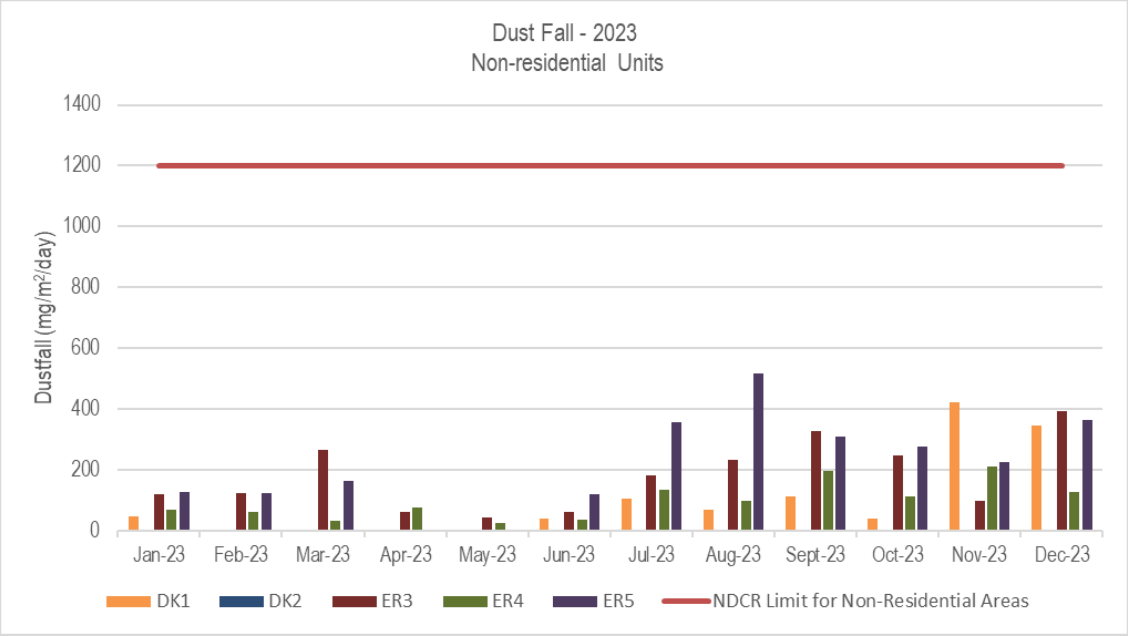



**Figure 15: Dustfall rates from January 2023 to December 2023 for Non-Residential sites**

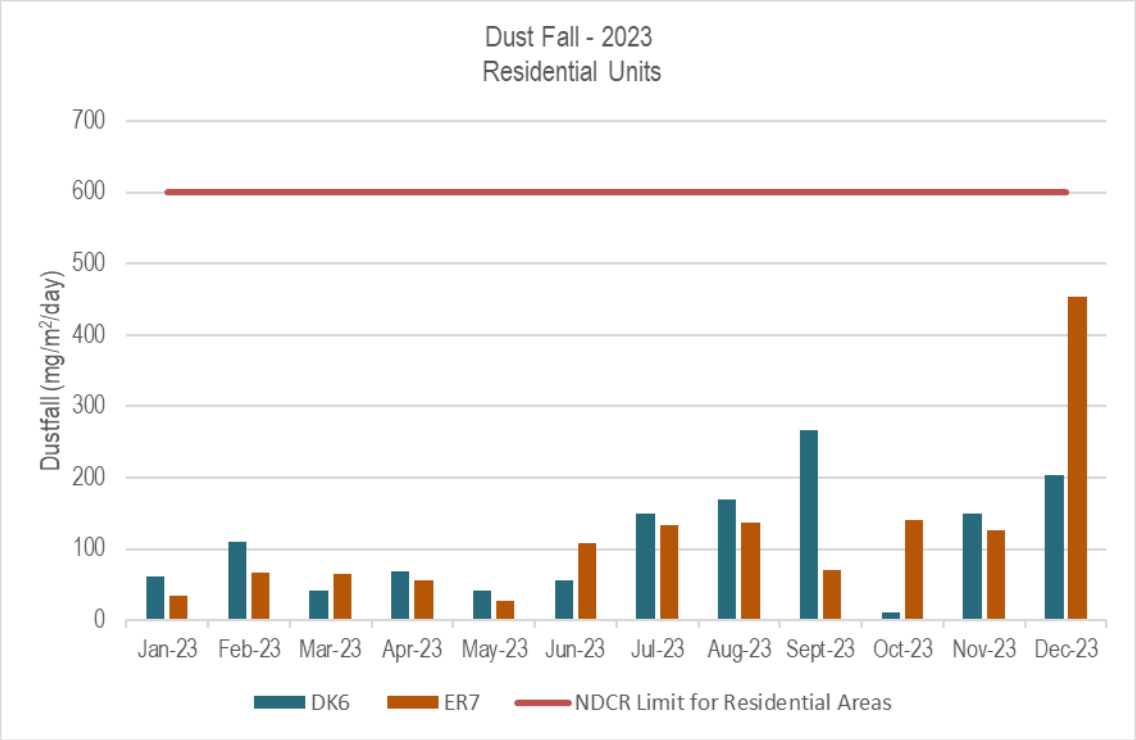



**Figure 16: Dustfall rates from January 2023 to December 2023 for Residential sites**

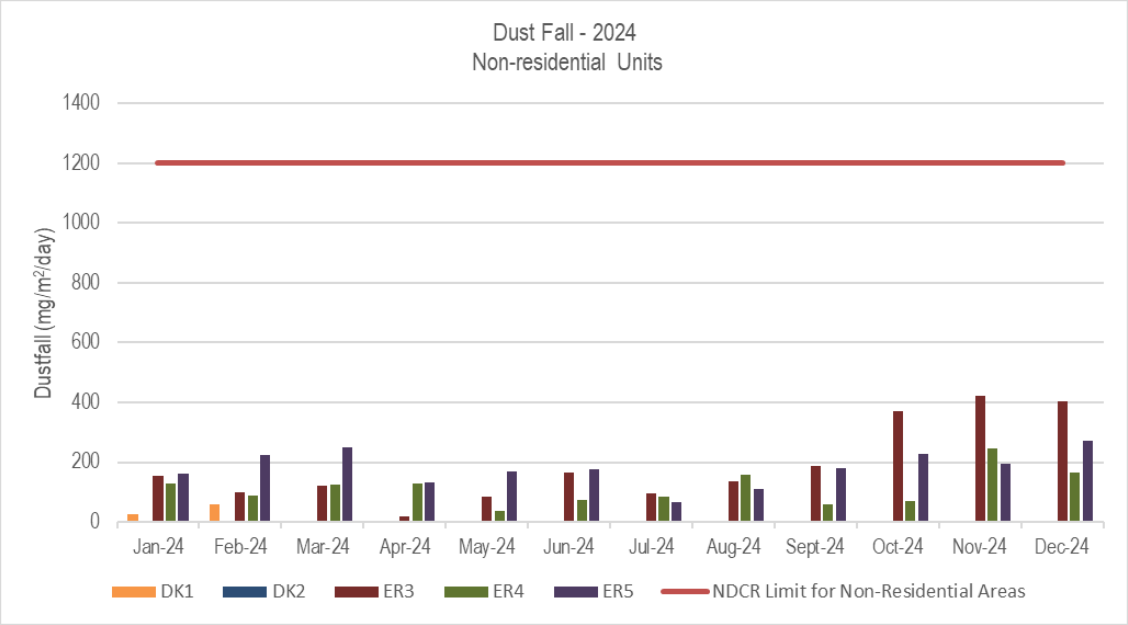



**Figure 17: Dustfall rates from January 2024 to December 2024 for Non-Residential sites**

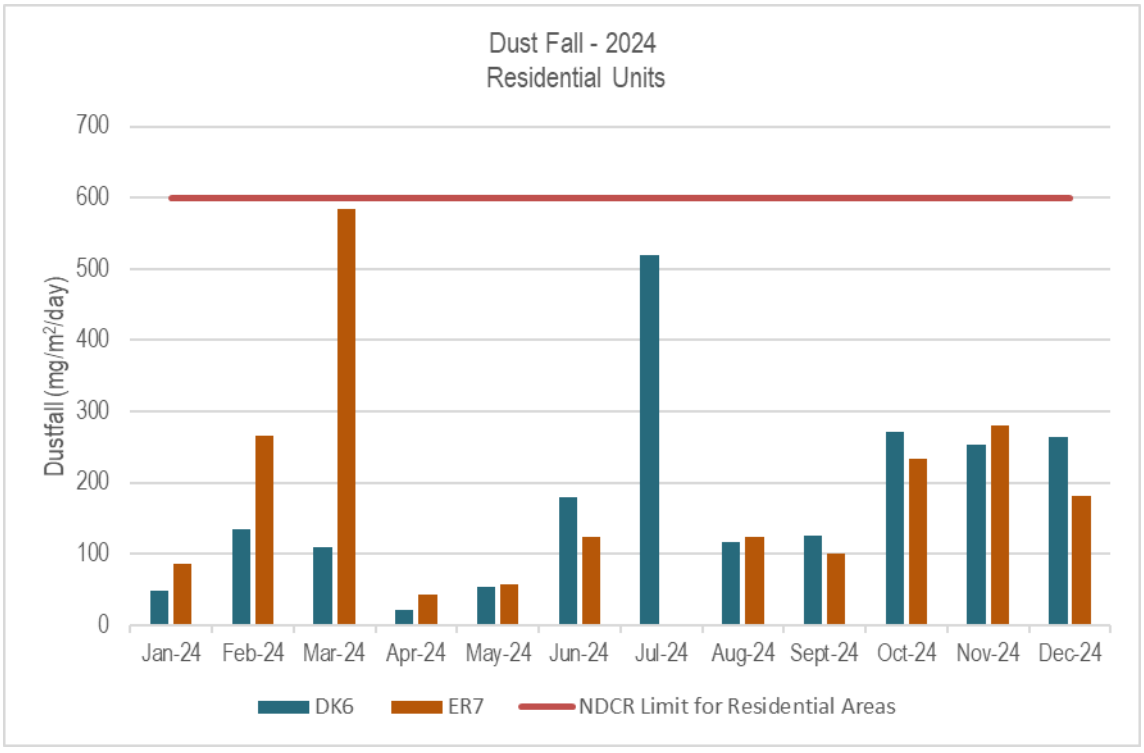



**Figure 18: Dustfall rates from January 2024 to December 2024 for Residential sites**

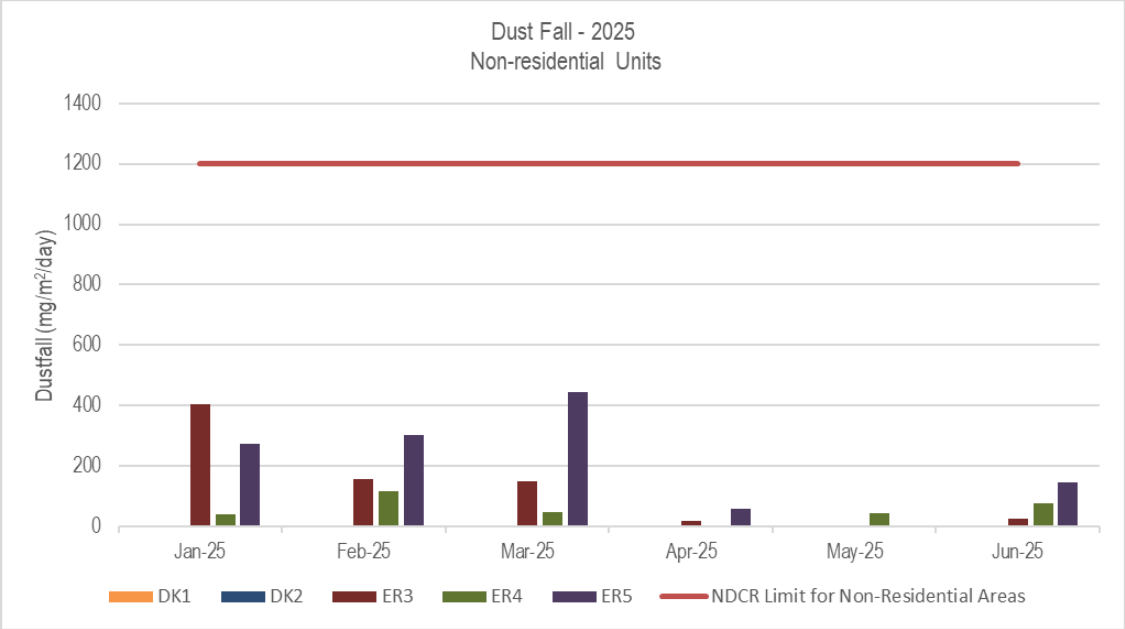



**Figure 19: Dustfall rates from January 2025 to June 2025 for Non-Residential sites**

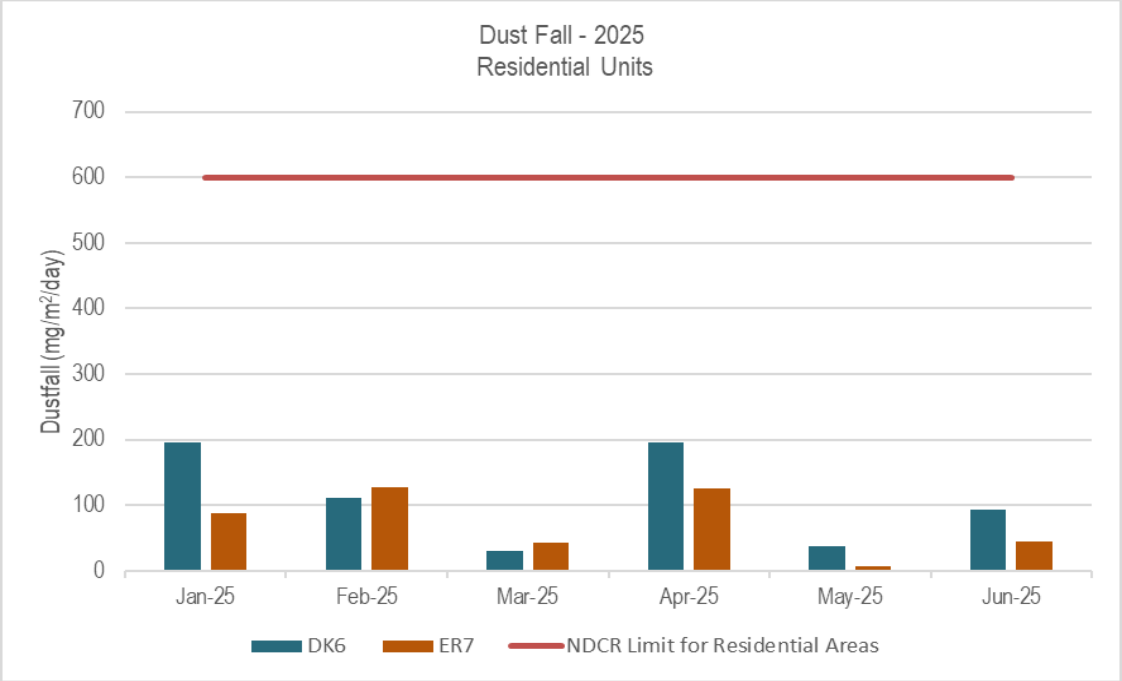



**Figure 20: Dustfall rates from January 2025 to June 2025 for Residential sites**

### *4.2.2 Savuka and Mponeng*

Dust fallout sampling has been undertaken around the Savuka and Mponeng operations since April 2004[4] and includes a network comprising of 15 single Dustfall Monitoring Units (DMU) in accordance with ASTM D1739 (1970) (Table 5). Eleven (11) of these DMUs fall within the Savuka operations and four (4) within the Mponeng operations, of which two (2) DMUs are screened against the NDCR non-residential limit of 1 200 mg/m²/day, with the remaining units all regarded as residential (screened against the NDCR residential limit of 600 mg/m²/day). Two of the Savuka DMUs, 'South of Savuka' and 'Harmony

[4] Previously owned by Anglo Gold Ashanti and referred to as the West Wits operations.

Hostel' are located north of Kusasalethu TSF. The Savuka DMU locations are listed in **Table 5**, with the two dustfall units mentioned highlighted.

**Table 5: Site description and location of Savuka and Mponeng Dustfall Monitoring Units (DMU)**

| Mine | DMU | Location | | Classification | Status 2025 |
|---|---|---|---|---|---|
| | | Longitude | Latitude | | |
| Savuka | Lesley Williams Private Hospital | 27.42453 | -26.4023 | Residential | Active |
| | AngloGold Hospital | 27.39908 | -26.429 | Residential | Decommissioned July 2023 |
| | Elandsrand Fire Station (Golf) | 27.36553 | -26.4461 | Residential | Decommissioned June 2023 [(a)] |
| | Harmony Hostel | 27.36236 | -26.4561 | Residential | Active |
| | Southdene Village | 27.37578 | -26.4127 | Residential | Active |
| | Engineering Training Centre | 27.39694 | -26.4183 | Residential | Active |
| | Envirogreen Sewage Plant | 27.34556 | -26.4279 | Residential | Decommissioned Dec 2024 [(b)] |
| | East of Old North | 27.40347 | -26.4159 | Non-residential | Active |
| | East of Savuka | 27.36897 | -26.4365 | Residential | Active |
| | South of Savuka | 27.35306 | -26.4521 | Residential | Active |
| | West Deep Area (Skomplaas) | 27.3971 | -26.4258 | Residential | Active |
| | Blyvoor Plant North | 27.34638 | -26.4213 | Residential | Active |
| Mponeng | Wedela Recreation Centre | 27.39183 | -26.4611 | Residential | Active |
| | Mponeng Gold Plant | 27.43503 | -26.4393 | Non-residential | Active |
| | NE Mponeng TSF | 27.42356 | -26.4456 | Residential | Active |
| | SSW Mponeng TSF | 27.39267 | -26.4656 | Residential | Active |
| | Village Substation | 27.40182 | -26.4466 | Residential | Active |

Notes: [(a)] Relocated to Village Substation

[(a)] Relocated to Blyvoor Plant North

Dustfall rates for the Savuka DMUs for the period January 2023 to July 2025 were made available for inclusion into this report and shown in **Figures 22 and 23** for 2022, **Figures 24 and 25** for 2023, **Figures 26 and 27** for 2024, and **Figures 28 and 29** for 2025.

During the three and half years (January 2022 – July 2025) for both the residential and non-residential locations the dustfall rates were below the respective NDCRs with no exceedances recorded.

