## APPENDIX G: AIR QUALITY STUDY

# AIR QUALITY IMPACT ASSESSMENT:

## PILANESBERG PLATINUM MINES PLANT EXPANSION

Project done on behalf of: **SLR Consulting (South Africa) (Pty) Ltd**

**Project Compiled by:**
N Grobler

**Report No:** 18SLR28 Rev3 **|** **Date:** March2019

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## Report Details

| | |
|---|---|
| **Project Name** | Atmospheric Impact Report: Pilanesberg Platinum Mines Plant Expansion |
| **Client** | SLR Consulting (South Africa) Pty Ltd |
| **Report Number** | 16SLR28 |
| **Report Version** | Rev3 |
| **Date** | March 2019 |
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## Revision Record

| Version | Date | Section(s) Revised | Summary Description of Revision(s) |
|---|---|---|---|
| Draft | November 2018 | | Draft report for client comment |
| Rev1 | January 2019 | All | Addressed client comments |
| Rev2 | March 2019 | ES, Sections 4 & 5 | Addressed client comments |
| Rev3 | March 2019 | All | Excluded modular tailings retreatment plant from the scope |

## Executive Summary

Airshed Planning Professionals (Pty) Ltd was appointed by SLR Consulting (South Africa) Pty Ltd to conduct an Air Quality Impact Assessment (AQIA) for the proposed plant expansion at the Pilanesberg Platinum Mines (PPM). Current operations at the PPM include open pit mining on the farm Tuschenkomst 135JP. Ore from the open pit operations is transported to the existing mineral processing facility for processing and waste rock is stockpiled on existing approved waste rock dumps. Tailings from the mineral processing facility is stored on an existing Tailings Storage Facility (TSF). Emission sources quantified and simulated during an Air Quality Impact Assessment completed in 2016 included:

- Mining activities (drilling, blasting, loading and unloading of run of mine (ROM) and waste rock)
- Transportation of ROM and waste rock on unpaved haul roads;
- Activities at the processing plant including conveying, crushing and screening of ore. Other activities at the processing plant have no emissions to air;
- Wind erosion from the waste rock dump and tailings storage facility;
- Stockpiling of ROM, waste rock and tailings and
- Traffic on public roads (P50-1 road).

PPM proposes to expand the existing mineral processing facility to incorporate:

- a hydrometallurgical plant for the extraction of PGMs and base metals (Kell plant),
- a UG2 milling and flotation circuit to process ore from the Sedibelo Platinum Mine (SPM) operation;

In addition, the following is planned:

- upgrading of the existing sewage treatment plant, and
- relocation of the waste storage and handling facility from inside the plant to an area outside the plant.

Furthermore, a number of community based initiatives have been established at the mine. These have been included in the report at the request of the DMR. These include:

- an aggregate crusher and brick making project;
- nursery;
- vegetable garden and composting area; and
- a car wash.

Of the proposed operations, only the Kell Plant and community crusher are expected to result in emissions to the atmosphere. The community aggregate crusher was assessed in the 2016 AQMP, so the focus of this AQIA will be on emissions from the proposed Kell Plant. Predicted impacts of the aggregate crusher are reflected in the simulated results of the current operations. Sampled $PM_{10}$, $PM_{2.5}$ and dust fallout results for 2015 to 2017 (in which the impact of the aggregate crusher is reflected) show compliance with the SA NAAQS.

Emissions from the PPM Plant Expansion operations were quantified and dispersion modelling simulations undertaken using the United States Environmental Protection Agency AERMOD model. The air quality baseline was described by summarizing the findings of the 2016 Air Quality Management Plan and the Annual Air Quality Reports compiled for PPM.

**The main findings from the Air Quality Impact Assessment was as follows:**

The hydrometallurgical (Kell) plant is expected to be the only significant source of emissions from the PPM Plant Expansion Project during the operational phase of the project. The UG2 milling and flotation circuit as well as the various community projects are not expected to result in atmospheric emissions apart from dust generated during the construction of these plants.

The Kell Plant is considered a listed activity (Subcategory 4.17) under Section 21 of NEM:AQA and requires an Atmospheric Emissions Licence (AEL) to operate. Emissions from the Kell Plant need to be in compliance with the Minimum Emission Standards for Subcategory 4.17. Pollutants arising from the Kell Plant include particulates, gaseous combustion pollutants ($SO_2$ and $NO_2$), chlorine ($Cl_2$), hydrogen chloride (HCl), hydrogen fluoride (HF) and possibly ammonia ($NH_3$).

If the Kell Plant is operated at or below the Subcategory 4.17 New Plant Minimum Emission Standards (MES), $PM_{10}$, $PM_{2.5}$, $NO_2$ and $SO_2$ concentrations are simulated to be in compliance with the SA NAAQS for the entire study area including at all areas outside the plant boundary and at all sensitive receptor locations. If the Kell Plant is operated at or below the Subcategory 4.17 MES, simulated concentrations of HCl, HF and $NH_3$ are below the most stringent identified international guidelines.

If the Kell Plant is operated at or below the Subcategory 4.17 MES, simulated $Cl_2$ concentrations exceed the Californian Office of Environmental Health Hazard Assessment Chronic Reference Exposure Levels for up to 1.5km from the Kell Plant. Simulated $Cl_2$ concentrations outside the PPM property boundary (including at all sensitive receptor locations) are below the abovementioned guideline. It is imperative that the Kell Plant be operated with $Cl_2$ emissions below the Subcategory 4.17 MES to avoid health impacts at nearby sensitive receptor locations. Cumulative impacts from the Kell Plant and the current PPM operations are expected to be negligible because the pollutants emitted by both the Kell Plant and the current operations ($PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_2$) are emitted in very small quantities by the Kell Plant, with impacts localised to the Kell Plant. Other pollutants emitted by the Kell Plant ($Cl_2$, HCl, HF and $NH_3$) are not emitted by the current operations.

**Based on the above findings the following conclusions are made:**

It is recommended that the Kell Plant be operated with all pollutant emissions below the Subcategory 4.17 MES to avoid health impacts at nearby sensitive receptor locations.

It is recommended that stacks at the Kell Plant be at least 5 meters in height but that the stack height of all stacks be maximised as far as is economically viable. A stack height of 12 meters is recommended. The PPM Kell Plant must be designed so that emissions from all point sources are in compliance with the Subcategory 4.17 MES. It is recommended that all stacks be sampled as soon as the plant is operational.

It is recommended that in addition to the current air quality monitoring undertaken at PPM, annual passive diffusive sampling of $Cl_2$, HCl and HF be conducted at the closest sensitive receptor locations namely the villages of Mothlabe and Ngweding. If sampled concentrations exceed the assessment criteria as described in Section 2.2.3, sources of these pollutants should be investigated and mitigation measures implemented if applicable. It is recommended that PPM employees as well as members of the surrounding communities be educated on the effects of $Cl_2$ (as well as HCl and HF) exposure and that all symptoms be reported on the PPM complaints register.

It is the opinion of the air quality specialist that should the PPM Plant Expansion Project be implemented, that the impact on the receiving environment would not be significant if the above recommendations are implemented.

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## NEMA Regulation (2017), Appendix 6

| NEMA Regulations (2017) - Appendix 6 | Relevant section in report |
|---|---|
| Details of the specialist who prepared the report. | Report details (page i) |
| The expertise of that person to compile a specialist report including curriculum vitae. | Section 10 |
| A declaration that the person is independent in a form as may be specified by the competent authority. | Section 11 |
| An indication of the scope of, and the purpose for which, the report was prepared. | Section 1 |
| Indication of the quality and age of base data used in the report | Sections 3.1 |
| A description of existing impacts on the site, cumulative impacts for the proposed development and levels of acceptable change | Sections 3.2, 3.3 and 2.2 |
| The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment. | Sections 3.1 |
| A description of the methodology adopted in preparing the report or carrying out the specialised process. | Section 1 |
| The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure. | Section 1 |
| An identification of any areas to be avoided, including buffers. | Not applicable |
| A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers. | Section 1, Section 5 |
| A description of any assumptions made and any uncertainties or gaps in knowledge. | Section 4 |
| A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment. | Section 7 |
| Any mitigation measures for inclusion in the environmental management programme report | Section 7.2 |
| Any conditions for inclusion in the environmental authorisation | Section 7.2 |
| Any monitoring requirements for inclusion in the environmental management programme report or environmental authorisation. | Section |
| A reasoned opinion as to whether the proposed activity or portions thereof should be authorised. | Section 7.2 |
| If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the environmental management programme report, and where applicable, the closure plan. | Section 7.2 |
| A description of any consultation process that was undertaken during the course of carrying out the study. | Not applicable. |
| A summary and copies if any comments that were received during any consultation process. | None |
| Any other information requested by the competent authority. | Not applicable. |

# 1 INTRODUCTION

Airshed Planning Professionals (Pty) Ltd was appointed by SLR Consulting (South Africa) Pty Ltd to conduct an Air Quality Impact Assessment (AQIA) for the proposed plant expansion at the Pilanesberg Platinum Mines (PPM). Current operations at the PPM include open pit mining on the farm Tuschenkomst 135JP. Ore from the open pit operations is transported to the existing mineral processing facility for processing and waste rock is stockpiled on existing approved waste rock dumps. Tailings from the mineral processing facility is stored on an existing Tailings Storage Facility (TSF). Emission sources quantified and simulated during an Air Quality Impact Assessment completed in 2016 included:

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- an aggregate crusher and brick making project;
- nursery;
- vegetable garden and composting area; and
- a car wash.

Of the proposed operations, only the Kell Plant and community crusher are expected to result in emissions to the atmosphere. The community aggregate crusher was assessed in the 2016 AQMP, so the focus of this AQIA will be on emissions from the proposed Kell Plant. Predicted impacts of the aggregate crusher are reflected in the simulated results of the current operations.

The establishment of the air quality management plan was broken down into two components, namely;

1. an air quality baseline assessment, outlining the findings of the 2016 AQMP and summarizing ambient air quality sampling results for the period 2015 to 2017 and;
2. an air quality impact assessment to assess the impact of emissions from PPM Plant Expansion on the receiving environment.

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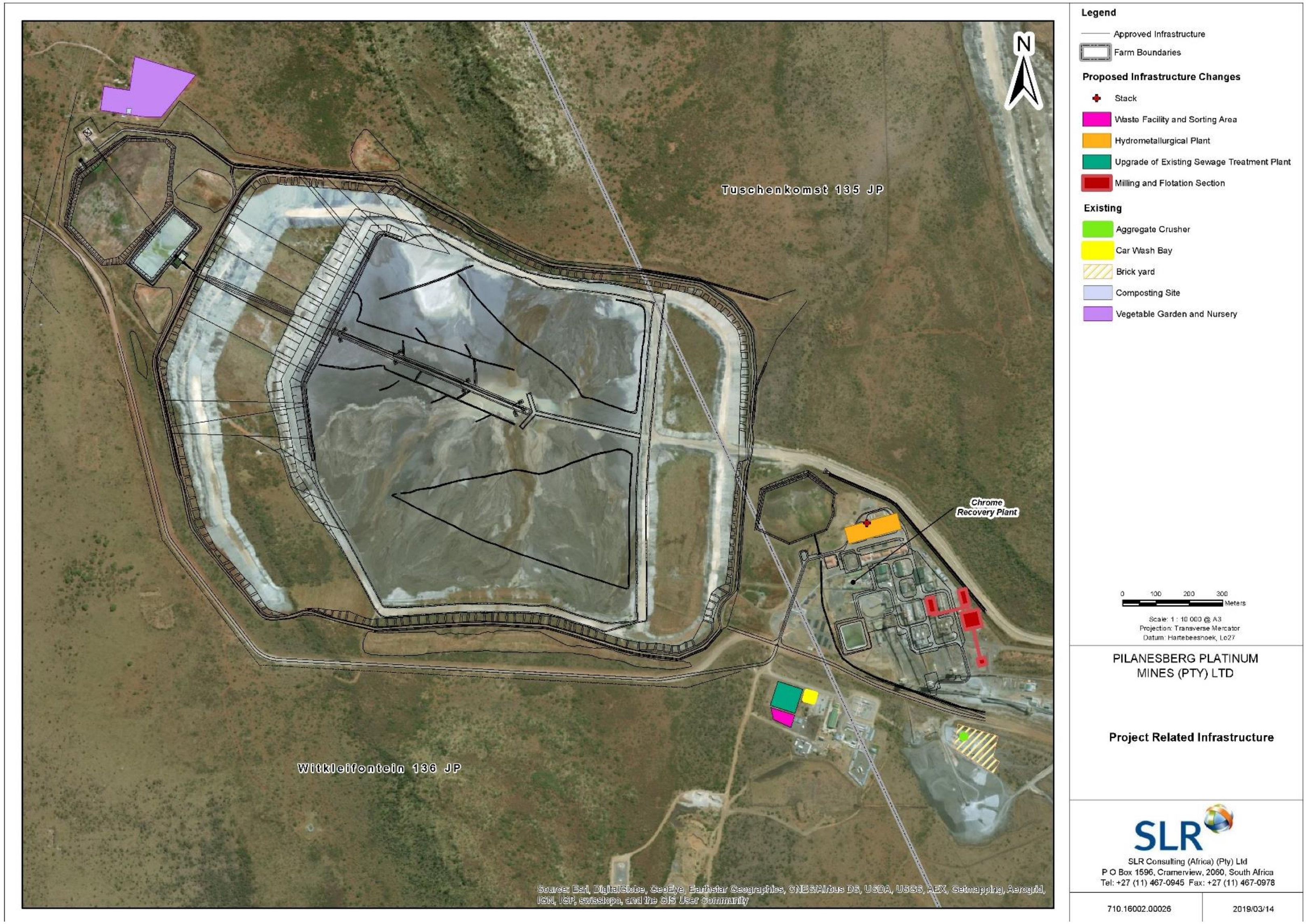


**Figure 1-1: Location of Plant Expansion Infrastructure (SLR, 2015)**

## 1.1 Terms of Reference

Based on the scope of work provided, the following tasks were completed:

### 1.1.1 Baseline Characterisation

- Determine the regional climate and site-specific atmospheric dispersion potential. (Sourced from the 2016 AQMP)
- Preparation of three years of raw meteorological data. The meteorological data includes hourly average wind speed, wind direction, temperature, humidity, cloud cover, solar radiation and precipitation data. (Sourced from the 2016 AQMP)
- Simulation of wind field, mixing depth and atmospheric stability. (Sourced from the 2016 AQMP)
- Identification of existing sources of emission and characterisation of ambient air quality within the region based on observational data recorded to date (if available). Use was made of the existing dust fallout, $PM_{10}$, $PM_{2.5}$, $SO_2$ and $NO_2$ monitoring data as reported in the Annual Reports compiled for PPM.
- Collate and analyse all monitoring data available from existing mining operations and recorded data from site.
- The legislative and regulatory context, including emission limits and ambient air quality standards and dustfall limits with specific reference to South African National Ambient Air Quality Standards and National Dust Control Regulations.

### 1.1.2 Air Quality Impact Assessment

- Evaluation of all project components to identify possible emission sources.
- Quantification of all potential routine emission sources from the Kell Plant.
- Dispersion simulations of ground level pollutant concentrations as a result of the Kell Plant operations. The US EPA approved AERMOD model was used for dispersion modelling.
    - Preparation of hourly average meteorological data for input to the dispersion model.
    - Obtain and process topographical data for input into the dispersion model.
- Analysis of dispersion modelling results, including determining zone of maximum predicted cumulative ground level impacts.
- Evaluation of potential for human health and environmental impacts.
- Compilation of a specialist Air Quality Impact Assessment Report.
- Recommendations for additional air quality monitoring.

## 1.2 Methodological Overview

### 1.2.1 Baseline Characterisation

Meteorological characteristics of a site govern the dispersion, transformation and eventual removal of pollutants from the atmosphere. Pollution concentrations 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. Meteorological data from the recently installed on-site weather station is still insufficient for dispersion modelling simulations and meteorological data for the period 2013 to 2015 were obtained from the US MM5 dataset. The dispersion modelling guidelines stipulate that three years of off-site meteorological data should be used from a period no older than five years to the year of assessment

The main pollutants of concern associated with the current mining operations are particulates (TSP, $PM_{10}$ and $PM_{2.5}$), oxides of nitrogen ($NO_2$) and sulfur dioxide ($SO_2$).

A comprehensive baseline assessment requires ambient monitoring data for a period of at least one year to account for seasonal variation. Dust fallout data are available for 2015 to 2017 and reported on, continuous sampling of ambient $PM_{10}$ and $PM_{2.5}$ concentrations at two locations started in March 2015, with sampling results available up to December 2017. Ambient monitoring data for 2018 will be reported in the annual report compiled by PPM in March 2019. Ambient $SO_2$ and $NO_2$ was sampled at the current generators (to the south of the Kell Plant location) in August 2018.

### 1.2.2 Emissions Inventory

The establishment of a comprehensive emissions inventory forms the basis for the assessment of the impacts of a project's emissions on the receiving environment. The establishment of an emissions inventory comprises the identification of sources of emission and the quantification of each source's contribution to ambient air pollution concentrations.

Pollutants of concern from the Kell Plant operations include the pollutants that have Minimum Emission Standards (MES) for Subcategory 4.17 (Precious and Base Metal Production and Refining) operations. These include; particulates ($PM_{10}$ & $PM_{2.5}$), $SO_2$, $NO_2$, chlorine ($Cl_2$), hydrogen chloride (HCl), hydrogen fluoride (HF) and ammonia ($NH_3$). While all of these pollutants might not be emitted by the Kell Plant sources, dispersion modelling simulations will be undertaken to assess worst case impact i.e. when the Kell Plant sources are emitting at the MES limits.

In the quantification of emissions use was made Subcategory 4.17 MES and plant and stack design parameters.

### 1.2.3 Site Description

PPM is located approximately 5 km from the north-north western edge of the Pilanesberg Alkaline Ring Complex. PPM shares it south western mining rights boundary with the Pilanesberg National Park. Surrounding land use includes agriculture, game farms, other mining operations, the Pilanesberg National Park as well as numerous settlements (Figure 1-2). The proposed location for the Kell Plant is to the north of the current PPM processing plant (Figure 1-1)

The potentially sensitive receptors identified in the vicinity of PPM include the settlements of Motlhabe (~5 km WNW from the current PPM processing plant), Ntswana-le-Metsing/Mankwe (~5 km N), Ngweding (~2.7 km N), Legkraal (~4 km SE), Makgope (~11 km W), Malorwe (~11km W) and the Black Rhino game reserve (~7 km S). There are no permanent sensitive receptors inside the mining rights/property boundary, but cattle herders sometimes use the areas inside the boundary. Due to the nature of the surrounding land use (Game farms, livestock grazing and the Pilanesberg National Park ~5 km S) all areas outside the property boundary are considered sensitive.

### 1.2.4 Topography

The topography surrounding PPM is fairly flat to the north, east and west while the Pilanesberg Alkaline Ring Complex mountain range lies to the south. The relief ranges within a 40 km radius between 950 m to 1700 m above mean sea level.

Topography (Figure 1-2) was included in the atmospheric dispersion modelling. Use was made of the Shuttle Radar Topography Mission (SRTM) 90 m Digital Elevation Model (DEM) Data.

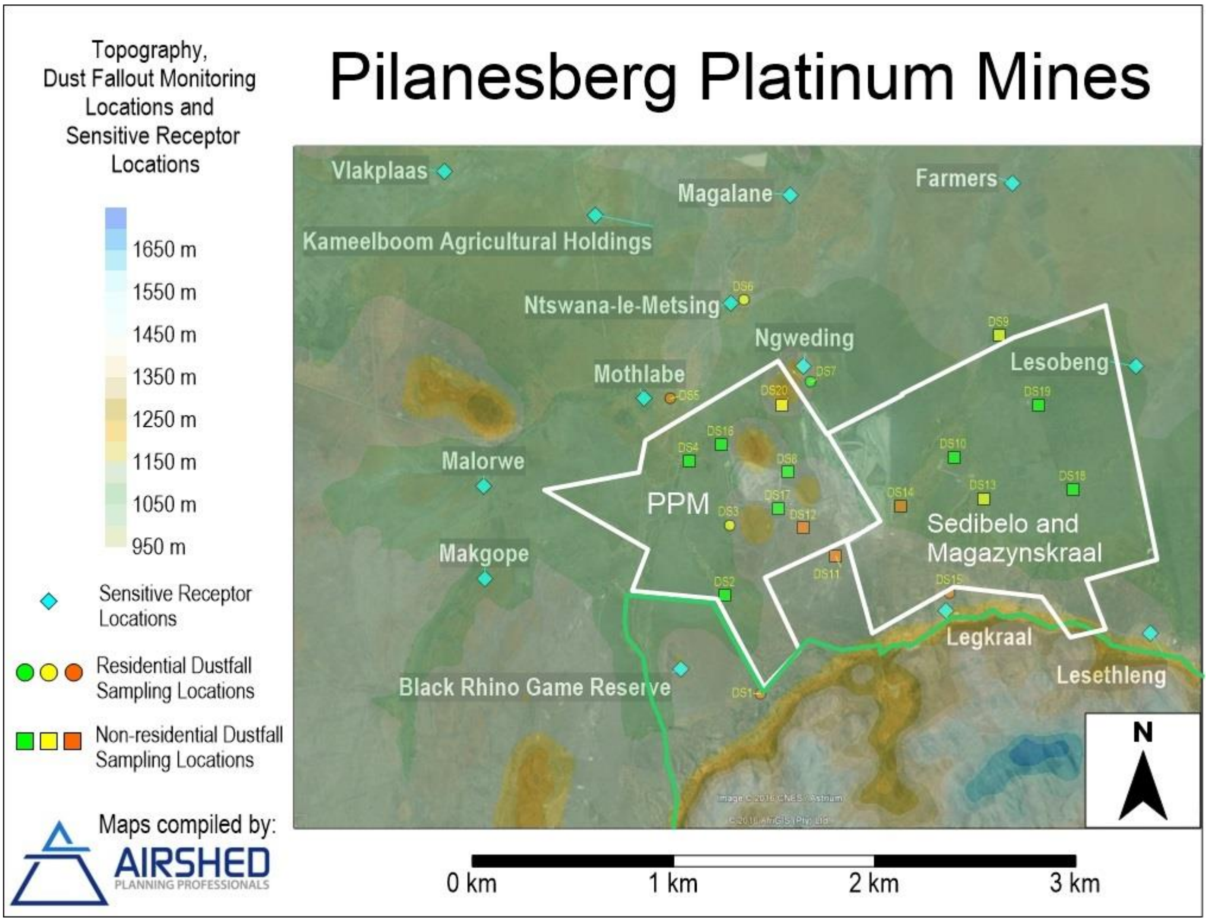


**Figure 1-2: Topography of the area surrounding PPM**

### 1.2.5 Atmospheric Dispersion Model Selection

Dispersion models compute ambient 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 of 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. It is therefore important to carefully select a dispersion model for the purpose.

