Air Quality Specialist Report for the Proposed Coal-fired Power Generation Project at Transalloys (Pty) Ltd, eMalahleni

Project done on behalf of **Savannah Environmental (Pty) Ltd**

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Report Title	Air Quality Specialist Report for the Proposed Coal-fired Power Generation Project at Transalloys (Pty) Ltd, eMalahleni
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Notice	Airshed Planning Professionals (Pty) Ltd is a consulting company located in Midrand, South Africa, specialising in all aspects of air quality, ranging from nearby neighbourhood concerns to regional air pollution impacts as well as noise impact assessments. The company originated in 1990 as Environmental Management Services, which amalgamated with its sister company, Matrix Environmental Consultants, in 2003.
Declaration	I, Oladapo Akinshipe, as authorised representative of Airshed Planning Professionals (Pty) Ltd hereby confirm my independence as a specialist and declare that neither I nor Airshed Planning Professionals (Pty) Ltd have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Airshed Planning Professionals (Pty) Ltd was appointed as air quality specialists in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the assessment summarised in this report. I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in this report.
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Acknowledgements	The authors would like to thank Eskom for providing meteorological data from its monitoring station at Kendal.

Revision Record

Revision Number	Date	Reason for Revision
0.0	13th May 2019	Draft for client review

Specialist Report Requirements

	A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	Relevant section in report
a	details of- (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Report details (page i) Section 9.3 (Appendix C)
b	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Report details (page i)
c	an indication of the scope of, and the purpose for which, the report was prepared;	Section 1.1
d	the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 3.5
e	a description of the methodology adopted in preparing the report or carrying out the specialised process;	Sections 1.3 and 4.1
f	the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;	Sections 3.1 and 3.2
g	an identification of any areas to be avoided, including buffers;	Sections 4.3 and 6.4
h	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;	Sections 1.2, Figure 1 and Section 4.3
i	a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.4
j	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 4, Section 5 and Section 7
k	any mitigation measures for inclusion in the EMPr;	Sections 6.2 and 6.3
l	any conditions for inclusion in the environmental authorisation;	Sections 6.2, 6.3, 6.4 and 6.5
m	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Sections 6.3.1 and 6.3.2
n	a reasoned opinion- (I) as to whether the proposed activity or portions thereof should be authorised; and (ii) 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 EMPr, and where applicable, the closure plan;	Sections 6.2, 6.3, 6.4, 6.5 and 7
o	a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 6.5
p	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Not applicable
q	any other information requested by the competent authority.	Not applicable

Abbreviations

ADF	Ash disposal facility
AERMIC	AMS/EPA Regulatory Model Improvement Committee
Airshed	Airshed Planning Professionals (Pty) Ltd
APPA	Air Pollution and Prevention Act
AQG	Air Quality Guideline (World Health Organisation)
AQSR	Air Quality Sensitive Receptor
ASG	Atmospheric Studies Group
ASTM	American Society for Testing and Materials
CE	Control Efficiency
DEA	Department of Environmental Affairs (South Africa)
EETM	Emissions Estimation Technique Manual
ESL	Effects Screening Levels
GLC(s)	Ground Level concentration(s)
GLCC	Global Land Cover Characterisation
IFC	International Finance Corporation
MESs	Minimum Emission Standards
MRLs	Minimal risk levels
NAAQS	National Ambient Air Quality Standards (South Africa)
NDCR	National Dust Control Regulations
NEMAQA	National Environmental Management Air Quality Act (South Africa)
NPI	National Pollutant Inventory (Australia)
SA	South Africa(n)
SABS	South African Bureau of Standards
Savannah	Savannah Environmental (Pty) Ltd
Transalloys	Transalloys (Pty) Ltd
TSP	Total Suspended Particulates
US EPA	United States Environmental Protection Agency
WHO	World Health Organization

Glossary

Air pollution	This 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
Ambient Air	This is defined as any area not regulated by Occupational Health and Safety regulations
Atmospheric emission or emission	Any emission or entrainment process emanating from a point, non-point or mobile source that results in air pollution
Averaging period	This implies a period of time over which an average value is determined
Dispersion	The spreading of atmospheric constituents, such as air pollutants
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
Mechanical mixing	Any mixing process that utilizes the kinetic energy of relative fluid motion
Oxides of nitrogen (NO_x)	The sum of nitrogen oxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide (NO_2)
Particulate Matter (PM)	These comprise a mixture of organic and inorganic substances, ranging in size and shape. These 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 (TSP) 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, however, suspended particles larger than 75 to 100 µm do not travel far and deposits 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. Also referred to as PM_{10}, it 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 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 ($PM_{2.5}$) 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.
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

Symbols and Units

°C	Degree Celsius
µg	Microgram(s)
µg/m³	Micrograms per cubic meter
CO	Carbon monoxide
CO_2	Carbon dioxide
L_{MO}	Monin-Obukhov Length
m/s	Meters per second
m^2	Metres squared
mg	Milligram(s)
mg/m³	Milligrams per cubic meter
mm	Millimeters
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
O_3	Ozone
Pb	Lead
PM	Particulate Matter
PM_{10}	Thoracic particulate matter
$PM_{2.5}$	Respirable particulate matter
SO_2	Sulfur dioxide
VOC(s)	Volatile organic compound(s)

Executive Summary

Introduction

Transalloys (Pty) Ltd (Transalloys) is a ferro-metal plant recovering Silicon Manganese (SiMn) from its ore. Transalloys is located 9 kilometres south-west of Witbank (eMalahleni) in Mpumalanga province and directly south of the N4 freeway between Pretoria and Nelspruit. It is situated on portions 34 and 35 of the farm Elandsfontein 309JS and portions 20 and 24 of the farm Schoongezicht 308JS. It is bounded to the south-east by Clewer, a small township south-west of Witbank. The site falls within the jurisdiction of the eMalahleni Local Municipality, a constituent of the Nkangala District Municipality. Land use activities in the Transalloys neighbourhood include agriculture, residential, industrial and mining.

Transalloys proposes to install a coal-fired power station to meet the needs of its existing operations (the proposed Project). The proposed power plant will have a generation capacity ranging from 120 to 150 mega Watt (MW) in order to meet Transalloys' current and future energy demands. The proposed power plant will make use of Circulating Fluidised Bed (CFB) boiler technology which utilizes low-grade coal and coal discards, which could be sourced from nearby coal mines.