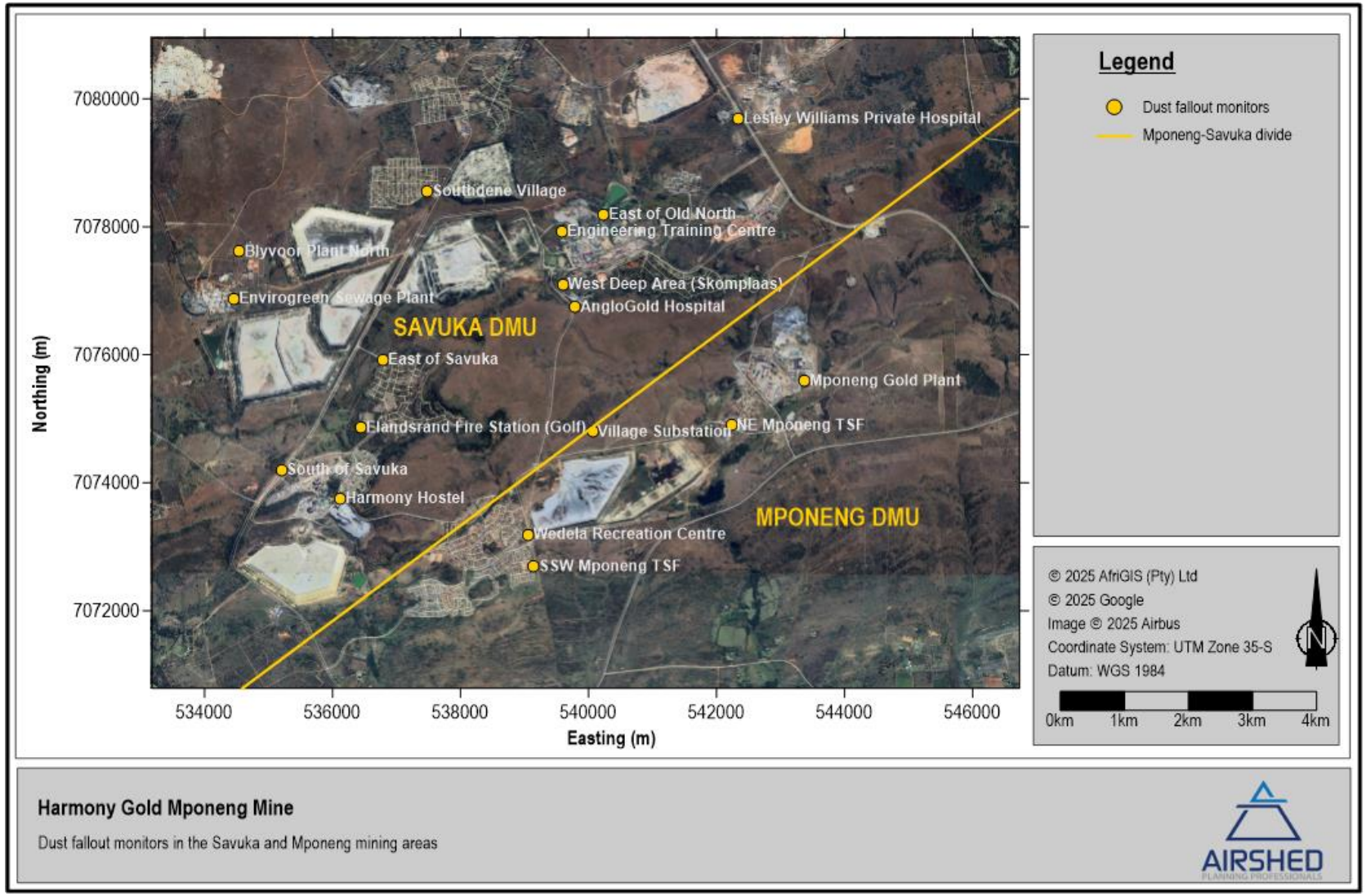



**Figure 21: Savuka and Mponeng Dustfall Monitoring Units (DMU)**

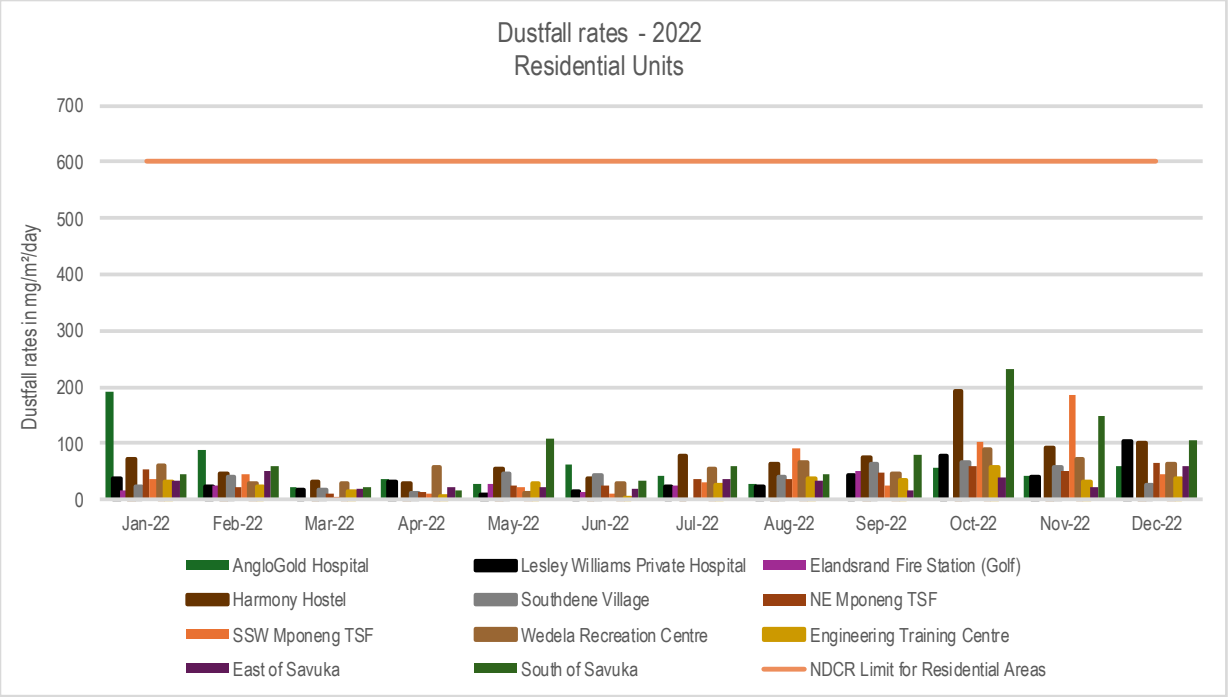



**Figure 22: Savuka DMU Dustfall rates from January 2022 to December 2022 for Residential sites**

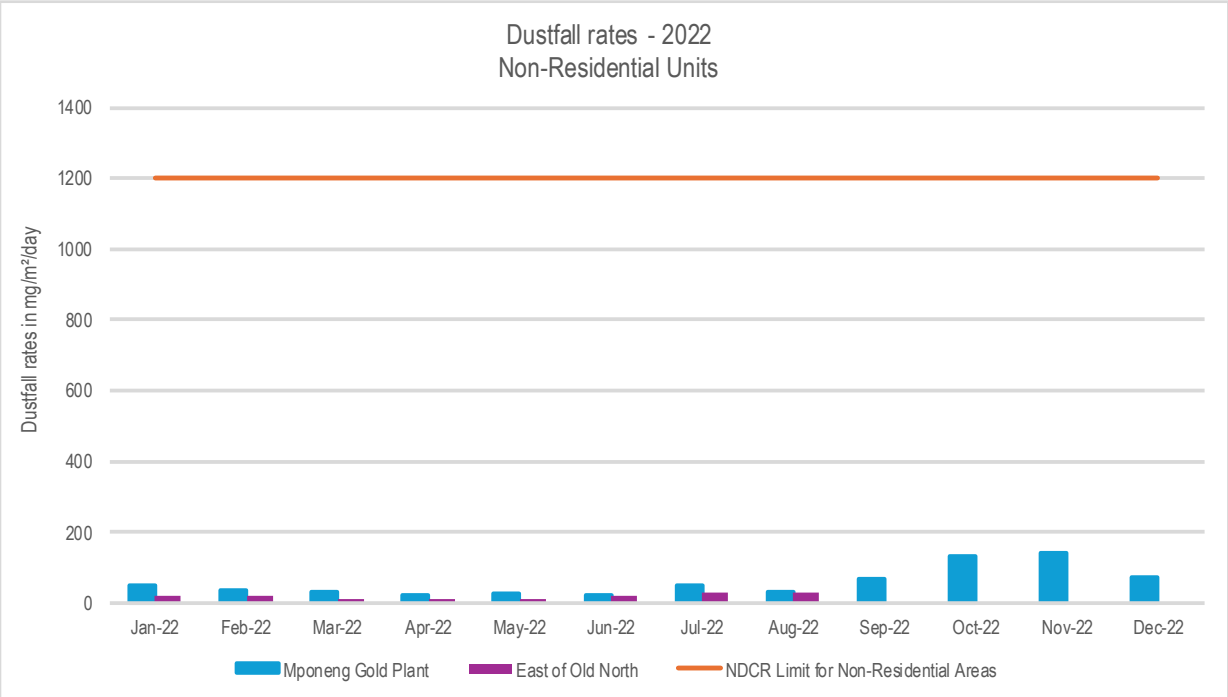



**Figure 23: Dustfall rates from January 2022 to December 2022 for Non-Residential sites**

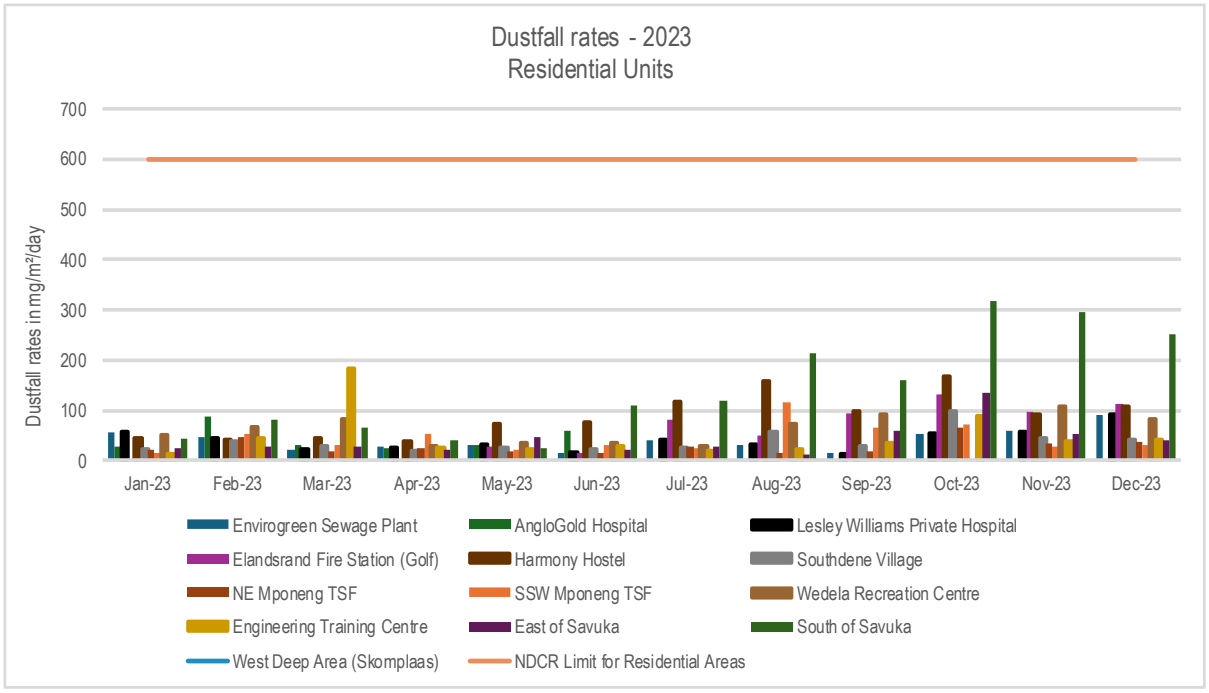



**Figure 24: Dustfall rates from January 2023 to December 2023 for Residential sites**

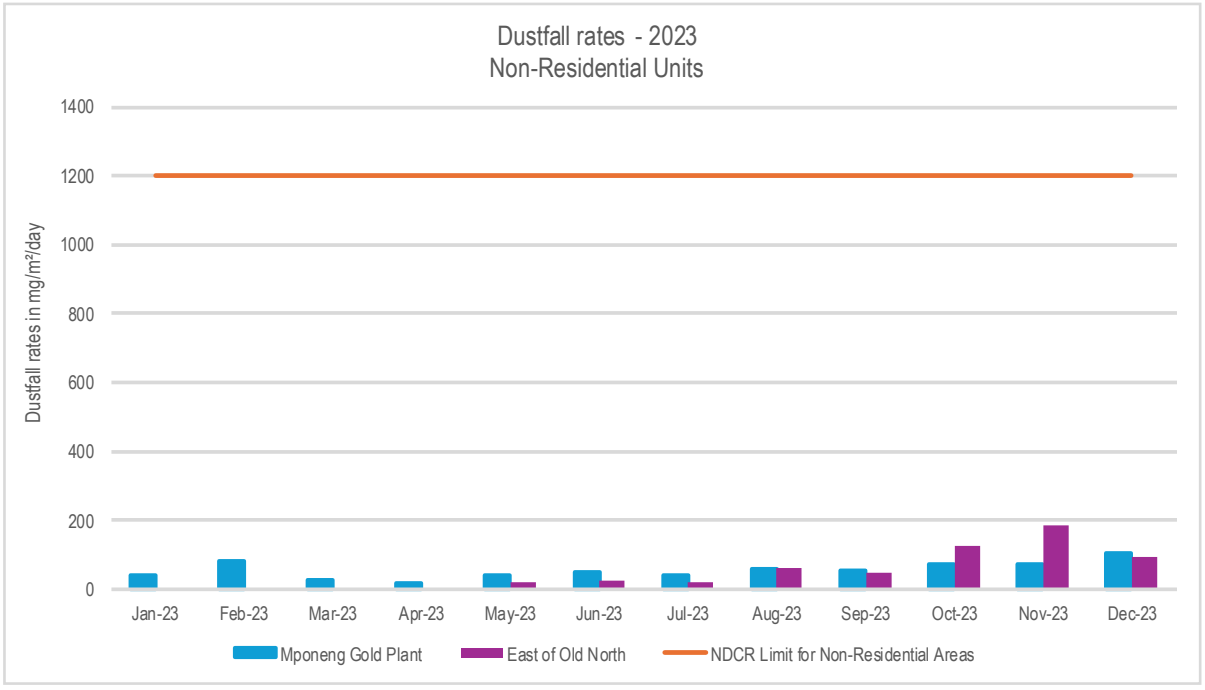



**Figure 25: Dustfall rates from January 2023 to December 2023 for Non-Residential sites**

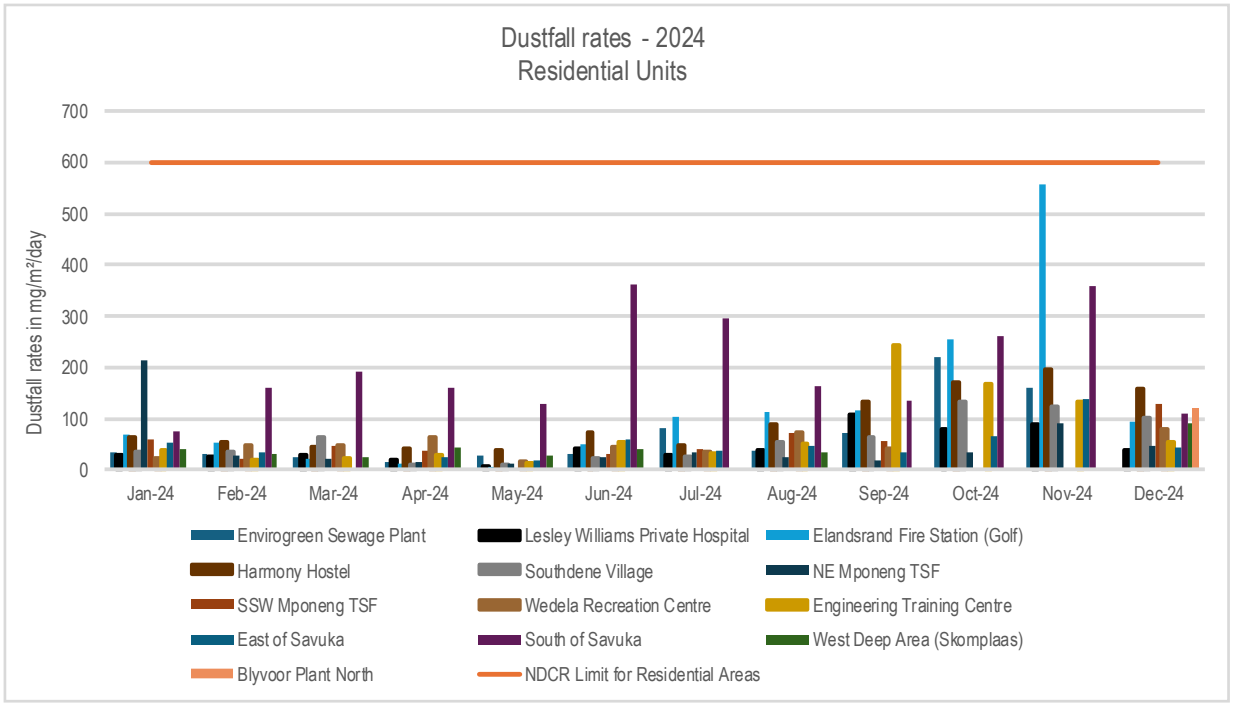



**Figure 26: Dustfall rates from January 2024 to December 2024 for Residential sites**

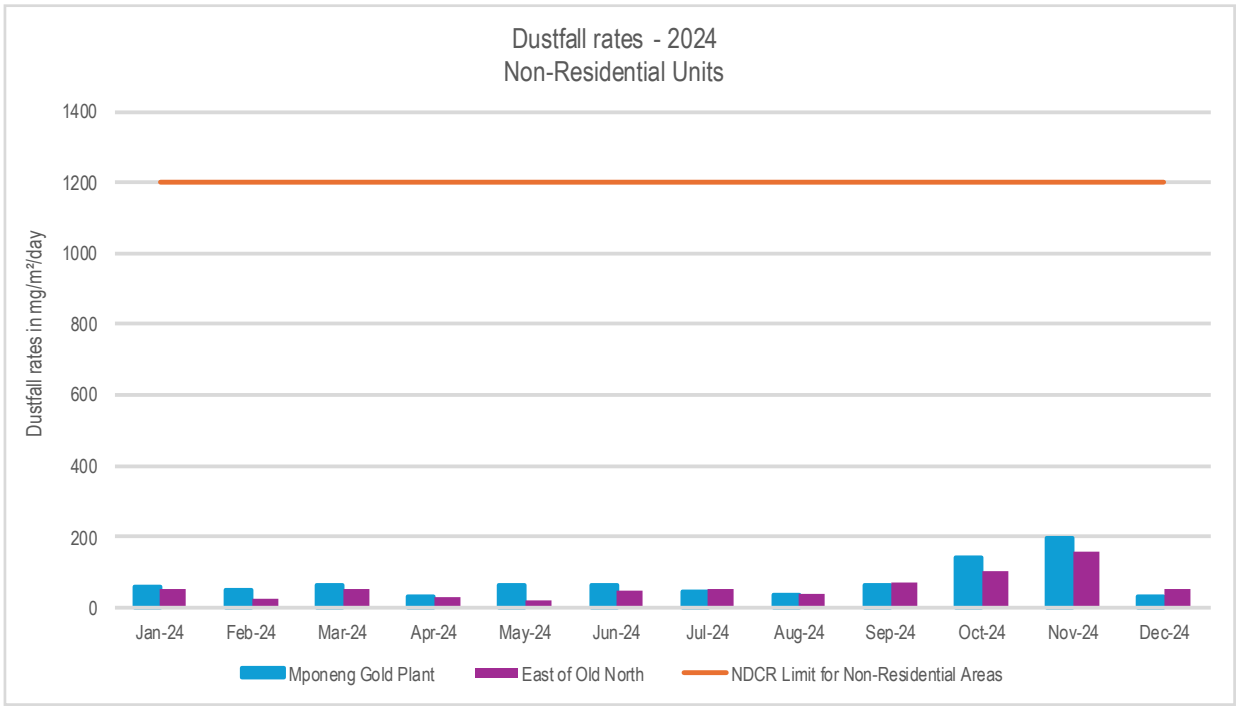



**Figure 27: Dustfall rates from January 2024 to December 2024 for Non-Residential sites**

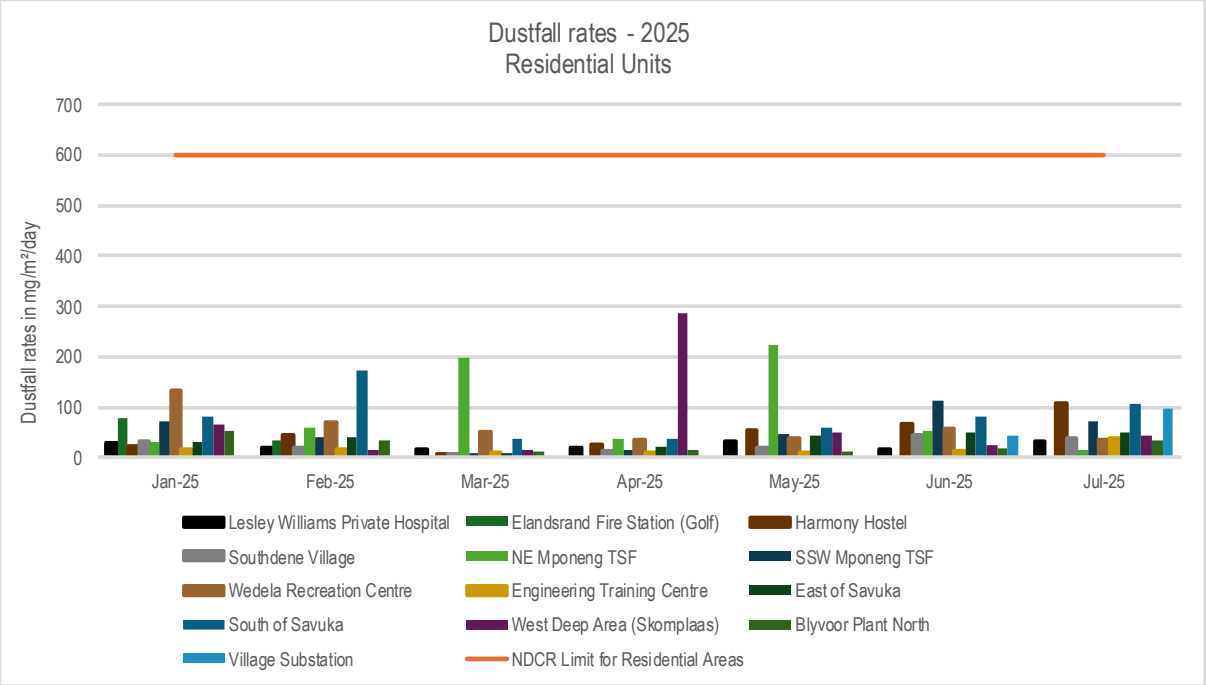



**Figure 28: Dustfall rates from January 2025 to July 2025 for Residential sites**

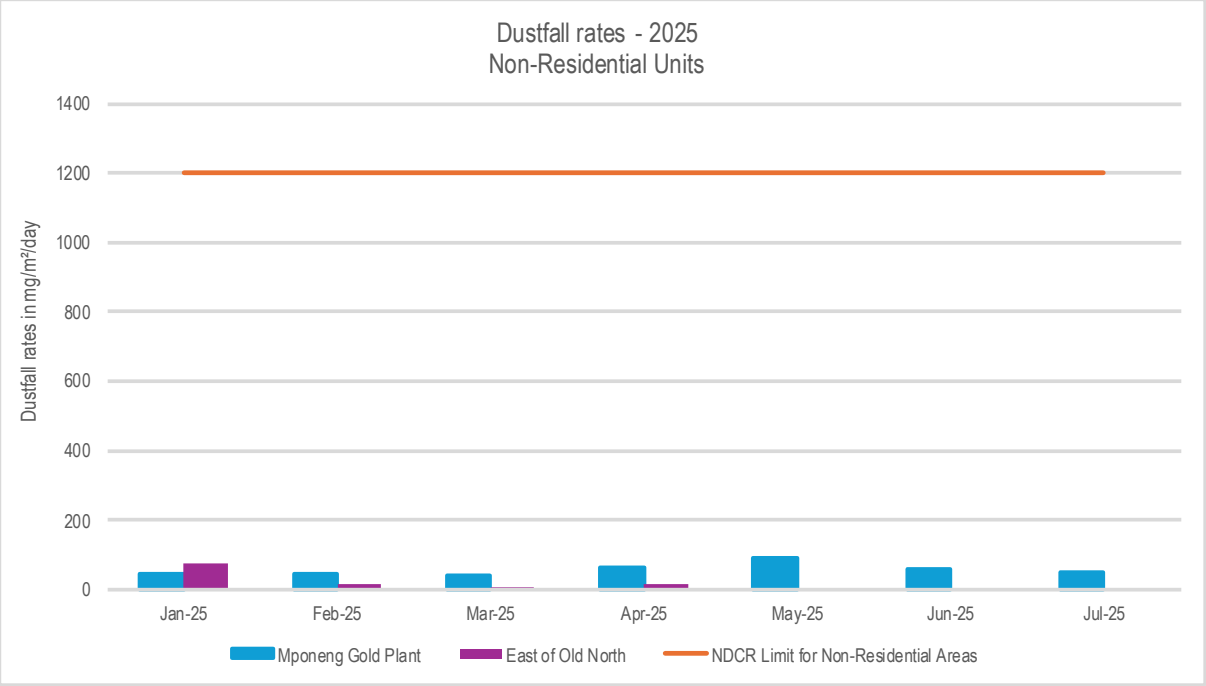



**Figure 29: Dustfall rates from January 2025 to July 2025 for Non-Residential sites**

# 5 AIR QUALITY IMPACT ASSESSMENT

## 5.1 Description of Current Operations in the West Wits area

The current operations include ventilation shaft emissions (underground operations), bulldozing, material transfer (loading and off-loading), wheel entrainment from vehicles, wind erosion from marginal ore dumps (MOD) and TSFs, and activities at the processing plant.