The US EPA AERMOD model, as required for air quality impact assessments by the Department of Environmental Affairs, was employed for the dispersion modelling simulations. AERMOD is a dispersion model, which was developed under the support of the AMS/EPA Regulatory Model Improvement Committee (AERMIC), whose objective has been to include state-of the-art science in regulatory models (Hanna, Egan, Purdum, & Wagler, 1999). The AERMOD is a dispersion modelling system with three components, namely: AERMOD (AERMIC Dispersion Model), AERMAP (AERMOD terrain pre-processor), and AERMET (AERMOD meteorological pre-processor).

- AERMOD is an advanced new-generation model. It is designed to predict pollutant concentrations from continuous point, flare, area, line, and volume sources (Trinity Consultants, 2004). 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 of ISCST3 (Hanna, Egan, Purdum, & Wagler, 1999).
- AERMET is a meteorological pre-processor for the AERMOD model. 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 standardize the input of terrain data for the AERMOD model. Input data includes receptor terrain elevation data. The terrain data may be in the form of digital terrain data. 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 (pre-processed by the AERMET model), terrain data and information on the nature of the receptor grid. Model details and domain parameters are summarised in Table 1-1 and Table 1-2 below.

**Table 1-1: Model details**

| Pollutants | Model Version | Executable |
|---|---|---|
| All pollutants | AERMOD 7.2.5 | EPA 09292 |

**Table 1-2: Simulation domain**

| Simulation domain | Details |
|---|---|
| **South-western corner of simulation domain** | 493577 m; 7 219 562 m |
| **Domain size** | 10 x 10 km |
| **Projection** | Grid: UTM Zone 35J, Datum: WGS 84 |
| **Resolution** | 100 m |

### 1.2.6 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). On-site surface meteorological data was not considered sufficient for dispersion modelling simulations. Use was therefor made of calculated MM5 meteorological surface and upper air data (for the period 2013 to 2015).

#### 1.2.7 Source Data Requirements

The AERMOD model is able to model point, area, volume and line sources. All sources from the Kell Plant were modelled as point sources.

#### 1.2.8 Assumptions and Limitations

- At the time that the study was conducted there was no information available regarding the Kell Plant stack locations or stack parameters. All stacks were assumed to be at the centre of the plant footprint. All stacks were assumed to be at least 5 metres high and conservatively modelled with a height of 5m.
- It was assumed that the Kell Plant will be designed to comply with the Subcategory 4.17 Minimum Emission Standards.
- Routine emissions from the proposed operations were simulated. Atmospheric releases occurring as a result of non-routine conditions were not included in the dispersion modelling.
- There will always be some error in any geophysical model, but it is desirable to structure the model in such a way to minimise the total error. A model represents the most likely outcome of an ensemble of experimental results. The total uncertainty can be thought of as the sum of three components: the uncertainty due to errors in the model physics; the uncertainty due to data errors; and the uncertainty due to stochastic processes (turbulence) in the atmosphere. Nevertheless, dispersion modelling is generally accepted as a necessary and valuable tool in air quality management.

### 1.3 Report outline

The overall structure of the document reflects this approach:

- Section 2 of the report provides a discussion on the legislation and regulatory requirements.
- Section 3 includes the baseline assessment of the study area.
- Section 4 includes the emissions inventory for the proposed PPM Plant Expansion.
- Section 5 includes a discussion of the Dispersion Modelling Results.
- Section 7 provides the conclusions and recommendations of the study.
- Section 8 provides a list of all the references.

## 2 POLICY AND REGULATORY REQUIREMENTS

PPM has to comply with all the requirements of the National Environmental Management Air Quality Act (Act No. 39 of 2004) (NEMAQA). The Air Quality Act (AQA) commenced on the 11th of September 2005 with the exclusion of the sections pertaining to the listing of activities and the issuing of atmospheric emissions licences. Listed Activities and associated Minimum Emission Standards were published in the Government Gazette on the 31st of March 2010 (No. 33064) in terms of Section 21 of the AQA. The Atmospheric Pollution Prevention Act (APPA) of 1965 was repealed on the 1st of April 2010 bringing the AQA into full force.

### 2.1 Waterberg-Bojanala Priority Area

PPM falls within the Waterberg-Bojanala priority area. Under the National Environmental Management: Air Quality Act, (Act No. 39 of 2004) Airshed priority areas can be declared where there is concern of elevated atmospheric pollutant concentrations within the area. The DEA identified the potential of an Airshed priority area in the vicinity of the Waterberg District Municipality (Government Gazette, Number 33600; 8 October 2010). This was later expanded to include the Bojanala Platinum District Municipality, North-West Province (Government Gazette, Number 34631; 30 September 2011) and the Waterberg Priority Area was officially declared on 15th June 2012 (Government Gazette, Number 35435). The air quality management plan (AQMP) for the Waterberg Priority Area was published in April 2015 and can be accessed on http://www.saaqis.org.za.


**Figure 2-1: Location of PPM within the Waterberg – Bojanala Priority Area, from (Scott, 2012)**

## 2.1 Minimum Emission Standards

The production or processing of precious and associated base metals through chemical treatment is a Listed Activity under Section 21 of the National Environmental Management: Air Quality Act (NEM:AQA) and requires an Atmospheric Emissions License (AEL) to operate. The New Plant Minimum Emission Standards (MES) for Subcategory 4.17 – Precious and Base Metal Production and Refining are given in Table 2-1. The Kell Plant must be designed to meet these MES limits.

**Table 2-1: Listed Activity Subcategory 4.17**

| Category 4.17: Precious and Base Metal Production and Refining | | |
|---|---|---|
| **Description:** | The production or processing of precious and associated base metals through chemical treatment | |
| **Application:** | All Installations | |
| **Substance or Mixture of Substances** | | **New Plant emission limits: mg/Nm³ under normal conditions of 273 Kelvin and 101.3 kPa** |
| **Common Name** | **Chemical Symbol** | |
| Particulate Matter | PM | 50 |
| Sulphur Dioxide | $SO_2$ | 400 |
| Oxides of nitrogen | $NO_x$ expressed as $NO_2$ | 300 |
| Chlorine | $Cl_2$ | 50 |
| Hydrogen chloride | HCl | 30 |
| Hydrogen fluoride | HF | 30 |
| Ammonia | $NH_3$ | 100 |

## 2.2 Air Quality Criteria relevant to PPM and the Proposed Kell Plant

Air quality standards are applicable to all areas where the general public has access to, as well as all off-site areas viz. all areas outside the property boundary. These standards are not applicable to on-site concentrations where the Occupational Health and Safety standards apply. Evaluation of on-site air pollutant concentrations does not form part of the scope of this study.

### 2.2.1 Ambient Air Quality Standards

The National Framework provided a stepped approach in setting ambient air quality standards. Based on this the standard for a specific pollutant must include limit values for specific exposures, the number of allowed exceedances and a timetable for compliance. The limit values (concentrations) are based on scientific evidence.

National Ambient Air Quality Standards (NAAQS) were determined based on international best practice for $PM_{10}$, dust fall, sulphur dioxide, nitrogen dioxide, ozone, carbon monoxide, lead and benzene. These standards were published for comment in the Government Gazette on 9 June 2007 with the new standards, which include frequency of exceedance and implementation timeframes, published on the in the Government Gazette on 24$^{th}$ of December 2009.

The NAAQS for pollutants of concern from the PPM Kell Plant (and current) operations are shown in Table 2-2.

**Table 2-2: National ambient air quality standards for $PM_{10}$**

| Pollutant | Averaging Period | Limit Value (µg/m³) | Permitted Frequency of Exceedance |
|---|---|---|---|
| $PM_{10}$ | 24 hour | 75 | 4 |
| | 1 year | 40 | 0 |
| $PM_{2.5}$ | 24 hour | 40 | 4 |
| | 1 year | 20 | 0 |
| $NO_2$ | 1 hour | 200 | 88 |
| | 1 year | 40 | 0 |
| $SO_2$ | 1 hour | 350 | 88 |
| | 24 hour | 125 | 4 |
| | 1 year | 50 | 0 |

### 2.2.2 National Dust Control Regulations

The National Dust Control Regulations were gazetted on 1 November 2013 (No. 36974). The purpose of the regulations is to prescribe general measures for the control of dust in all areas including residential and light commercial areas. The standard for acceptable dustfall rate is set out in Table 2-3. The method to be used for measuring dustfall rate and the guideline for locating sampling points shall be ASTM D1739: 1970, or equivalent method approved by any internationally recognized body.

**Table 2-3: Acceptable dustfall rates**

| Restriction Area | Dustfall Rate (D) (mg/m²/day, 30 days average) | Permitted Frequency of Exceeding Dustfall Rate |
|---|---|---|
| **Residential area** | D<600 | Two on a year, not sequential months |
| **Non-residential area** | 600<D<1200 | Two on a year, not sequential months |

### 2.2.3 Screening Criteria for $NH_3$, HF, $Cl_2$ and HCl

Air quality criteria for non-criteria pollutants such as $NH_3$, HF, $Cl_2$ and HCl are published by various sources. Criteria referred to in this study include:

- Integrated Risk Information System (IRIS) chronic inhalation reference concentrations (RfCs) (US EPA, 2014), Provisional Peer Reviewed Toxicity Values (PPRTV) and cancer URFs published by the US EPA; and
- Minimal risk levels (MRLs) issued by the US Federal Agency for Toxic Substances and Disease Registry (ATSDR).; and
- Reference exposure levels (RELs) published by the Californian Office of Environmental Health Hazard Assessment (OEHHA).

The most stringent international concentration guidelines for each averaging period are given in Table 2-4.

**Table 2-4: International guidelines for hydrogen fluoride, ammonia, hydrogen chloride and chlorine.**

| Pollutant | Averaging Period | Limit Value (µg/m³) | Source |
|---|---|---|---|
| $NH_3$ | Acute | 1 180 | ATSDR |
| | Sub-chronic | 100 | PPRTV |
| | Chronic | 100 | IRIS |
| HF | Acute | 240 | OEHHA |
| | Chronic | 14 | OEHHA |
| $Cl_2$ | Acute | 170 | ATSDR |
| | Short-term | 5.8 | ATSDR |
| | Sub-chronic | 5.8 | ATSDR |
| | Chronic | 0.2 | OEHHA |
| HCl | Acute | 2 100 | OEHHA |
| | Chronic | 20 | IRIS |

The US ATSDR uses the NOAEL/uncertainty factor (UF) approach to derive maximum risk levels (MRLs) for hazardous substances. These are set levels that, based on current information, might cause adverse health effects in the people most sensitive to such substance-induced effects. MRLs are derived for acute (1-14 days), intermediate or sub-chronic (>14-364 days), and chronic (365 days and longer) exposure durations, and for the oral and inhalation routes of exposure. MRLs are generally based on the most sensitive substance-induced end-point considered to be of relevance to humans. ATSDR does not use serious health effects (such as irreparable damage to the liver or kidneys, or birth defects) as a basis for establishing MRLs. Exposure to a level above the MRL does not mean that adverse health effects will occur. Similarly, RELs published by the California OEHHA as well as RFCs published by the US EPA in their IRIS database uses an estimate of non-carcinogenic effects representing a level of environmental exposure at or below which no adverse effect is expected to occur. Non-carcinogenic effects are evaluated by calculating the ratio, or hazard index, between a dose (in this case the dosage) and the pollutant-specific inhalation RfC or REL.

#### 2.2.4 Screening criteria for animals and vegetation

The impact of dust on vegetation and grazing quality is a concern in the area due to the proximity of nature reservations and game farms. While there is little direct evidence of what the impact of dust fall on vegetation is under a South African context, a review of European studies has shown the potential for reduced growth and photosynthetic activity in various crops. A literature review done by Farmer (1991) looked at the impact of dust on vegetation and grazing quality. The study stated that the effects of dust on plants vary significantly depending on the crop and tree species – blocked stomata, increased transpiration, inhibition of pollen germination, cell plasmolysis, no starch production, reduced photosynthesis, reduced reproductive growth, leave spotting, increased water loss, no mineral uptake, etc. Furthermore, dust deposition affects plants indirectly through changes in soil chemistry. Most of the studies focused on anthropogenic dust sources such as cement factories, fly-ash, charcoal and limestone factories.

# 3 BASELINE CHARACTERISATION

## 3.1 Atmospheric Dispersion Potential

The analysis of hourly average meteorological data is necessary to facilitate a comprehensive understanding of the dispersion potential of the site. Surface meteorological data were obtained for a location at the mine from the MM5 data set. Hourly average surface and upper air metrological data were obtained for the period 1 January 2013 to 31 December 2015. The dataset includes wind speed, wind direction, temperature and rainfall data and various other parameters.

### 3.1.1 Wind Field

The dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. Period, daytime and night-time wind roses for the area for the period are provided in Figure 3-1. Figure 3-2 provides the variation between the seasons for the period.

The prevailing wind direction is from the eastern sector. Very little airflow is recorded from the west. Strong winds are experienced during the day from the east and north, with a decrease in the wind velocity during the night time. No change in the wind direction is reflected during the night with the prevailing winds remaining to be from the north and east. There is an increase in the number of calm conditions during the day; from 10.7% (night-time) to 13.5% during the day.


**Figure 3-1: Period, day-time and night-time wind roses for the PPM site (for the period January 2013 to December 2015)**

During the summer and spring months, stronger winds are from east and east-northeast. The autumn and spring months show a similar pattern to summer months with prevailing winds from the eastern sector. A high percentage of calm conditions (wind speeds <1 m/s) is reflected during the autumn months. During spring and winter months an increased frequency of strong winds are from the southeast and south-southeast.

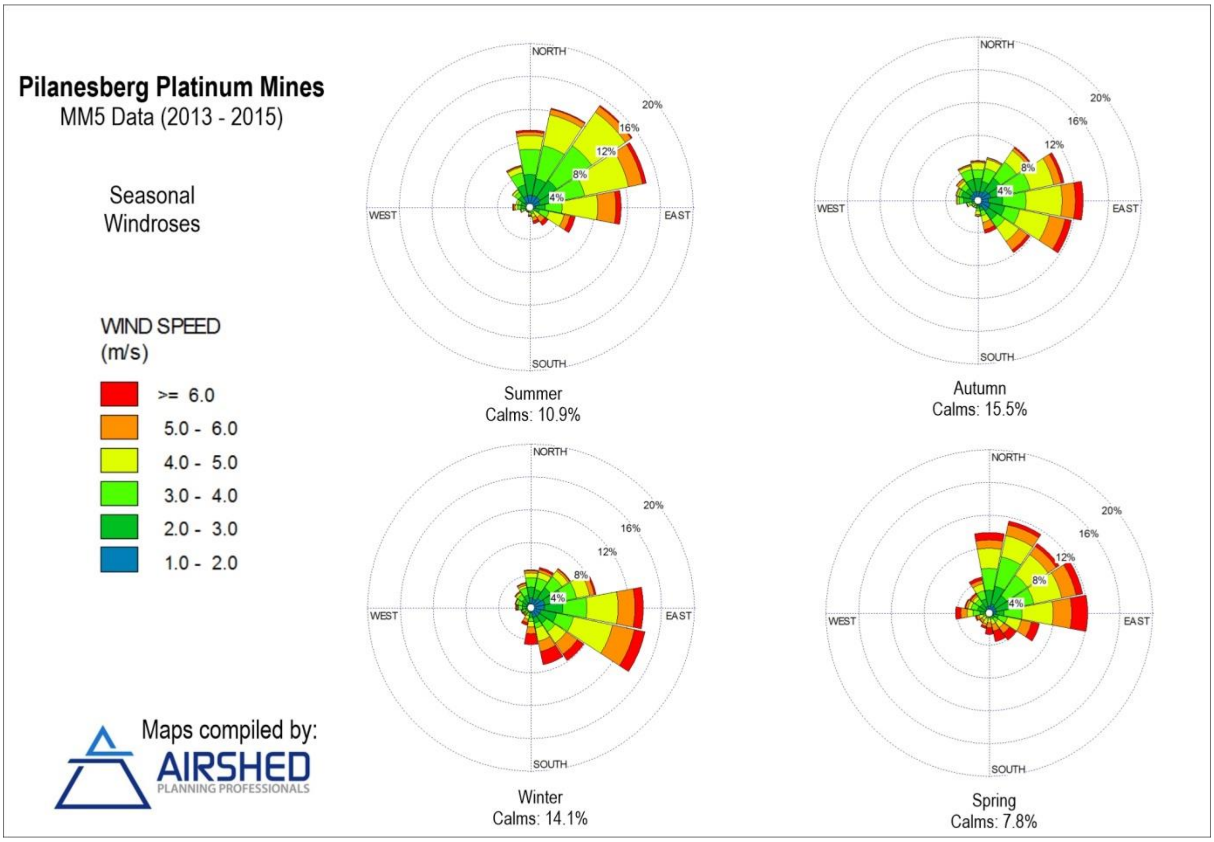


**Figure 3-2: Seasonal wind roses for the for the PPM site (for the Period January 2013 to December 2015)**

### 3.1.2 Temperature

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers. The diurnal temperature profile for the PPM site is given in Figure 3-3 with the minimum, maximum and average temperatures provided in Table 3-1. Temperatures range from 1.1°C in winter to 34.6°C in summer with an average temperature of around 19.5°C.

**Table 3-1: Minimum, maximum and average temperatures for the PPM site for 2013 - 2015.**

| | Jan | Feb | Mar | April | May | June | July | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Max | 32.1 | 32.4 | 30.5 | 28.6 | 24.4 | 22.2 | 20.8 | 27 | 28.5 | 32.2 | 32.6 | 34.6 |
| Min | 16 | 15.8 | 12.6 | 8.9 | 4.8 | 2 | 1.1 | 2.9 | 4.1 | 7.9 | 9.2 | 15.2 |
| Ave | 24.3 | 24.3 | 22.3 | 18.5 | 15.4 | 11.8 | 11.4 | 14.4 | 18.6 | 21.0 | 23.0 | 24.6 |

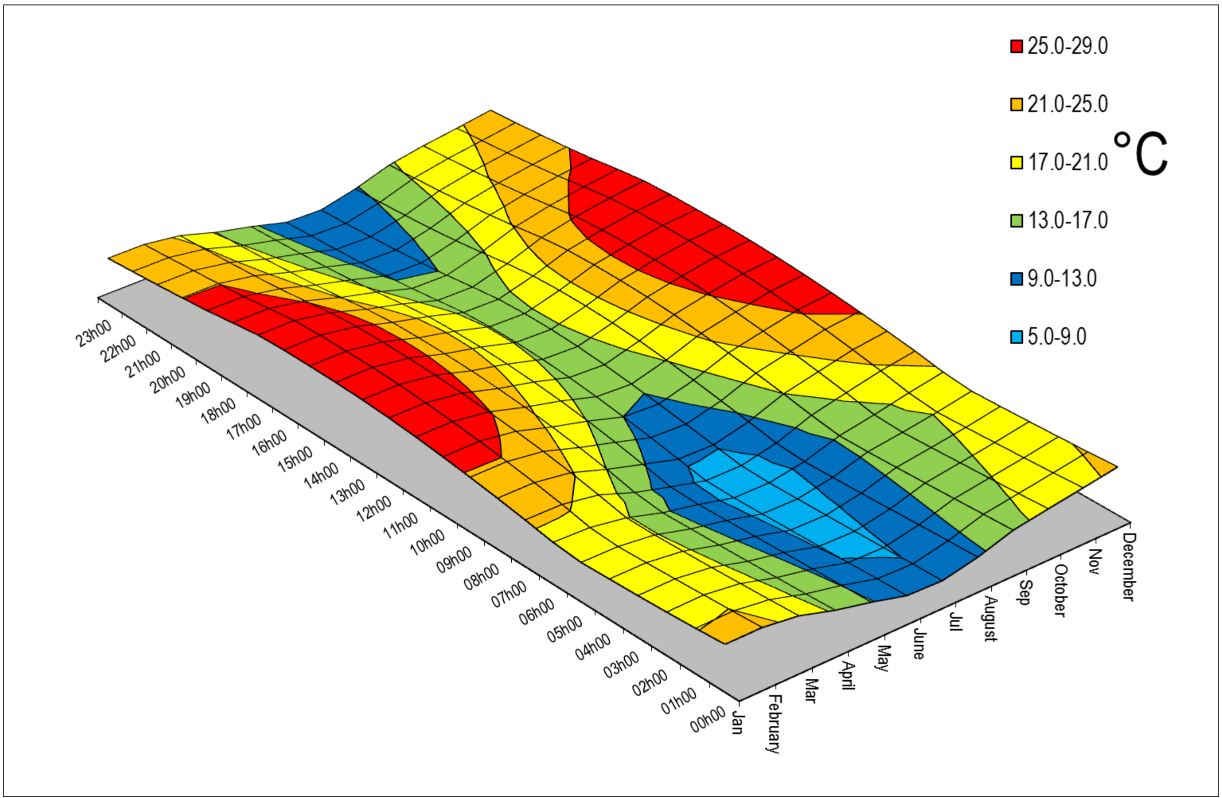


**Figure 3-3: Diurnal temperature profile for the PPM site (January 2013 to December 2015)**

### 3.1.3 Precipitation

Precipitation is important to air pollution studies since it represents an effective removal mechanism for atmospheric pollutants and inhibits dust generation potentials. Reference is made to both precipitation trends measured at PPM (Lentsoane, 2016) and trends observed at Saulspoort Hospital (in Moruleng) between 1951 and 1971 (Schulze, 1986)(Table 3-2 and Figure 3-4).