The air quality impact assessment forms part of the Environmental and Socio-Economic Impact Assessment (ESEIA) for the proposed project which will assess the impact of 120 MW to 150 MW coal-fired power station and associated coal handling and transport systems, as well as an ash disposal facility (ADF).

The construction, operation and closure phases of the project may impact ambient air quality in the vicinity of the project. Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by Savannah Environmental (Pty) Ltd (Savannah) to undertake the air quality impact assessment for the proposed Project. The study is conducted as an amendment to the impact assessment study conducted in 2014 (with an originally proposed capacity of 150MW). The study also reflects new power plant and ash storage facility layout located within the project implementation sites assessed in 2014 and successfully approved through the 2nd March 2016 Environmental Authorisation (as per the final EIR dated May 2015). Currently, both a Water Use Licence (WUL) process and an Atmospheric Emissions Licence (EAL) are being submitted in parallel to the proposed Part II amendment process required for the amendment of the layout, amongst others.

Scope and Approach

The aim of this investigation was to determine baseline air quality conditions, delineate sensitive receptors, identify potential impacts to air quality that may arise from the proposed Project and provide an assessment of the amendment proposal in terms of changes to impact rating from the 2014 study.

The following tasks, typical of an air quality impact assessment, were included in the scope of work:

- A review of proposed project activities in order to identify sources of emission and associated pollutants.
- A study of regulatory requirements and health thresholds for identified key pollutants against which compliance is to be assessed and health risks screened.
- A study of the receiving environment in the vicinity of the project; including:
  - The identification of potential air quality sensitive receptors (AQSRs);
  - A study of the atmospheric dispersion potential of the area taking into consideration local meteorology, land-use and topography; and

- The analysis of all available ambient air quality information/data to determine pre-development ambient pollutant levels and dustfall rates.

- The compilation of a comprehensive emissions inventory.
- Atmospheric dispersion modelling to simulate ambient air pollutant concentrations and dustfall rates as a result of the project.
- A screening assessment to determine:
    - Compliance of criteria pollutants with National Ambient Air Quality Standards (NAAQSs); and
    - Nuisance dustfall gauged against the National Dust Control Regulations (NDCR).
- The ranking of impact significance based on the methodology adopted by Savannah, and comparison with impact ratings from the 2014 study.
- The compilation of a comprehensive air quality specialist report detailing the study approach, limitations, assumption, results and recommendations of mitigation and management of air quality impacts.

The air quality impact assessment included a study of the receiving environment and the quantification and assessment of the impact of the Transalloys Power Project on human health and the environment. The receiving environment was described in terms of local atmospheric dispersion potential, the location of AQSRs in relation to proposed activities as well as ambient pollutant levels and dustfall rates.

A comprehensive atmospheric emissions inventory was compiled for the construction and operational phase of the project. Pollutants quantified included those most commonly associated with power projects i.e. particulate matter (PM) (TSP, PM_{10}, and $PM_{2.5}$[1]), oxides of nitrogen (NO_x) and sulfur dioxide (SO_2). In the quantification of operational phase impacts, mitigation as provided by Savannah was utilized.

Meteorological data was obtained from eMalahleni monitoring station of the South African Weather Services (SAWS) for the period January 2016 to December 2018. The weather station is located ~9 km northeast of Transalloys and is considered representative of the weather conditions at Transalloys.

In simulating pollutants dispersion, two operational phase scenarios were quantified to represent the difference in emissions as follows:

- Design specification emissions – represents emissions based on Transalloys power plant and as disposal facility design specifications and MESs.
- Emissions due to additional mitigation – based on additional mitigation applied to fugitive emission sources beyond the design specifications.

Main Findings

This section summarises the main findings of the assessment.

- The receiving environment:
    - The area is dominated by winds from the north, north-northwest, east, east-southeast and west, with an average wind speed of 3.3 m/s measured over the 2016 to 2018 period.

[1] See Glossary for definitions

- Ambient air pollutant levels in the proposed Project area are currently affected by the following sources of emission: the existing Transalloys ferro-metal plant; mining activities to the east, south-east and south; and a steel processing plant to the west. Ferrobank, an Industrial area hosting various manufacturing and processing plants, is situated about 5 km to the north east. Other activities and sources of pollution in the region include: mining; chemical and metallurgical industries; vehicle tailpipe emissions; agriculture; domestic fuel combustion; and open areas exposed to wind erosion.
- Pollutants released in the region include but are not limited to, fugitive $PM_{2.5}$, PM_{10} and TSP, as well as metallic and gaseous pollutants, which are products of the processing of ore and combustion of petrol, diesel and coal.
- Transalloys continuously measures PM_{10} concentrations and dustfall rates. Analysis of the results are discussed as follows:
  - The 2016/2017 results indicate elevated (non-compliant) PM_{10} concentrations at Transalloys weighbridge and at Clewer, an AQSR.
  - Results from 2013 and 2015 obtained at Transalloys Weighbridge (on-site) and the Clewer Primary School (off-site) monitoring stations indicate elevated PM_{10} concentrations in exceedance of the 24-hour NAAQS. Calculated period average PM_{10} concentrations did not exceed the annual average NAAQS of 40 $\mu g/m^3$, but only marginally.
  - More recent results (August 2018 to January 2019) obtained from both locations did not exceed the daily or the annual NAAQS.
  - Dustfall results from October 2015 to January 2019 indicate compliant dustfall deposition rates at five on-site and two residential sampling locations. Dustfall rates are generally low.
- The nearest AQSRs are Clewer and Kwa-Guqa. Clewer is immediately adjacent to the existing Transalloys premises and the proposed power station location. Kwa-Guqa is situated north of the proposed project.