### *5.1.1 Ventilation shafts*

Typical operations associated with underground mining include sub-surface drilling and blasting, sub-surface transferring ore and waste rock to surface with conveyors, material transfer points, stockpiling, and mobile equipment operations. There is one operational shaft at Deelkraal mine Mine, one at Kusasalethu Mine one at Savuka mine and one at Mponeng mine.

### *5.1.2 Deelkraal and Kusasalethu Gold Plants*

None of the gold plants are operational at the moment as the one at Deelkraal has been completely demolished and the Kusasalethu Gold plant was scheduled to stop in March 2025 which.

### *5.1.3 Tailings Storage Facilities*

The Deelkraal TSF is non-operational (dormant) since 2006 and placed under care and maintenance of an outside contractor to ensure physical integrity. The Kusasalethu TSF is currently still in use and is used to deposit fresh tailings. It should be noted that there are several active and dormant TSFs to the north and west of the Kusasalethu TSF. All these TSFs are subject to wind erosion.

Wind erosion is a complex process, including three different phases of particle entrainment, transport and deposition. It is primarily influenced by atmospheric conditions (e.g. wind, precipitation and temperature), soil properties (e.g. soil texture, composition and aggregation), land-surface characteristics (e.g. topography, moisture, aerodynamic roughness length, vegetation and non-erodible elements) and land-use practice (e.g. farming, grazing and mining) (Shao, 2008). Windblown dust generates from natural and anthropogenic sources. For wind erosion to occur, the wind speed needs to exceed a certain threshold, called the friction velocity. This relates to gravity and the inter-particle cohesion that resists removal. Surface properties such as soil texture, soil moisture and vegetation cover influence the removal potential. Conversely, the friction velocity or wind shear at the surface is related to atmospheric flow conditions and surface aerodynamic properties. Thus, for particles to become airborne the wind shear at the surface must exceed the gravitational and cohesive forces acting upon them, called the threshold friction velocity (Shao, 2008).

The US EPA indicates a friction velocity of 5.4 m/s to initiate erosion from coal storage piles (US EPA, 2006). Liebenberg-Enslin (2014) estimated a wind erosion threshold of 8.8 m/s for gold tailings, and Mian & Yanful (2003) calculated a wind speed more than 9 m/s is required to initiate wind erosion from two tailings storage facilities in in New Brunswick and Ontario, Canada. Thus, the likelihood exists for wind erosion to occur from open and exposed surfaces, with loose fine material, when the wind speed exceeds at least 5.4 m/s.

As indicated, any binding properties would reduce the potential for wind erosion. One of the most effective measures of minimizing wind erosion emissions from tailings storage facilities is re-vegetation. The control efficiency of vegetation is given as 40% for non-sustaining vegetation and 90% for re-vegetation. Secondary rehabilitation would up the control efficiency to 60% for non-sustaining vegetation (NPI, 2012). The current active TSFs and proposed TSF would not be covered and therefore pose the largest risk for wind-blown dust

### 5.1.4 Waste Rock Dumps

The Deelkraal WRD was reclaimed, but the footprint was not rehabilitated and Kusasalethu WRD are being removed.

#### 5.1.4.1 Vehicles operations

Trucks transport waste rock material by unpaved road to and from the Kusasalethu Plant WRD. The operation of the trucks would result in both entrainment of dust along the unpaved roads and exhaust emissions. It has been found that of these two particulate matter sources associated with the truck operations the entrainment of dust as the trucks travel along the unpaved roads is far more significant than exhaust emissions and is often one of the most significant sources of elevated ground-level fine particulate matter concentrations and dustfall rates at and around mining operations.

## 5.2 Project Activities from an Air Quality Perspective

The proposed activities will result in emissions to air from a variety of activities and sources. Slurry and return water pipes will have to be constructed between the Savuka Plant, Kusasalethu Plant, the Deelkraal I TSF, the Kusasalethu TSF and the proposed Deelkraal II TSF. The main air pollution activities are listed in **Table 6**.

**Table 6: Activities and associated air pollutants from the Deelkraal and Kusasalethu Operations**

| Activity | Associated pollutants |
|---|---|
| **CURRENT OPERATIONS** | |
| **Underground Mining (emissions released via vent shafts)** | |
| Drilling and blasting | particulate matter (PM)[a][c], sulfur dioxide ($SO_2$); oxides of nitrogen (NOx); carbon monoxide (CO); Total Organic Compounds (TOC) and carbon dioxide ($CO_2$)[b] |
| Loading and tipping of ore and waste | mostly PM, gaseous emissions from mining equipment (Diesel Particulate Matter [DPM], $SO_2$; NOx; CO; $CO_2$) |
| Primary crusher (assumed to be underground) | mostly PM, gaseous emissions from machinery (PM, $SO_2$; NOx; CO; $CO_2$) |
| Materials handling (loading of ore and waste) | mostly PM, gaseous emissions from Front-end-Loaders (FELs) (PM, $SO_2$; NOx; CO; $CO_2$) |
| **Surface Operations** | |
| Secondary & tertiary crushing and screening | mostly PM[c], gaseous emissions from machinery (PM, $SO_2$; NOx; CO; $CO_2$) |
| Materials handling (loading & off-loading) | mostly PM[c] and windblown dust from storage piles |
| Trucks transporting ore and waste | PM from vehicle entrainment on unpaved road sections and gaseous emissions from truck exhaust (PM, $SO_2$; NOx; CO; $CO_2$) |
| Tailings Storage Facilities (TSFs) | PM[c] from windblown dust and radon |
| Waste Rock Dumps (WRDs) | PM[c] from windblown dust and radon |
| **PROPOSED OPERATIONS** | |
| Deelkraal II TSF | PM[c] from windblown dust and radon |
| Reclamation | PM[c] from associated activities such as vehicles on access roads, stockpiles, etc. |
| Processing plant stacks | PM[c], $SO_2$; NOx; CO; $CO_2$ |

Notes: [a] Particulate matter (PM) refers to Total Suspended Particulates (TSP), $PM_{10}$ and $PM_{2.5}$ (see Section 1.3.1).
[b] $CO_2$ and methane are greenhouse gasses (GHG).
[c] Radionuclides associated with PM emissions

## 5.3 Emissions Quantification

### *5.3.1 Construction Phase*

Construction normally comprises a series of different operations including land clearing, topsoil removal, material loading and hauling, stockpiling, grading, bulldozing, compaction, etc. The redeposition on the Deelkraal II TSF will require the removal of vegetation cover and topsoil at some areas for the establishment of the TSF basis (i.e. material compaction, surface lining, digging of trenches and laying of pipes, etc.) which will cover an area of approximately 457 ha. A new Return Water Dam (RWD) needs to be constructed with a footprint of approximately 11.7 ha.

Other construction proposed are:

- Upgrades to the existing Kusasalethu plant including new/upgrade of gold and new uranium sections;
- Slurry pipelines:
    - Reclaimed Slurry from Deelkraal 1 to Kusasalethu (~10.6 km);
    - Kusasalethu Barren Tailings to Deelkraal II and booster pump station (~10.2 km);
    - Reclaimed Slurry from Kusasalethu TSF to Kusasalethu Plant (~2 km);
    - Slurry pipeline from Kusasalethu Plant to Savuka TSF (~4.97 km); and
    - Slurry pipeline from Savuka plant to DF5 TSF (~2.9 km).
- Process Water Pipelines:
    - Process Water Feed from Kusasalethu Plant to Deelkraal Reclamation (~9.54 km) –
    - Return Water Feed to Kusasalethu Process Water Tank (~9.58 km); -
    - Driefontein DP2 Pump Station to North Boundary Dam (~4.78 km); -
    - DP2 feed to Tau Tona Reverse Osmosis Plant (~0.1 km); -
    - Nursery Pumpstation #3 to Kusasalethu Process Water Tank (~9 km); and
    - Process Water pipelines from Kusasalethu Plant to Savuka White Tanks (~8 km).
- Powerlines (all powerlines will be 22 kV or lower):
    - Powerline from Kusasalethu Plant to the existing Deelkraal TSF (~9.2 km);
    - Powerline from Kusasalethu Plant to the Kusasalethu TSF (~1.8 km);
    - Powerline from Savuka shaft to Kusasalethu Plant (~8.1 km).
- Potable Water pipeline from Rand Water supply point to the Deelkraal TSF (~8.52 km).
- Deelkraal 1 TSF Reclamation Pump Station.
- Kusasalethu TSF Reclamation Pump Station.
- New Access Roads (2 x 3.5 m double road) adjacent to pipeline routes/OH lines and around Deelkraal II TSF (where no access road is already in place).
- Topsoil Stockpiles and overburden stockpiles.
- Ancillary construction infrastructure including workshops and laydown areas.

The main pollutant of concern from construction operations is particulate matter, including $PM_{10}$, $PM_{2.5}$ and TSP. $PM_{10}$ and $PM_{2.5}$ concentrations are associated with potential health impacts due to the size of the particulates being small enough to be inhaled. Nuisance effects are caused by the TSP fraction (20 µm to 75 µm in diameter) resulting in soiling of materials and visibility reductions. This could in effect also have financial implications due to the requirement for more cleaning materials.

All operations associated with the construction phase of the has their own duration and potential for dust generation. It is therefore often necessary to estimate area wide construction emissions, without regard to the actual plans of individual construction process. Dispersion simulation was not undertaken for construction emissions since a construction schedule was

not known. Impacts from construction operations are usually lower than operational phase due to their temporary nature and duration, and the likelihood that these activities will not occur concurrently at all portions of the site.

The US EPA documents emission factors which aim to provide a general rule-of-thumb as to the magnitude of emissions which may be anticipated from construction operations (US EPA, 2006). The quantity of dust emissions is assumed to be proportional to the area of land being worked and the level of construction activity. The approximate emission factors for general construction activity operations are given as:

**E = 2.69 Mg/hectare/month of activity (269 g/m²/month)**

The $PM_{10}$ fraction is given as ~39% of the US EPA total suspended particulate factor. These emission factors are most applicable to construction operations with (i) medium activity levels, (ii) moderate silt contents, and (iii) semiarid climates. The emission factor for TSP considers 42 hours of work per week of construction activity. Test data were not sufficient to derive the specific dependence of dust emissions on correction parameters, and because the above emission factor is referenced to TSP, use of this factor to estimate $PM_{10}$ emissions will result in conservatively high estimates. Also, because derivation of the factor assumes that construction activity occurs 30 days per month, the above estimate is somewhat conservatively high for TSP as well.

Areas assumed to be cleared of vegetation for infrastructure development and TSF preparation are listed in **Table 7**. It should be noted that some areas share similar construction paths and were grouped together with the longest estimated length used in calculating area cleared. Assuming all areas to be developed simultaneously within the 2.5-year period, the resulting emission estimates are 4587 tpa for TSP, 2294 tpa for $PM_{10}$.

**Table 7: Areas affected by Construction activities**

| Mining Area | Area / Length | Area (m²) | Comment |
|---|---|---|---|
| Reclaimed Slurry Deelkraal 1 to Kusasalethu<br>Kusasalethu Barren Tailings to Deelkraal II<br>Process Water Feed from Kusasalethu Plant to Deelkraal<br>Reclamation Return Water Feed to Kusasalethu Process Water Tank<br>Powerline from Kusasalethu Plant to the existing Deelkraal TSF<br>Potable Water pipeline | 10667 m | 81069.20 | Pipeline assumed to be 600 mm wide and flanked by two 3.5 m wide roads. |
| Reclaimed Slurry from Kusasalethu TSF to Kusasalethu Plant | 2904 m | 22070.40 | Pipeline assumed to be 600 mm wide and flanked by two 3.5 m wide roads. |
| Slurry pipeline from Kusasalethu Plant to Savuka TSF | 4967 m | 37749.2 | Pipeline assumed to be 600 mm wide and flanked by two 3.5 m wide roads. |
| Slurry pipeline from Savuka plant to DF5 TSF | 2778 m | 21112.8 | Pipeline assumed to be 600 mm wide and flanked by two 3.5 m wide roads. |
| Driefontein DP2 Pump Station to North Boundary Dam | 4784 m | 36358.4 | Pipeline assumed to be 600 mm wide and flanked by two 3.5 m wide roads. |
| DP2 feed to Tau Tona Reverse Osmosis Plant | 75.9 m | 576.84 | Pipeline assumed to be 600 mm wide and flanked by two 3.5 m wide roads. |
| Nursery Pumpstation #3 to Kusasalethu Process Water Tank<br>2 Process Water pipelines from Kusasalethu Plant to Savuka White Tanks<br>Powerline from Savuka shaft to Kusasalethu Plant | 9018 m | 68536.8 | Pipeline assumed to be 600 mm wide and flanked by two 3.5 m wide roads. |
| Powerline from Kusasalethu Plant to the Kusasalethu TSF | 1800 m | 13680 | Pipeline assumed to be 600 mm wide and flanked by two 3.5 m wide roads. |
| Deelkraal 1 TSF Reclamation Pump Station | 4.0275 ha | 40275 | Referenced from Google Earth Maps |

| Mining Area | Area / Length | Area (m²) | Comment |
|---|---|---|---|
| Kusasalethu TSF Reclamation Pump Station | 1.9086 ha | 19086 | Referenced from Google Earth Maps |
| New Access Roads | 9933 m | 19086 | Roads assumed to 3.5 m and runs on the Deelkraal II TSF boundary |
| Topsoil Stockpiles and overburden stockpiles 1 | 25.0498 ha | 250498 | Referenced from Google Earth Maps |
| Topsoil Stockpiles and overburden stockpiles 2 | 11.743 ha | 117430 | Referenced from Google Earth Maps |
| Return Water Dam Deelkraal II TSF | 11.7887 ha | 117887 | Referenced from Google Earth Maps |
| Deelkraal Reclamation Construction Laydown Area | 7.3318 ha | 73318 | Referenced from Google Earth Maps |
| TSF Construction Laydown Area #1 | 33.8949 ha | 338949 | Referenced from Google Earth Maps |
| Piping Construction Laydown Area | 10.4992 ha | 104992 | Referenced from Google Earth Maps |
| Kusasalethu Plant Construction Laydown Area | 3.9615 ha | 39615 | Referenced from Google Earth Maps |
| Kusasalethu Reclamation | 1.8738 ha | 18738 | Referenced from Google Earth Maps |

For the Deelkraal II TSF more detailed information was available for the construction phase such as fuel use, amounts of materials moved and type of construction vehicles. Emissions due to construction could be calculated using standard EFs from US EPA AP-42 and Australian NPI Emission Estimation Technique Manual for Mining. Emission quantification for these activities is provided in **Table 8**. The resulting emissions estimated are 2847 tpa for TSP and 806.6 tpa for PM10.

**Table 8: Deelkraal II Construction Emission estimation techniques and parameters**

<table>
<tr><th>Source Group</th><th>Emission Estimation Technique</th><th>Input Parameters/Notes</th></tr>
<tr><td>Materials handling</td><td>US EPA miscellaneous transfer and conveying emission factor equation (US EPA, 2006)<br>$\mathrm{EF} = \mathrm{k} \cdot 0.0016 \cdot \left(\frac{\mathrm{U}}{2.3}\right)^{1.3} \cdot \left(\frac{\mathrm{M}}{2}\right)^{-1.4}$ (1)<br>EF is the emission factor in kg/tonne material handled<br>k is the particle size multiplier ($k_{TSP}$ – 0.74, $k_{PM10}$ – 0.35, $k_{PM2.5}$ – 0.053)<br>U is the average wind speed in m/s<br>M is the material moisture content in %</td><td>Handling of materials at the for the construction of the Deelkraal TSF was supplied.<table><tr><th></th><th>Deelkraal II TSF</th></tr><tr><td>Material throughput (t/h)</td><td>1956</td></tr></table>Notes: *based on total constructed material.<br>Moisture:<ul><li>Sand 4% (assumed)</li><li>Clay 10% (assumed)</li><li>WRD 3% (assumed)</li></ul>Wind Speed: 3.63 m/s (WRF data 2022-2024)<br>Hours of operation: 260 days per year, 10 hours per day.<br>Operation steps: 3<br>Mitigation: None.</td></tr>
<tr><td>Vehicle Combustion</td><td>Australian NPI for combustion engines emission factors for industrial vehicles (NPI, 2008)<br>$E = P \cdot \mathrm{OpHrs} \cdot \mathrm{LF} \cdot \mathrm{EF}_i \cdot \mathrm{CF}$<br>EF is the emission factor in kg/kWh for vehicle type<br>LF is the load factor (assumed to be 0.5)<br>OpHrs is the estimated operating hours of vehicle type<br>P is the estimated amount of fuel use<br>CF is the conversion factor from kg/kWh to kg/litre</td><td>Vehicle types, fuel usage and operating hours was supplied.<br>Operating hours: 260 days per year, 10 hours per day.</td></tr>
<tr><td>Entrained dust from unpaved roads</td><td>US EPA emission factor equation (US EPA, 2006a)<br>$EF = k \cdot \left(\frac{s}{12}\right)^{a} \cdot \left(\frac{W}{3}\right)^{b} \cdot 281.9$ (2)<br>Where<br>EF is the emission factor in g/VKT<br>k is the particle size multiplier ($k_{TSP}$ – 4.9, $k_{PM10}$ – 1.5, $k_{PM2.5}$ – 0.15)<br>a is a constant (TSP – 0.7, $PM_{10}$ – 0.9, $PM_{2.5}$ – 0.9)<br>b is a constant (TSP – 0.45, $PM_{10}$ – 0.45, $PM_{2.5}$ – 0.45)</td><td>Transport activities include the transport of construction materials on the TSF.<br>VKT were calculated from road lengths (limited to the TSF area), truck capacities and the number of trips required to transport materials.<br>Average vehicle weight:<ul><li>45 t Articulated Dump Trucks assumed to 96.5 tonnes.</li><li>70 t Rigid Dump Trucks assumed to 80.2 tonnes.</li><li>Water Bowsers assumed to 105 tonnes.</li><li>Service Trucks assumed to 105 tonnes.</li></ul></td></tr>
</table>

| Source Group | Emission Estimation Technique | Input Parameters/Notes |
|---|---|---|
| | s is the road surface material silt content in %<br>W is the average weight vehicles in tonnes | • Light Delivery Vehicles assumed to 5.9 tonnes.<br>• Double Cab Vehicles assumed to 5.9 tonnes.<br><br>Previous studies road surface silt content of 8.3% was applied in calculations for the roads.<br>Hours of operation: 260 days per year, 10 hours per day.<br>Mitigation: None. |
| **Graders** | Australian NPI default emission factors for various operations at Coal mines (NPI, 2012)<br>$EF_{TSP} = 0.0034 \cdot s^{2.5}$<br>$EF_{PM10} = 0.0034 \cdot s^{2}$<br>EF is the emission factor in kg/VKT<br>S is the vehicle speed in km/h | 5 km/h assumed<br><br>VKT were calculated from road lengths (limited to the TSF area) and operating hours. |
| **Bulldozers** | Australian NPI default emission factors for various operations at Coal mines (NPI, 2012)<br>$EF_{TSP} = 2.6 \cdot \frac{s^{1.2}}{M^{1.3}}$<br>$EF_{PM10} = 0.34 \cdot \frac{s^{1.5}}{M^{1.4}}$<br>EF is the emission factor in kg/h<br>s is the road surface material silt content in %<br>M is the moisture content content in % | Moisture:<br>• Sand 4% (assumed)<br>• Clay 10% (assumed)<br>• WRD 3% (assumed)<br>Silt<br>• Sand 2.6% (assumed)<br>• Clay 6% (assumed)<br>• WRD 7.5% (assumed)<br>Hours of operation: 260 days per year, 10 hours per day. |
| **Wheeled Loaders** | Australian NPI default emission factors for various operations at Coal mines (NPI, 2012)<br>$EF_{TSP}$ = 17 kg/t<br>$EF_{PM10}$ = 4.1 kg/t | Material throughput (t/h) = 1956 tpa |

### 5.3.2 *Operational Phase*

Sources of emissions for the current operations at Deelkraal and Kusasalethu Mines include wind erosion of the existing Deelkraal and Kusasalethu WRDs and TSFs. While the proposed operations include two new stacks at the Kusasalethu plant, and wind erosion from the existing Kusasalethu TRF and WRD and the proposed Deelkraal II TSF. Two new Topsoil dumps are included too. Sources of emissions for the cumulative scenario include the future scenario already mentioned above and active ventilation shafts, materials handling points, crushing and screening, vehicle entrainment on unpaved roads, and windblown dust from the TSFs and MODs from the existing Savuka and Mponeng mines. These sources were identified from a previous West Wits Study and Google Earth locations provided by EIMS.