Annual rainfall trends indicate summer rainfall (October to March) typical of the Bushveld and dry winter months (April to September). 2015 was a very dry year, with drought experienced through much of South Africa, particularly in the North West Province.

**Table 3-2: Monthly average rainfall for the PPM site (2009 to 2011) and Saulspoort (1951-1971).**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PPM (Lentsoane, 2016) | 94 | 45 | 36 | 14 | 0 | 0 | 3 | 0 | 30 | 0 | 34 | 16 | 272 |
| Average (1951-1971) | 112 | 94 | 69 | 65 | 23 | 8 | 5 | 4 | 13 | 53 | 85 | 128 | 659 |

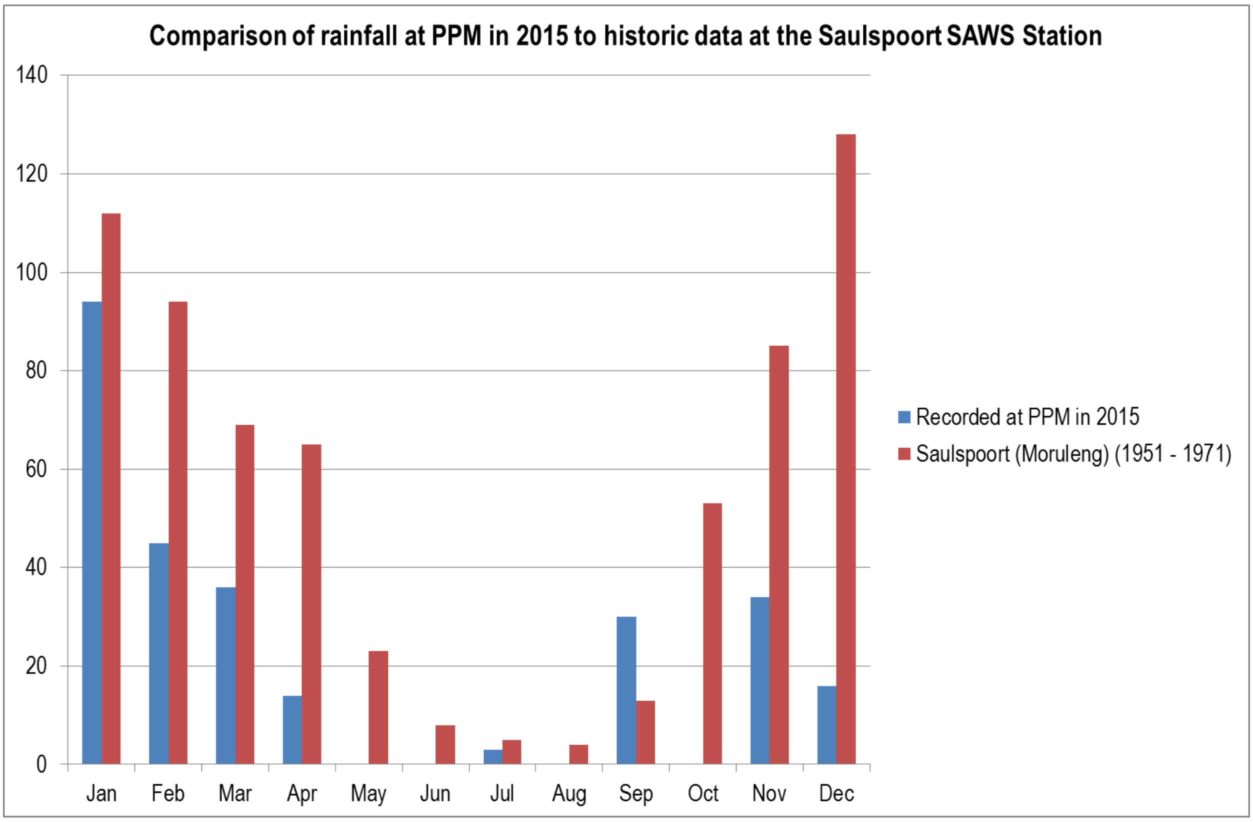


**Figure 3-4: Monthly rainfall for the PPM site for 2015 and average rainfall for the Saulspoort Hospital station from 1951 to 1971.**

## 3.2 Existing sources of Air Pollution in the Area

Source types present in the area and the pollutants associated with such source types are noted with the aim of identifying pollutants which may be of importance in terms of the cumulative impact potential.

- Mining and processing emissions from the current PPM operations. Emissions were quantified and simulated in the 2016 AQMP (Grobler & Petzer, 2016). A summary of simulated impacts from the 2016 AQMP is given in Section 3.3
- Stack, vent and fugitive emissions from mining activities in the area, including the Ruighoek Chrome to the southwest, the Union Platinum mine to the north east, the proposed Sedibelo and Magazynskraal mines directly to the east (future sources that are not currently operational) as well as various other exploration phase mining operations in the area.
- Vehicle tailpipe emissions.
- Household fuel combustion.
- Biomass burning (veld fires).
- Various miscellaneous fugitive dust sources (agricultural activities, wind erosion of open areas, vehicle-entrainment of dust along paved and unpaved roads).

## 3.3 Simulated Impact of Current PPM Operations (from AQMP) (Grobler & Petzer, 2016)

Emissions from the current PPM mining and processing operations were quantified and simulated when the Air Quality Management Plan for PPM (Grobler & Petzer, 2016) was compiled in 2016. The main findings from the AQMP are summarised below.

Sources of particulate emissions (Figure 3-5) from the current PPM operations include vehicle entrainment from unpaved roads, material handling of run of mine (ROM) and waste rock in the pit, at the waste rock dump and at the ROM stockpile, crushing and screening of ROM, wind erosion from the TSF, waste rock dump and other exposed area and drilling and blasting emissions.

Sources of gaseous emissions from the current PPM operations include vehicle exhaust from the mining fleet and generator exhaust emissions from the standby generators.

Simulated annual average $PM_{10}$ concentrations (Figure 3-6) due to current PPM operations exceeded the SA NAAQS to the north west of the open pit, including at the southern edges of Ngweding.

Simulated annual average $PM_{2.5}$ concentrations (Figure 3-7) were in compliance with the SA NAAQS at all sensitive receptor locations.

Simulated dust fallout rates (Figure 3-8) were in exceedance of the SA NDCR limit for non-residential areas in the immediate vicinity of the mining and processing operations, but in compliance with the SA NDCR limit for residential areas outside the property boundary.

Simulated $NO_2$ (Figure 3-9) and $SO_2$ concentrations due to PPM sources were in compliance with the SA NAAQS for the entire study area.

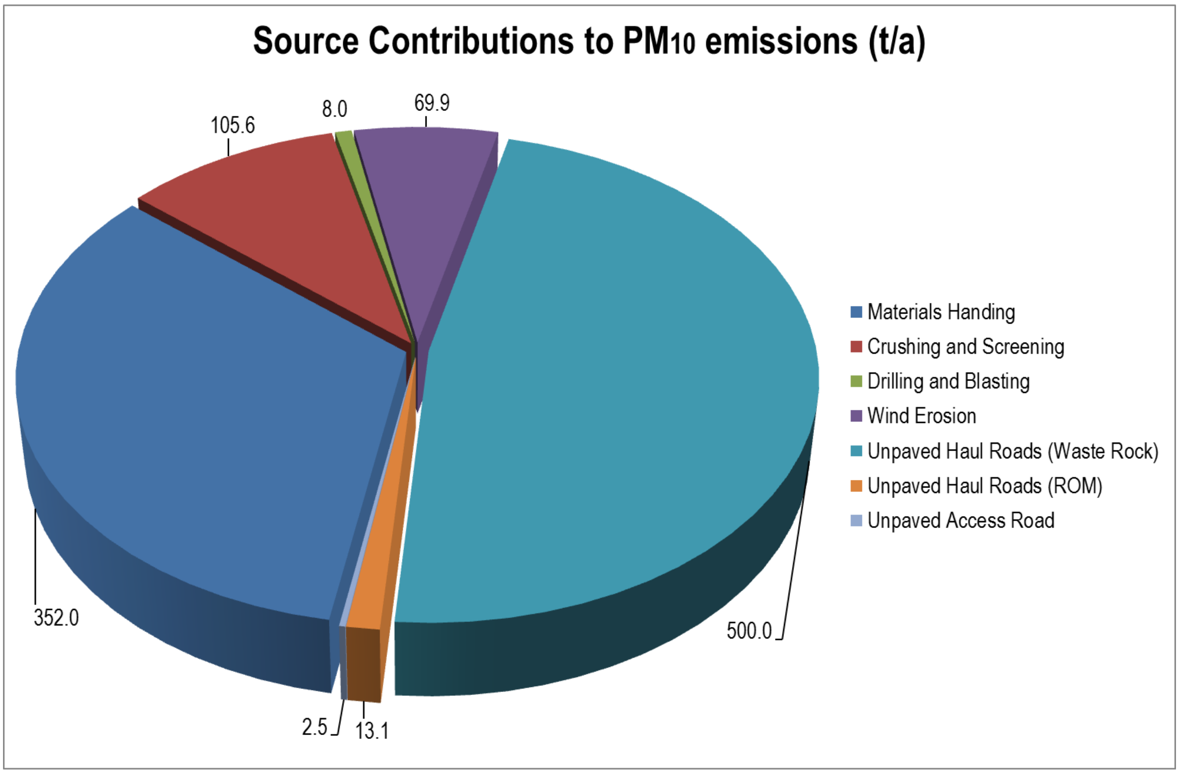


**Figure 3-5: Source contributions to particulate emissions from current PPM operations.**

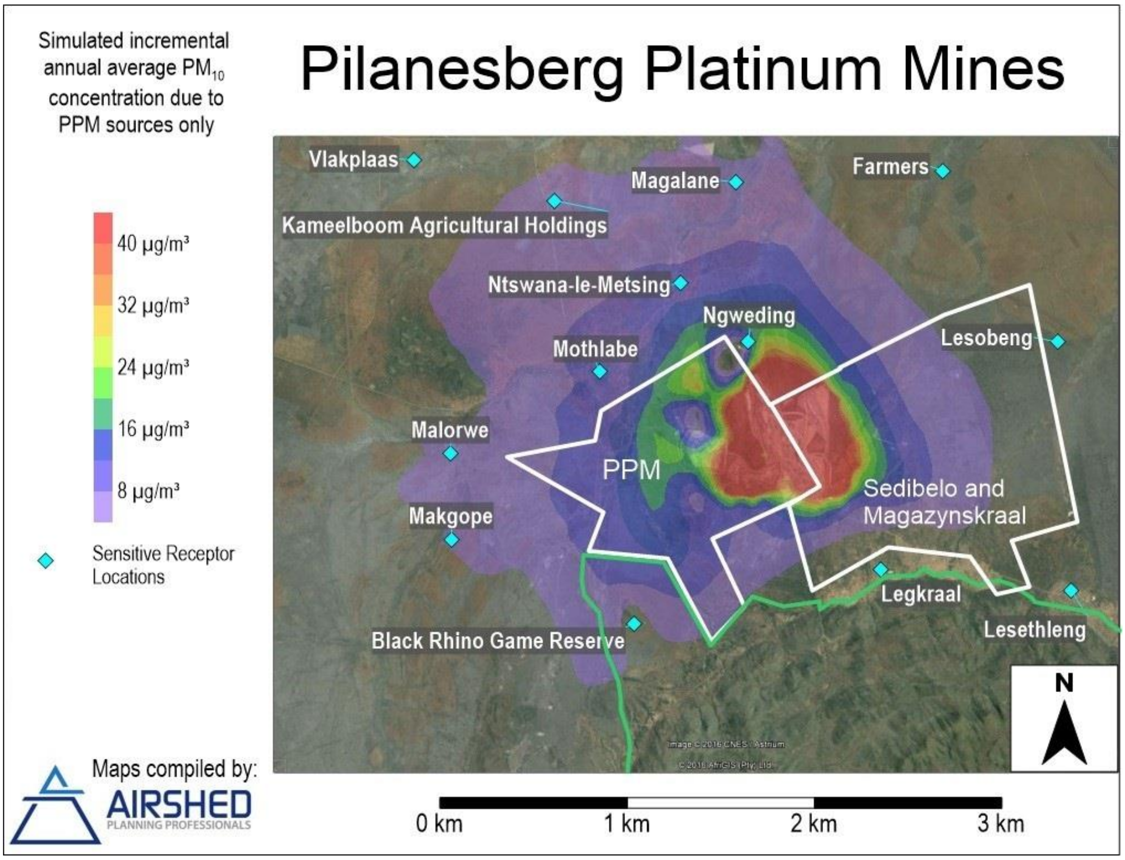


**Figure 3-6: Simulated annual average $PM_{10}$ concentrations due to current PPM operations.**

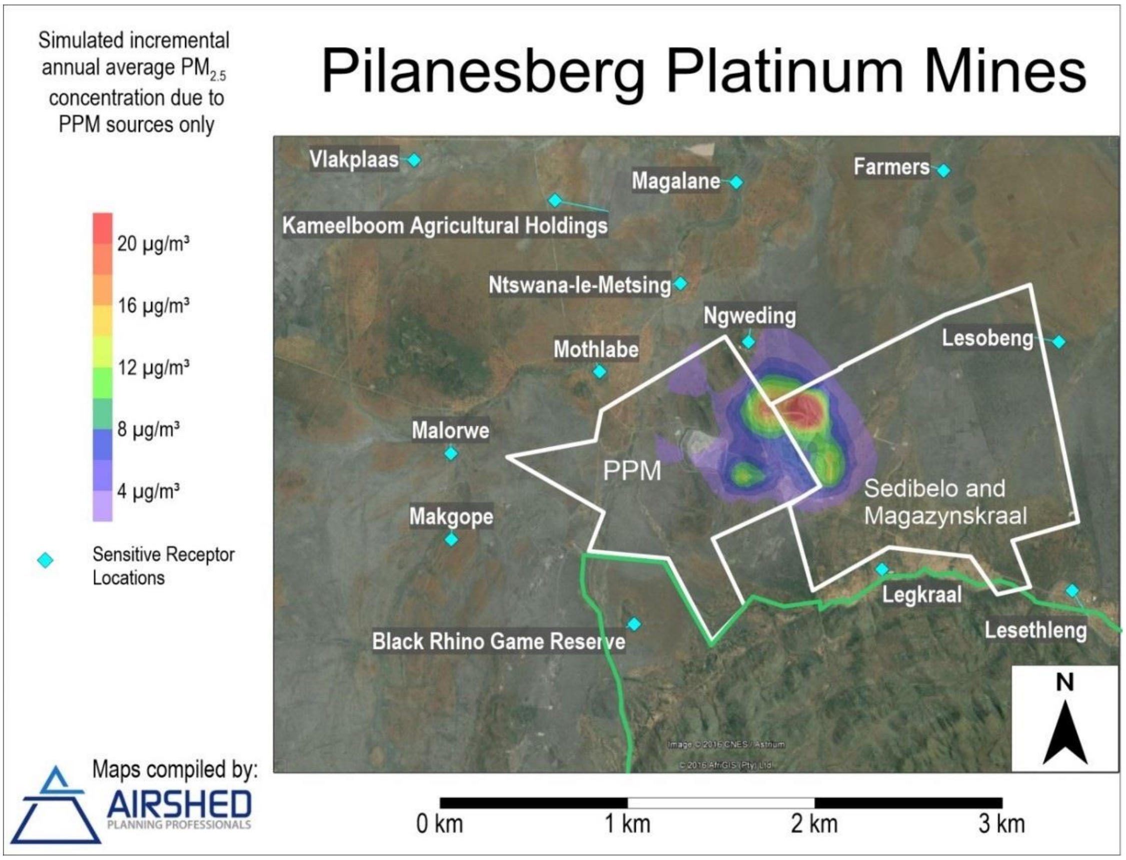


**Figure 3-7: Simulated annual average $PM_{2.5}$ concentrations due to current PPM operations.**

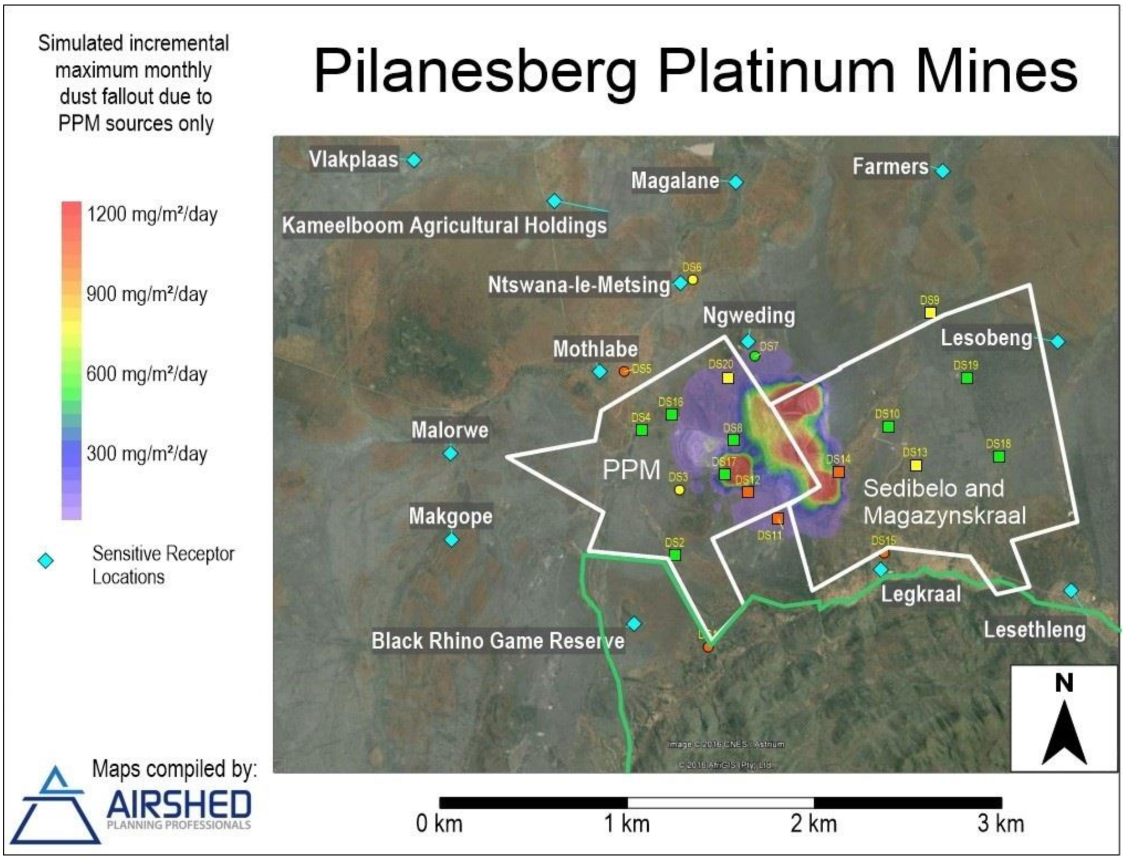


**Figure 3-8: Simulated highest monthly dust fallout rates due to current PPM operations.**

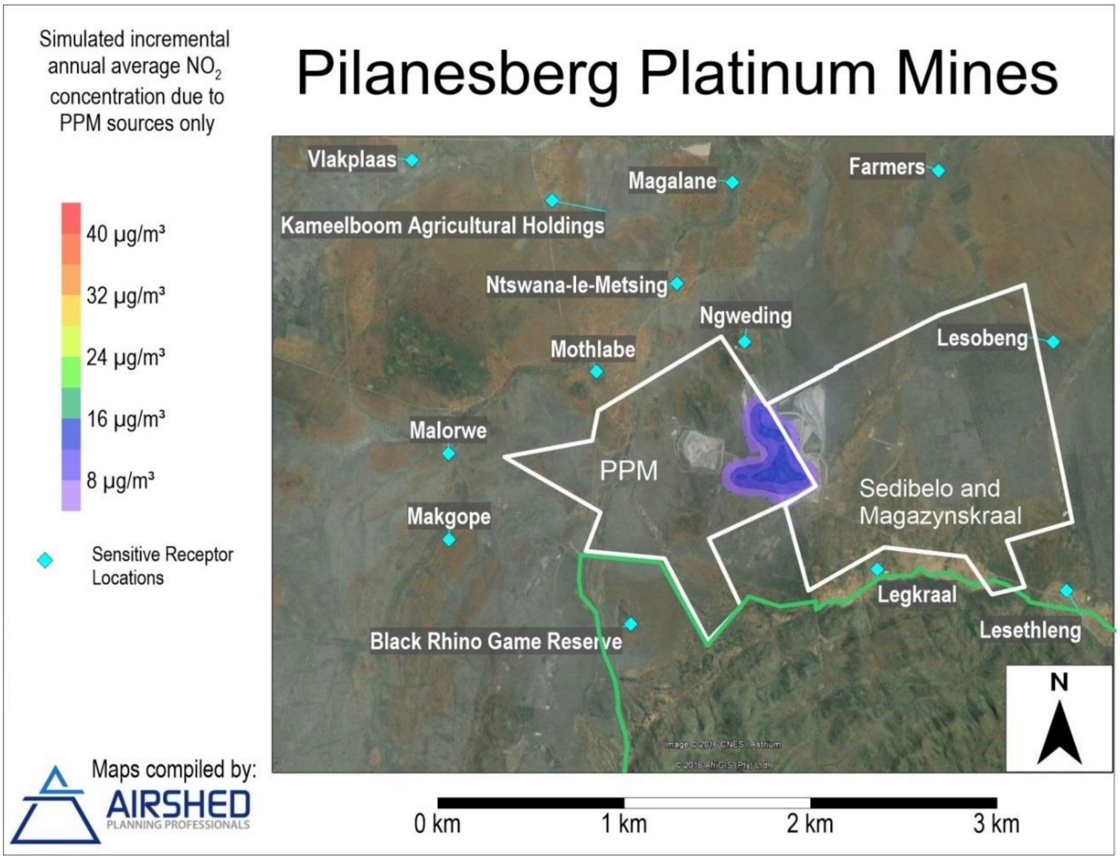


**Figure 3-9: Simulated annual average $NO_2$ concentrations due to PPM operations.**

## 3.4 Dust Fallout Monitoring (Grobler, 2018)

Monthly dust fallout rates are sampled at 6 residential locations and 14 non-residential locations around the PPM operations (Figure 3-10 and Table 3-3).