- Impact of the proposed Project:
  - Construction/closure phases:
    - Construction and closure phase emissions were not quantified since, as for most power plant projects, the emissions are expected to be less than the operational phase. Unmitigated and mitigated incremental significance rating due to construction phase emissions were assigned a ***'low'*** rating. Post-mitigation cumulative impacts were qualitatively assigned a ***'low'*** rating.
  - Operational phase:
    - Sources of emission quantified included crushing and screening, materials handling, vehicles travelling on unpaved and paved roads, windblown dust from stockpiles and the ash disposal facility, vehicle exhaust and stack emissions.
    - Operational phase PM emissions ($PM_{2.5}$, PM_{10} and TSP) and gaseous emissions (CO, NO_x, SO_2 and VOC) were quantified and used in simulations.
    - The release of $PM_{2.5}$, PM_{10} and NO_2 during the operational phase are expected to result in exceedances of both long term (annual) and short term (1-hour and/or 24-hour) ambient air quality criteria off-site. A

significance weighting of ***'medium'*** was assigned to potential inhalation health impacts associated with unmitigated incremental $PM_{2.5}$, PM_{10} and NO_2 emissions.

- The study assumed some basic fugitive dust mitigation measures (mostly dust suppression with water) to reduce PM emissions from fugitive sources. Whereas the impact significance associated with $PM_{2.5}$ and PM_{10} may reduce, the significance still indicates a ***'medium'*** weighting. Post-mitigation cumulative $PM_{2.5}$ and PM_{10} impacts were assigned a ***'medium'*** impact rating due to elevated background levels in the area.
- Although mitigation options for NO_2 were not quantified, the impact significance thereof can be reduced by looking at technology options to reduce emissions from vehicle exhaust and diesel engines.
- Dustfall as a result of unmitigated PM emissions may exceed the criteria for residential areas at the closest residences of Clewer. Hence, an impact significance rating of ***'medium'*** was assigned. With basic mitigation measures in place to suppress fugitive dust, the impact significance rating can be reduced to ***'low'.*** Cumulative impacts were qualitatively assigned a ***'medium'*** rating.
- Simulated CO, SO_2 and VOC concentrations are very minimal with impact significance ratings expected to be ***'low".*** Cumulative impacts were qualitatively assigned a ***'medium'*** rating due to elevated levels in the area.
- A stack sensitivity study was conducted utilizing varying stack heights from 100 m to 200 m. The result of the sensitivity study indicates that a change in stack height between 100 m and 200 m has little or no effect in GLCs. Also, since the contribution of stack emission to overall plant impact is negligible, it is expected that the effect of stack height (between 100 m and 200 m) will be insignificant. Hence, a stack height between 100 m and 150m is considered adequate for the project.
- Additional impacts due to upset conditions are also expected to be insignificant. The impact contribution due to upset conditions is expected to be negligible when compared to the overall plant impacts. Thus, impacts during upset conditions will be similar to normal conditions.
- Carbon footprint (direct emissions only) calculated for the proposed Transalloys Power Project was in excess of the 100 000 tons CO_2 equivalent, beyond which a pollution prevention plan is required to be submitted to the Minister of Environment. However, the actual footprint of the proposed project can only be ascertained in a full carbon footprint assessment which will include the identification, documentation and assessment of GHG reduction and energy efficiency improvement opportunities, and the development of a GHG and energy efficiency action plan.

Recommendations

In this study, the proposed amendment to the layout (power plant and ADF), as well as the amendment to the range in output capacity (120 MW to 150 MW) did not result in any significant change to the pollutants impact rating assessed in the 2014 study. Hence, it is the specialist opinion that the proposed amendment be authorised, provided the recommended air quality mitigation and management measures are implemented to ensure the lowest possible impact on Clewer, Kwa-Guqa and the environment. The recommended management measures include the following:

- The mitigation and management of sources of major emissions – ensuring compliance with NAAQS at both the existing Transalloys ferro-metal plant boundary and the proposed Transalloys Power Project (when operational), will result in significant reduction in elevated levels measured at Clewer.

  Therefore, management and mitigation of operational phase impacts should ensure concerted efforts to mitigate impacts at the existing Transalloys ferro-metal plant as well as the proposed Transalloys Power Project. As a management measure, ambient PM and NO_2 concentrations at Clewer and other AQSRs such as Kwa-Guga should be targeted to comply with the NAAQS during the construction phase of the proposed project. On-site emissions monitoring during the construction phase will provide insight as to the levels to be anticipated during operation (since construction phase emissions are generally lower than operational phase and intermittent in nature.

- Ambient air quality monitoring – Ambient PM, SO_2 and NO_2 concentrations at Clewer and other areas need to comply with the NAAQS during the construction phase of the proposed project, in order to provide an indication of the concentration levels to be anticipated during the operational phase.

Also, with the proposed project located within the Highveld Priority Area, where the background concentrations of PM_{10} and SO_2 are already elevated, it is recommended that the management plan for the Highveld Priority Area outlined in this report be included in all management plan proposed for the project.

Finally, the findings from the study are only valid provided that the MESs set out in Section 21 of the National Environmental Management Air Quality Act (sub-section 1.1) are not exceeded for the boiler stack emissions. It is recommended, therefore, that a stack emission measurement campaign be conducted once the proposed power project is fully operational. This is to confirm that the emissions fall within their required standards.

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1 INTRODUCTION

Transalloys (Pty) Ltd (Transalloys) is a ferro-metal plant recovering Silicon Manganese (SiMn) from its ore. Transalloys is located 9 kilometres south-west of Witbank (eMalahleni) in Mpumalanga province and directly south of the N4 freeway between Pretoria and Nelspruit. It is situated on portions 34 and 35 of the farm Elandsfontein 309JS and portions 20 and 24 of the farm Schoongezicht 308JS. It is bounded to the south-east by Clewer, a small township south-west of Witbank. The site falls within the jurisdiction of the eMalahleni Local Municipality, a constituent of the Nkangala District Municipality. Land use activities in the Transalloys neighbourhood include agriculture, residential, industrial and mining.

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The air quality impact assessment forms part of the Environmental and Socio-Economic Impact Assessment (ESEIA) for the proposed project which will assess the impact of a 120 MW to 150 MW coal-fired power station and associated coal handling and transport systems, as well as an ash disposal facility (ADF). The location of the existing and proposed Transalloys complex is depicted in Figure 1.