The total emissions from current and future scenarios operations are provided in **Table 9**. The addition of the Deelkraal II TSF and the two process stacks will have an increase in PM emissions of 82% ($PM_{2.5}$), 77% ($PM_{10}$) and 87% (TSP). Cumulatively, including the Savuka and Mponeng mining and processing operations, the increase in PM emissions will be less at 37% ($PM_{2.5}$), 44% ($PM_{10}$) and 54% (TSP). The emissions quantification approach for each of current and future activities are provided in **Table 10**. Please see **Appendix C** – Cumulative Future Scenario Emissionsfor emission quantification summary for the Savuka and Mponeng mining and processing operations included in the cumulative scenario.

**Table 9: Emissions in tonnes per annum (tpa) for the various scenarios**

| Scenarios | $PM_{2.5}$ (tpa) | $PM_{10}$ (tpa) | TSP (tpa) |
|---|---|---|---|
| Current – West Wits Operations | 37.54 | 166.22 | 394.18 |
| Future – Proposed Operations West Wits | 209.92 | 730.05 | 2 984.26 |
| Future Cumulative – Proposed Operations West Wits and Existing Savuka & Mponeng Operations | 562.98 | 1 664.12 | 5 542.44 |

**Table 10: Emission estimation techniques and parameters**

<table>
<tr><th>Source Group</th><th>Emission Estimation Technique</th><th>Input Parameters/Notes</th></tr>
<tr><td>Cabinet Exhaust Stack</td><td>Data provided by Harmony Gold</td><td>Carbon Regeneration Kilns 1, 2 and 3<br><table><tr><th>Exit velocity (m/s)</th><th>Diameter (m)</th><th>Exit temp (°C)</th><th>Release height (m)</th><th>Emission rate (mg/Nm³)</th></tr><tr><td>9.5</td><td>0.293</td><td>775</td><td>15</td><td>50*</td></tr></table>Notes: *based on MES Subcategory 4.17<br>Hours of operation: 365 days per year, 24 hours per day.<br>Diameter based on 520 × 520 mm square stack.</td></tr>
<tr><td>Steam Exhaust Stack</td><td>Data provided by Harmony Gold</td><td><table><tr><th>Exit velocity (m/s)</th><th>Diameter (m)</th><th>Exit temp (°C)</th><th>Release height (m)</th><th>Emission rate (mg/Nm³)</th></tr><tr><td>11</td><td>0.3</td><td>575</td><td>15</td><td>50*</td></tr></table>Notes: *based on MES Subcategory 4.17<br>Hours of operation: 365 days per year, 24 hours per day.</td></tr>
<tr><td>Wind erosion: TSFs</td><td>Use if the Airshed Planning Professionals (Pty) Ltd in-house wind erosion emissions estimation program “Airborne Dust Dispersion Model from Area Sources” (ADDAS) (Burger & Held, Revised User's Manual for the Airborne Dust Dispersion Model from Area Sources (ADDAS), 1997; Burger L. W., 2010; Liebenberg-Enslin, 2014)</td><td>Moisture content: Active TSFs = 1.3%; Dormant TSFs = 0.68%.<br>Particle size distribution, particle density and moisture content from previous study.<br><table><tr><th>TSF</th><th>Description</th><th>Area (ha)</th><th>Active/ Dormant</th><th>PM2.5 (tpa/ha)</th><th>PM10 (tpa/ha)</th><th>TSP (tpa/ha)</th></tr><tr><td>TSF8</td><td>Deelkraal I TSF</td><td>104.13</td><td>Dormant</td><td>0.19</td><td>0.84</td><td>1.98</td></tr><tr><td>TSF9</td><td>Kusasalethu TSF</td><td>94.06</td><td>Dormant</td><td>0.19</td><td>0.84</td><td>1.98</td></tr><tr><td>TSF10</td><td>Deelkraal II TSF</td><td>456.83</td><td>Active</td><td>0.41</td><td>1.42</td><td>6.07</td></tr></table></td></tr>
<tr><td>Wind erosion: WRD and Topsoil Stockpiles</td><td>Australian NPI default emission factors for various operations for wind erosion (NPI, 2012).<br><br>TSP = 0.4 kg/ha/h<br>PM10 = 0.2 kg/ha/h</td><td><table><tr><th>WRD</th><th>Description</th><th>Area (ha)</th></tr><tr><td>WRD4</td><td>WRD Kusasalethu</td><td>20.1</td></tr><tr><th>TSD</th><th>Description</th><th>Area (ha)</th></tr><tr><td>TP1</td><td>Topsoil South</td><td>11.4</td></tr><tr><td>TP2</td><td>Topsoil North</td><td>24.06</td></tr></table></td></tr>
</table>

## 5.4 Simulation Results

Simulation results of particulate emissions for the current and future operations are discussed in this section.

### *5.4.1 Respirable particulate matter ($PM_{2.5}$)*

The simulated $PM_{2.5}$ 24-hour concentrations are within compliance with the NAAQS (4 days of exceedance of 40 µg/m$^3$) at all the AQSRs, for both current and future operations (**Figure 30**). The annual $PM_{2.5}$ concentrations for current (**Figure 31**) and future (**Figure 32**) operations are also within compliance with the NAAQS. A summary of the results is presented in **Table 11**.

The additional emission due to the Deelkraal II TSF and Kusasalethu plant would result on average in a 29% increase in daily GLCs at the various AQSRs, and a 14% increase annually when taking existing sources from Savuka and Mponeng into account but still falling within compliance with the NAAQS.

**Table 11: Simulated $PM_{2.5}$ concentrations at the AQSRs**

| ID | AQ Sensitive Receptor | Current | | | Future | | | Cumulative Future | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Highest Daily | Annual | No of Exceedances | Highest Daily | Annual | No of Exceedances | Highest Daily | Annual | No of Exceedances |
| **8** | Elandsridge | 0.0 | 0.0 | 0 | 0.1 | 0.0 | 0 | 8.2 | 0.3 | 0 |
| **9** | Elandsrand | 0.1 | 0.0 | 0 | 0.4 | 0.0 | 0 | 4.7 | 0.2 | 0 |
| **10** | Harmony Hostel | 0.7 | 0.1 | 0 | 1.0 | 0.1 | 0 | 3.7 | 0.3 | 0 |
| **11** | Wedela | 0.0 | 0.0 | 0 | 0.2 | 0.0 | 0 | 8.6 | 0.4 | 0 |
| **12** | Deelkraal | 0.2 | 0.0 | 0 | 0.6 | 0.0 | 0 | 2.2 | 0.1 | 0 |
| **23** | Homestead | 0.0 | 0.0 | 0 | 0.1 | 0.0 | 0 | 4.0 | 0.4 | 0 |
| **50** | Homestead | 0.0 | 0.0 | 0 | 0.2 | 0.0 | 0 | 2.9 | 0.2 | 0 |
| **51** | Informal settlement | 0.0 | 0.0 | 0 | 0.1 | 0.0 | 0 | 5.4 | 0.3 | 0 |
| **52** | Homestead | 0.8 | 0.0 | 0 | 0.9 | 0.0 | 0 | 2.9 | 0.1 | 0 |
| **53** | Homestead | 0.7 | 0.0 | 0 | 0.8 | 0.0 | 0 | 2.6 | 0.1 | 0 |
| **54** | Homestead | 0.4 | 0.0 | 0 | 0.5 | 0.0 | 0 | 1.8 | 0.1 | 0 |
| **55** | Homestead | 1.3 | 0.0 | 0 | 1.7 | 0.0 | 0 | 2.8 | 0.1 | 0 |
| **56** | Homestead | 1.0 | 0.0 | 0 | 1.3 | 0.0 | 0 | 2.4 | 0.1 | 0 |
| **57** | Homestead | 0.8 | 0.0 | 0 | 1.1 | 0.0 | 0 | 2.2 | 0.1 | 0 |
| **58** | Homestead | 0.8 | 0.0 | 0 | 1.1 | 0.0 | 0 | 2.2 | 0.1 | 0 |
| **65** | Homestead | 0.5 | 0.0 | 0 | 0.8 | 0.0 | 0 | 2.7 | 0.1 | 0 |
| **66** | Homestead | 0.4 | 0.0 | 0 | 0.8 | 0.0 | 0 | 2.5 | 0.1 | 0 |
| **67** | Homestead | 0.4 | 0.0 | 0 | 0.8 | 0.0 | 0 | 2.6 | 0.1 | 0 |
| **68** | Homestead | 0.4 | 0.0 | 0 | 0.9 | 0.0 | 0 | 2.6 | 0.1 | 0 |
| **69** | Homestead | 0.3 | 0.0 | 0 | 0.7 | 0.0 | 0 | 2.4 | 0.1 | 0 |
| **70** | Homestead | 0.1 | 0.0 | 0 | 2.2 | 0.0 | 0 | 2.4 | 0.1 | 0 |
| **71** | Homestead | 0.2 | 0.0 | 0 | 2.3 | 0.0 | 0 | 2.5 | 0.1 | 0 |
| **72** | Homestead | 0.2 | 0.0 | 0 | 1.7 | 0.0 | 0 | 2.0 | 0.1 | 0 |

| ID | AQ Sensitive Receptor | Current | | | Future | | | Cumulative Future | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Highest Daily | Annual | No of Exceedances | Highest Daily | Annual | No of Exceedances | Highest Daily | Annual | No of Exceedances |
| **73** | Homestead | 0.2 | 0.0 | 0 | 1.6 | 0.0 | 0 | 1.9 | 0.1 | 0 |
| **74** | Homestead | 0.2 | 0.0 | 0 | 1.4 | 0.0 | 0 | 1.6 | 0.1 | 0 |
| **75** | Homestead | 0.2 | 0.0 | 0 | 1.2 | 0.0 | 0 | 1.5 | 0.1 | 0 |
| **78** | Homestead | 0.1 | 0.0 | 0 | 1.7 | 0.1 | 0 | 1.9 | 0.1 | 0 |
| **79** | Homestead | 0.3 | 0.0 | 0 | 1.0 | 0.0 | 0 | 1.2 | 0.1 | 0 |
| **80** | Homestead | 0.3 | 0.0 | 0 | 0.8 | 0.0 | 0 | 1.1 | 0.0 | 0 |
| **87** | Homestead | 0.0 | 0.0 | 0 | 0.1 | 0.0 | 0 | 10.7 | 0.4 | 0 |

Notes: Bolded text indicates exceedance of NDCRs

Only receptors with a 5 km radius of the Deelkraal II TSF and Kusasalethu plant listed.

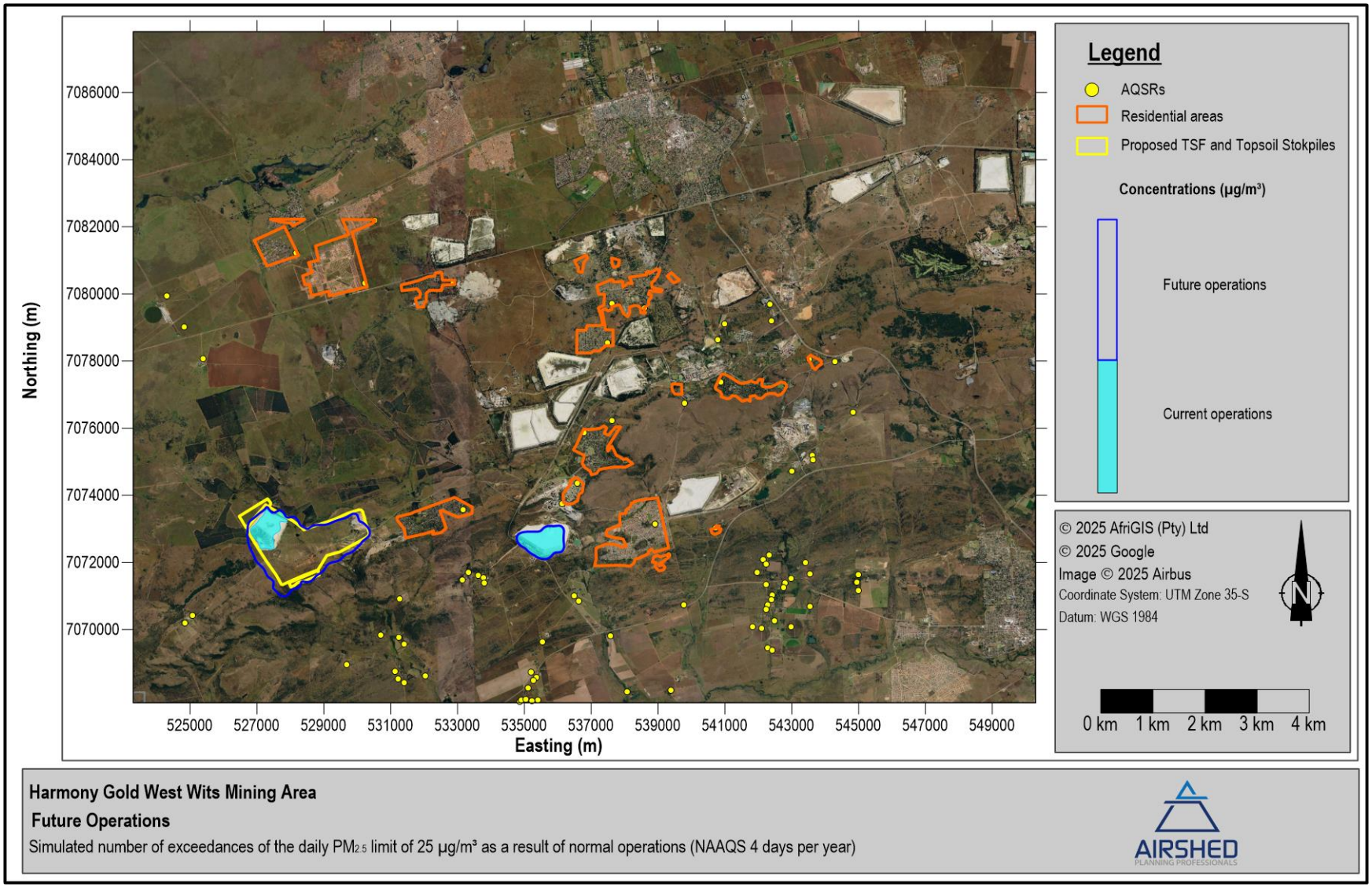



**Figure 30: Simulated area of exceedance of the 24-hour $PM_{2.5}$ NAAQS as a result of current and future operations with mitigation measures applied**