Sampled dust fallout rates exceeded the NDCR limits at DS1, DS5, DS13, DS14, and DS15 during 2015. During 2016 and 2017 sampled dust fallout were in compliance NDCR limit at all sampling locations, although one exceedances each were recorded at DS5 and DS6, the NDCR allows for two exceedances per year in non-consecutive months. Sampled dust fallout rates are shown in Appendix A.

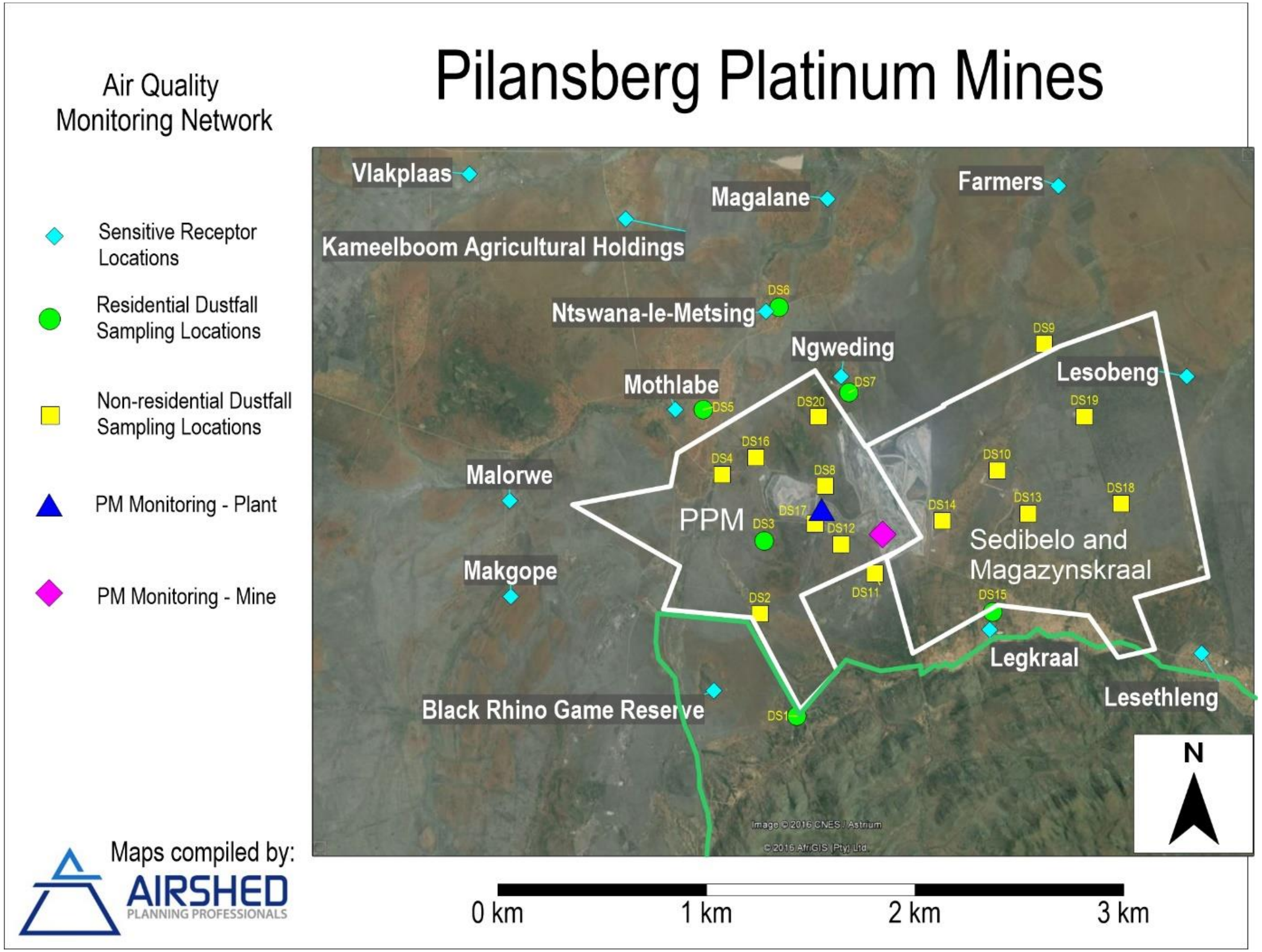


**Figure 3-10: PPM Air Quality Monitoring Network**

### Table 3-3: PPM Dust Fallout Sampling Network

| Site ID | Type | Description | Co-Ordinates |
|---|---|---|---|
| DS 1 | Residential | 60m Away from Black rhino Game Reserve fence | 25°09’27.1“ S 26°58’59.3” E |
| DS 2 | Non-residential | Access road to well-field boreholes near Eskom power lines | 25°07’41.57“ S 26°58’22.01” E |
| DS 3 | Residential | Proposed area for PPM housing development | 25°06’41.87“ S 26°58’18.76” E |
| DS 4 | Non-residential | Bullfrog Buffer Zone along P50-1 road to Motlhabe | 25°05’46.9“ S 26°57’30.40” E |
| DS 5 | Residential | Mathlakana School | 25°04’44.2“ S 26°56’59.1” E |
| DS 6 | Residential | Ramanotwana Primary School | 25°03’01.8“ S 26°58’27.2” E |
| DS 7 | Residential | Ngweding Village near Tuschenkomst WRD | 25°04’25.73“ S 26°59’48.45” E |
| DS 8 | Non-residential | Witkleifontein TSF eastern paddock wall | 25°05’57.83“ S 26°59’18.87” E |
| DS 9 | Non-residential | North east corner of Wilgespruit farm along the pipeline and Magong road | 25°03’45.72“S 27°02’58.38”E |
| DS 10 | Non-residential | Sedibelo Mining Project Offices | 25°05’36.16“S 27°02’20.72”E |
| DS 11 | Non-residential | Access gate of South Storm Water Dam | 25°07’06.0“ S 27°00’14.6” E |
| DS 12 | Non-residential | Corner of DMS (Crusher) dump fence | 25° 6'42.10"S 26°59'42.42"E |
| DS 13 | Non-residential | Behind Sedibelo Mining Topsoil Dump near the fire break road | 25°06’6.0“ S 27°2’51.0” E |
| DS 14 | Non-residential | Between Farmers Area and Sedibelo Mining Project Area | 25°06’19.3“ S 27°01’27.29” E |
| DS 15 | Residential | Legkraal Village, downstream of earth dam | 25° 7'52.37"S 27° 2'39.02"E |
| DS 16 | Non-residential | Vegetable Garden (Hydroponics) | 25° 5'29.12"S 26°58'5.70"E |
| DS 17 | Non-residential | Near Sewerage Treatment Plant and explosives magazine | 25° 6'25.29"S 26°59'13.51"E |
| DS 18 | Non-residential | Sedibelo East along Magong Road | 25° 6'26.4"S 27° 4'42.6"E |
| DS 19 | Non-residential | Near Eskom Power Station along Magong Road | 25° 4'43.04"S 27° 4'0.64"E |
| DS 20 | Non-residential | Tributary Of Motlhabe/ Heritage Triangle Area | 25° 4'51.05"S 26°59'11.33"E |

## 3.5 $PM_{10}$ and $PM_{2.5}$ Monitoring

A $PM_{10}$ and $PM_{2.5}$ sampling network was installed at PPM in March 2016. Ambient $PM_{10}$ concentrations are sampled at the PPM processing Plant since August 2016, from March to July 2016 $PM_{2.5}$ was also sampled at this location before the $PM_{2.5}$ sampler was moved to sample $PM_{2.5}$ concentrations at the mine offices. $PM_{2.5}$ sampling during 2017 was interrupted from March to November 2017 due to water damage to the sampler. Sampled $PM_{10}$ and $PM_{2.5}$ concentrations at these locations were similar or lower than simulated concentrations, but it should be noted that during 2016 and 2017 the PPM mining operations were operated at a lower throughput of material than what was used to estimate and quantify particulate emissions during the 2016 AQMP.

### 3.5.1 2016 Sampling Results (Grobler, 2017)

2016 $PM_{2.5}$ sampling results from the sampler located at the mine offices are shown in Figure 3-11. Only one exceedance of the daily SA NAAQS of 40 µg/m³ was recorded on 8 July 2016. The SA NAAQS allows for 4 exceedances of the NAAQS per calendar year. The average $PM_{2.5}$ concentration at the mine sampling location was 12.5 µg/m³ for the 2016 sampling period.

$PM_{2.5}$ concentrations sampled at the plant sampling location (Figure 3-12) exceeded the daily SA NAAQS of 40 µg/m³ on eight days during the period March to July 2016. One exceedance was recorded on 3 June 2016 while the other seven exceedances were recorded on consecutive days from 5 to 11 July 2016 when a veld fire swept through the area (the single exceedance at the mine sampling location was also recorded during this period). The average $PM_{2.5}$ concentration at the plant sampling location was 17.9 µg/m³ for the period March to July 2016. No exceedances of the daily SA NAAQS for $PM_{10}$ (75 µg/m³) were recorded at the plant sampling location during the period August to November 2016 (Figure 3-13) The average $PM_{10}$ concentration during this period was 19.2 µg/m³.

With the exception of the period from 5 to 11 July 2016 when a veld fire resulted in high particulate concentrations at both the mine and the plant sampling locations; sampled concentrations at both sampling locations were in compliance with the SA NAAQS.

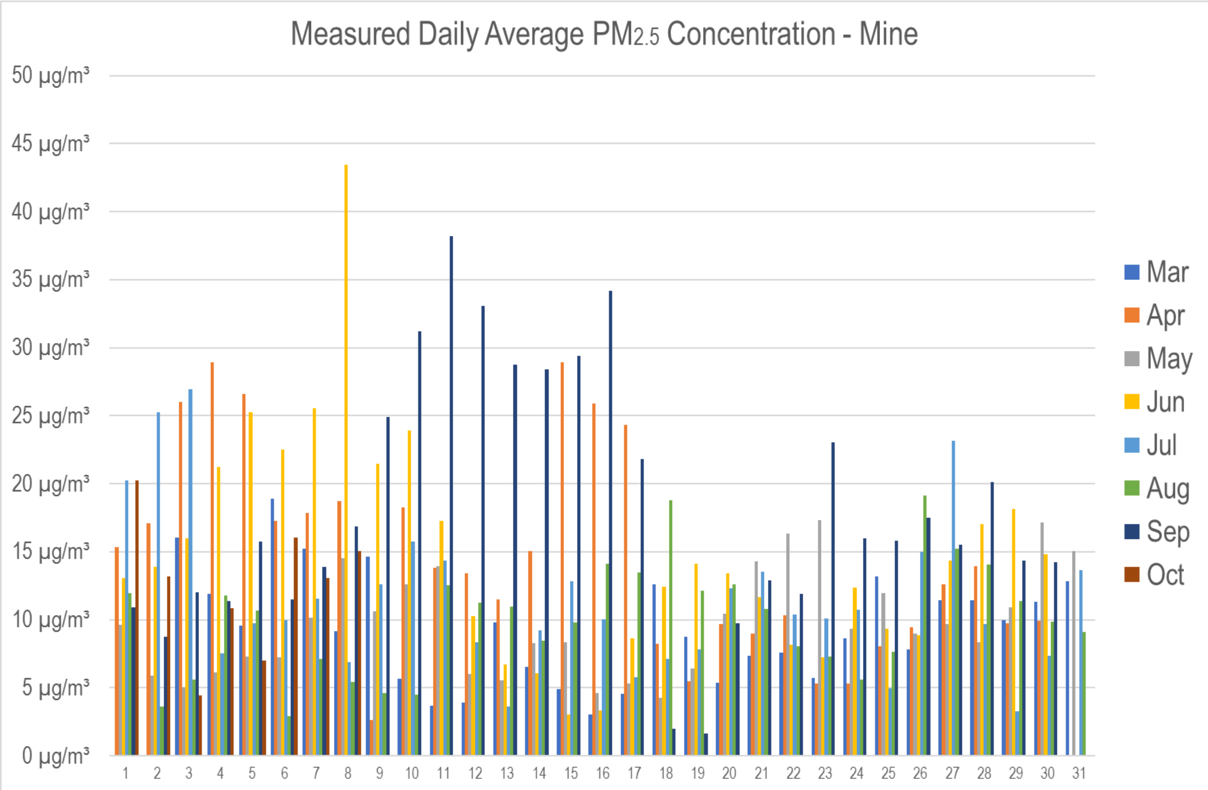


**Figure 3-11: 2016 $PM_{2.5}$ Sampling Results - Mine**

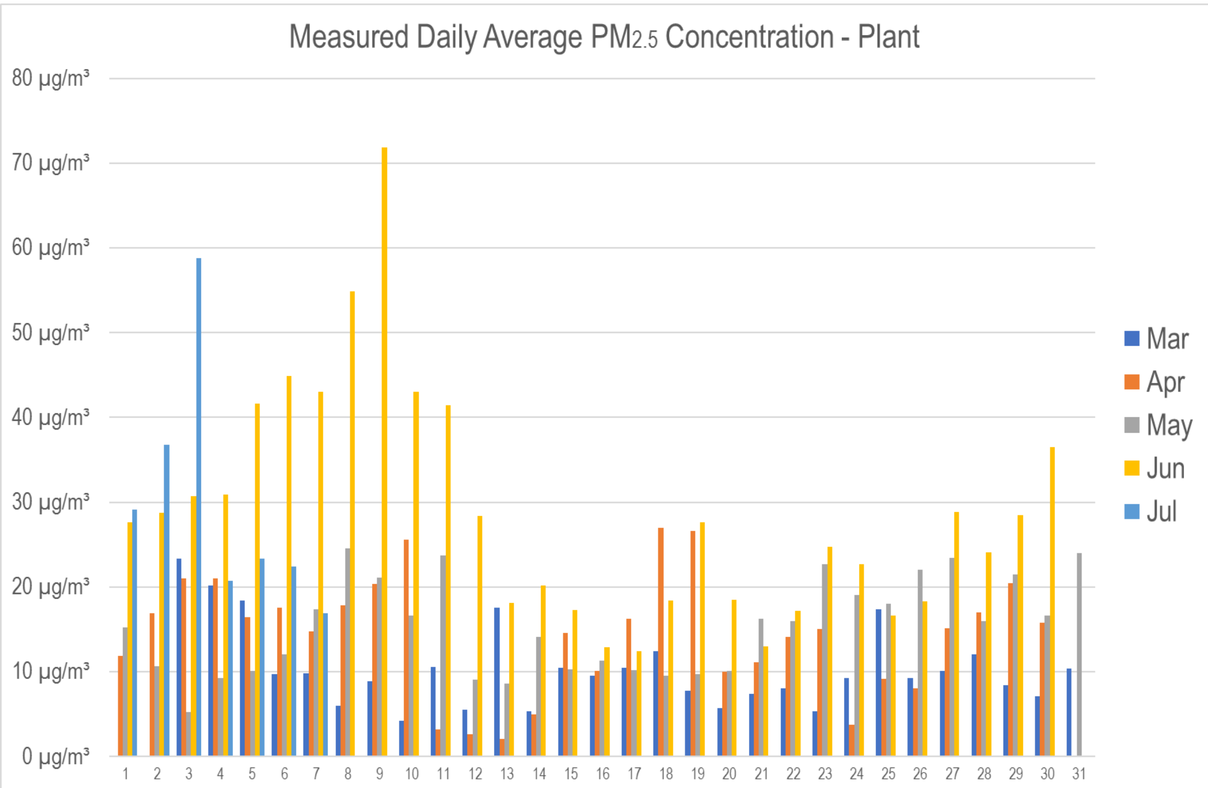


**Figure 3-12: 2016 $PM_{2.5}$ Sampling Results - Plant**

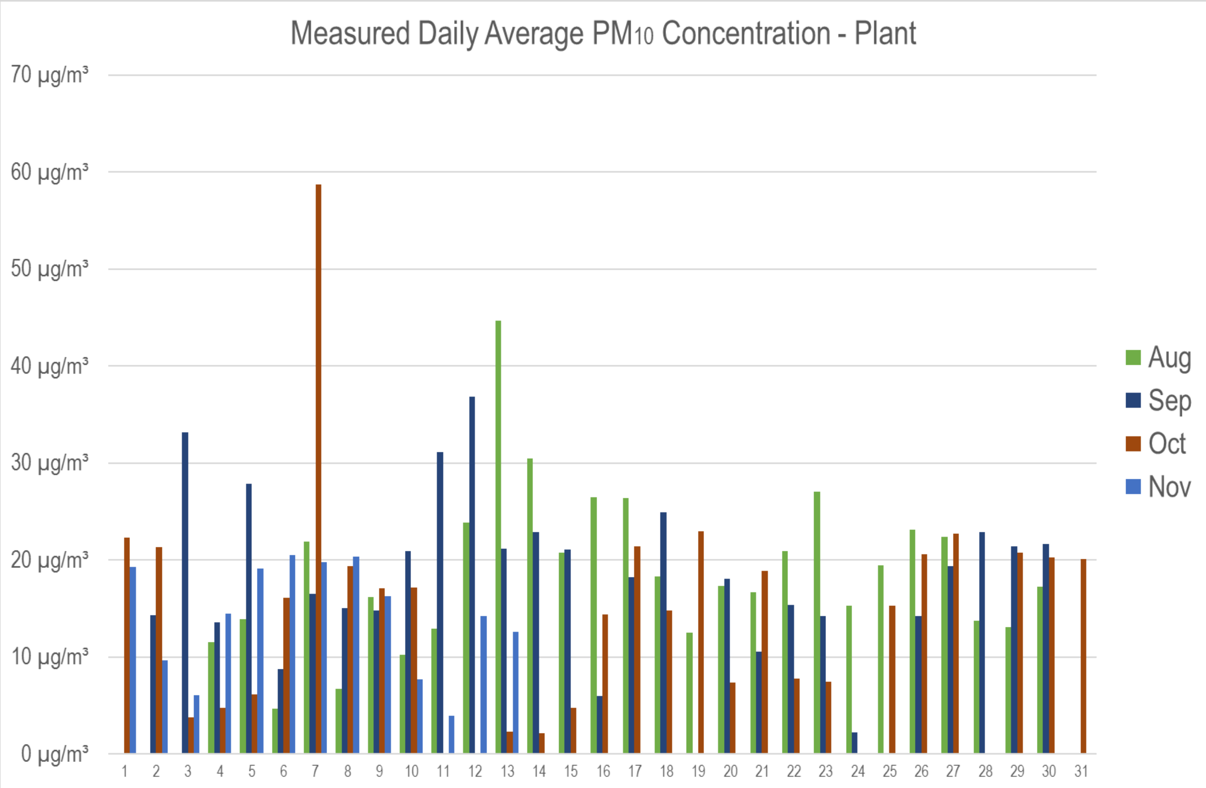


**Figure 3-13: 2016 $PM_{10}$ Sampling Results - Plant**

### 3.5.2 2017 Sampling Results (Grobler, 2018)

During 2017, one exceedance of the NAAQS limit for $PM_{2.5}$ (Figure 3-14) was recorded at the mine sampling location (on 17 February 2017). The average $PM_{2.5}$ concentration at the mine sampling location was 7.9 µg/m³ for the 2017 sampling period. One exceedance of the NAAQS limit value for $PM_{10}$ (Figure 3-15) was recorded on 24 April 2017. The average $PM_{10}$ concentration at the plant sampling location was 7.5 µg/m³ for the 2017 sampling period.