The construction, operation and closure phases of the project may impact ambient air quality in the vicinity of the project. Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by Savannah Environmental (Pty) Ltd (Savannah) to undertake the air quality impact assessment for the proposed Project. The study is conducted as an amendment to the impact assessment study conducted in 2014 (with an originally proposed capacity of 150MW). The study also reflects new power plant and ash storage facility layout located within the project implementation sites assessed in 2014 and successfully approved through the 2nd March 2016 Environmental Authorisation (as per the final EIR dated May 2015). Currently, both a Water Use Licence (WUL) process and an Atmospheric Emissions Licence (EAL) are being submitted in parallel to the proposed Part II amendment process required for the amendment of the layout, amongst others.

1.1 Scope of Work

The aim of this investigation was to determine baseline air quality conditions, delineate sensitive receptors, identify potential impacts to air quality that may arise from the proposed Project and provide an assessment of the amendment proposal in terms of changes to impact rating from the 2014 study. The following tasks were included in the scope of work:

- A review of proposed project activities in order to identify sources of emission and associated pollutants.
- A study of regulatory requirements and health thresholds for identified key pollutants against which compliance is to be assessed and health risks screened.
- A study of the receiving environment in the vicinity of the project; including:
  - The identification of potential air quality sensitive receptors (AQSRs);
  - A study of the atmospheric dispersion potential of the area taking into consideration local meteorology, land-use and topography; and
  - The analysis of all available ambient air quality information/data to determine pre-development ambient pollutant levels and dustfall rates.

- The compilation of a comprehensive emissions inventory;
- Atmospheric dispersion modelling to simulate ambient air pollutant concentrations and dustfall rates as a result of the project.
- A screening assessment to determine:
  - Compliance of criteria pollutants with National Ambient Air Quality Standards (NAAQSs);
  - Potential health risks as a result of exposure to non-criteria pollutants; and
  - Nuisance dustfall evaluated against the National Dust Control Regulations (NDCR).
- The ranking of impact significance based on the methodology adopted by Savannah, and comparison with impact ratings from the 2014 study.
- The compilation of a comprehensive air quality specialist report detailing the study approach, limitations, assumption, results and recommendations of mitigation and management of air quality impacts.

1.2 Description of Project Activities from an Air Quality Perspective

Air quality impacts will be associated with four distinct phases namely: the construction phase, the operational phase, the decommissioning phase and the post-closure phase. A description of each of these phases, from an air quality impact perspective is summarised below.

Construction will typically include land clearing of the construction footprint, general construction activities (i.e. bulk earthworks and infrastructure development for the plant, buildings, dams, onsite roads etc.), bulldozing, truck unloading and grading activities. These operations will likely result in fugitive[2] PM emissions as well as particulate and gaseous vehicle exhaust emissions. Gaseous emissions, associated with the combustion of diesel, mainly include carbon monoxide (CO), oxides of nitrogen (NO_x), sulfur dioxide (SO_2) and volatile organic compounds (VOC).

During the **operational phase,** fugitive $PM_{2.5}$, PM_{10} and TSP emissions will result mainly as a result of the following; conveying and handling of coal, ash and limestone, crushing and screening, traffic on paved and unpaved haul routes and open dusty areas exposed to the wind. Exhaust emissions from diesel mobile equipment, generators, auxiliary boilers and fire water pumps will result in additional $PM_{2.5}$ PM_{10} and TSP as well as CO, NO_x, SO_2 and VOC emissions.

It is important to note that, in the discussion, regulation and estimation of PM emissions and impacts, a distinction is made between different particle size fractions, *viz*. TSP, PM_{10} and $PM_{2.5}$. PM_{10} is defined as particulate matter with an aerodynamic diameter of less than 10 µm and is also referred to as thoracic particulates. Inhalable particulate matter, $PM_{2.5}$, is defined as particulate matter with an aerodynamic diameter of less than 2.5 µm. Whereas PM_{10} and $PM_{2.5}$ fractions are considered to determine the potential for human health risks, total suspended particulate matter (TSP) is included to assess nuisance dustfall.

The **closure phase** will include fugitive PM generating activities such as bulk earthworks, demolition and re-vegetation. *Incremental* impacts due to the closure phase are expected to be of low significance. With the successful implementation of a closure and rehabilitation plan, no atmospheric emissions will be expected during the **post-closure phase**.

[2] Fugitive emissions refer to emissions that are spatially distributed over a wide area and not confined to a specific discharge point as would be the case for process related emissions (IFC, 2007)