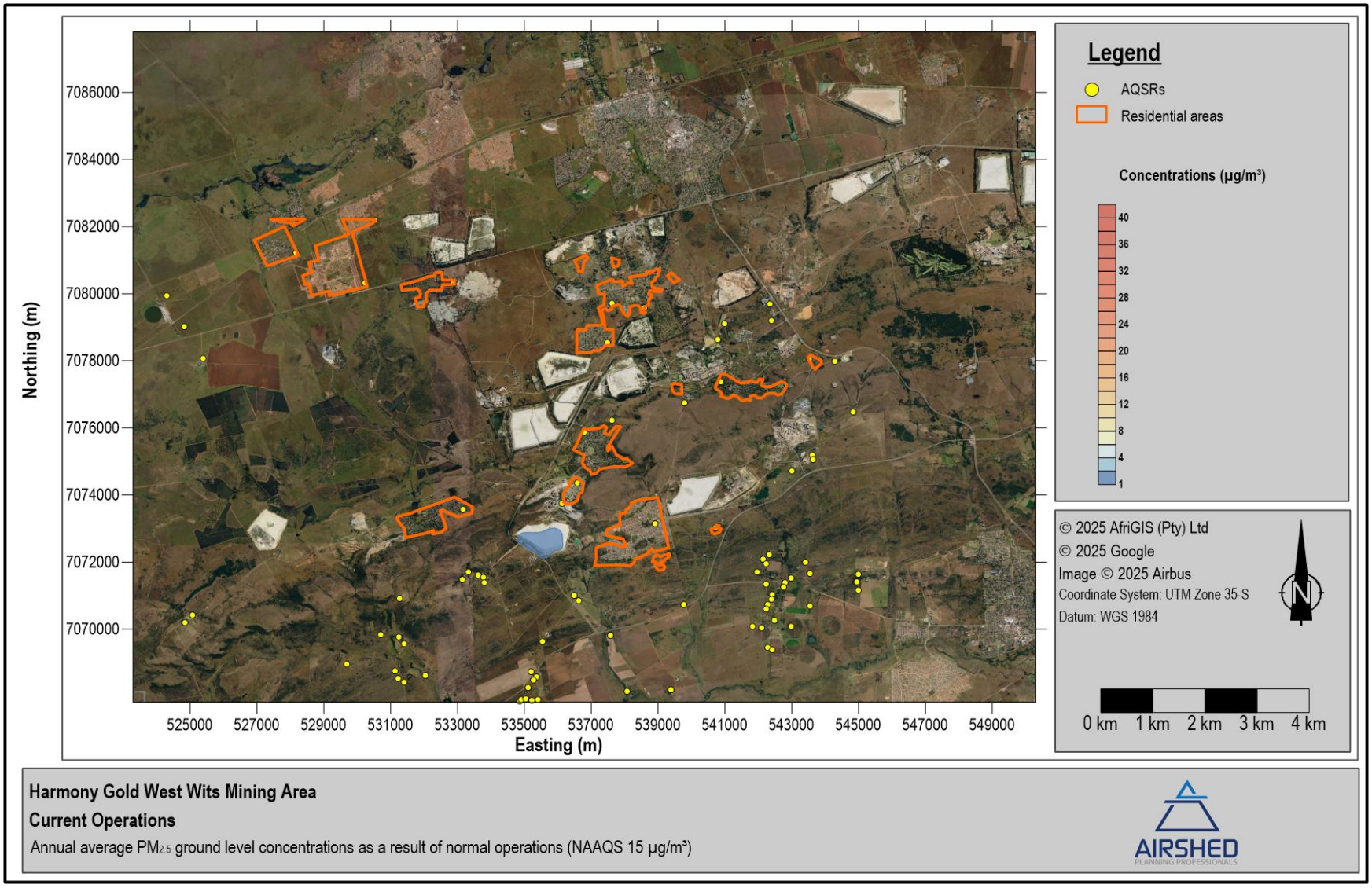



**Figure 31: Simulated annual average $PM_{2.5}$ concentrations as a result of current operations**

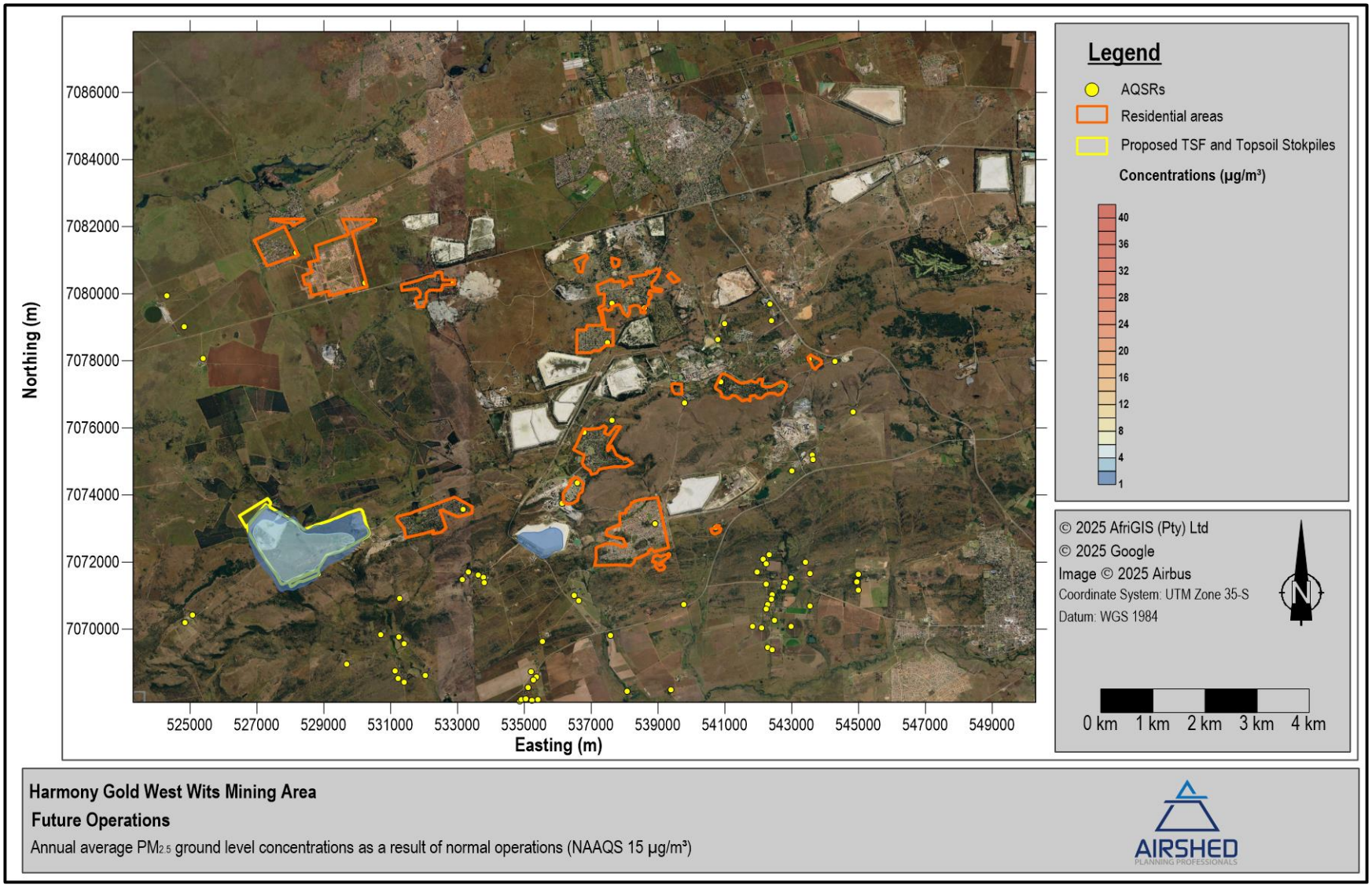



**Figure 32: Simulated annual average $PM_{2.5}$ concentrations as a result of future operations**

### *5.4.2 Inhalable particulate matter ($PM_{10}$)*

The simulated $PM_{10}$ 24-hour GLCs are within compliance with the NAAQS (4 days of exceedance of 75 µg/m$^3$) at all the AQSRs, for both current and future operations (**Table 12**). The annual $PM_{10}$ concentrations for current (**Figure 34**) and future (**Figure 35**) operations are also within compliance with the NAAQS. A summary of the results is presented in **Table 12**.

The additional emission due to the Deelkraal II TSF and Kusasalethu plant would result on average in a 29% increase in daily GLCs at the various AQSRs, and a 14 % increase annually increase when taking exiting sources from Savuka and Mponeng into account but still falling within compliance with the NAAQS.

**Table 12: Simulated $PM_{10}$ concentrations at the AQSRs**

| ID | AQ Sensitive Receptor | Current | | | Future | | | Cumulative Future | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Highest Daily | Annual | No of Exceedances | Highest Daily | Annual | No of Exceedances | Highest Daily | Annual | No of Exceedances |
| **8** | Elandsridge | 1.0 | 0.0 | 0 | 1.0 | 0.0 | 0 | 56.5 | 0.8 | 0 |
| **9** | Elandsrand | 2.8 | 0.0 | 0 | 3.4 | 0.1 | 0 | 27.3 | 0.6 | 0 |
| **10** | Harmony Hostel | 8.5 | 0.5 | 0 | 8.5 | 0.6 | 0 | 21.8 | 1.0 | 0 |
| **11** | Wedela | 0.8 | 0.0 | 0 | 1.4 | 0.0 | 0 | 79.0 | 0.8 | 0 |
| **12** | Deelkraal | 3.4 | 0.0 | 0 | 3.6 | 0.0 | 0 | 15.7 | 0.3 | 0 |
| **23** | Homestead | 0.6 | 0.0 | 0 | 1.2 | 0.0 | 0 | 27.6 | 0.7 | 0 |
| **50** | Homestead | 0.7 | 0.0 | 0 | 1.0 | 0.0 | 0 | 13.0 | 0.4 | 0 |
| **51** | Informal settlement | 1.3 | 0.0 | 0 | 2.0 | 0.0 | 0 | 34.5 | 0.8 | 0 |
| **52** | Homestead | 7.8 | 0.1 | 0 | 8.5 | 0.1 | 0 | 20.8 | 0.3 | 0 |
| **53** | Homestead | 6.0 | 0.1 | 0 | 6.6 | 0.1 | 0 | 17.6 | 0.3 | 0 |
| **54** | Homestead | 2.8 | 0.0 | 0 | 3.1 | 0.0 | 0 | 10.5 | 0.3 | 0 |
| **55** | Homestead | 10.5 | 0.1 | 0 | 11.3 | 0.1 | 0 | 15.8 | 0.3 | 0 |
| **56** | Homestead | 7.5 | 0.1 | 0 | 8.2 | 0.1 | 0 | 12.3 | 0.3 | 0 |
| **57** | Homestead | 6.6 | 0.1 | 0 | 6.9 | 0.1 | 0 | 10.9 | 0.2 | 0 |
| **58** | Homestead | 6.6 | 0.1 | 0 | 7.0 | 0.1 | 0 | 10.8 | 0.2 | 0 |
| **65** | Homestead | 5.9 | 0.0 | 0 | 5.9 | 0.1 | 0 | 16.8 | 0.3 | 0 |
| **66** | Homestead | 5.8 | 0.0 | 0 | 5.8 | 0.1 | 0 | 20.6 | 0.3 | 0 |
| **67** | Homestead | 8.9 | 0.0 | 0 | 8.9 | 0.1 | 0 | 23.9 | 0.4 | 0 |
| **68** | Homestead | 11.5 | 0.0 | 0 | 11.5 | 0.1 | 0 | 25.0 | 0.4 | 0 |
| **69** | Homestead | 2.4 | 0.0 | 0 | 6.3 | 0.1 | 0 | 15.4 | 0.3 | 0 |
| **70** | Homestead | 1.1 | 0.0 | 0 | 10.9 | 0.1 | 0 | 10.9 | 0.2 | 0 |
| **71** | Homestead | 1.7 | 0.0 | 0 | 12.7 | 0.1 | 0 | 12.7 | 0.2 | 0 |
| **72** | Homestead | 1.8 | 0.0 | 0 | 9.7 | 0.1 | 0 | 9.7 | 0.2 | 0 |

| ID | AQ Sensitive Receptor | Current | | | Future | | | Cumulative Future | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Highest Daily | Annual | No of Exceedances | Highest Daily | Annual | No of Exceedances | Highest Daily | Annual | No of Exceedances |
| **73** | Homestead | 1.6 | 0.0 | 0 | 9.0 | 0.1 | 0 | 9.0 | 0.2 | 0 |
| **74** | Homestead | 2.0 | 0.0 | 0 | 7.5 | 0.1 | 0 | 8.4 | 0.2 | 0 |
| **75** | Homestead | 2.5 | 0.0 | 0 | 6.7 | 0.1 | 0 | 8.0 | 0.2 | 0 |
| **78** | Homestead | 1.3 | 0.0 | 0 | 10.9 | 0.2 | 0 | 10.9 | 0.3 | 0 |
| **79** | Homestead | 8.4 | 0.0 | 0 | 9.9 | 0.1 | 0 | 10.0 | 0.1 | 0 |
| **80** | Homestead | 7.0 | 0.0 | 0 | 8.5 | 0.1 | 0 | 8.5 | 0.1 | 0 |
| **87** | Homestead | 0.3 | 0.0 | 0 | 0.8 | 0.0 | 0 | 74.8 | 1.1 | 0 |

Notes: Bolded text indicates exceedance of NDCRs

Only receptors with a 5 km radius of the Deelkraal II TSF and Kusasalethu plant listed.

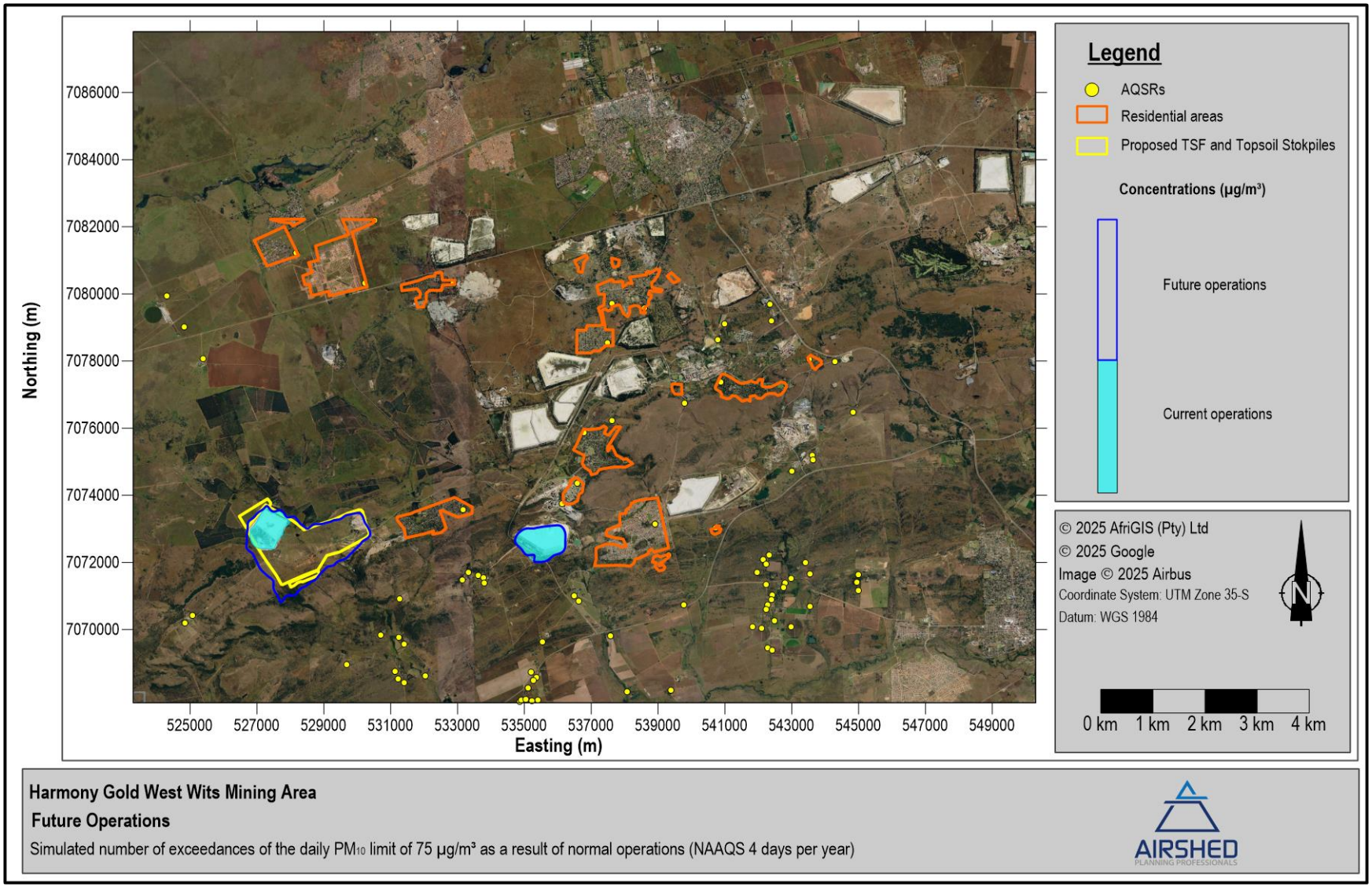



**Figure 33: Simulated area of exceedance of the 24-hour $PM_{10}$ NAAQS as a result of current and future operations**

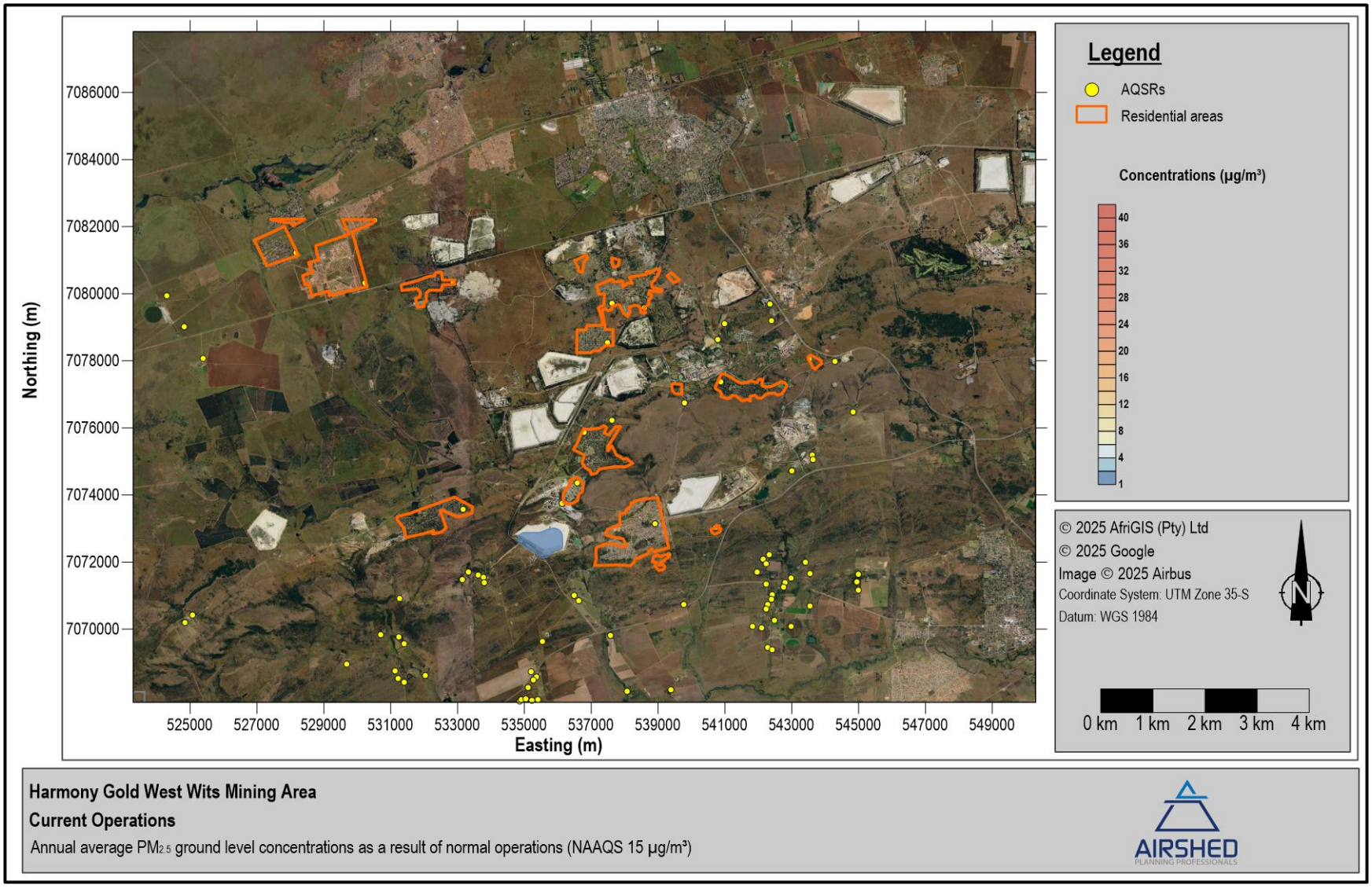



**Figure 34: Simulated annual average $PM_{10}$ concentrations as a result of current operations**

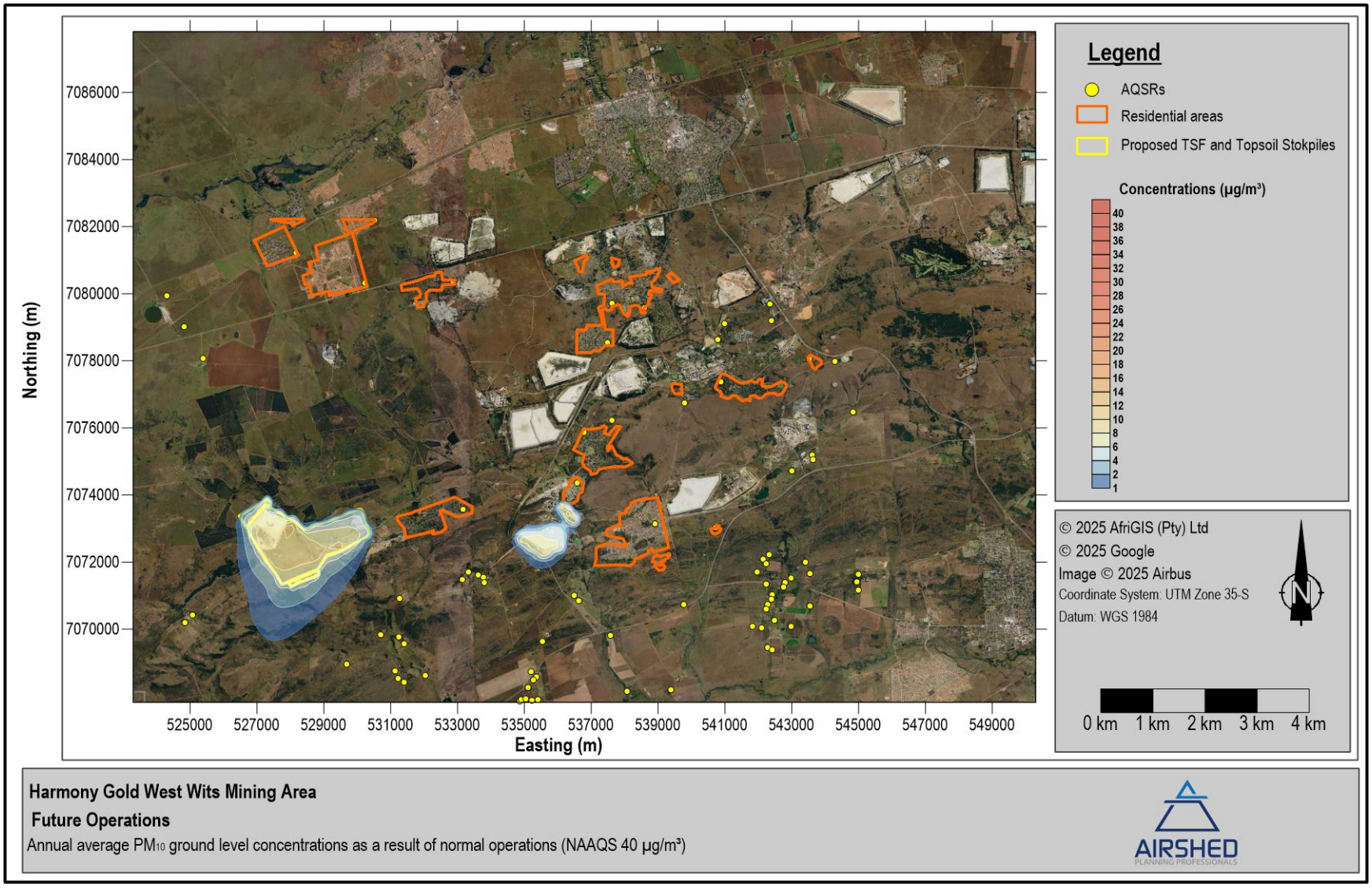



**Figure 35: Simulated annual average $PM_{10}$ concentrations as a result of future operations**

### 5.4.3 Fallout Dust

The simulated daily average dustfall rates with the current operations does not exceed the NDCR limit for residential areas (600 mg/m²-day). The limit for agricultural areas is exceeded for up to 1.7 km to the south-southwest from the existing dormant TSF at Deelkraal and up to 1.95 km south-southwest from the inactive TSF at Kusasalethu (**Figure 36**). The simulated daily average dustfall rates for the future operations show similar impact areas to the current operations but with exceedance of the agricultural limit for up to 4.7 km from the proposed Deelkraal II TSF, and average increase of 56% when taking exiting sources from Savuka and Mponeng into account (**Figure 37**). The dustfall rates at the AQSRs are provided in **Table 13**.