The exceedances of the daily NAAQS limit values described above only occurred on one occasion each for $PM_{10}$ and $PM_{2.5}$, with recorded concentrations being generally much lower. The exceedances were probably caused by one-time events such as wild fires, vehicles or activities very close to the sampling locations or high wind gusts. The SA NAAQS allows for four exceedances per calendar year of the limit values.

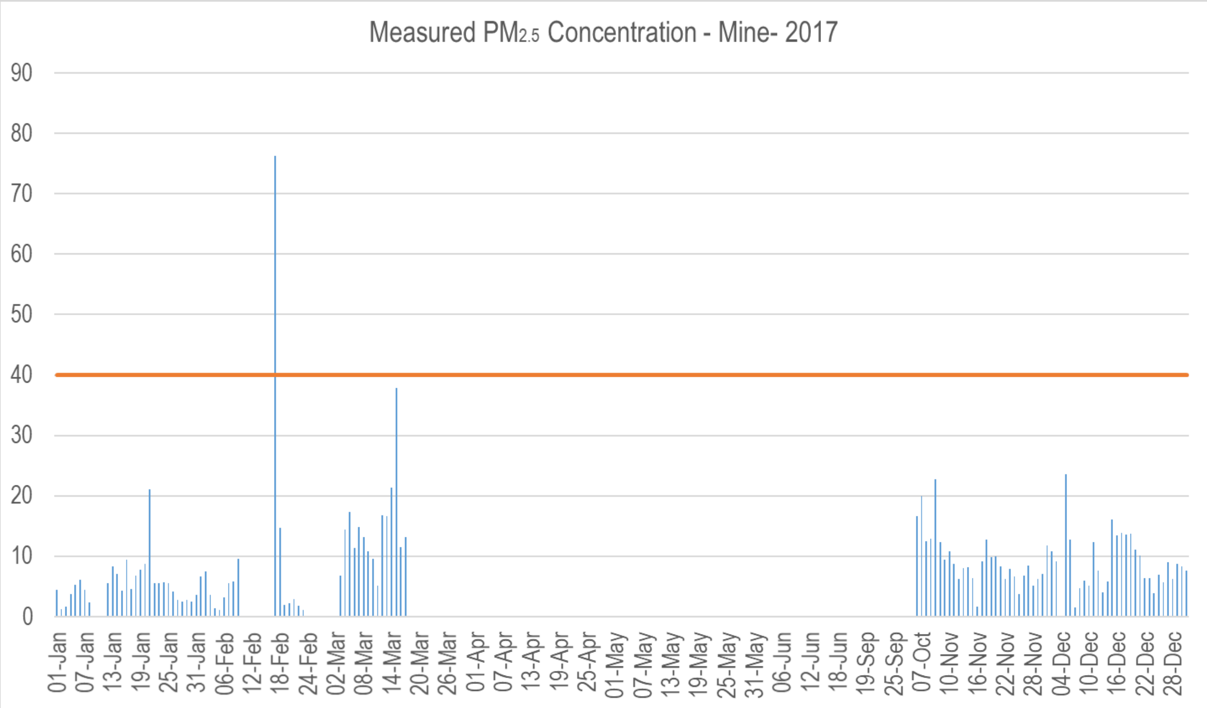


**Figure 3-14: 2017 $PM_{2.5}$ Sampling Results - Mine**

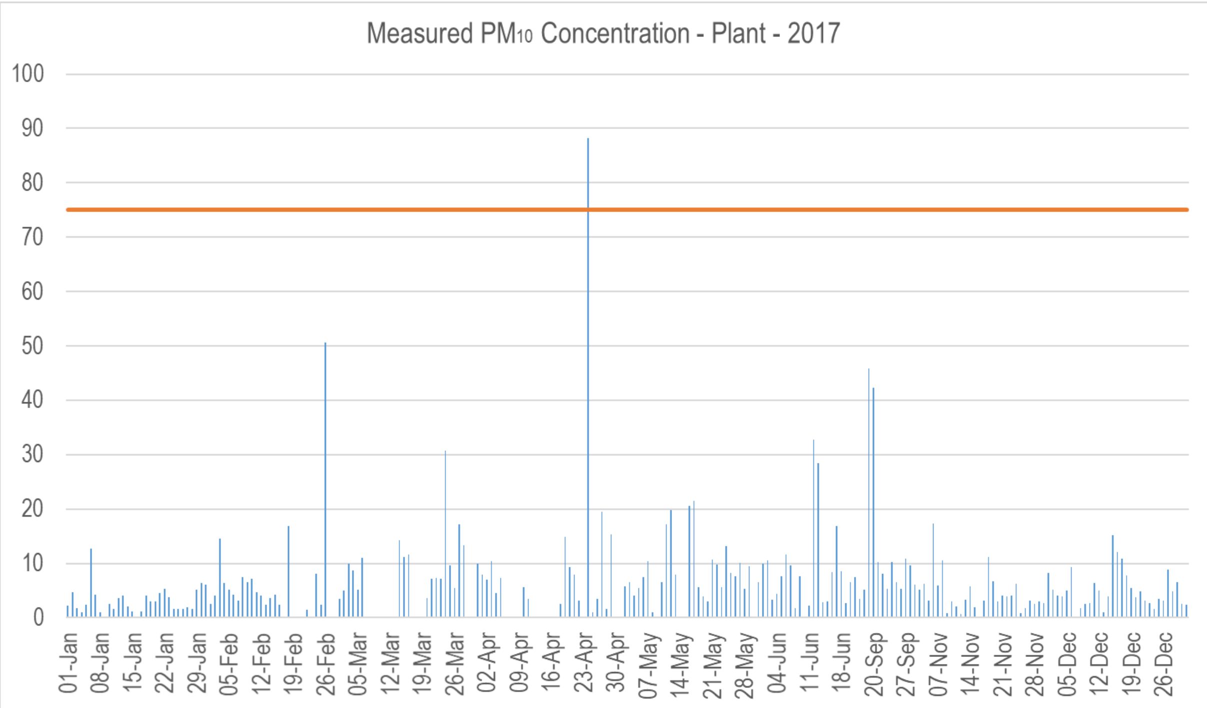


**Figure 3-15: 2017 $PM_{10}$ Sampling Results – Plant**

## 3.6 $SO_2$ and $NO_2$ Monitoring (Grobler, 2018)

During August 2018 passive diffusive sampling of $SO_2$ and $NO_2$ was conducted at four locations surrounding the seven generators (Genset) at PPM.

Sampled $SO_2$ concentrations (Figure 3-16) were below the detection limit (approximately 8 µg/m³) at all sampling locations while the generators were not in operation. Sampled $SO_2$ concentrations were between 20 and 25 µg/m³ at sampling locations 1, 3 and 4 while the generators were active.

With the exception of one sampling location (when the generators were not active), sampled $NO_2$ concentrations (Figure 3-17) were below the detection limit of 24 µg/m³ at all sampling locations, including during the periods when the generators were active.

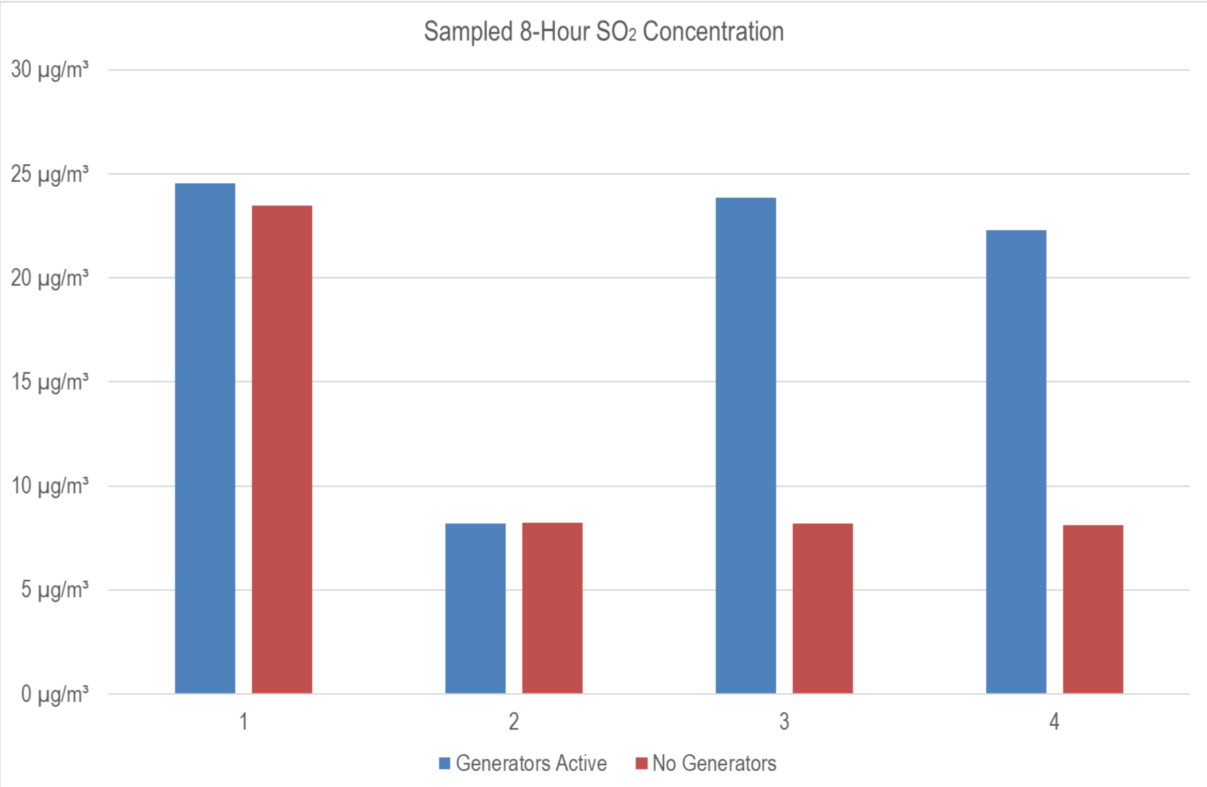


**Figure 3-16: Sampled $SO_2$ Concentrations at the PPM Genset**

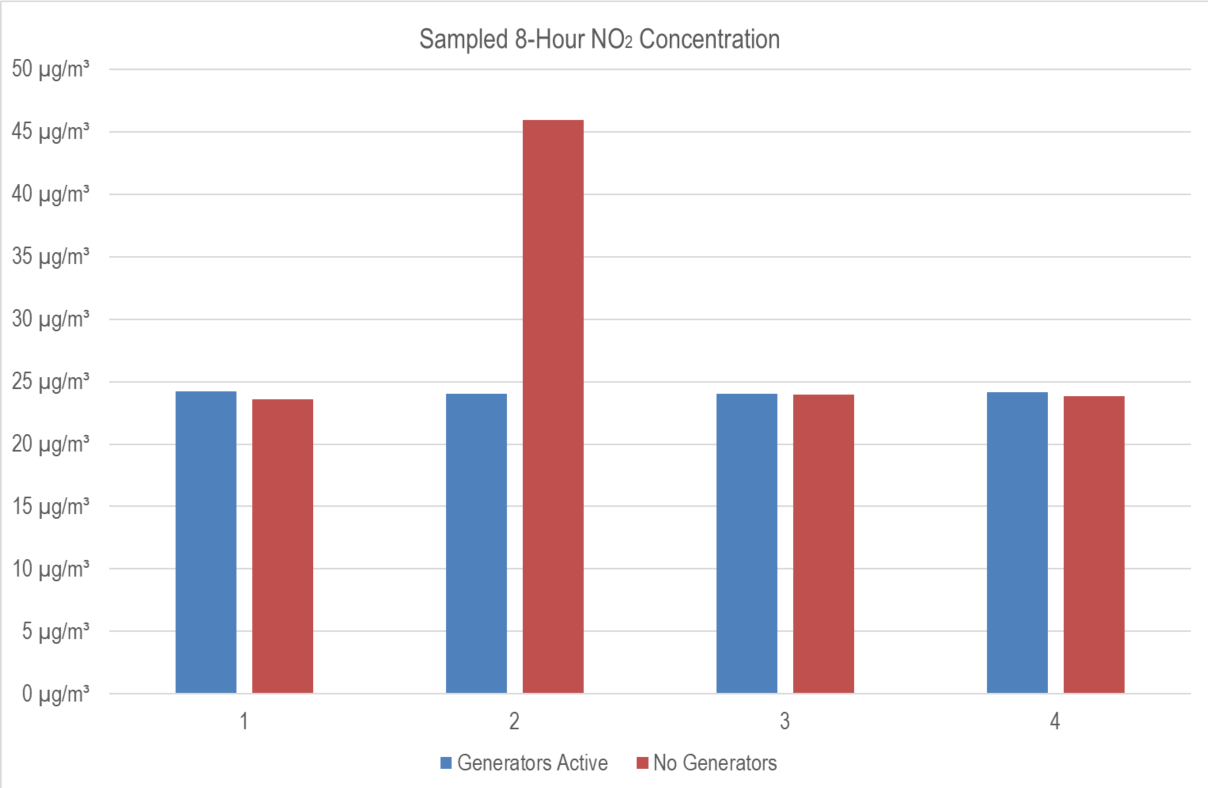


**Figure 3-17: Sampled $NO_2$ Concentrations at the PPM Genset**

# 4 EMISSIONS INVENTORY

## 4.1 Process Description

The PPM Plant Expansion Project will include a UG2 milling and flotation circuit and a hydrometallurgical plant (Kell Plant) for the extraction of platinum group metals (PGMs) and base metals (SLR, 2015). The current sewerage treatment facility will be upgraded and the current waste storage facility and training centre will be relocated. Various community projects will also implemented as part of the PPM Plant Expansion Project. These include an aggregate crusher and brick making project, a vegetable garden and nursery, an organic composting project and a car wash bay. With the exception of the aggregate crusher, which was included in the 2016 AQMP, none of these community projects are expected to result in significant emissions to atmosphere.

### 4.1.1 UG2 Milling and Flotation Plant

The UG2 milling and flotation circuit will be a duplication of the existing UG2 circuit on site and will be constructed within the existing processing plant footprint. The UG2 milling and flotation circuit will have a throughput of approximately 65 000 tonnes per annum. The addition of this circuit will not require the expansion of the TSF and other supporting processing infrastructure. With the proposed changes, the flotation concentrate will no longer be transported to an off-site third party smelting facility as the concentrate will be further processed on site in the proposed hydrometallurgical plant. With the exception of dust generated during the construction of the UG milling and flotation circuit the UG2 milling and flotation circuit is not expected to result in any further release to atmosphere due to the wet nature of the process.

### 4.1.2 Kell Plant (Hydrometallurgical Plant)

The hydrometallurgical plant will treat the concentrate generated from the flotation circuits. The hydrometallurgical plant will follow the KELL Process (Figure 4-1) and will replace the conventional platinum smelting and base metal refining processes. The hydrometallurgical plant will use sulphate leach extraction of PGMs and base metals from the flotation concentrate utilising oxygen ($O_2$) and sulphuric acid ($H_2SO_4$) and chloride leach extraction of PGMs and gold utilising chlorine gas ($Cl_2$) and hydrochloric acid (HCl). The estimated throughput of the Kell Plant is 110 000 tonnes of concentrate per annum.

Three waste products will be generated from the Kell Plant for co-disposal onto the existing TSF, namely:

- neutralised solids from the sulphate based leach process;
- tailings from the chloride extraction process; and
- an iron based tailings from the precious metal recovery circuit.

The hydrometallurgical process will generate the following products:

- nickel cathode and cobalt concentrate;

- copper cathode;
- PGM and gold sponge concentrate.

The nickel cathode and cobalt concentrate, and copper cathode will be sold to third parties. The PGM and gold concentrate will be transported to an off-site precious metals refinery for the extraction of the various precious metals or sold to third parties.

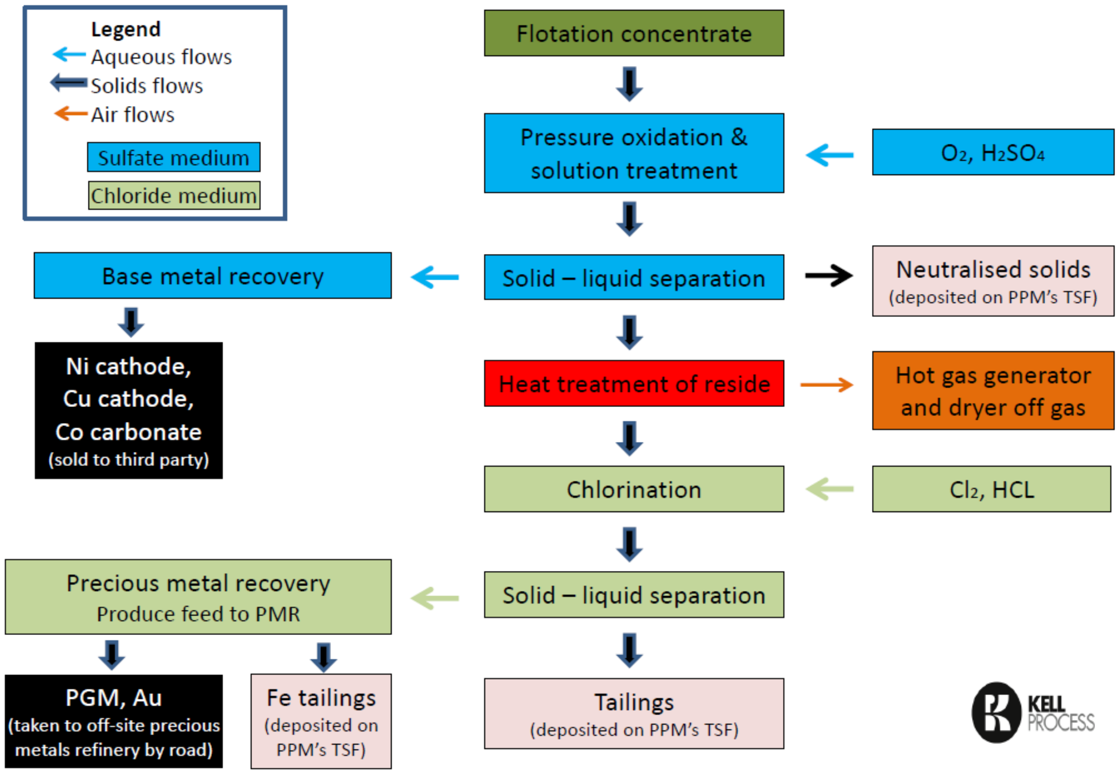


**Figure 4-1: Kell Process Diagram (SLR, 2015)**

## 4.2 Kell Plant Atmospheric Emissions

Emissions from the Kell Plant were estimated based on design parameters provided by the plant designers (Simulus Laboratories), pilot plant emission testing results (Emission Assessments, 2016) and MES for Subcategory 4.17 activities (Table 2-1). A summary of point source parameters and emission rates from the Kell Plant is shown in Table 4-1. The exact coordinates of the point sources at the Kell Plant are not know at this stage and neither is the height of the five stacks. All stacks were assumed to be at the centre of the plant footprint. All stacks were assumed to be at least 5 metres high. Recommendations regarding required stack height will be made based on dispersion modelling results.

**Table 4-1: Kell Plant Point Source Parameters and Emission Rates**

| Point Source Name | Units | POX | Total Fe | Scrubber | Total HT | Scrubber |
|---|---|---|---|---|---|---|

| | | | Scrubber Vent | Rem area | Vent | area | Vent |
|---|---|---|---|---|---|---|---|
| **Volumetric Flow Rate** | | $Nm^3/h$ | 5.7 | 612.1 | 77.1 | 20013.5 | 308.1 |
| **Exit Temperature** | | C | 44 | 25 | 92 | 25 | 51 |
| **Exit Velocity** | | m/s | 17 | 17 | 17 | 17 | 17 |
| **Stack Diameter** | | mm | 13 | 136 | 48 | 822 | 93 |
| **Maximum Emission Rate** | $PM_{10}$ & $PM_{2.5}$ | g/s | 0.0001 | 0.01 | 0.001 | 0.28 | 0.004 |
| | $SO_2$ | g/s | 0.0006 | 0.07 | 0.01 | 2.22 | 0.03 |
| | $NO_2$ | g/s | 0.0005 | 0.05 | 0.01 | 1.67 | 0.03 |
| | $Cl_2$ | g/s | 0.0001 | 0.01 | 0.001 | 0.28 | 0.004 |
| | HCl | g/s | 0.00005 | 0.01 | 0.001 | 0.17 | 0.003 |
| | HF | g/s | 0.00005 | 0.01 | 0.001 | 0.17 | 0.003 |
| | $NH_3$ | g/s | 0.0002 | 0.02 | 0.002 | 0.56 | 0.01 |

# 5 Impact Assessment

Dispersion modelling was undertaken to determine highest hourly, highest daily and annual average $PM_{10}$, $PM_{2.5}$, $NO_2$, $SO_2$, $Cl_2$, HCl, HF and $NH_3$ concentrations due to the Kell Plant. These averaging periods were selected to facilitate the comparison of predicted pollutant concentrations with NAAQS and international guidelines.

Ground level concentration (GLC) isopleth plots presented in this section depict interpolated values from the concentrations simulated by AERMOD at each of the receptor grid points specified. The isopleth plots figure numbers are summarised in Table 5-1.

Typically, ambient air quality applies to areas where the Occupational Health and Safety regulations do not apply, thus outside the mine property. Ambient air quality standards are therefore not occupational health indicators but applicable to areas where the general public has access i.e. off-site.