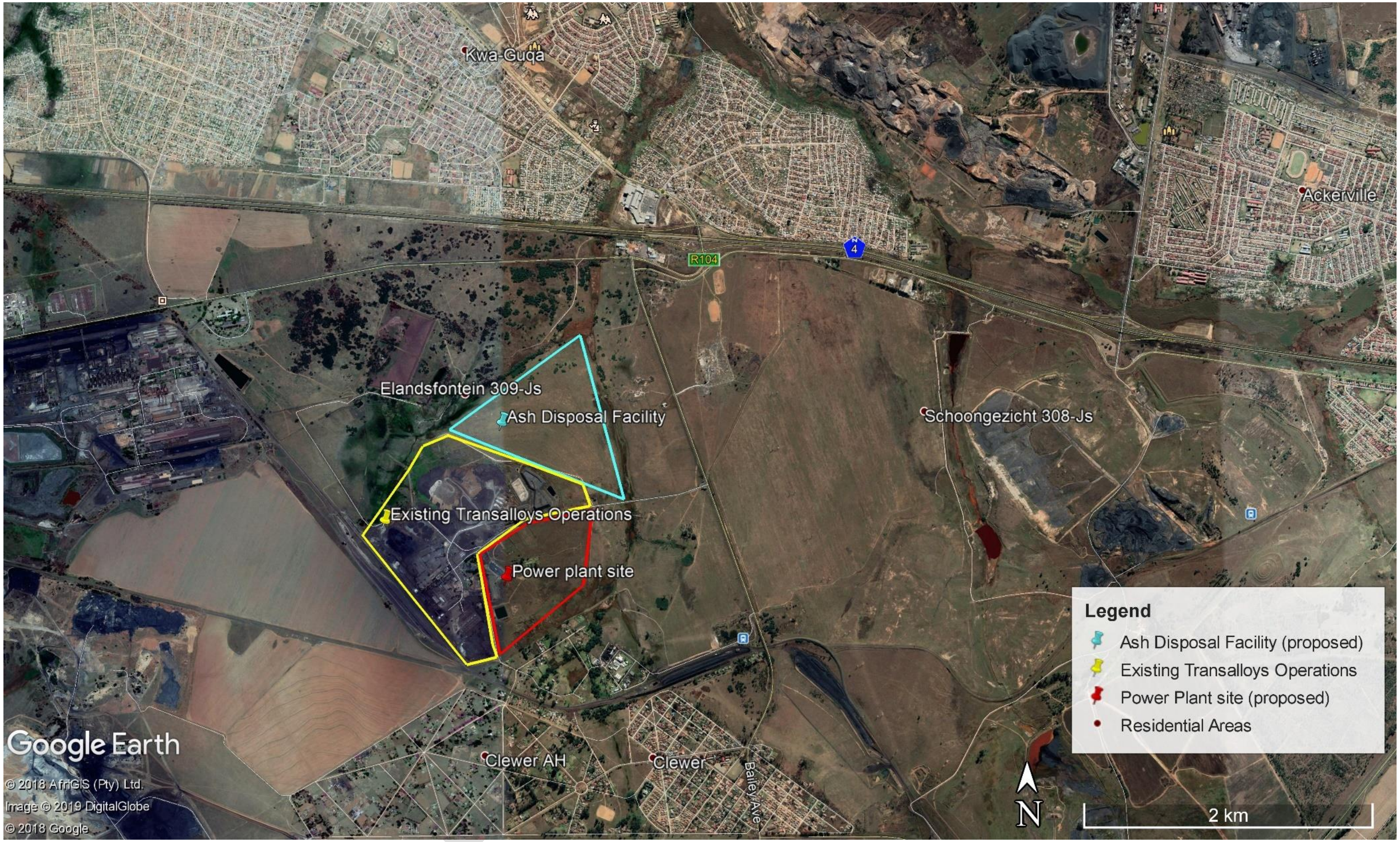


Figure 1: Locality map showing the existing Transalloys operations and the proposed Transalloys Power Plant and ADF site boundaries

1.3 Approach and Methodology

The approach to, and methodology followed in the completion of tasks completed as part of the scope of work are discussed.

1.3.1 Project Information and Activity Review

All project/process related information referred to in this study was provided by Savannah and Transalloys. The following previous studies (in the public domain) conducted for the existing Transalloys ferro-metal plant, as well as the previous air quality study for the proposed Transalloys Power Project were also considered in this study:

- Air Quality Specialist Report for the Proposed Coal-fired Power Station at Transalloys (Pty) Ltd, eMalahleni – Report No.: 18SAV07 (Akinshipe & Liebenberg-Enslin, 2019).
- Atmospheric Impact Report for the Proposed Process Modifications at Transalloys (Pty) Ltd, eMalahleni – Report No.: 16TPE04 (Akinshipe & von Reiche, 2017).
- Air Quality Specialist Report for the Proposed Coal-fired Power Station at Transalloys (Pty) Ltd, eMalahleni – Report No.: 13SAV02 (Akinshipe & Liebenberg-Enslin, 2014).
- Air Quality Impact Assessment for the Proposed Furnace Expansion at Transalloys (Pty) Ltd, eMalahleni – Report No.: 12TPE04 (Akinshipe & von Reiche, 2013).

1.3.2 The Identification of Regulatory Requirements and Health Thresholds

In the evaluation of ambient air quality impacts and dustfall rates reference was made to:

- South African National Ambient Air Quality Standards (SA NAAQS); and
- National Dust Control Regulations (SA NDCR) as set out in the National Environmental Management Air Quality Act (Act No. 39 of 2004) (NEMAQA).

1.3.3 Study of the Receiving Environment

Physical environmental parameters that influence the dispersion of pollutants in the atmosphere include terrain, land cover and meteorology. Existing pre-development ambient air quality in the study area is also considered.

1.3.4 Determining the Impact of the Project on the Receiving Environment

The establishment of a comprehensive emission inventory formed the basis for the assessment of the air quality impacts from the project's emissions on the receiving environment. In the quantification of emissions, use was made of emission factors which associate the quantity of release of a pollutant to the activity. Emissions were calculated using emission factors and equations published by the United States Environmental Protection Agency (US EPA) and Environment Australia (EA) in their National Pollutant Inventory (NPI) Emission Estimation Technique Manuals (EETMs).

1.3.5 Compliance Assessment and Health Risk Screening

Compliance was assessed by comparing simulated ambient criteria pollutant concentrations (CO, NO_2, $PM_{2.5}$, PM_{10} and SO_2) and dustfall rates to selected ambient air quality and dustfall criteria. Health risk screening was done through the comparison of simulated non-criteria pollutant concentrations (VOCs) to selected inhalation screening levels.

1.3.6 Impact Significance

The significance of impacts was determined in accordance with the procedure adopted and prescribed by Savannah.

1.3.7 The Development of an Air Quality Management Plan

The findings of the above components informed recommendations of air quality management measures, including mitigation and monitoring.

1.4 Assumptions, Exclusions and Limitations

In interpreting the study findings, it is important to note the limitations and assumptions on which the assessment was based. All calculations and simulations were based on throughput information and plant design specifications as received from the client. Certain assumptions had to be made due to inadequate information. Limitations and assumptions associated with this project are listed below:

- Project information required to calculate emissions for proposed operations were provided by Savannah and Transalloys. Where necessary, assumptions were made based on company and specialist's experience.
- Emission factors were used to estimate all fugitive and processing emissions resulting from plant activities and transport. These emission factors generally assume average operating conditions.
- The impact assessment was limited to airborne particulates (including TSP, PM_{10} and $PM_{2.5}$) and gaseous pollutants from internal combustion engines, including CO, NOx, VOCs and SO_2.
- Nitrogen monoxide (NO) emissions are rapidly converted in the atmosphere into the much more poisonous nitrogen dioxide (NO_2). NO_2 impacts where calculated by AERMOD using the ozone limiting method assuming constant monthly average background ozone concentrations of 30 ppb (Zunckel, et al., 2004) and a short-term NO_2/NOx emission ratio of 0.2 (Howard, 1988).
- There will always be some degree of uncertainty in any geophysical model, but it is desirable to structure the model in such a way to minimize 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.

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 environmental regulations governing the impact of such operations i.e. air emission standards, ambient air quality standards and dust control regulations.