**Table 13: Simulated dustfall rates at the AQSRs**

| ID | AQ Sensitive Receptor | Current | Future | Cumulative Future |
|---|---|---|---|---|
| | | Highest 30-day average | Highest 30-day average | Highest 30-day average |
| **8** | Elandsridge | 34 | 139 | 142 |
| **9** | Elandsrand | 45 | 167 | 168 |
| **10** | Harmony Hostel | 59 | 212 | 213 |
| **11** | Wedela | 76 | 262 | 263 |
| **12** | Deelkraal | 91 | 318 | 319 |
| **23** | Homestead | 9 | 444 | 445 |
| **50** | Homestead | 53 | 68 | 200 |
| **51** | Informal settlement | 68 | 83 | 214 |
| **52** | Homestead | 85 | 99 | 228 |
| **53** | Homestead | 102 | 116 | 240 |
| **54** | Homestead | 117 | 130 | 249 |
| **55** | Homestead | 125 | 138 | 252 |
| **56** | Homestead | 126 | 138 | 247 |
| **57** | Homestead | 117 | 130 | 234 |
| **58** | Homestead | 102 | 114 | 213 |
| **65** | Homestead | 9 | 21 | 82 |
| **66** | Homestead | 8 | 20 | 77 |
| **67** | Homestead | 7 | 19 | 75 |
| **68** | Homestead | 8 | 20 | 76 |
| **69** | Homestead | 8 | 20 | 80 |
| **70** | Homestead | 8 | 20 | 88 |
| **71** | Homestead | 8 | 20 | 99 |
| **72** | Homestead | 7 | 19 | 112 |
| **73** | Homestead | 7 | 19 | 125 |
| **74** | Homestead | 6 | 18 | 135 |
| **75** | Homestead | 6 | 18 | 139 |
| **78** | Homestead | 4 | 16 | 113 |
| **79** | Homestead | 4 | 15 | 95 |
| **80** | Homestead | 4 | 15 | 77 |
| **87** | Homestead | 4 | 12 | 24 |

**Notes**: Bolded text indicates exceedance of NDCRs; Only receptors with a 5 km radius of the Deelkraal II TSF and Kusasalethu plant listed.

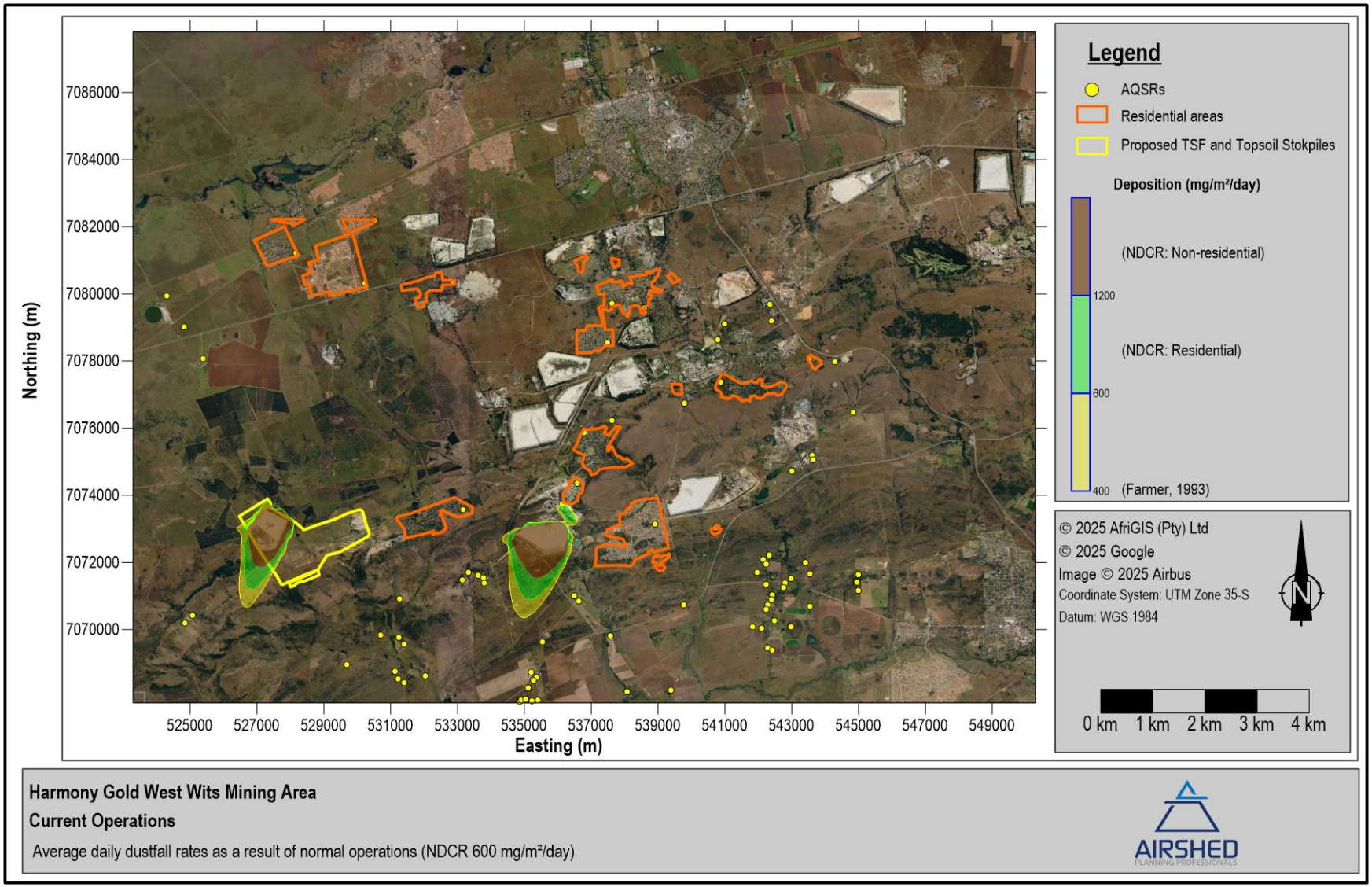



**Figure 36: Simulated average daily dustfall rates as a result of current operations**

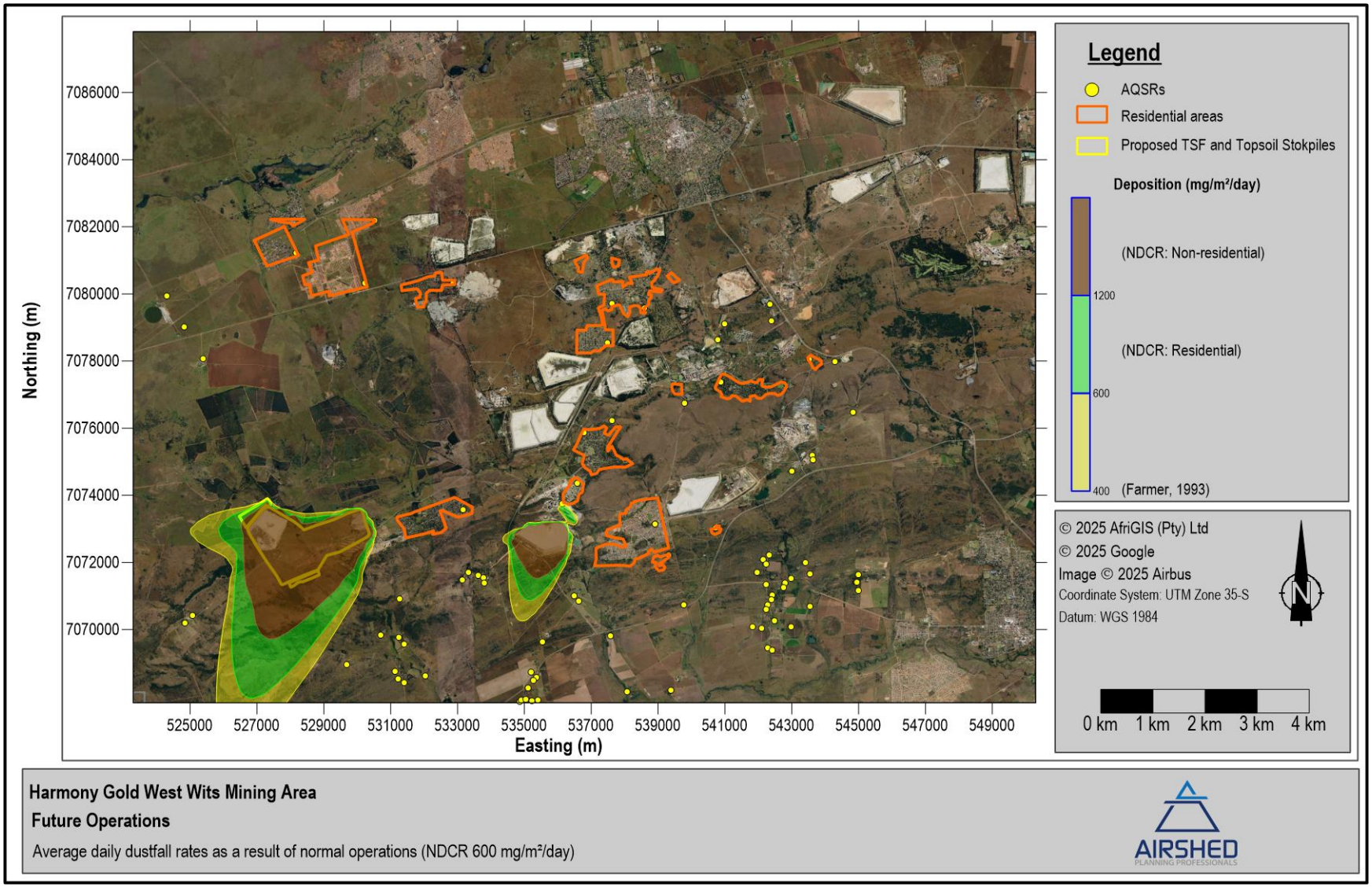



**Figure 37: Simulated average daily dustfall rates as a result of future operations**

## 5.5 Impact Significance Rating

The significance of environmental air quality impacts due to the proposed project was assessed according to the methodology adopted by EIMS (**Appendix B**).

**Table 14: Significance rating for potential air quality impacts due to the current operations**

| **Impact Name** | **Air quality impacts due to current operations at Deelkraal and Kusasalethu Mine** | | | | |
|---|---|---|---|---|---|
| **Alternative** | NA | | | | |
| **Phase** | Operational Current | | | | |
| **Environmental Risk** | | | | | |
| **Attribute** | **Pre-mitigation** | **Post-mitigation** | **Attribute** | **Pre-mitigation** | **Post-mitigation** |
| Nature of Impact | -1 | -1 | Magnitude of Impact | 3 | 2 |
| Extent of Impact | 3 | 2 | Reversibility of Impact | 2 | 2 |
| Duration of Impact | 4 | 4 | Probability | 4 | 3 |
| Environmental Risk (Pre-mitigation) | | | | | -12.00 |
| Mitigation Measures | | | | | |
| • In assessing the mitigated impact, it is assumed that the slopes of the TSF are vegetated, and a control efficiency of 60% is achieved through secondary rehabilitation (NPI, 2012). | | | | | |
| Environmental Risk (Post-mitigation) | | | | | -7.5 |
| Degree of confidence in impact prediction: | | | | | Medium |
| **Impact Prioritisation** | | | | | |
| Cumulative Impacts | | | | | 1 |
| Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change. | | | | | |
| Degree of potential irreplaceable loss of resources | | | | | 1 |
| The impact is unlikely to result in irreplaceable loss of resources. | | | | | |
| Prioritisation Factor | | | | | 1 |
| **Final Significance** | | | | | -7.5 |

**Table 15: Significance rating for potential air quality impacts due to future operational phase with Kusasalethu upgrades and Deelkraal II receiving process tailings.**

| **Impact Name** | **Increase in air quality impacts due to upgrades at Kusasalethu min and deposition on Deelkraal II TSF** | | | | |
|---|---|---|---|---|---|
| **Alternative** | NA | | | | |
| **Phase** | Operational Future | | | | |
| **Environmental Risk** | | | | | |
| **Attribute** | **Pre-mitigation** | **Post-mitigation** | **Attribute** | **Pre-mitigation** | **Post-mitigation** |
| Nature of Impact | -1 | -1 | Magnitude of Impact | 3 | 2 |
| Extent of Impact | 3 | 3 | Reversibility of Impact | 2 | 3 |
| Duration of Impact | 4 | 4 | Probability | 4 | 3 |
| Environmental Risk (Pre-mitigation) | | | | | -12.00 |
| Mitigation Measures | | | | | |
| In assessing the mitigated impact, it is assumed that<br>• the slopes of the TSF will be vegetated, and a control efficiency of 40% can be achieved (NPI, 2012).<br>• It is assumed that the deposition process will be wet (slurry).<br>• 50% CE for water sprays keeping ore wet at the secondary rushing and screening (NPI, 2012). | | | | | |
| Environmental Risk (Post-mitigation) | | | | | -9 |
| Degree of confidence in impact prediction: | | | | | Medium |
| **Impact Prioritisation** | | | | | |
| Cumulative Impacts | | | | | 1 |
| Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in significant spatial and temporal cumulative change. | | | | | |
| Degree of potential irreplaceable loss of resources | | | | | 1 |
| The impact is unlikely to result in irreplaceable loss of resources. | | | | | |
| Prioritisation Factor | | | | | 1. |
| **Final Significance** | | | | | -9 |

# 6 DUST MANAGEMENT PLAN

A Dust Management Plan (DMP) for the proposed Deelkraal II TSF, the existing Kusasalethu TSFs and WRD should follow an iterative process, including: implementation, monitoring, reporting, reviewing and adjustment to the necessary steps. The following sections of this DMP aim to detail the starting point with regards to fugitive dust emissions management. Included below are the definition of objectives and targets to achieve through dust suppression strategies. Monitoring, reporting, and review allow for the assessment of operations and adjustment of implemented strategies to meet objectives.

## 6.1 Objectives and Targets

The establishment of objectives and targets with regards to fugitive emissions are important to minimise the impacts of these emissions on the surrounding environment. The objective of the DMP generally is to reduce dust emissions within specific target ranges, by employing appropriate dust suppression strategies.

Windblown dust from the proposed Deelkraal II TSF, the existing Kusasalethu TSFs and WRD could be a significant source of dust emissions if not managed.

## 6.2 Dust Management Measures

Target control efficiencies are presented for the main dust emission sources identified in the emissions inventory, so that the overall objective is achieved.

### *6.2.1 Wind Erosion*

Any approach that either binds the particles together and makes it more resistant to wind erosion or reduce to the force of the wind will result in a reduction in windblown dust emissions.

Surface treatment techniques to reduce dust generation include: wet suppression, chemical stabilisation, covering of surface with less erodible aggregate material and the vegetation of open areas. Wet suppression (the use of sprinklers) can achieve results in the short-term but will require constant maintenance and management to remain effective.

Substantial research has been done on erosion from gold mine tailings. Parameters which have the potential to impact on the rate of emission of fugitive dust include the extent of surface compaction, moisture content, ground cover, the shape of the storage pile, particle size distribution, wind speed and precipitation. Any factor that binds the erodible material or otherwise reduces the availability of erodible material on the surface, decreases the erosion potential of the fugitive source. High moisture contents, whether due to precipitation or deliberate wetting, promote the aggregation and cementation of fines to the surfaces of larger particles, thus decreasing the potential for dust emissions. Surface compaction and ground cover similarly reduces the potential for dust generation (Burger *et al*., 1997).

Rock cladding or armouring of the sides of tailings dams has been shown in various international studies to be effective in various instances in reducing wind erosion of slopes. Cases in which rock cladding has been found to be effective in this regard generally involve rock covers of greater than 0.5 m in depth (Ritcey, 1989; Jewell and Newson, 1997). The application of a 300 mm layer of fine rock was found to be the most successful of the non-vegetative measures, resulting in an erosion control efficiency of 90% if the base is levelled and compacted – wind erosion is considered to reduce by 100% through the addition of such a rock cover.

In addition, screens could be installed on the crest of the tailings dam walls mainly to act as windbreaks and to reduce the potential for dust deposition on the vegetated side walls, hence curbing the growth of the grass.

Vegetal cover retards erosion by binding the residue with a root network, by sheltering the residue surface and by trapping material already eroded. Sheltering occurs by reducing the wind velocity close to the surface, thus reducing the erosion potential and volume of material removed. Vegetation is also considered the most effective control measure in terms of its ability to also control water erosion. In investigating the feasibility of vegetation types the following properties are normally taken into account: indigenous plants; ability to establish and regenerate quickly; proven effective for reclamation elsewhere; tolerant to the climatic conditions of the area; high rate of root production; easily propagated by seed or cuttings; and nitrogen-fixing ability. The long-term effectiveness of suitable vegetation selected for the site will be dependent on (a) the nature of the cover, and (b) the availability of aftercare. Multi-layer covers are frequently being used to ensure the best results (Dixon, 1997; Jewell and Newson, 1997; Ritchey, 1989). Erosion losses from grassed slopes measured by Blight (1989) were found to be in the order of 100 t/ha/year compared to uncontrolled slopes from which losses of up to 500 t/ha/year were recorded.

The removal of the TSF would be the most effective mitigation measure, providing the exposed footprint be vegetated and rehabilitated.

In assessing the mitigated impact, it was assumed that the slopes of the TSF will be vegetated to ensure a control efficiency of 80% as measured by Blight (1989).

## 6.3 Performance Indicators

Key performance indicators against which progress of implemented mitigation and management measures may be assessed, form the basis for all effective environmental management practices. In the definition of key performance indicators careful attention is usually paid to ensure that progress towards their achievement is measurable, and that the targets set are achievable given available technology and experience.

Performance indicators are usually selected to reflect both the source of the emission directly (source monitoring) and the impact on the receiving environment (ambient air quality monitoring). Ensuring that no visible evidence of windblown dust exists represents an example of a source-based indicator, whereas maintaining off-site dustfall levels, at the identified AQSRs, to below 600 mg/m²-day represents an impact- or receptor-based performance indicator.

Source monitoring at operational activities can be challenging due to the fugitive and wind-dependent nature of particulate emissions. The focus is therefore rather on receptor-based performance indicators i.e. compliance with ambient air quality standards and dustfall regulations.

### *6.3.1 Ambient Air Quality Monitoring*

It is recommended that the current dustfall monitoring network be maintained and the monthly dustfall results used as indicators to tract the effectiveness of the applied mitigation measures. Dustfall collection should follow the ASTM method as per the NDCRs. The ASTM method covers the procedure of collection of dustfall and its measurement and employs a simple device consisting of a cylindrical container exposed for one calendar month (30 ±2 days).

It is recommended that dust fallout monitor DK 1 be moved to south-western boundary if the nearby Deelkraal town, since it falls in the footprint of the proposed Deelkraal II TSF and needs to be moved. It is also recommended that a new dust fallout

monitor be placed on the south-western boundary of the proposed Deelkraal II TSF. The recommended locations are listed below in **Table 16** and shown in **Figure 38**.

**Table 16: Recommended dust fallout monitoring locations**

| Dust fallout monitor | Description | UTM WGS84 (33S) | |
|---|---|---|---|
| | | Longitude (°) | Latitude (°) |
| **DK 1** | Should be moved to Deelkraal town | 27.313532 | -26.461664 |
| **DK 8** | Deelkraal II TSF south-western boundary | 27.269988 | -26.470146 |

### *6.3.2 Periodic Inspections and Audits*

Periodic inspections and external audits are essential for progress measurement, evaluation, and reporting purposes. It is recommended that site inspections and progress reporting be undertaken at regular intervals (at least quarterly), with annual environmental audits being conducted. Annual environmental audits should be continued at least until closure. Results from site inspections and monitoring efforts should be combined to determine progress against source- and receptor-based performance indicators. Progress should be reported to all interested and affected parties (I&APs), including authorities and persons affected by pollution.

The criteria to be taken into account in the inspections and audits must be made transparent by way of minimum requirement checklists included in the management plan. Corrective action or the implementation of contingency measures must be proposed to the stakeholder forum in the event that progress towards targets is indicated by the quarterly/annual reviews to be unsatisfactory.

### *6.3.3 Liaison Strategy for Communication with Interested and Affected Parties (I&APs)*

Stakeholder forums provide possibly the most effective mechanisms for information dissemination and consultation. Management plans should stipulate specific intervals at which forums will be held and provide information on how people will be notified of such meetings. Given the proximity of the study site to the nearby Wedela and Deelkraal, it is recommended that such meetings be scheduled and held at least on an annual basis. A complaints register must be kept at all times.