**Table 5-1: Isopleth Plots**

| Pollutant | Annual Average Concentration | Highest Daily Concentration | Highest Hourly Concentration |
|---|---|---|---|
| $PM_{10}$ | Below 10% of NAAQS | Figure 5-1 | No NAAQS |
| $PM_{2.5}$ | Below 10% of NAAQS | Figure 5-2 | No NAAQS |
| $SO_2$ | Figure 5-3 | Figure 5-4 | Figure 5-5 |
| $NO_2$ | Figure 5-6 | No NAAQS | Figure 5-7 |
| $Cl_2$ | Figure 5-8 | Figure 5-9 | Figure 5-10 |
| HCl | Below 10% of guideline values | | |
| HF | Below 10% of guideline | No guideline | Figure 5-11 |
| $NH_3$ | Below 10% of guideline | Figure 5-12 | Figure 5-13 |

Simulated annual average and highest daily $PM_{10}$ and $PM_{2.5}$ concentrations from the Kell Plant only are below the SA NAAQS for the entire study area and well below the SA NAAQS for all areas outside the property boundary including at sensitive receptor locations.

Simulated annual average $SO_2$ and $NO_2$ concentrations as well as highest daily $SO_2$ concentrations are well below the SA NAAQS for all areas except the immediate vicinity of the Kell Plant, including outside the property boundary and at all sensitive receptor locations. Simulated highest hourly $SO_2$ and $NO_2$ concentrations exceed the NAAQS limit values for up to 2km from the Kell Plant, but not outside the PPM property boundary or at any sensitive receptor locations. The SA NAAQS allow for 88 hourly exceedances of the hourly limit values. It should also be noted that all Kell Plant sources were modelled at the New Plant MES. It is however highly unlikely that significant $NO_2$ and $SO_2$ emissions will be present in the non-combustion source streams. Even if these pollutants are present in the other off-gas streams, emission rates are likely to be insignificant compared to the pollutants emitted through the combustion of coal at the Kell Plant (the quantified and modelled emissions).

Simulated annual average, highest daily and highest hourly $Cl_2$ concentrations exceed the identified (Table 2-4) chronic, sub-chronic and acute guidelines for $Cl_2$ for a significant part of the PPM operations, including at the current processing plant and at the tailings storage facility. Simulated $Cl_2$ concentrations are however below the identified international guidelines for all areas outside the property boundary, including at all sensitive receptor locations.

Simulated HCl, HF and $NH_3$ concentrations are below the relevant international guidelines for the entire study domain including at all areas outside the property boundary and at sensitive receptor locations.