Air emission standards are generally provided for point sources and 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 indicate safe daily exposure levels for most 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 criteria pollutants and dustfall, as well as inhalation health risk for VOCs. Discussions on regulations regarding dispersion modelling and emissions reporting, as well as screening criteria for animals and vegetation, are also provided.

2.1 Emission Standards

2.1.1 South African Emission Standards

The NEMAQA (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. 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 Minimum National Emission Standards (MES) were published on the 22nd November 2013 (Government Gazette No. 37054). An amendment to this Act was published in June 2015. According to the process descriptions, the Listed Activity that will be triggered is "***Subcategory 1.1: Solid fuel combustion installations***". The minimum emission standards (MESs) are presented in Table 1.

Table 1: MESs for solid fuel combustion installations primarily used for steam raising or electricity generation

Description:	**Solid fuels combustion installations primarily used for steam raising or electricity generation**		
Application:	All installations with design capacity equal to or greater than 50MW heat input per unit, based on the lower calorific value of the fuel used		
Substance or mixture of substances		**Plant Status**	**Mg/Nm³ under normal conditions of 10% O_2, 273 Kelvin and 101.3 kPa**
Common Name	**Chemical symbol**		
Particulate matter	N/A	New	50
		Existing	100
Sulfur Dioxide	SO_2	New	500
		Existing	3500
Oxides of nitrogen	NO_x expressed as NO_2	New	750
		Existing	1100

2.1.2 International guidelines

Emission guidelines, specified by the IFC in the document "Thermal Power Plants", for **Solid Fuels (Plant >/=600 MWth)** are given in Table 2 (IFC, 2008). In the table, the limit values given in the "DA" column refer to limits applicable in degraded airsheds, which are defined as follows: "An airshed should be considered as having poor air quality if nationally legislated air quality standards or WHO Air Quality Guidelines are exceeded significantly" (IFC, 2008).

Table 2: World Bank emission guidelines for Turbines/reciprocating engines (reproduced from IFC, (2008)

Pollutants	Solid Fuels (Plant >/=600 MWth)	
	Non-degraded Airshed	Degraded Airshed
Particulates (mg/Nm³)	50	30
Sulfur Dioxide (mg/Nm³)	200 – 850 [a]	200
Nitrogen Oxides (mg/Nm³)	510 [b] Or up to 1 100 if volatile matter <10%	200
Dry Gas, Excess O_2 Content (%)	6%	6%

NOTE:

[a] Targeting the lower guidelines values and recognizing variability in approaches to the management of SO_2 emissions (fuel quality vs. use of secondary controls) and the potential for the higher energy conversion efficiencies (FGD may consume between 0.5% and 1.6 % of electricity generated by the plant). Larger plants are expected to have additional emission control measure. Selection of the emission level in the range to be determined by EA considering the project's sustainability, development impact, and cost-benefit of the pollution control performance.

[b] Stoker boilers may require different emissions values which should be evaluated on a case-by-case basis through the EA process.

2.2 Ambient Air Quality Standards for Criteria Pollutants

Criteria pollutants are considered those pollutants most commonly found in the atmosphere, that have proven detrimental health effects when inhaled and are regulated by ambient air quality criteria. In the context of this project, these include CO, NO_2, $PM_{2.5}$, PM_{10} and SO_2 (Table 3).

The South African Bureau of Standards (SABS) assisted the Department of Environmental Affairs (DEA) in the development of ambient air quality standards. National Ambient Air Quality Standards (NAAQS) were determined based on international best practice for PM_{10}, $PM_{2.5}$, dustfall, SO_2, NO_2, O_3, CO, lead and benzene.

The final revised SA NAAQSs were published in the Government Gazette on 24 of December 2009 and in some instances included a margin of tolerance and implementation timelines linked to it. SA NAAQSs for $PM_{2.5}$ were published on 29 July 2012. SA NAAQSs referred to in this study are listed in Table 3. Currently, only $PM_{2.5}$ has a margin of tolerance, which is applicable until 31 December 2029. Short-term standards (hourly and daily) are represented by a limit value based on the 99th percentile of the observation (or simulated concentration) for that averaging period.

Table 3: Air quality standards for specific criteria pollutants (SA NAAQS)

Pollutant	Averaging Period	Limit Value (µg/m³)	Limit Value (ppb)	Frequency of Exceedance	Compliance Date
CO	1 hour	30 000	26 000	88	Immediate
	8 hour	10 000	8 700	11	Immediate
NO_2	1 hour	200	106	88	Immediate
	1 year	40	21	0	Immediate
PM_{10}	24 hour	75	-	4	1 Jan 2015
	1 year	40	-	0	1 Jan 2015
$PM_{2.5}$	24 hour	40	-	4	1 Jan 2016 – 31 Dec 2029
		25		4	1 Jan 2030
	1 year	20	-	0	1 Jan 2016 – 31 Dec 2029
		15		0	1 Jan 2030
SO_2	10 minutes	500	191	526	Immediate
	1 hour	350	134	88	Immediate
	24 hour	125	48	4	Immediate
	1 year	50	19	0	Immediate
Pb	1 year	0.5	-	0	Immediate
O_3	8 hour	120	61	11	Immediate
C_6H_6	1 year	5	-	0	1 Jan 2015

2.3 National Dust Control Regulations

The National Dust Control Regulations (NDCR) was published on the 1st of November 2013. The purpose of the regulation is to prescribe general measures for the control of dust in all areas including residential and non-residential areas. Acceptable dustfall rates according to the regulation are summarised in Table 4.

Table 4: Acceptable dustfall rates

Restriction areas	Dustfall rate (D) in mg/m^2-day over a 30 day average	Permitted frequency of exceedance
Residential areas	D < 600	Two within a year, not sequential months.
Non-residential areas	600 < D < 1 200	Two within a year, not sequential months.

The regulation also specifies that the method to be used for measuring dustfall and the guideline for locating sampling points shall be ASTM D1739 (1970), or equivalent method approved by any internationally recognized body. It is important to note that dustfall is assessed for nuisance impact and not inhalation health impact.