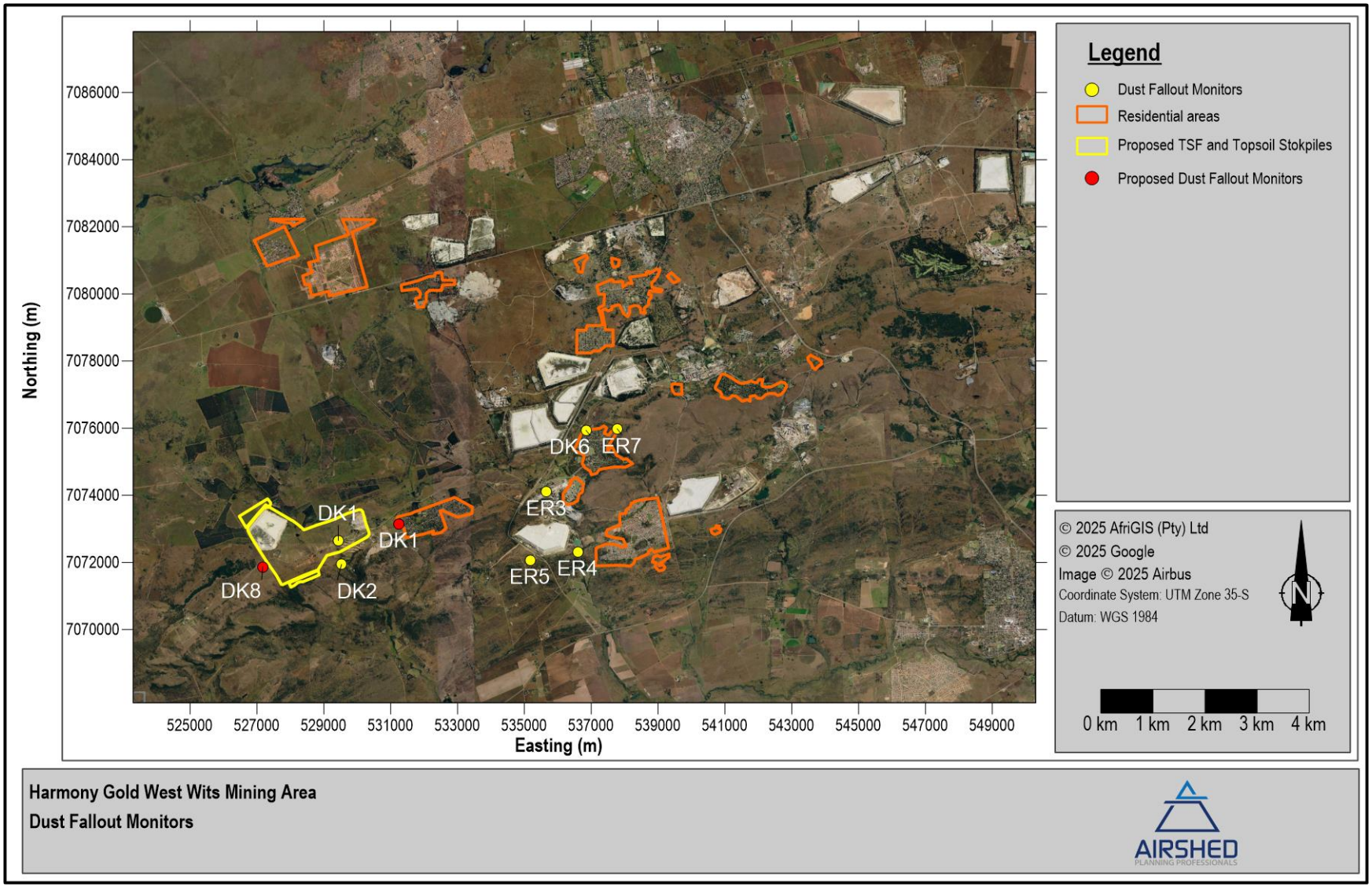



**Figure 38: Prosed locations of new dust fallout monitors at Deelkraal and Kusasalethu**

# 7 MAIN FINDINGS AND RECOMMENDATIONS

An air quality impact assessment, as part of the EIA process, was done for the proposed Harmony West Wits Reclamation and Deposition Project. The main objective of this study was to establish the current air quality levels at the Kusasalethu mines and the Deelkraal TSFs and determine whether there may be significance air quality impacts associated with the proposed project. This section summarises the main findings and to provide the method that will be followed for the impact assessment phase.

## 7.1 Main Findings

The main findings of the receiving environment assessment are:

- AQSRs near the Deelkraal and Kusasalethu operations include individual households and residential areas: Deelkraal, Elandsrand and Wedela communities.
- AQSRs near the Savuka and DF5 TSFs include individual households and residential areas: Elandsridge, Western Deep Levels, The Village, Southdene communities.
- The main sources associated with the proposed operations likely to contribute to baseline PM emissions include mining and reclaiming operations, processing operations, vehicle entrained dust from roads, vehicle exhaust and windblown dust from exposed areas on existing TSFs and WRDs.
- Other sources of PM within the area include other companies mining, transport and processing activities, farm activities, occasional biomass burning, household fuel burning in the residential areas, vehicle entrained dust from public roads and vehicle exhaust.
- The wind field is dominated by winds from the northerly sector with the strongest winds (>6 m/s) mostly from the north-northeasterly sector. The predominant northerly wind field remains similar throughout the seasons.
- Dust fallout results from the five (7) DMUs at Kusasalethu for the period January 2020 to June 2025 show compliance with the NDCR at both the residential and non-residential sites with one residential exceedance in November 2020.
- Dust fallout results from the five (12) DMUs at Savuka for the period January 2023 to July 2025 show compliance with the NDCR at both the residential and non-residential sites.

The main findings of the impact assessment for current and future operations are as follows:

- The simulated $PM_{2.5}$ 24-hour concentrations indicate compliance with the NAAQS at all the AQSRs, for both current and future operations. The annual $PM_{2.5}$ concentrations for current and future operations are also likely to be within compliance with the NAAQS. The additional emission due to the Deelkraal II TSF and Kusasalethu plant would result on average in a 29% increase in daily GLCs at the various AQSRs, and a 14% increase annually when taking existing sources from Savuka and Mponeng.
- The simulated $PM_{10}$ 24-hour GLCs indicate compliance with the NAAQS all the AQSRs, for both current and future operations. The annual $PM_{10}$ concentrations for current and future operations are also likely to be within compliance with the NAAQS. The additional emission due to the Deelkraal II TSF and Kusasalethu plant would result on average in a 29% increase in daily GLCs at the various AQSRs, and a 14 % increase annually increase when taking exiting sources from Savuka and Mponeng into account but likely still within compliance with the NAAQS.
- The simulated daily average dustfall rates with the current operations project no exceedances of the NDCR limit for residential areas (600 mg/m²-day). The limit for agricultural areas was projected to be exceeded up to 1.7 km to the south-southwest from the existing dormant TSF at Deelkraal and up to 1.95 km south-southwest from the inactive TSF at Kusasalethu. The simulated daily average dustfall rates for the future operations show similar impact areas to the current operations but with exceedance of the agricultural limit for up to 4.7 km from the proposed Deelkraal II TSF, and average increase of 56% when taking exiting sources from Savuka and Mponeng into account.

- The environmental risk due to unmitigated future operations is classified as **Medium** based om the Deelkraal and Kusasalethu operations**,** with minor spatial and temporal cumulative change**.** With mitigation (80% CE through grassing of TSF side slopes and wet slurry deposition) the risk is classified as **Low**.

## 7.2 Recommendations

With the potential impacts from windblown dust from the active TSFs, especially for the proposed Deelkraal II TSF, the following recommendations are proposed:

- Dustfall monitoring continues to ensure dustfall rates are in compliance with the NDCR limits;
- Dust fallout monitor DK 1 should be moved to south-western boundary if the nearby Deelkraal town.
- A new dust fallout monitor be placed on the south-western boundary of the proposed Deelkraal II TSF
- Mitigation measures aimed at reducing wind erosion from the active TSFs, i.e. the vegetation of TSF side slopes, with dust suppression on the surface of the TSF in the form of wet deposition and water sprays.
- Further dust suppression should include regular water sprays on unpaved surface roads, preferably combined with chemicals.

In conclusion, it is the specialist opinion that the project may be authorised provided that the recommended air quality management measures are implemented.

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# 9 APPENDIX A: SPECIALIST CURRICULUM VITAE

| ABBREVIATED CURRICULUM VITAE | HANLIE LIEBENBERG-ENSLIN |
|---|---|

***FULL CURRICULUM VITAE***

| | |
|---|---|
| **Name of Firm** | Airshed Planning Professionals (Pty) Ltd |
| **Name of Staff** | Hanlie Liebenberg-Enslin |
| **Profession** | Managing Director / Air Quality Scientist |
| **Date of Birth** | 09 January 1971 |
| **Years with Firm/ entity** | 25 years |
| **Nationalities** | South African |

## MEMBERSHIP OF PROFESSIONAL SOCIETIES

- International Union of Air Pollution Prevention and Environmental Protection Associations (IUAPPA) – President 2010–2013, Board member 2013-present
- Member of the National Association for Clean Air (NACA) - President 2008-2010, NACA Council member 2010 –2014

## KEY QUALIFICATIONS

Hanlie Liebenberg-Enslin started her professional career in Air Quality Management in 2000 when she joined Environmental Management Services (EMS) after completing her master's degree at the University of Johannesburg (then Rand Afrikaans University) in the same field. She is one of the founding members of Airshed Planning Professionals in 2003 where she has worked as a company Director until May 2013 when she was appointed as Managing Director. She has extensive experience on the various components of air quality management including emissions quantification for a range of source types, simulations using a range of dispersion models, impacts assessment and health risk screening assessments. She has worked all over Africa and has an inclusive knowledge base of international legislation and requirements pertaining to air quality.

She has developed technical and specialist skills in various modelling packages including the industrial source complex models (ISCST3 and SCREEN3), EPA Regulatory Models (AERMOD and AERMET), UK Gaussian plume model (ADMS), EPA Regulatory puff-based model (CALPUFF and CALMET), puff-based HAWK model and line-based models such as CALINE. Her experience with emission models includes Tanks 4.0 (for the quantification of tank emissions) and GasSim (for the quantification of landfill emissions).

Having worked on projects throughout Africa (i.e. South Africa, Mozambique, Botswana, Namibia, Malawi, Kenya, Mali, Democratic Republic of Congo, Tanzania, Madagascar, Guinea and Mauritania) Hanlie has developed a broad experience base. She has a good understanding of the laws and regulations associated with ambient air quality and emission limits in South Africa and various other African countries, as well as the World Bank Guidelines, European Community Limits and World Health Organisation.

Being an avid student, she received her PhD from the University of Johannesburg in 2014, specialising in Aeolian dust transport. Hanlie is also actively involved in the National Association for Clean Air and is their representative at the International Union of Air Pollution Prevention and Environmental Protection Associations.

## RELEVANT EXPERIENCE

### Air Quality Management Plans and Strategies

Vaal Triangle Airshed Priority Area Draft Second Generation Air Quality Management Plan (AQMP)(Aug 2017 – Jun 2020); Advanced Air Quality Management for the Strategic Environmental Management Plan for the Uranium and Other Industries in the Erongo Region (May 2016 – Feb 2019); City of Johannesburg AQMP (2016-2019); Air Quality Monitoring and Management for the Al Madinah Al Munawarah Development Authority (MDA) in Saudi Arabia (2016-2017). Provincial Air Quality Management Plan for the Limpopo Province (March 2013); Mauritius Road Development Agency Proposed Road Decongestion Programme (July 2013); Transport Air Quality Management Plan for the Gauteng Province (February 2012); Gauteng Green Strategy (2011); Air Quality and Radiation Assessment for the Erongo Region Namibia as part of a Strategic Environmental Assessment (June, 2010); Vaal Triangle Airshed Priority Area AQMP (March, 2009); Gauteng Provincial AQMP (January 2009); North West Province AQMP (2008); City of Tshwane AQMP (April 2006); North West Environment Outlook 2008 (December 2007); Ambient Monitoring Network for the North West Province (February 2007); Spatial Development Framework Review for the City of uMhlathuze (August 2006); Ambient Particulate Pollution Management System (Anglo Platinum Rustenburg).

Hanlie has also been the Project Director on all the listed Air Quality Management plan developments.

### Mining and Ore Handling

Hanlie has undertaken numerous air quality impact assessments and management plans for coal, platinum, uranium, copper, cobalt, chromium, fluorspar, bauxite and mineral sands mines. These include air quality impact assessments for: Namibia – Husab Uranium Mine, Trekkopje Uranium Mine; Bannerman Uranium Project; Langer Heinrich Uranium Mine, Valencia Uranium Mine, Rössing Uranium Mine; and B2Gold Otjikoto Gold Mine. South Africa – Sishen Iron Ore Mine; Tshipi Borwa Manganese Mine; Mamatwan Manganese Mine; Kolomela Iron Ore Mine; Thabazimbi Iron ore Mine; UKM Manganese Mine; Everest Platinum Mine; Impala Platinum Mine; Anglo Platinum Mines; Abglo Gold Ashanti MWS, Vaal River and West Wits complexes, Harmony Gold, Glencore Coal Mines, South32 and Anglo Coal; Tselentis Coal mine (Breyeton); Lime Quarries (De Hoek, Dwaalboom, Slurry); Beesting Colliery (Ogies); Anglo Coal Opencast Coal Mine (Heidelberg); Klippan Colliery (Belfast); Beesting Colliery (Ogies); Xstrata Coal Tweefontein Mine (Witbank); Xstrata Coal Spitskop Mine (Hendrina); Middelburg Colliery (Middelburg); Klipspruit Project (Ogies); Rustenburg Platinum Mine (Rustenburg); Impala Platinum (Rustenburg); Buffelsfontein Gold Mine (Stilfontein); Kroondal Platinum Mine (Kroondal); Lonmin Platinum Mine (Mooinooi); Rhovan Vanadium (Brits); Macauvlei Colliery (Vereeniging); Voorspoed Gold Mine (Kroonstad); Pilanesberg Platinum Mine (Pilanesberg); Kao Diamond Mine (Lesotho); Modder East Gold Mine (Brakpan); Modderfontein Mines (Brakpan); Zimbiwa Crusher Plant (Brakpan); RBM Zulti South Titanium mining (Richards Bay); Premier Diamond Mine (Cullinan). Botswana – Jwaneng Diamond Mine and Debswana Mining Company. Zimbabwe – Murowa Diamond Mine. Other mining projects include Sadiola Gold Mine (Mali); North Mara Gold Mine (Tanzania); Bulyanhulu North Mara Gold Mine (Tanzania).

### Metal Recovery

Air quality impact assessments have been carried out for Smelterco Operations (Kitwe, Zimbia); Waterval Smelter (Amplats, Rustenburg); Hernic Ferrochroime Smelter (Brits); Rhovan Ferrovanadium (Brits); Impala Platinum (Rustenburg); Impala Platinum (Springs); Transvaal Ferrochrome (now IFM, Mooinooi), Lonmin Platinum (Mooinooi); Xstrata Ferrochrome Project Lion (Steelpoort); ArcelorMittal South Africa (Vandebijlpark, Vereeniging, Pretoria, Newcastle, Saldanha); Hexavalent Chrome Xstrata (Rustenburg); Portland Cement Plant (DeHoek, Slurry, Dwaalboom, Hercules, Port Eelizabeth); Vantech Plant (Steelpoort); Bulyanhulu Gold Smelter (Tanzania), Sadiola Gold Recovery Plant (Mali); RBM Smelter Complex (Richards Bay);

Chibuto Heavy Minerals Smelter (Mozambique); Moma Heavy Minerals Smelter (Mozambique); Boguchansky Aluminium Plant (Russia); Xstrata Chrome CMI Plant (Lydenburg); SCAW Metals (Germiston).

### Chemical Industry

Comprehensive air quality impact assessments have been completed for AECI (Pty) Ltd Operations (Modderfontein); Kynoch Fertilizer (Potchefstroom), Foskor (Richards Bay) and Omnia (Rustenburg).

### Petrochemical Industry

Numerous air quality impact assessments have been completed for SASOL operations (Sasolburg); Sapref Refinery (Durban); Health risk assessment of Island View Tank Farm (Durban Harbour).

### Pulp and Paper Industry

Air quality studies have been undertaken or the expansion of Mondi Richards Bay, Multi-Boiler Project for Mondi Merebank (Durban), impact assessments for Sappi Stanger, Sappi Enstra (Springs), Sappi Ngodwana (Nelspruit) and Pulp United (Richards Bay).

### Power Generation

Air quality impact assessments have been completed for numerous Eskom coal fired power station studies including the Coal 3 Power Project near Lephalale, Komati Power Station and Lethabo Power Stations. In addition to Eskom's coal fired power stations, projects have been completed for the proposed Mmamabula Energy Project (Botswana); Morupule Power Plant (Botswana), NamPower Erongo Power Project (Namibia), NamPower Van Eck Power Station (Namibia) and NamPower Biomass Power Plant (Namibia).

Apart from Eskom projects, heavy fuel oil power station assessments have also been completed in Kenya (Rabai Power Station) and Namibia (Arandis Power Plant).

Green energy projects included several Solar Photovoltaic Projects (Mulilo and Enertrag South Africa (Pty) Ltd) and assessing potential particulate matter impacts from Wind Farms near the South African Large Telescope (SALT).

### Waste Disposal

Air quality impact assessments, including odour and carcinogenic and non-carcinogenic pollutants were undertaken for the proposed Coega Waste Disposal Facility (Port Elizabeth); Boitshepi Waste Disposal Site (Vanderbijlpak); Umdloti Waste Water Treatment Plant (Durban).

### Cement Manufacturing

Impact assessments for ambient air quality have been completed for the PPC Cement Alternative Fuels Project (which included the assessment of the cement manufacturing plants in the North West Province, Gauteng and Western).

### Vehicle emissions

Transport Air quality Management Plan for the Gauteng Department of Roads and Transport (Feb 2012); Platinum Highway (N1 to Zeerust); Gauteng Development Zone (Johannesburg); Gauteng Department of Roads and Transport (Transport Air Quality Management Plan); Mauritius Road Development Agency (Proposed Road Decongestion Programme); South African Petroleum Industry Association (Impact Urban Air Quality).

### Government and International Strategy Projects

Hanlie in one of the Lead Authors of Section 1.1: Africa's Development: Challenges, Drivers and key objectives, of the United Nations Environment Programme (UNEP), Climate and Clean Air Coalition (CCAC) and Stockholm Environment Institute (SEI) coordinated 'Integrated Assessment of Air Pollution and Climate Change for Africa Report. She was also the Terminal Reviewer of the UNEP/UNDA project "Air quality data for health and environment policies in Africa and the Asia-Pacific region" (May 2020). Hanlie was also the project Director on the APPA Registration Certificate Review Project for Department of Environmental Affairs (DEA); Green Strategy for Gauteng (2011).

## EDUCATION

| | |
|---|---|
| **Ph.D Geography** | **Ph.D Geography,** University of Johannesburg, RSA (2014)<br>Title: *A functional dependence analysis of wind erosion modelling system parameters to determine a practical approach for wind erosion assessments* |
| **M.Sc Geography and Environmental Management** | University of Johannesburg, RSA (1999)<br>Title: *Air Pollution Population Exposure Evaluation in the Vaal Triangle using GIS* |
| **B.Sc Hons. Geography** | University of Johannesburg, RSA (1995)<br>GIS & Environmental Management |
| **B.Sc Geography and Geology** | University of Johannesburg, RSA (1994)<br>Geography and Geology |

## ADDITIONAL COURSES AND ACADEMIC REVIEWS

| | |
|---|---|
| **External Examiner (July 2025)** | PhD Candidate: TJB van Niekerk<br>Spatial planning solutions to mitigate poor air quality in South African dense, low-income areas<br>Department Geography and Environmental Management, North-West University |
| **External Examiner (January 2022)** | MSc Candidate: P Chidhindi<br>Using dispersion models as a regulatory tool in South Africa<br>Department Geography and Environmental Management, North-West University |
| **External Examiner (February 2021)** | PhD Candidate: Ms NM Walton<br>Aerosol source apportionment in southern Africa<br>Faculty of Natural and Agricultural Sciences, North-West University |
| **External Examiner (May 2018)** | MSc Candidate: Ms A Quta<br>Characterisation of Particulate Matter and Some Pollutant Gasses in the City of Tshwane<br>Department of Environmental Sciences, University of South Africa |

| | |
|---|---|
| **External Examiner (December 2017)** | MSc Candidate: Ms B Wernecke<br>Ambient and Indoor Particulate Matter Concentrations on the Mpumalanga Highveld<br>Faculty of Natural and Agricultural Sciences, North-West University |
| **External Examiner (January 2016)** | MSc Candidate: Ms M Grobler<br>Evaluating the costs and benefits associated with the reduction in $SO_2$ emissions from Industrial activities on the Highveld of South Africa<br>Department of Chemical Engineering, University of Pretoria |
| **External Examiner (August 2014)** | MSc Candidate: Ms Seneca Naidoo<br>Quantification of emissions generated from domestic fuel burning activities from townships in Johannesburg<br>Faculty of Science, University of the Witwatersrand |
| **Air Quality Law– Lecturer (2012 - 2016)** | Environmental Law course: Centre of Environmental Management. |
| **Air Quality law for Mining – Lecturer (2014)** | Environmental Law course: Centre of Environmental Management. |
| **Air Quality Management – Lecturer (2006 -2012)** | Air Quality Management Short Course: NACA and University of Johannesburg, University of Pretoria and University of the North West |
| **ESRI SA (1999)** | ARCINFO course at GIMS: Introduction to ARCINFO 7 course |
| **ESRI SA (1998)** | ARCVIEW course at GIMS: Advanced ARCVIEW 3.1 course |

## COUNTRIES OF WORK EXPERIENCE

South Africa, Mozambique, Botswana, Namibia, Malawi, Mauritius, Kenya, Mali, Zimbabwe, Democratic Republic of Congo, Tanzania, Zambia, Madagascar, Guinea, Russia, Mauritania, Morocco, and Saudi Arabia.