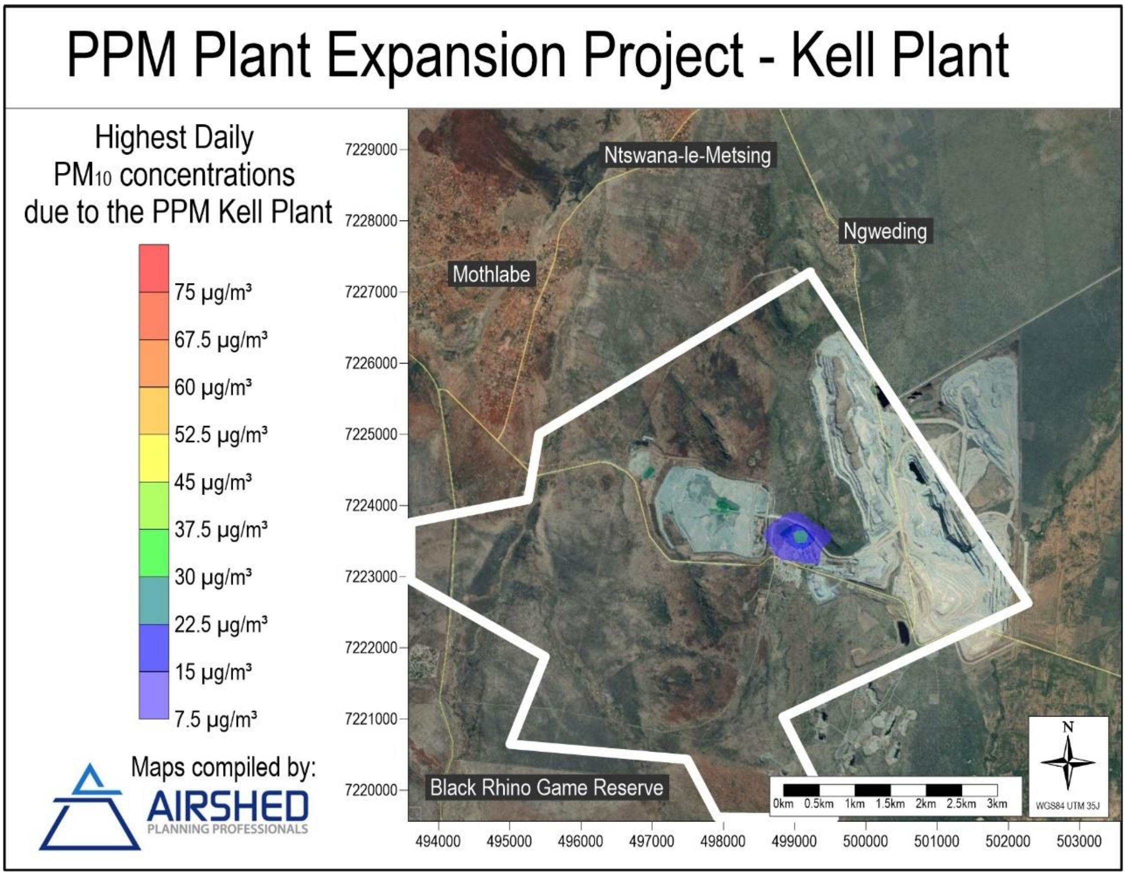


**Figure 5-1: Highest Daily $PM_{10}$ Concentration due to PPM Kell Plant Sources**

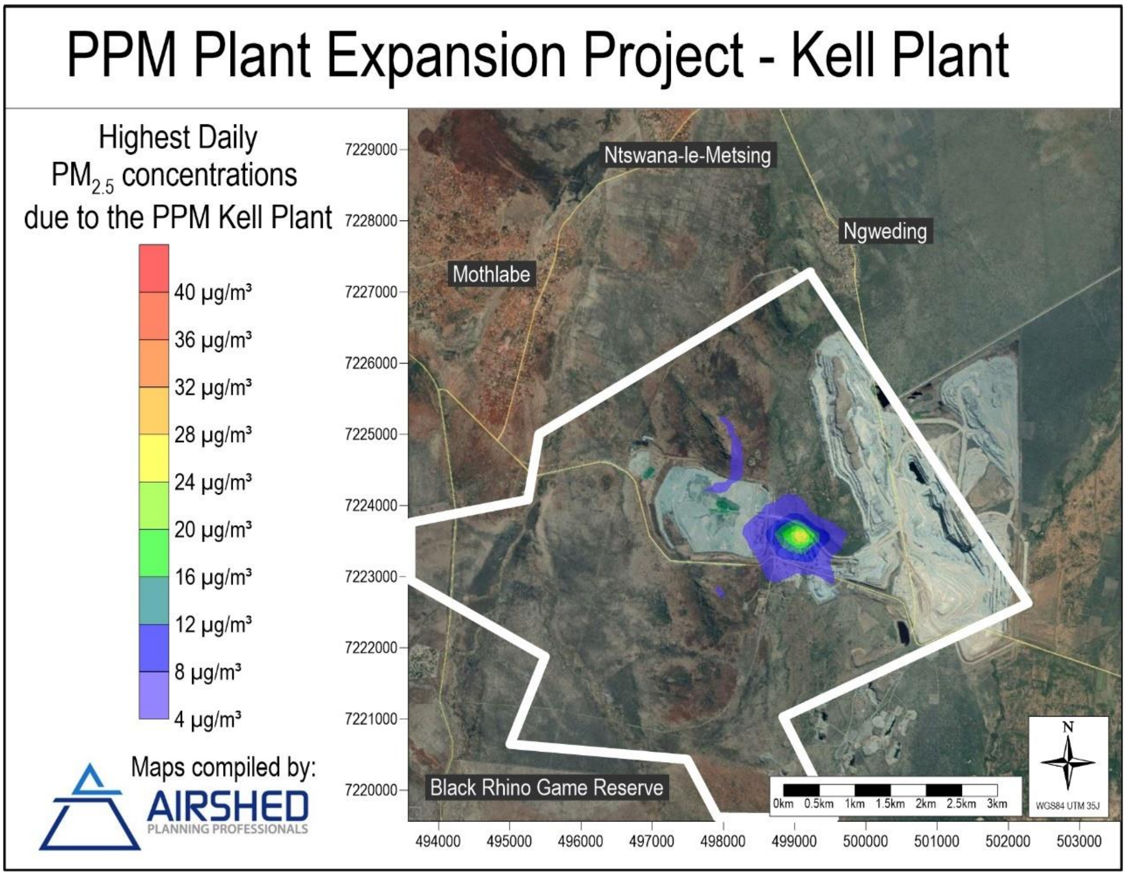


**Figure 5-2: Highest Daily $PM_{2.5}$ Concentration due to PPM Kell Plant Sources**

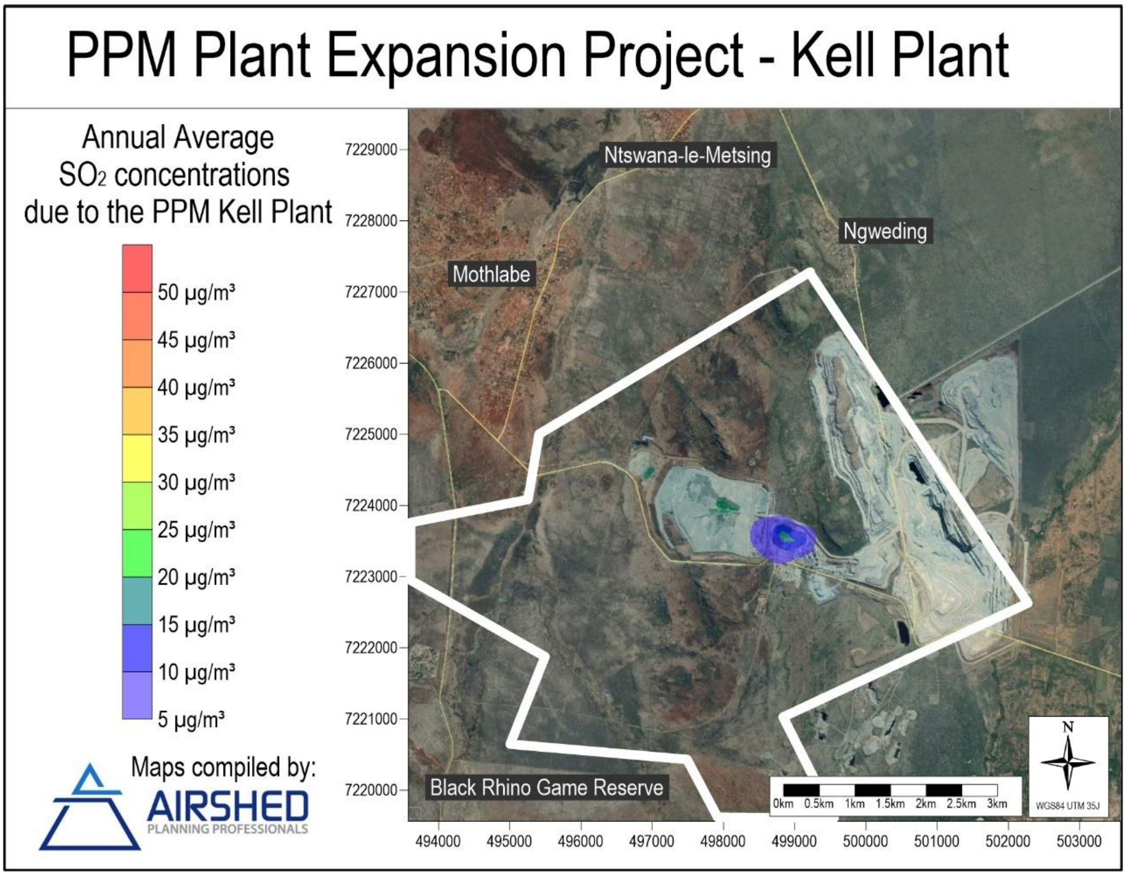


**Figure 5-3: Annual Average $SO_2$ Concentration due to PPM Kell Plant Sources**

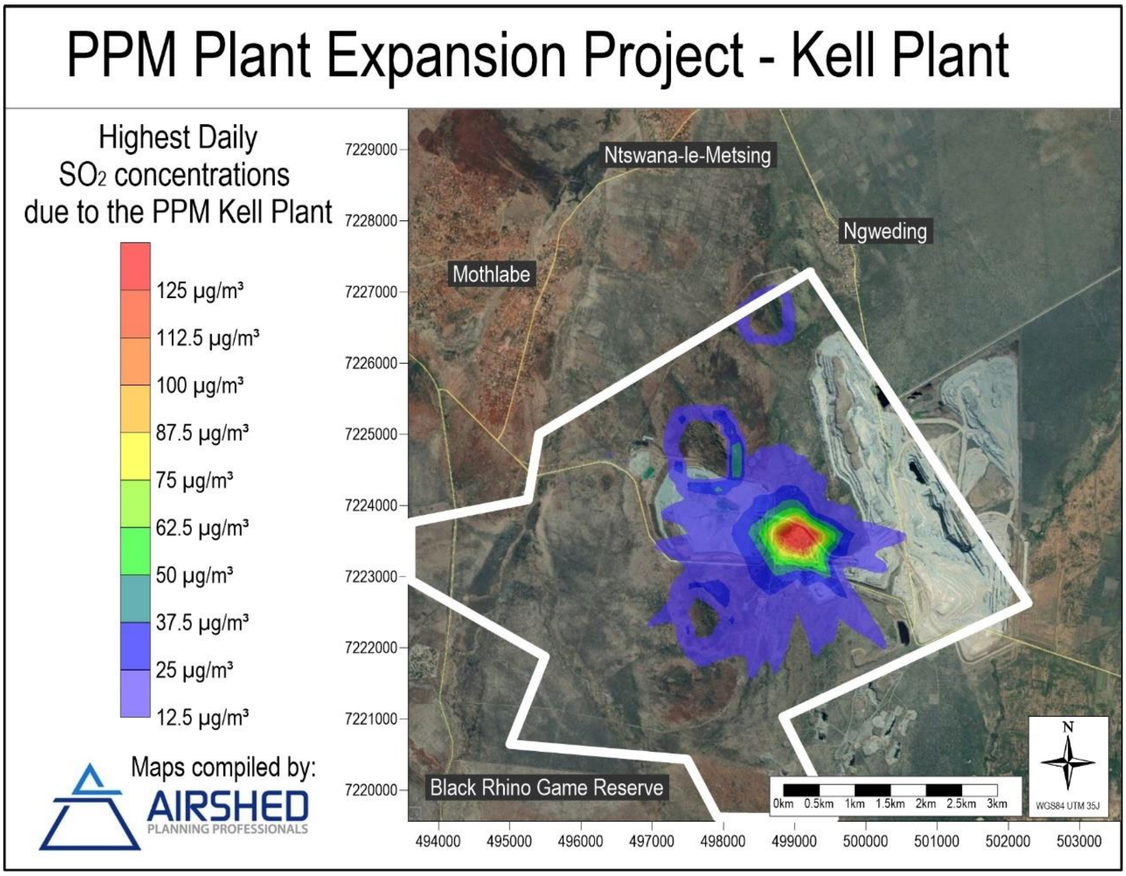


**Figure 5-4: Highest Daily $SO_2$ Concentration due to PPM Kell Plant Sources**

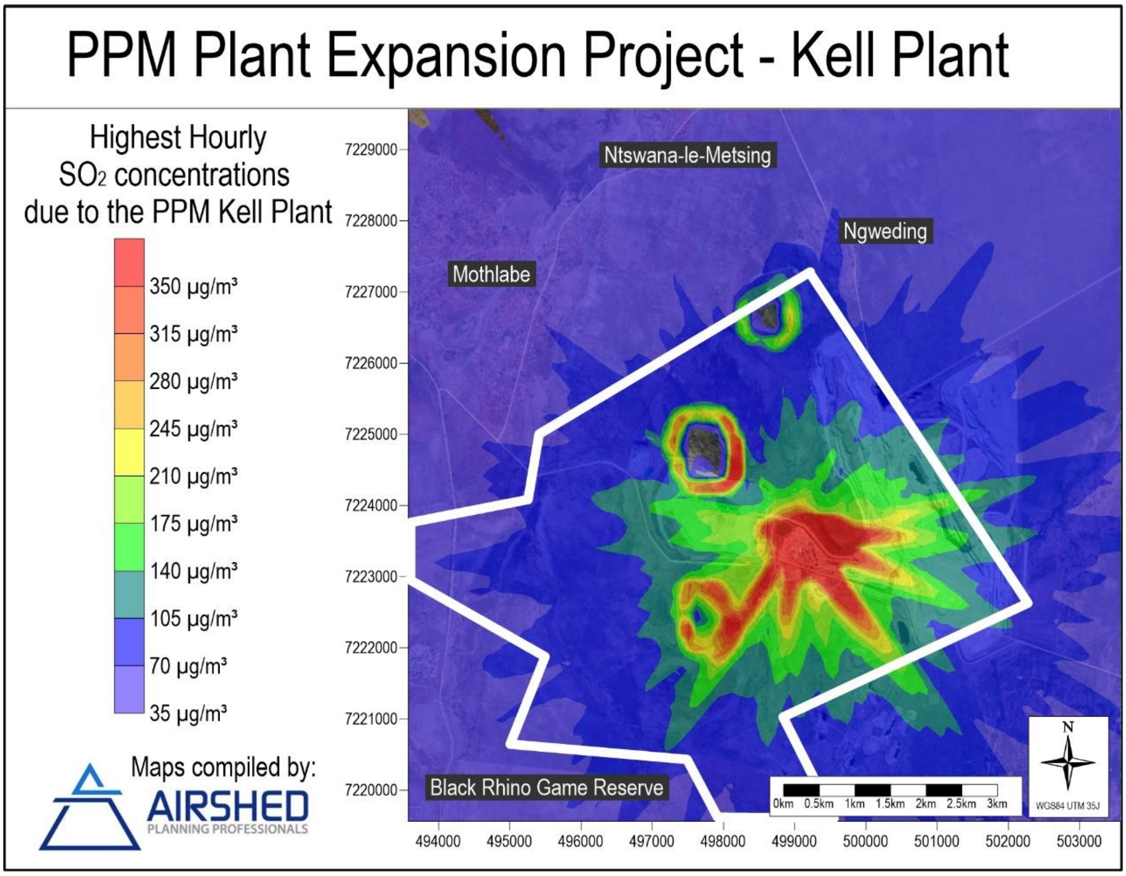


**Figure 5-5: Highest Hourly $SO_2$ Concentration due to PPM Kell Plant Sources**

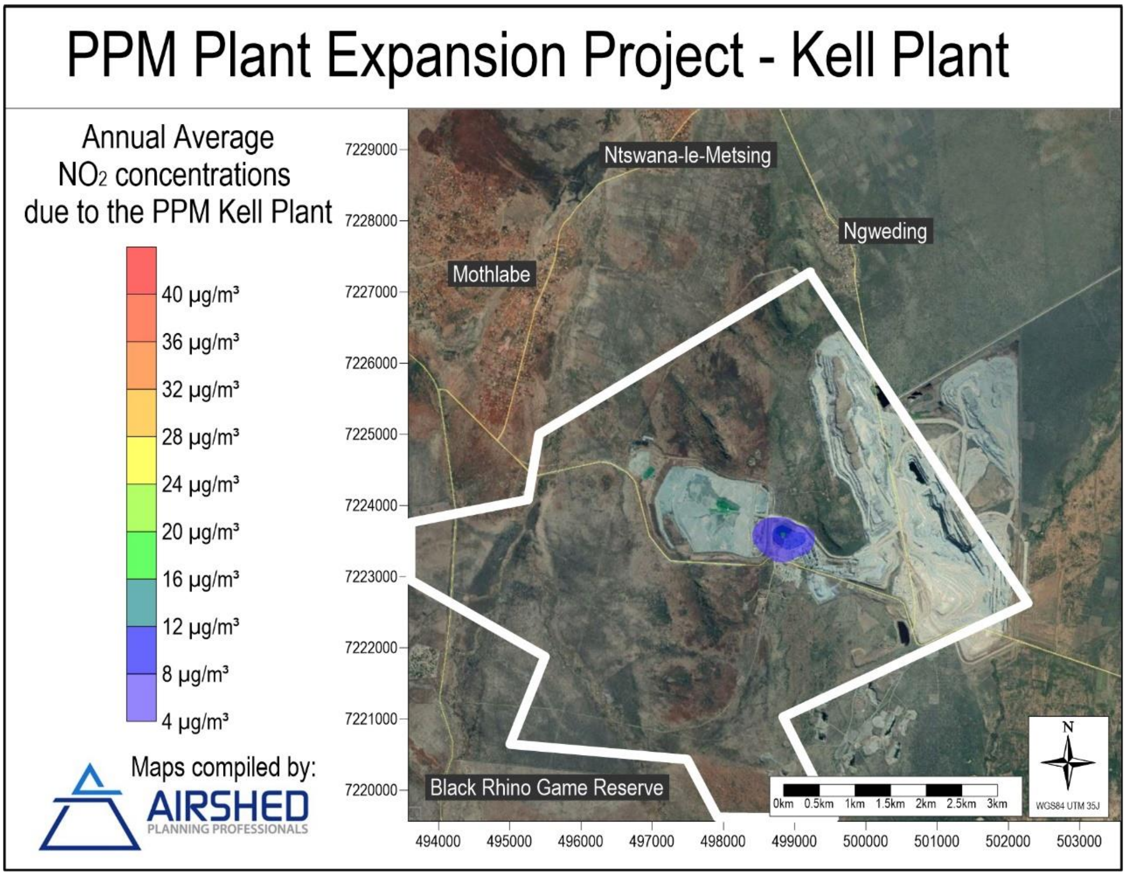


**Figure 5-6: Annual Average $NO_2$ Concentration due to PPM Kell Plant Sources**

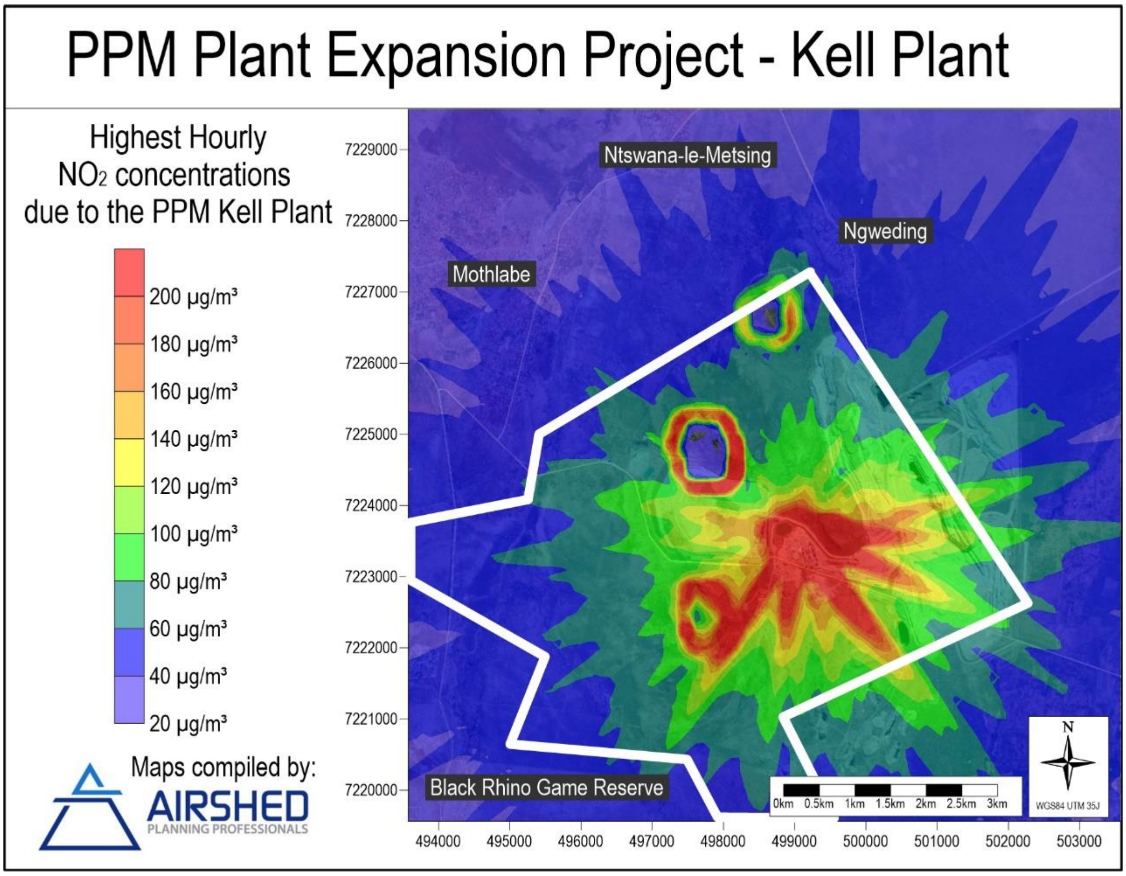


**Figure 5-7: Highest Hourly $NO_2$ Concentration due to PPM Kell Plant Sources**

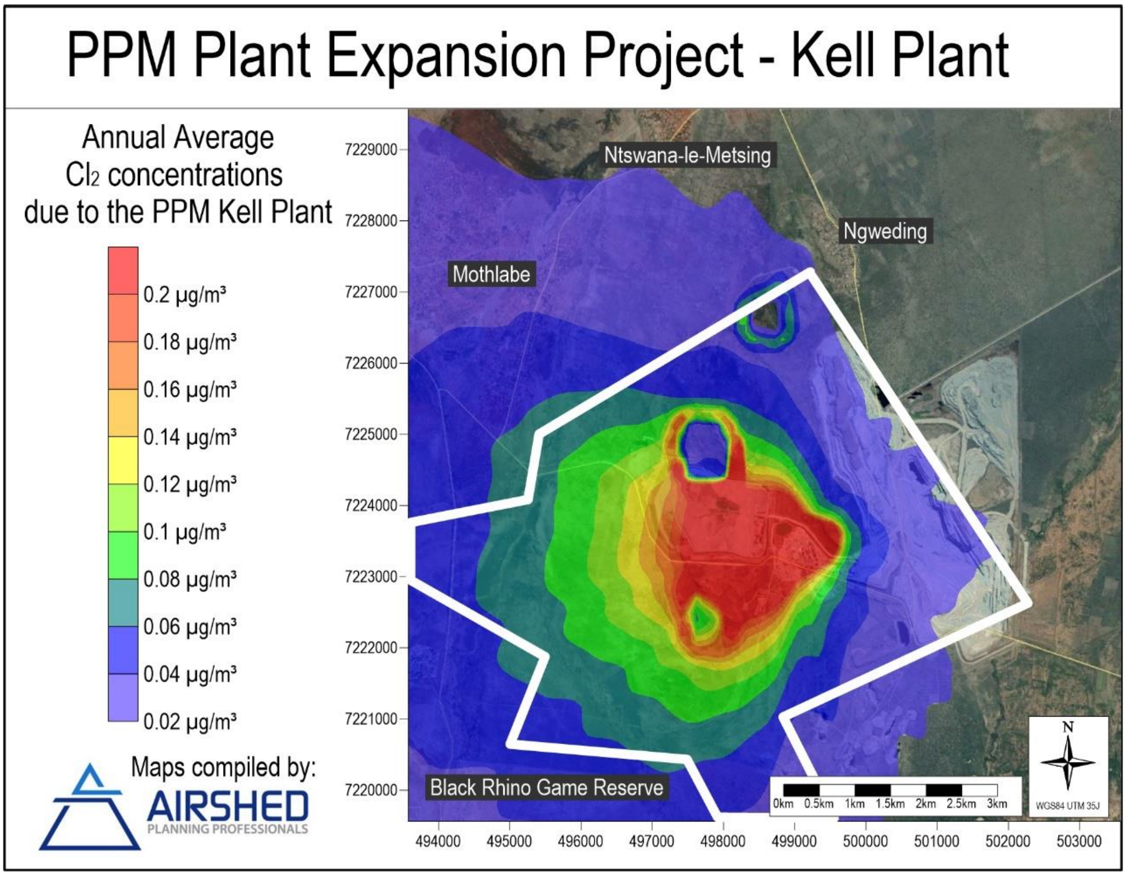


**Figure 5-8: Annual Average $Cl_2$ Concentration due to PPM Kell Plant Sources**

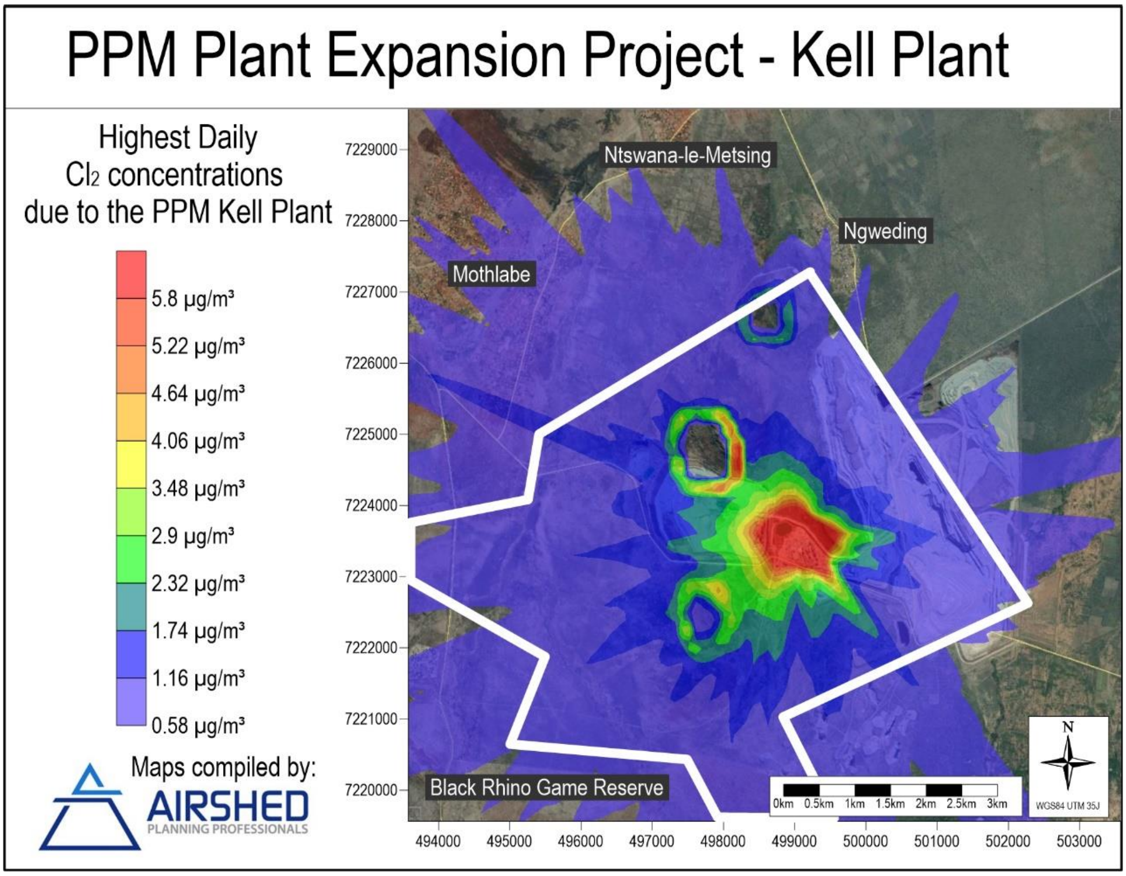


**Figure 5-9: Highest Daily $Cl_2$ Concentration due to PPM Kell Plant Sources**

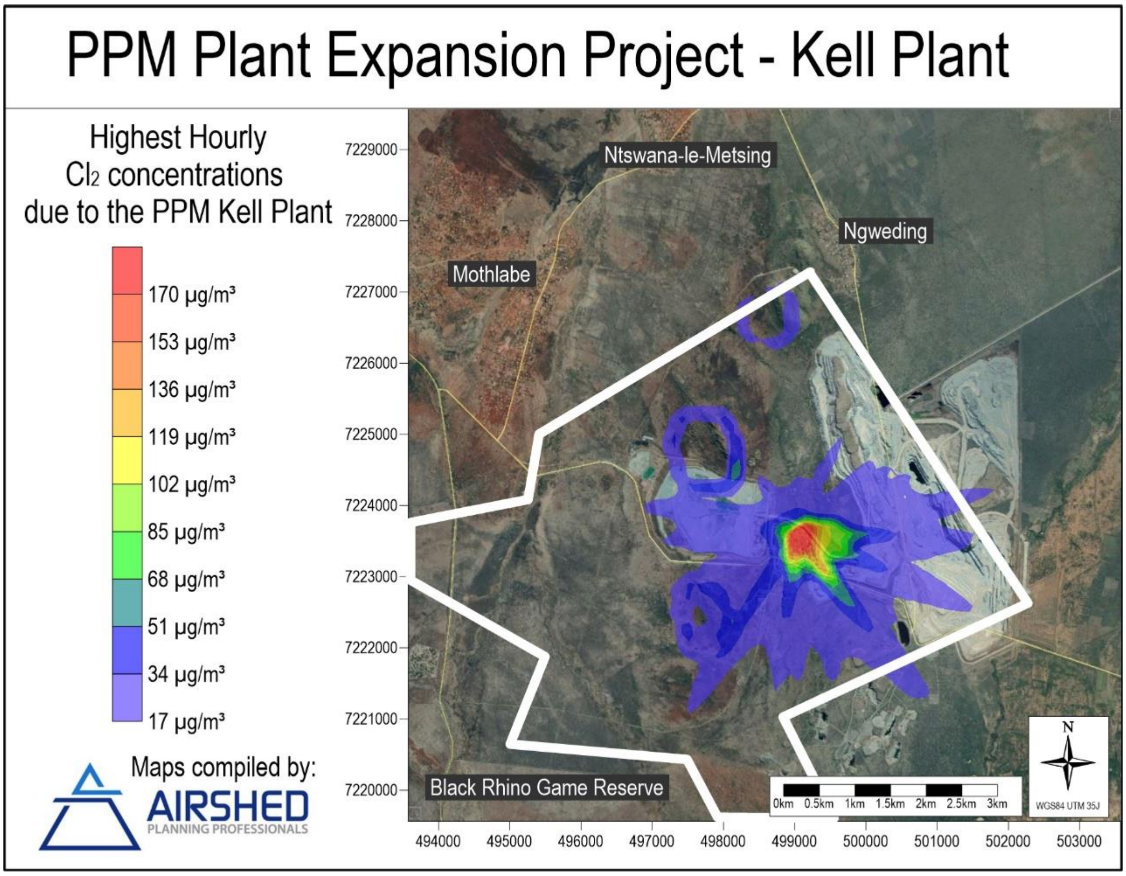


**Figure 5-10: Highest Hourly $Cl_2$ Concentration due to PPM Kell Plant Sources**

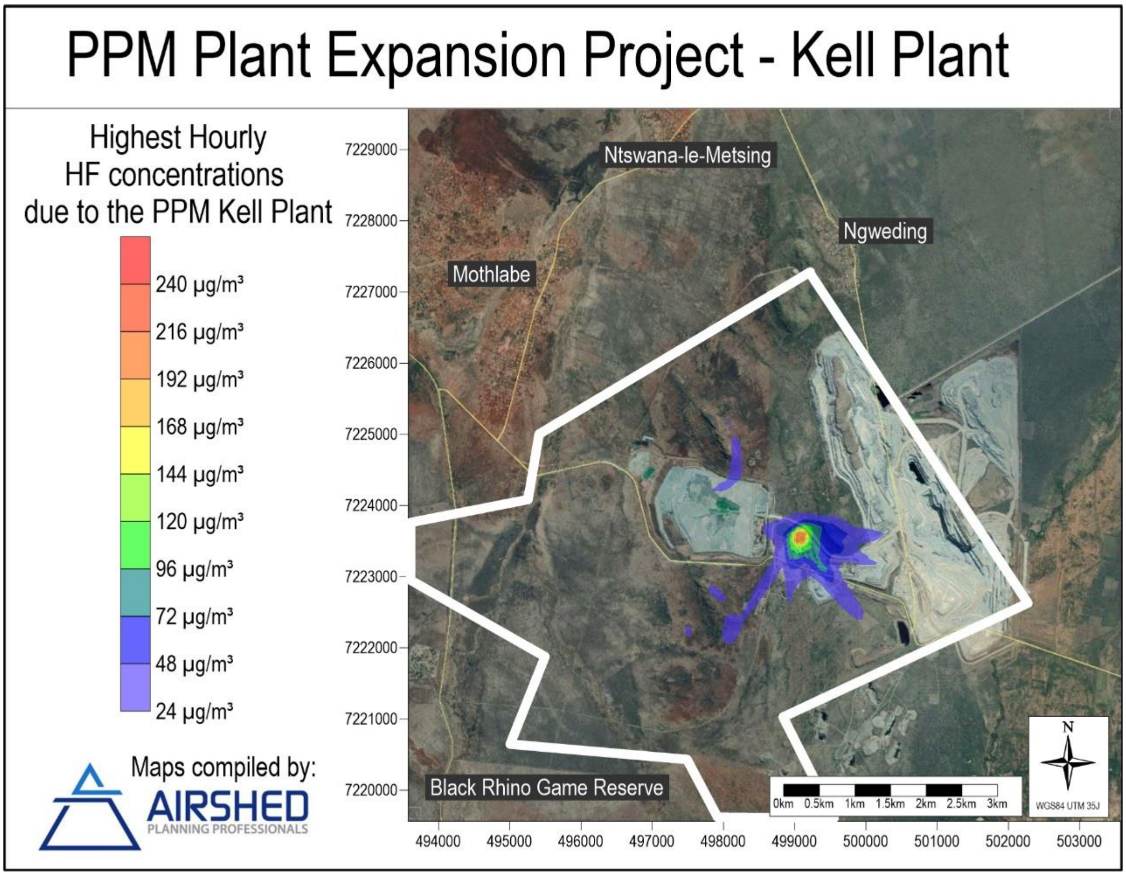


**Figure 5-11: Highest Hourly HF Concentration due to PPM Kell Plant Sources**

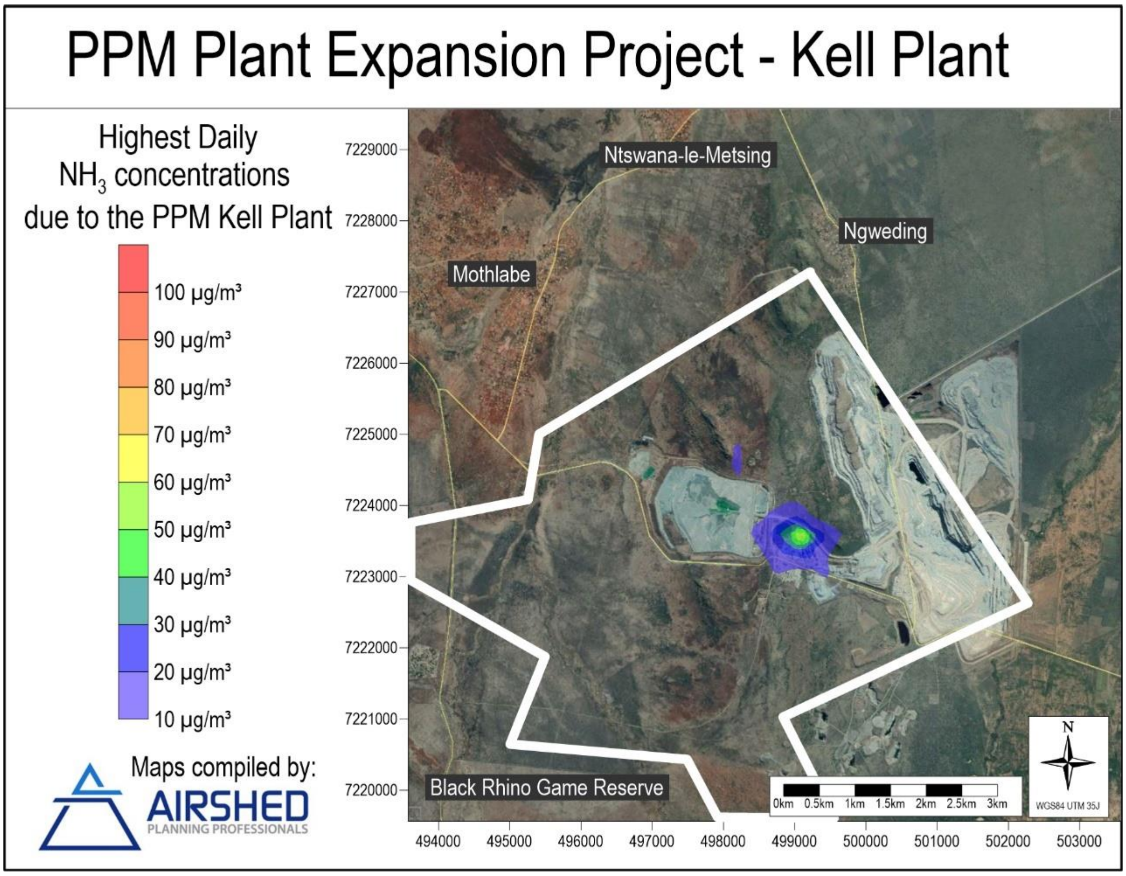


**Figure 5-12: Highest Daily $NH_3$ Concentration due to PPM Kell Plant Sources**

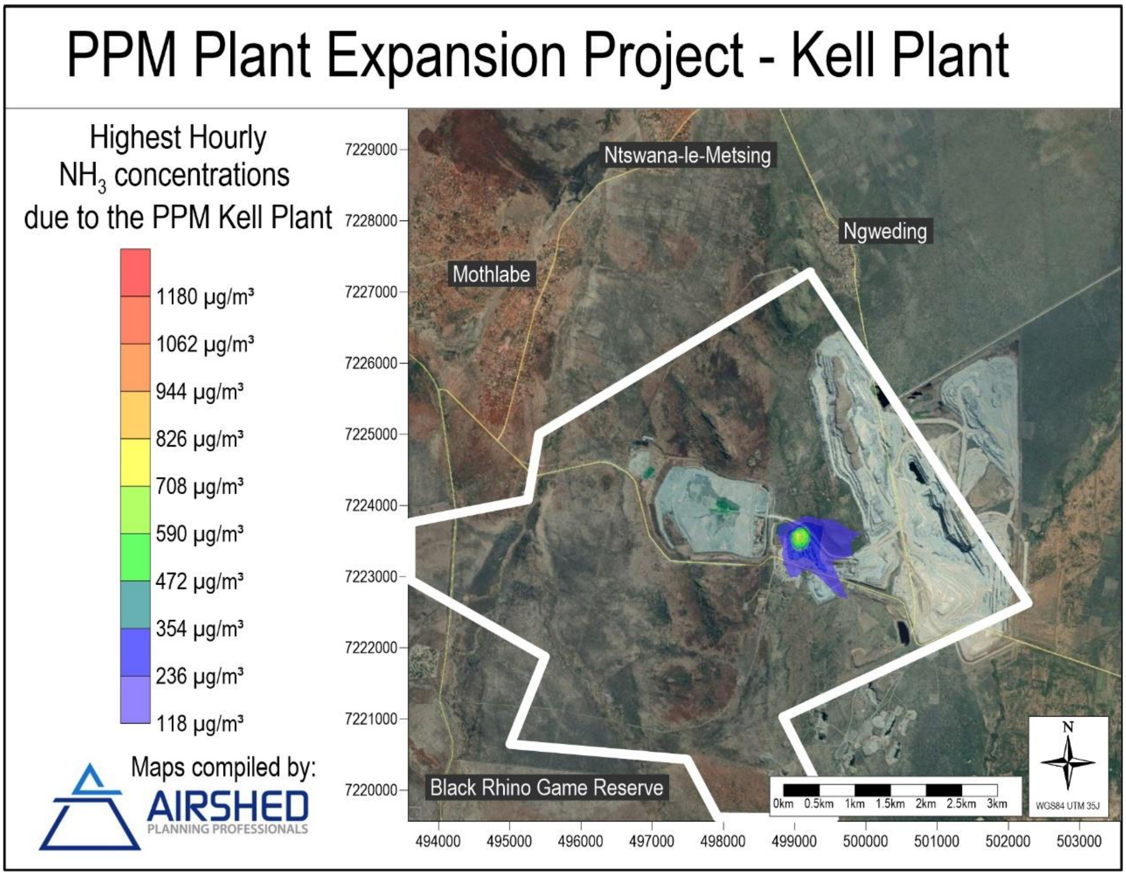


**Figure 5-13: Highest Hourly $NH_3$ Concentration due to PPM Kell Plant Sources**

# 6 CUMULATIVE IMPACTS AND IMPACT SIGNIFICANCE RATINGS

Cumulative impacts from the Kell Plant and the current PPM operations are expected to be negligible for the following reasons:

- $PM_{10}$ and $PM_{2.5}$ impacts from the Kell Plant are simulated to be localized to the Kell Plant operations.
- $SO_2$ and $NO_2$ impacts from the current PPM operations are insignificant according to dispersion modelling simulations previously completed for the current PPM operations (Grobler & Petzer, 2016) and $SO_2$ and $NO_2$ sampling conducted in the vicinity of the current Genset (Grobler, 2018).
- $Cl_2$, HCl, HF and $NH_3$ are not emitted by the current PPM operations.