2.4 Regulations regarding Air Dispersion Modelling

Air dispersion modelling provides a cost-effective means for assessing the impact of air emission sources, the major focus of which is to assess compliance with the relevant ambient air quality standards. Regulations regarding Air Dispersion Modelling were promulgated in Government Gazette No. 37804 vol. 589; 11 July 2014, (DEA, 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 –

- In the development of an air quality management plan, as contemplated in Chapter 3 of the NEMAQA;
- In the development of a priority area air quality management plan, as contemplated in section 19 of the NEMAQA;

- In the development of an atmospheric impact report, as contemplated in section 30 of the NEMAQA; and,
- In the development of a specialist air quality impact assessment study, as contemplated in Chapter 5 of the NEMAQA.

The Regulations have been applied to the development of this report. 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. Chapter 2 of the Regulations present the typical levels of assessments, technical summaries of the prescribed models (SCREEN3, AERSCREEN, AERMOD, SCIPUFF, and CALPUFF) and good practice steps to be taken for modelling applications. The proposed operation falls under a Level 2 assessment – which is described as follows:

- The distribution of pollutant concentrations and deposition are required in time and space.
- Pollutant dispersion can be reasonably treated by a straight-line, steady-state, Gaussian plume model with first order chemical transformation. The model specifically to be used in the air quality impact assessment of the proposed operation is AERMOD.
- Emissions are from sources where the greatest impacts are in the order of a few kilometers (less than 50 km) downwind)

Dispersion modelling provides a versatile means of assessing various emission options for the management of emissions from existing or proposed installations. Chapter 3 of the Regulation prescribe the source data input to be used in the model. Dispersion models are particularly useful under circumstances where the maximum ambient concentration approaches the ambient air quality limit value and provide a means for establishing the preferred combination of mitigation measures that may be required.

Chapter 4 of the Regulations prescribe meteorological data input from onsite observations to simulated meteorological data. The chapter also gives information on how missing data and calm conditions are to be treated in modelling applications. Meteorology is fundamental for the dispersion of pollutants because it is the primary factor determining the diluting effect of the atmosphere.

Topography is also an important geophysical parameter. The presence of terrain can lead to significantly higher ambient concentrations than would occur in the absence of the terrain feature. In particular, where there is a significant relative difference in elevation between the source and off-site receptors large ground level concentrations can result.

The modelling domain would normally be decided on the expected zone of influence; the extent being defined by simulated ground level concentrations from initial model runs. The modelling domain must include all areas where the ground level concentration is significant when compared to the air quality limit value (or other guideline). Air dispersion models require a receptor grid at which ground-level concentrations can be calculated. The receptor grid size should include the entire modelling domain to ensure that the maximum ground-level concentration is captured and the grid resolution (distance between grid points) sufficiently small to ensure that areas of maximum impact adequately covered. No receptors should however be located within the property line as health and safety legislation (rather than ambient air quality standards) is applicable within the site.

Chapter 5 provides general guidance on geophysical data, model domain and coordinates system requirements, whereas Chapter 6 elaborates more on these parameters as well as the inclusion of background air pollutant concentration data. This chapter also provides guidance on the treatment of NO_2 formation from NOx emissions, chemical transformation of SO_2 into sulfates and deposition processes.

Chapter 7 of the Regulation outlines how the plan of study and modelling assessment reports are to be presented to authorities.

2.5 Regulations Regarding Reporting of Atmospheric Emissions

The National Atmospheric Emission Reporting Regulations (NAERR) was published on the 2nd of April 2015 by the Minister of Environmental Affairs. The Regulation aims to standardize 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), towards the compilation of atmospheric emission inventories (DEA , 2015).

Annexure 1 of the NAERR classify power stations as a data provider. Sections of the regulation that applies to data providers are summarized below.

With regards to registration, the regulation stipulates that:

(a) A person classified as a data provider must register on the NAEIS within 30 days from the date upon which these Regulation came into effect;
(b) A person classified as a data provider and who commences with an activity or activities classified as emission source in terms of the regulation 4(1) after the commencement of the Regulation, must register on the NAEIS within 30 days after commencing with such an activity or activities.

With regards to reporting and record keeping, the regulation stipulates that:

(a) A data provider must submit the required information for the preceding calendar year, as specified in Annexure 1 to these Regulations, to the NAEIS by **31 March of each calendar year.**
(b) A data provider must keep a record of the information submitted to the NAEIS for five years and such record must, on request, be made available for inspection by the relevant authority.

With regards to verification of information, the Regulation requires data providers to verify requested information within 60 days after receiving the written request from the relevant authority.

2.6 Greenhouse Gas Emissions

The regulations pertaining to Greenhouse Gas (GHG) reporting using the NAEIS was published in 2017 (DEA, 2017a).

The South African mandatory reporting guidelines focus on the reporting of Scope 1 emissions only. The three broad scopes for estimating GHG are:

- Scope 1: All direct GHG emissions.
- Scope 2: Indirect GHG emissions from consumption of purchased electricity, heat or steam.
- Scope 3: Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities not covered in Scope 2, outsourced activities, waste disposal, etc.

The NAEIS web-based monitoring and reporting system will also be used to collect GHG information in a standard format for comparison and analyses. The system forms part of the National Atmospheric Emission Inventory component of SAAQIS.

The DEA is working together with local sectors to develop country specific emissions factors in certain areas; however, in the interim the Intergovernmental Panel on Climate Change's (IPCC) default emission figures may be used to populate the

SAAQIS GHG emission factor database. These country specific emission factors will replace some of the default IPCC emission factors.

Also, the Carbon Tax Policy Paper (CTPP) (Department of National Treasury, 2013) states that consideration will be given to sectors where the potential for emissions reduction is limited. GHG emitters in excess of 0.1 Mt, measured as $CO_{2\text{-eq}}$, are also required by law to submit a pollution prevention plan to the Minister for approval (DEA, 2017a; DEA, 2017c).

3 Description of the Receiving Environment

3.1 Air Quality Sensitive Receptors

AQSRs primarily refer to places where humans reside; however, it may also refer to other sensitive environments that may adversely be affected by air pollutants. Ambient air quality guidelines and standards, as discussed under section 2, have been developed to protect human health. Ambient air quality, in contrast to occupation exposure, pertains to areas outside of an industrial site boundary where the public has access to and according to the Air Quality Act, excludes areas regulated under the Occupational Health and Safety Act (Act No 85 of 1993).