## EMPLOYMENT RECORD

### March 2003 - Present

**Airshed Planning Professionals (Pty) Ltd,** Managing Director and Principal Air Quality Scientist, Midrand, South Africa.

### January 2000 – February 2003

**Environmental Management Services CC,** Senior Air Quality Scientist.

### May 1998 – December 1999

**Independent Broadcasting Authority (IBA),** GIS Analyst and Demographer.

**February 1997 – April 1998**

**GIS Business Solutions (PQ Africa),** GIS Analyst

**January 1996 – December 1996**

**Annegarn Environmental Research (AER),** Student Researcher

## LANGUAGES

| | Speak | Read | Write |
|---|---|---|---|
| **English** | Excellent | Excellent | Excellent |
| **Afrikaans** | Excellent | Excellent | Excellent |

## CONFERENCE AND WORKSHOP PRESENTATIONS AND PAPERS

- Air Quality Evolution in South Africa over the past 20 years: A Consultants' Journey. Hanlie Liebenberg-Enslin. 55th Annual Conference of the National Association for Clean Air, 4 to 6 September 2024, Johannesburg. Keynote speaker.
- Integrated Assessment of Air Pollution and Climate Change for Sustainable Development in Africa – Towards "the Africa we want". Hanlie Liebenberg-Enslin, and Kevin Hicks. Air Protection 2023 & International Conference and 13th Croatian Scientific and Professional Meeting, CAPPA, 20 - 24 September 2023, Dubrovnik, Croatia at Hotel Astarea, Mlini.
- Dust and radon levels on the west coast of Namibia – What did we learn? Hanlie Liebenberg-Enslin, Detlof von Oertzen, and Norwel Mwananawa. Atmospheric Pollution Research, 2020. https://doi.org/10.17159/caj/2020/30/1.8467
- Understanding the Atmospheric Circulations that lead to high particulate matter concentrations on the west coast of Namibia. Hanlie Liebenberg-Enslin, Hannes Rauntenbach, Reneé von Gruenewaldt, and Lucian Burger. Clean Air Journal, 27, 2, 2017, 66-74.
- Cooperation on Air Pollution in Southern Africa: Issues and Opportunities. SLCPs: Regional Actions on Climate and Air Pollution. Liebenberg-Enslin, H. 17th IUAPPA World Clean Air Congress and 9th CAA Better Air Quality Conference. Clean Air for Cities - Perspectives and Solutions. 29 August - 2 September 2016, Busan Exhibition and Convention Center, Busan, South Korea.
- A Best Practice prescription for quantifying wind-blown dust emissions from Gold Mine Tailings Storage Facilities. Liebenberg-Enslin, H., Annegarn, H.J., and Burger, L.W. VIII International Conference on Aeolian Research, Lanzhou, China. 21-25 July 2014.
- Quantifying and modelling wind-blown dust emissions from gold mine tailings storage facilities. Liebenberg-Enslin, H. and Annegarn, H.J. 9th International Conference on Mine Closure, Sandton Convention Centre, 1-3 October 2014.
- Gauteng Transport Air Quality Management Plan. Liebenberg-Enslin, H., Krause,N., Burger, L.W., Fitton, J. and Modisamongwe, D. National Association for Clean Air Annual Conference, Rustenburg. 31 October to 2 November 2012. Peer reviewed.

- Developing an Air Quality Management Plan: Lessons from Limpopo. Bird, T.; Liebenberg-Enslin, H., von Gruenewaldt, R., Modisamongwe, D. National Association for Clean Air Annual Conference, Rustenburg. 31 October to 2 November 2012. Peer reviewed.

- Modelling of wind eroded dust transport in the Erongo Region, Namibia, H. Liebenberg-Enslin, N Krause and H.J. Annegarn. National Association for Clean Air (NACA) Conference, October 2010. Polokwane.

- The lack of inter-discipline integration into the EIA process-defining environmental specialist synergies. H. Liebenberg-Enslin and LW Burger. IAIA SA Annual Conference, 21-25 August 2010. Workshop Presentation. Not Peer Reviewed.

- A Critical Evaluation of Air Quality Management in South Africa, H Liebenberg-Enslin. National Association for Clean Air (NACA) IUAPPA Conference, 1-3 October 2008. Nelspuit.

- Vaal Triangle Priority Area Air Quality Management Plan – Baseline Characterisation, R.G. Thomas, H Liebenberg-Enslin, N Walton and M van Nierop. National Association for Clean Air (NACA) conference, October 2007, Vanderbijl Park.

- Air Quality Management plan as a tool to inform spatial development frameworks – City of uMhlathuze, Richards Bay, H Liebenberg-Enslin and T Jordan. National Association for Clean Air (NACA) conference, 29 – 30 September 2005, Cape Town.

## CERTIFICATION

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.



21 August 2025

Full name of staff member: Hanlie Liebenberg-Enslin

# 10 APPENDIX B – IMPACT SIGNIFICANCE RATING METHODOLOGY

The impact significance rating methodology, as presented herein and utilised for all EIMS Impact Assessment Projects, is guided by the requirements of the NEMA EIA Regulations 2014 (as amended). The approach may be altered or substituted on a case by case basis if the specific aspect being assessed requires such- such instances require prior EIMS Project Manager approval. The broad approach to the significance rating methodology is to determine the significance (S) of an environmental risk or impact by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relating this to the probability/ likelihood (P) of the impact occurring. The S is determined for the pre- and post-mitigation scenario. In addition, other factors, including cumulative impacts and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the S to determine the overall final significance rating (FS). The impact assessment will be applied to all identified alternatives.

Determination of Significance:

The final significance (FS) of an impact or risk is determined by applying a prioritisation factor (PF) to the post-mitigation environmental significance. The significance is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and Reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$C = \frac{(E+D+M+R)}{4} \times N$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 17.

**Table 17: Criteria for determining impact consequence**

| Aspect | Score | Definition |
|---|---|---|
| Nature | - 1 | Likely to result in a negative/ detrimental impact |
| | +1 | Likely to result in a positive/ beneficial impact |
| Extent | 1 | Activity (i.e. limited to the area applicable to the specific activity) |
| | 2 | Site (i.e. within the development property boundary), |
| | 3 | Local (i.e. the area within 5 km of the site), |
| | 4 | Regional (i.e. extends between 5 and 50 km from the site |
| | 5 | Provincial / National (i.e. extends beyond 50 km from the site) |
| Duration | 1 | Immediate (<1 year) |
| | 2 | Short term (1-5 years), |
| | 3 | Medium term (6-15 years), |
| | 4 | Long term (the impact will cease after the operational life span of the project), |
| | 5 | Permanent (no mitigation measure of natural process will reduce the impact after construction). |
| Magnitude/ Intensity | 1 | Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected), |

| Aspect | Score | Definition |
|---|---|---|
| | 2 | Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected), |
| | 3 | Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way; moderate improvement for +ve impacts; or where change affects area of potential conservation or other value, or use of resources). (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected, or affected environmental components are already degraded) |
| | 4 | High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease; high improvement for +ve impacts; or where change affects high conservation value areas or species of conservation concern) |
| | 5 | Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease, substantial improvement for +ve impacts; or disturbance to pristine areas of critical conservation value or critically endangered species) |
| Reversibility | 1 | Impact is reversible without any time and cost. |
| | 2 | Impact is reversible without incurring significant time and cost. |
| | 3 | Impact is reversible only by incurring significant time and cost. |
| | 4 | Impact is reversible only by incurring prohibitively high time and cost. |
| | 5 | Irreversible Impact |

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P (Table 19). Probability is rated/scored as per Table 18.

It is noted that both environmental risks as well as environmental impacts should be identified and assessed. Environmental Risk can be regarded as the potential for something harmful to happen to the environment, and in many instances is not regarded as something that is expected to occur during normal operations or events (e.g. unplanned fuel or oil spills at a construction site). Probability and likelihood are key determinants or variables of environmental risk. Environmental Impact can be regarded as the actual effect or change that happens to the environment because of an activity and is typically an effect that is expected from normal operations or events (e.g. vegetation clearance from site development results in loss of species of concern). Typically the probability of an unmitigated environmental impact is regarded as highly likely or certain (management and mitigation measures would ideally aim to reduce this likelihood where possible). In summary, environmental risk is about what could happen, while environmental impact is about what does happen.

**Table 18: Probability scoring**

| | | |
|---|---|---|
| Probability | 1 | Improbable (Rare, the event may occur only in exceptional circumstances, the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <5% chance). |
| | 2 | Low probability (Unlikely, impact could occur but not realistically expected; >5% and <20% chance). |
| | 3 | Medium probability (Possible, the impact may occur; >20% and <50% chance). |
| | 4 | High probability (Likely, it is most probable that the impact will occur- > 50 and <90% chance). |
| | 5 | Definite (Almost certain, the impact is expected to, or will, occur, >90% chance). |

The result is a qualitative representation of relative significance associated with the impact. Significance is therefore calculated as follows:

$$S = C \times P$$

**Table 19: Determination of Significance**

| | | | | | | |
|---|---|---|---|---|---|---|
| Consequence | 5 - Very High[5] | 5 | 10 | 15 | 20 | 25 |
| | 4 - High | 4 | 8 | 12 | 16 | 20 |
| | 3 - Medium | 3 | 6 | 9 | 12 | 15 |
| | 2 - Low | 2 | 4 | 6 | 8 | 10 |
| | 1 - Very low | 1 | 2 | 3 | 4 | 5 |
| | | 1 Improbable | 2 Low | 3 Medium/Possible | 4 High/ Probable | 5 Highly likely/ Definite |
| | **Probability** | | | | | |

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These significance scores are then grouped into respective classes as described in Table 20.

**Table 20: Significance classes**

| **Environmental Risk Score** | |
|---|---|
| **Value** | **Description** |
| < 4.25 | Low (i.e. where this impact is unlikely to be a significant environmental risk/ reward). |
| ≥4.25; <8.5 | Medium to Low (i.e. where the impact could have a significant environmental risk/ reward). |
| ≥8.5; <13.75 | Medium to High (i.e. where the impact could have a significant environmental risk/ reward), |
| ≥ 13.75 | High (i.e. where the impact will have a significant environmental risk/ reward).). |

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/mitigated.

Impact Prioritisation:

Further to the assessment criteria presented in the section above, it is necessary to consider each potentially significant impact in terms of:

- Cumulative impacts; and
- The degree to which the impact may cause irreplaceable loss of resources.

To ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impacts' post-mitigation significance (post-mitigation). This prioritisation factor does not aim to detract from the significance ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to

[5] In the event that an impact or risk has very high or catastrophic consequences, but the likelihood/ probability is low, then the resultant significance would be Low-medium. This does in certain instances detract from the relative important of this impact or risk and must consequently be flagged for further specific consideration, management, mitigation, or contingency planning.

the post-mitigation significance based on the assumption that relevant suggested management/mitigation impacts are implemented.

**Table 21: Criteria for determining prioritisation**

| | | |
|---|---|---|
| **Cumulative Impact (CI)** | Low (1) | Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change. |
| | Medium (2) | Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change. |
| | High (3) | Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change. |
| **Irreplaceable loss of resources (LR)** | Low (1) | Where the impact is unlikely to result in irreplaceable loss of resources. |
| | Medium (2) | Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited. |
| | High (3) | Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions). |

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 21. The impact priority is therefore determined as follows:

$$\textbf{Priority} = \textbf{PR} + \textbf{CI} + \textbf{LR}$$

The result is a priority score which ranges from 2 to 6 and a consequent PF ranging from 1 to 1.5 (refer to Table 22).

**Table 22: Determination of prioritisation factor**

| Priority | Prioritisation Factor |
|---|---|
| 2 | 1 |
| 3 | 1.125 |
| 4 | 1.25 |
| 5 | 1.375 |
| 6 | 1.5 |

In order to determine the final impact significance (FS), the PF is multiplied by the post-mitigation significance scoring. The ultimate aim of the PF is an attempt to increase the post mitigation environmental risk rating by a factor of 0.5, if all the priority attributes are high (i.e. if an impact comes out with a high medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a higher significance).

**Table 23: Final environmental significance rating**

| Environmental Significance Rating | |
|---|---|
| **Value** | **Description** |
| >13.75 | High positive |
| 8.5 to 13.75 | Medium-High positive |
| >4.25 to <8.5 | Medium-Low positive |
| 1 to 4.25 | Low positive |
| 0 | No impact |
| -1 to -4.25 | Low negative (i.e. Impacts in this class are minor and unlikely to have a significant environmental risk. They do not influence the decision to develop in the area and are typically easily mitigated. |
| <-4.25 to <-8.5 | Medium- Low negative (i.e. These impacts are slightly more significant than low impacts but still do not pose a major environmental risk. They might require some mitigation measures but are generally manageable). |
| -8.5 to -13.75 | Medium-High negative (i.e. Impacts in this class are more substantial and could have a significant environmental risk. They may influence the decision to develop in the area and require more robust mitigation measures). |
| <-13.75 to -25 | High negative (These impacts are significant and must be carefully considered in the decision-making process. They have a high environmental risk or impact and require extensive mitigation measures). |
| <-25 | Very High (Impacts in this class are extremely significant and pose a very high environmental risk. In certain instances these may represent a fatal flaw. They are likely to have a major influence on the decision and may be difficult or impossible to mitigate. Offset's may be necessary. |

# 11 APPENDIX C – CUMULATIVE FUTURE SCENARIO EMISSIONS

**Table 24: Cumulative Emissions Emission estimation techniques and parameters**

<table>
<tr><th>Source Group</th><th>Emission Estimation Technique</th><th>Input Parameters/Notes</th></tr>
<tr><td>Kiln stacks</td><td>Data provided by AngloGold Ashanti as per 2019 NAEIS reporting</td><td>Carbon Regeneration Kilns 1, 2 and 3
<table>
<tr><th>Exit velocity (m/s)</th><th>Diameter (m)</th><th>Exit temp (°C)</th><th>Release height (m)</th><th>Emission rate (mg/Nm³)</th></tr>
<tr><td>4.2</td><td>0.3</td><td>96</td><td>20</td><td>147.7*</td></tr>
</table>
Notes: *based on Stack sampling reports for 2017(Rayten, Prj No RES-AGA-171552 & RES-AGA-171598)<br>Hours of operation: 365 days per year, 24 hours per day.<br>Mitigation: None.</td></tr>
<tr><td>Smelter stack</td><td>Data provided by AngloGold Ashanti as per 2019 NAEIS reporting</td><td>
<table>
<tr><th>Exit velocity (m/s)</th><th>Diameter (m)</th><th>Exit temp (°C)</th><th>Release height (m)</th><th>Emission rate (mg/Nm³)</th></tr>
<tr><td>7.96</td><td>0.564</td><td>50</td><td>20</td><td>2.1*</td></tr>
</table>
Notes: *based on Stack sampling reports for 2017(Rayten, Prj No RES-AGA-171552)<br>Hours of operation: 104 days per year, 3 hours per day.<br>Mitigation: Baghouse (Fabric Filter).</td></tr>
<tr><td>Materials handling</td><td>US EPA miscellaneous transfer and conveying emission factor equation (US EPA, 2006)<br>$\mathrm{EF} = \mathrm{k} \cdot 0.0016 \cdot \left(\frac{\mathrm{U}}{2.3}\right)^{1.3} \cdot \left(\frac{\mathrm{M}}{2}\right)^{-1.4}$ (1)<br>EF is the emission factor in kg/tonne material handled<br>k is the particle size multiplier ($k_{TSP}$ – 0.74, $k_{PM10}$ – 0.35, $k_{PM2.5}$ – 0.053)<br>U is the average wind speed in m/s<br>M is the material moisture content in %</td><td>Handling of materials at the Old North TSF, Savuka MOD, Mponeng MOD, Savuka Plant and Mponeng Gold Plant.
<table>
<tr><th></th><th>Old North TSF</th><th>Savuka MOD</th><th>Mponeng MOD</th></tr>
<tr><td>Material throughput (t/h)</td><td>500</td><td>198.63*</td><td>164.38*</td></tr>
</table>
Notes: *based on AEL renewal application throughput<br>Moisture: 4% (assumed)<br>Wind Speed: 3.63 m/s (WRF data 2022-2024)<br>Hours of operation: 365 days per year, 10 hours per day.<br>Mitigation: None.</td></tr>
<tr><td>Crushing and screening</td><td>Emission factors
<table>
<tr><th>Crushing</th><th>TSP</th><th>$PM_{10}$</th><th>$PM_{2.5}$[a]</th><th>Unit</th></tr>
<tr><td>Secondary</td><td>0.03</td><td>0.012</td><td>0.006</td><td>kg/tonne</td></tr>
<tr><td>Tertiary</td><td>0.03</td><td>0.010</td><td>0.005</td><td>kg/tonne</td></tr>
</table>
Notes: [a] Fraction of $PM_{2.5}$ taken from US-EPA crushed stone emission factor ratio for tertiary crushing.</td><td>
<table>
<tr><th></th><th>Old North TSF</th><th>Savuka MOD</th><th>Mponeng MOD</th></tr>
<tr><td>Material throughput (t/h)</td><td>500</td><td>198.63*</td><td>164.38*</td></tr>
</table>
Notes: *based on AEL renewal application throughput<br>Moisture: 4% (assumed)<br>Hours of operation were given as 24 hrs per day, 7 days per week.<br>Assumed only secondary and tertiary crushing at Processing Plants with Primary crushing underground.</td></tr>
</table>

<table>
<tr><th>Source Group</th><th>Emission Estimation Technique</th><th>Input Parameters/Notes</th></tr>
<tr><td></td><td>Where,<br>E = Default emission factor for high moisture content ore (moisture > 4%)</td><td></td></tr>
<tr><td>Underground operations (ventilation shaft)</td><td>South African Occupational Exposure Limits (OEL) for $PM_{2.5}$ and $PM_{10}$</td><td>
<table>
<tr><th>Flow rate ($m^3/s$)</th><th>Exit velocity (m/s)</th><th>Diameter (m)</th><th>Exit temp (°C)</th><th>Release height (m)</th><th>Emission rate (g/s)</th></tr>
<tr><td>827</td><td>81</td><td>3.6</td><td>25</td><td>7.2</td><td>4.14</td></tr>
</table>
Hours of operation: 365 days per year, 24 hours per day.<br>Mitigation: None for ventilation shaft, all controls would be applied to underground operations.
</td></tr>
<tr><td>Wind erosion</td><td>Use if the Airshed Planning Professionals (Pty) Ltd in-house wind erosion emissions estimation program “Airborne Dust Dispersion Model from Area Sources” (ADDAS) (Burger & Held, Revised User's Manual for the Airborne Dust Dispersion Model from Area Sources (ADDAS), 1997; Burger L. W., 2010; Liebenberg-Enslin, 2014)</td><td>Moisture content: Active TSFs = 1.3%; Dormant TSFs = 0.68%.<br>Particle size distribution, particle density and moisture content from previous study.
<table>
<tr><th>TSF</th><th>Description</th><th>Area (ha)</th><th>Active/ Dormant</th><th>$PM_{2.5}$ (tpa/ha)</th><th>$PM_{10}$ (tpa/ha)</th><th>TSP (tpa/ha)</th></tr>
<tr><td>TSF1</td><td>Savuka 7a& 7b TSF</td><td>137.24</td><td>Active</td><td>0.57</td><td>1.96</td><td>8.39</td></tr>
<tr><td>TSF3</td><td>Savuka 5a TSF</td><td>29.04</td><td>Dormant</td><td>0.20</td><td>0.88</td><td>2.08</td></tr>
<tr><td>TSF4</td><td>Savuka 5b TSF</td><td>30.09</td><td>Dormant</td><td>0.20</td><td>0.88</td><td>2.08</td></tr>
<tr><td>TSF5</td><td>Old North TSF</td><td>136.03</td><td>Dormant</td><td>0.20</td><td>0.88</td><td>2.08</td></tr>
<tr><td>TSF6</td><td>Mponeng TSF</td><td>115.65</td><td>Dormant</td><td>0.20</td><td>0.88</td><td>2.08</td></tr>
</table>
</td></tr>
<tr><td>Entrained dust from unpaved roads</td><td>US EPA emission factor equation (US EPA, 2006a)<br>$EF = k \cdot \left(\frac{s}{12}\right)^a \cdot \left(\frac{W}{3}\right)^b \cdot 281.9$ (2)<br>Where<br>EF is the emission factor in g/VKT<br>k is the particle size multiplier ($k_{TSP}$ – 4.9, $k_{PM10}$ – 1.5, $k_{PM2.5}$ – 0.15)<br>a is a constant (TSP – 0.7, $PM_{10}$ – 0.9, $PM_{2.5}$ – 0.9)<br>b is a constant (TSP – 0.45, $PM_{10}$ – 0.45, $PM_{2.5}$ – 0.45)<br>s is the road surface material silt content in %<br>W is the average weight vehicles in tonnes</td><td>Transport activities include the transport of reclaimed tailings and MOD material along the unpaved roads to the Mponeng Gold Plant.<br>VKT were calculated from road lengths (limited to simulation area), truck capacities and the number of trips required to transport materials.<br>Average vehicle weight of 20 tonnes.<br>Previous studies road surface silt content of 11% was applied in calculations for the roads.<br>Hours of operation: 365 days per year, 10 hours per day.<br>Design Mitigation: Level 2 watering with a control efficiency of 75%.</td></tr>
</table>