The significance of impacts from the PPM Plant Expansion Project on the receiving environment is summarised in Table 6-1. It should be noted that operational phase impacts described in Table 6-1 reflect a “mitigated scenario”. The Kell Plant must be designed in such a manner that emissions comply with Subcategory 4.17 MES as described in Section 2.1, there is therefore no “unmitigated scenario”.

**Table 6-1: Impact Significance Ratings (only incremental impacts are shown, cumulative impacts are negligible, see above)**

| Activity | Impact | Nature (Negative or Positive Impact) | Probability | Duration | Scale | Magnitude/ Severity | Significance |
|---|---|---|---|---|---|---|---|
| **Construction and Closure Phases - UG2 Milling and Flotation Circuit, Kell Plant and Community Projects** | | | | | | | |
| Movement of vehicles on site, earthworks, demolition of buildings resulting in generation of dust | Ambient Air Quality – Nuisance Impact | Negative | Possible | Short term | Localised | Low | Low |
| **Operational Phase – UG2 Milling and Flotation Circuit** | | | | | | | |
| Gaseous and particulate pollutants | Ambient Air Quality | Negative | Seldom | Medium term | Localised | Low | Negligible |
| **Operational Phase – Kell Plant** | | | | | | | |
| Dust fallout | Ambient Air Quality – Nuisance Impact | Negative | Unlikely | Medium term | Localised | Low | Negligible |
| Particulate pollutants | Ambient Air Quality - Health Impact | Negative | Probable | Medium term | Localised | Low | Low |
| Gaseous priority pollutants ($SO_2$ and $NO_2$) | | Negative | Possible | Medium term | Beyond the site boundary | Low | Low |
| Other gaseous pollutants ($Cl_2$, HCl, HF and $NH_3$) | Ambient Air Quality - Health Impact | Negative | Possible | Medium term | Beyond the site boundary | High | Medium |

# 7 Conclusions and Recommendations

## 7.1 Conclusions

The hydrometallurgical (Kell) plant is expected to be the only significant source of emissions from the PPM Plant Expansion Project during the operational phase of the project. The UG2 milling and flotation circuit as well as the various community projects are not expected to result in atmospheric emissions apart from dust generated during the construction of these plants.

The Kell Plant is considered a listed activity (Subcategory 4.17) under Section 21 of NEM:AQA and requires an Atmospheric Emissions Licence (AEL) to operate. Emissions from the Kell Plant need to be in compliance with the Minimum Emission Standards for Subcategory 4.17. Pollutants arising from the Kell Plant include particulates, gaseous combustion pollutants ($SO_2$ and $NO_2$), chlorine ($Cl_2$), hydrogen chloride (HCl), hydrogen fluoride (HF) and possibly ammonia ($NH_3$).

If the Kell Plant is operated at or below the Subcategory 4.17 New Plant Minimum Emission Standards (MES), $PM_{10}$, $PM_{2.5}$, $NO_2$ and $SO_2$ concentrations are simulated to be in compliance with the SA NAAQS for the entire study area including at all areas outside the plant boundary and at all sensitive receptor locations. If the Kell Plant is operated at or below the Subcategory 4.17 MES, simulated concentrations of HCl, HF and $NH_3$ are below the most stringent identified international guidelines.

If the Kell Plant is operated at or below the Subcategory 4.17 MES, simulated $Cl_2$ concentrations exceed the COEHHA Chronic Reference Exposure Levels for up to 1.5km from the Kell Plant. Simulated $Cl_2$ concentrations outside the PPM property boundary (including at all sensitive receptor locations) are below the abovementioned guideline. It is imperative that the Kell Plant be operated with $Cl_2$ emissions below the Subcategory 4.17 MES to avoid health impacts at nearby sensitive receptor locations. Based on the simulated concentrations, odour impacts from gaseous pollutants are expected to be negligible.

## 7.2 Recommendations

It is recommended that the Kell Plant be operated with all pollutant emissions below the Subcategory 4.17 MES to avoid health impacts at nearby sensitive receptor locations. It is recommended that stacks at the Kell Plant be at least 5 meters in height but that the stack height of all stacks be maximised as far as is economically viable. A stack height of 12 meters is recommended. The PPM Kell Plant must be designed so that emissions from all point sources are in compliance with the Subcategory 4.17 MES. It is recommended that all stacks be sampled as soon as the plant is operational.

It is recommended that in addition to the current air quality monitoring undertaken at PPM, annual passive diffusive sampling of $Cl_2$, HCl and HF be conducted at the closest sensitive receptor locations namely the villages of Mothlabe and Ngweding. If sampled concentrations exceed the assessment criteria as described in Section 2.2.3, sources of these pollutants should be investigated and mitigation measures implemented if applicable. It is recommended that PPM employees as well as members of the surrounding communities be educated on the effects of $Cl_2$ (as well as HCl and HF) exposure and that all symptoms be reported on the PPM complaints register.

It is the opinion of the air quality specialist that should the PPM Plant Expansion Project be implemented, that the impact on the receiving environment would not be significant if the above recommendations are implemented.

# 8 REFERENCES


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# 9 APPENDIX A – 2015 TO 2017 DUST FALLOUT SAMPLING RESULTS.


**Figure 9-1: Residential Location Dust Fallout – 2017 sampling compared to 2015 and 2016 sampling.**

Non-residential Dust Fallout Sampling Results – 2015 to 2017

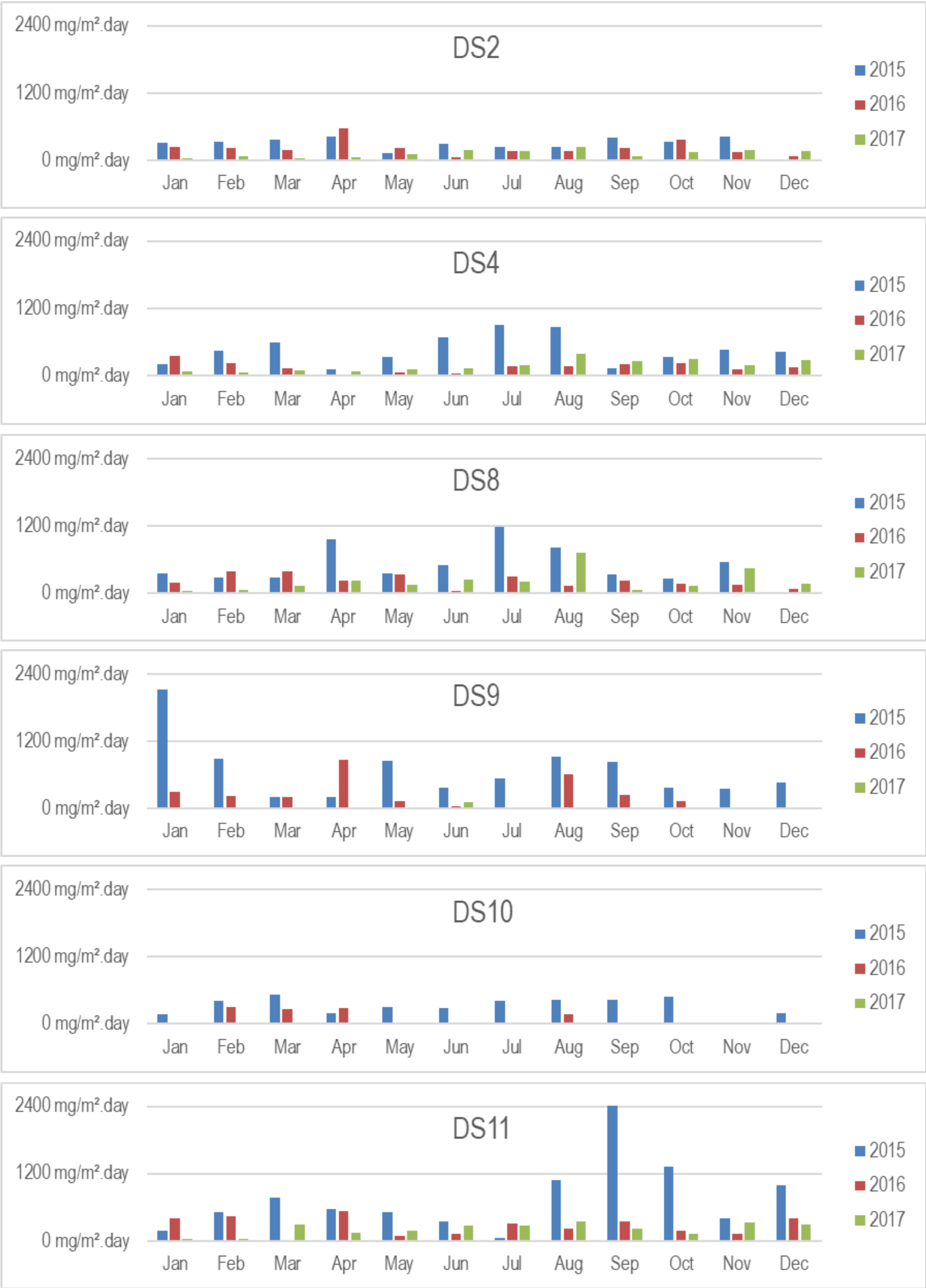


**Figure 9-2: Non-residential Location Dust Fallout – 2017 sampling compared to 2015 and 2016 sampling**

**Non-residential Dust Fallout Sampling Results – 2015 to 2017 (continued)**

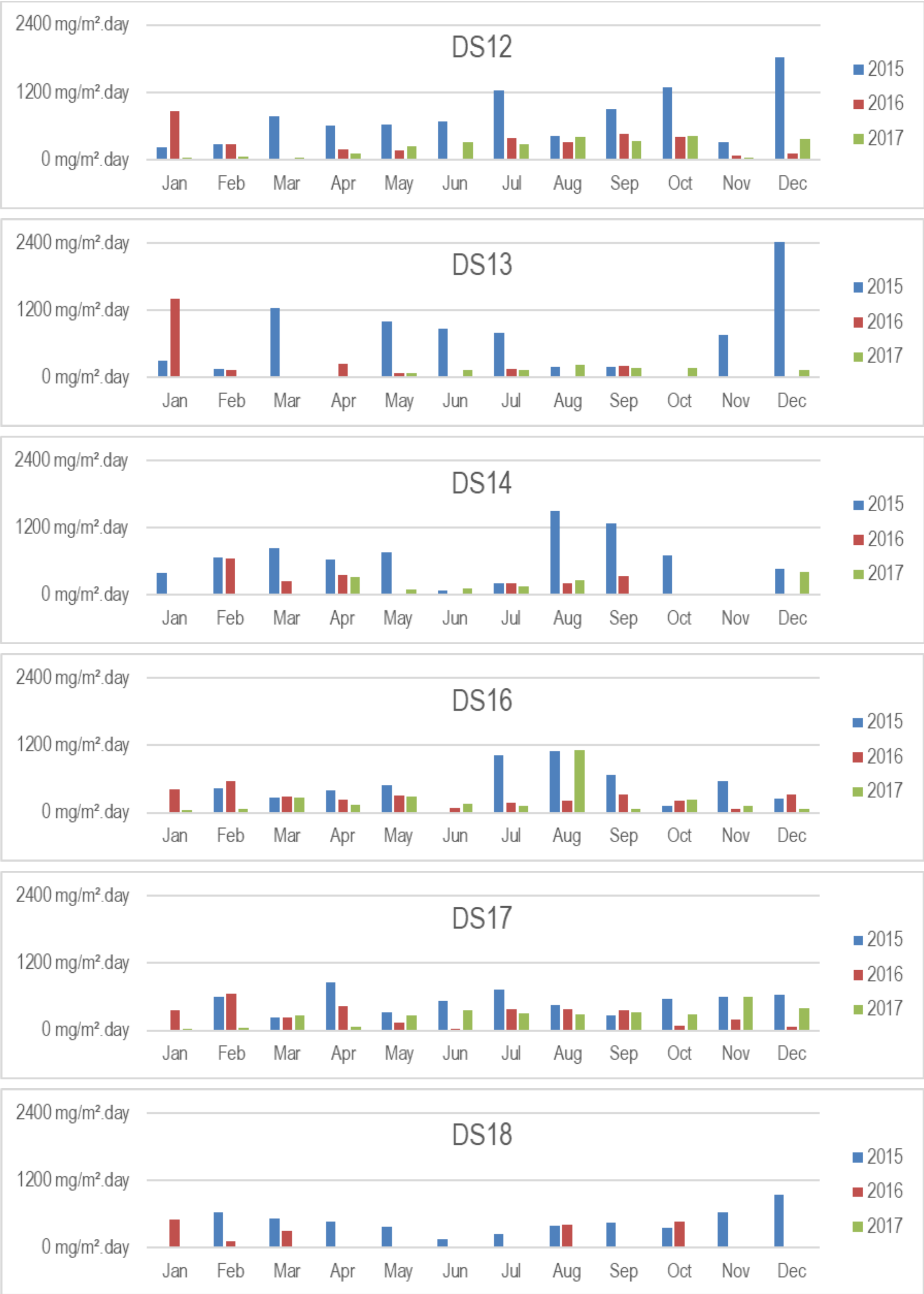


**Figure 9-3: Non-residential Location Dust Fallout – 2017 sampling compared to 2015 and 2016 sampling (continued).**

**Non-residential Dust Fallout Sampling Results – 2015 to 2017 (continued)**

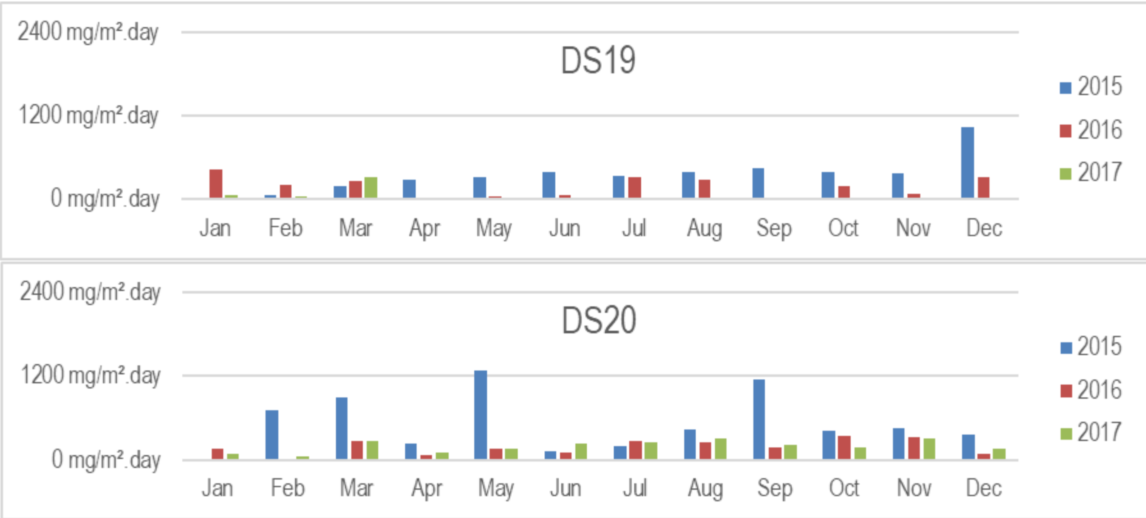


**Figure 9-4: Non-residential Location Dust Fallout – 2017 sampling compared to 2015 and 2016 sampling (continued).**

# 10 CURRICULUM VITAE– NB GROBLER

| | |
|---|---|
| **Name** | Nick Brian Grobler |
| **Date of Birth** | 14 August 1986 |
| **Nationality** | South African |
| **Employer** | Airshed Planning Professionals (Pty) Ltd |
| **Position** | Senior Air Quality Specialist |
| **Profession** | Chemical Engineer employed as an Air Quality Specialist |
| **Years with Firm** | 7.5 Years |

## Membership of Professional Societies

- Institution of Chemical Engineers (IChemE) – Associate Member – 2014 to present.
- Golden Key International Honour Society - 2011 to present.

## Experience

- Emissions inventory compilation
- Meteorological, topographical and land use data processing and preparation
- Dispersion modelling experienced in SCREEN, AERMOD, ADMS, CALPUFF and HAWK dispersion models.
- Impact and compliance assessment
- Air quality and dust management plan preparation
- Air quality monitoring program design and implementation
- Air quality monitoring set-up, training and processing of: dust fallout, $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_2$, $H_2S$, $O_3$, $NH_3$, HCl, VOCs, BTEX, CO, $CO_2$, $CH_4$, PAHs as well as meteorological station setup
- Environmental noise monitoring
- Atmospheric emission license application
- Industry sectors in which experience have been gained with specific reference to air quality include:
  - Opencast and underground mining of: copper, platinum, chrome, gold, iron, coal, limestone, potash, lead and zinc.
  - Production of: copper, platinum, gold, base metals, iron, coal, heavy mineral sands, vanadium, solder, lime, gypsum, asphalt, acetylene, vegetable oil, fertilizer, wood pulp, cement, oil recycling, tyre pyrolysis as well as meat processing and rendering at abattoirs and animal waste incineration.

## Software Proficiency

- Atmospheric Dispersion Models: AERMOD, ISC, CALPUFF, ADMS (United Kingdom), HAWK, TANKS
- Other: Golden Software Surfer, Lakes Environmental WRPlot, MS Word, MS Excel, MS PowerPoint, Adobe Dreamweaver

## Education

- BEng (Chemical Engineering) University of Pretoria – Completed in 2009
- BEng (Hons) (Environmental Engineering) University of Pretoria – Completed in 2010

## Courses Completed

- Spreadsheets as an Engineering Tool, Presented by the University of Pretoria, RSA (September 2012)

## Courses Presented

- NWU Centre for Environmental Management Essential Air Quality Management Course

## Countries of Work Experience

South Africa, Zimbabwe, Namibia, Mozambique, Zambia, Democratic Republic of Congo, Republic of Congo, Ghana, Mali, Guinea, Saudi Arabia

## Languages

| Language | Proficiency |
|---|---|
| English | Full proficiency |
| Afrikaans | Full proficiency |

# 11 DECLARATION OF INDEPENDENCE

**DECLARATION OF INDEPENDENCE - PRACTITIONER**

**Name of Practitioner: Nick Grobler**

**Name of Registration Body: Institution of Chemical Engineers**

**Professional Registration No.: 99963196 – Associate Member**

Declaration of independence and accuracy of information provided:

**Atmospheric Impact Report in terms of section 30 of the Act.**

I, **Nick Brian Grobler** , declare that I am independent of the applicant. I have the necessary expertise to conduct the assessments required for the report and will perform the work relating the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. I will disclose to the applicant and the air quality officer all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the air quality officer. The information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at **Midrand** on this **27** day of **November 2018**

**SIGNATURE**

Senior Air Quality Specialist
**CAPACITY OF SIGNATORY**