Sensitive receptors around Transalloys premises and the proposed power plant site include the following (refer to Figure 1):

- Clewer – located about 200 m from the Transalloys southern boundary
- Kwa-Guqa – located about 3 km north of Transalloys
- Ackerville and Lynnville – located about 6 km northeast of Transalloys
- Ferrobank – An industrial area located about 6.5 km northeast of Transalloys

Ambient air pollutant levels in the proposed Project area are currently affected by the following sources of emission: the existing Transalloys ferro-metal plant; mining activities to the east, southeast and south; and a steel processing plant to the west. Ferrobank, an Industrial area hosting various manufacturing and processing plants, is situated about 5 km away to the northeast.

3.2 Atmospheric Dispersion Potential

Meteorological mechanisms govern the dispersion, transformation, and eventual removal of pollutants from the atmosphere. The analysis of hourly average meteorological data is necessary to facilitate a comprehensive understanding of the dispersion potential of the site. The horizontal 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 (Tiwary & Colls, 2010). Parameters useful in describing the dispersion and dilution potential of the site i.e. wind speed, wind direction, temperature and atmospheric stability, are subsequently discussed.

Meteorological data was obtained from eMalahleni monitoring station of the South African Weather Services (SAWS) for the period January 2016 to December 2018. The weather station is located ~9 km northeast of Transalloys and is considered representative of the weather conditions at Transalloys.

3.2.1 Topography and Land-use

Changes in terrain around an air pollution source can significantly influence the way the plume is dispersed. Hills or rough terrain influence the wind speed, wind direction and turbulence characteristics. Significant valleys can cause persistent drainage flows and restrict horizontal movement whereas sloping terrain may help provide katabatic or anabatic flows. The topography of the study area is flat, comprising of undulating terrain slightly increasing in height above mean sea level to the northeast of the area (Figure 2). An analysis of topographical data indicated a slope of less than 1:10 from over most of the project area. Dispersion modelling guidance recommends the inclusion of topographical data in dispersion simulations only in areas where the slope exceeds 1:10 (US EPA, 2004).

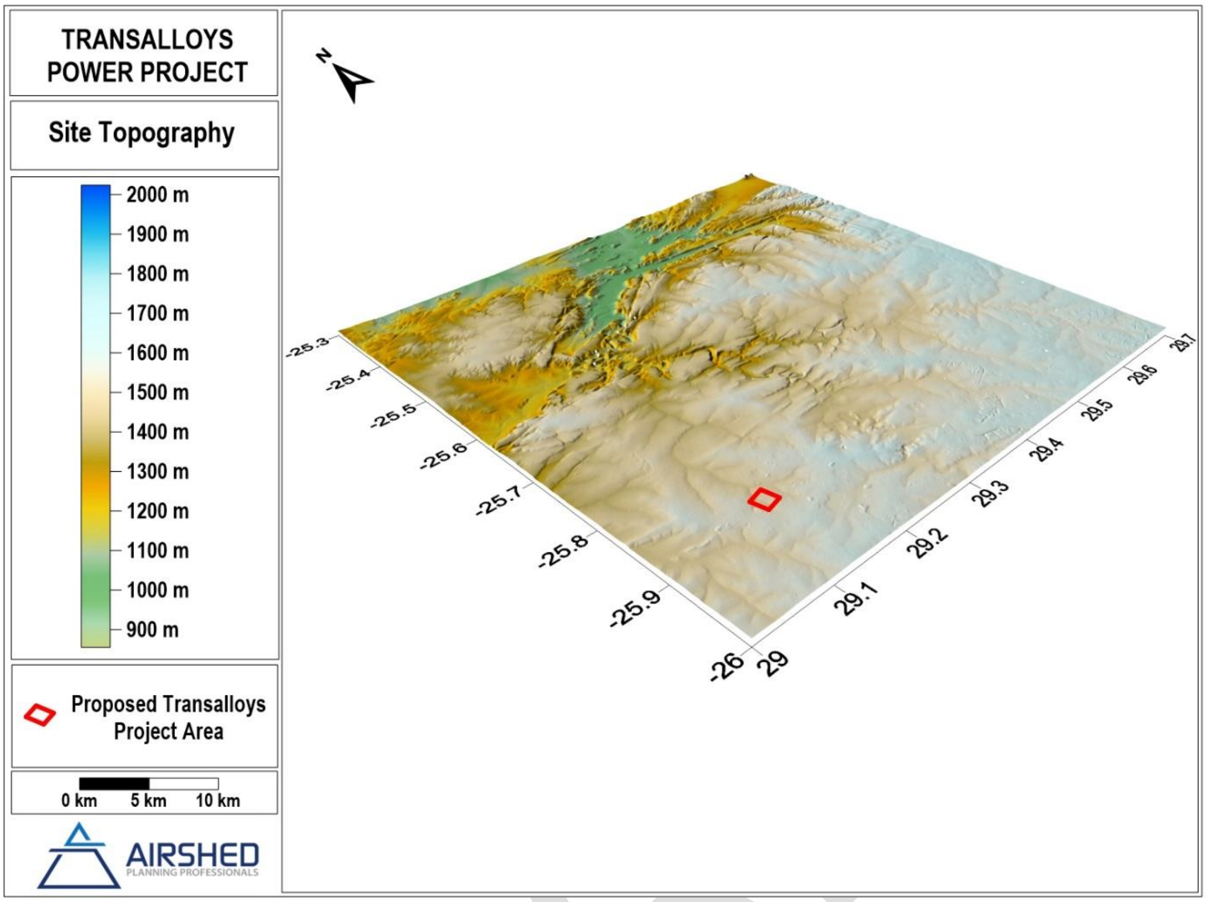


Figure 2: Topography of the proposed Project and surrounding area

3.2.2 Surface Wind Field

Wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses in Figure 3 below reflect the different categories of wind speeds; the yellow area, for example, representing winds in between 5 and 6 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.

Wind field data availability was 99%. The period wind field and diurnal variability in the wind field are shown in Figure 3. During the recording period, the wind field was dominated by winds from the north, north-northwest, east, east-southeast and west, with an average wind speed of 3.3 m/s. The strongest winds (more than 10 m/s) were from the east, east-south-east and north. There is a notable shift in wind field from predominantly northerly during the day to easterly and east-south-easterly during the night.

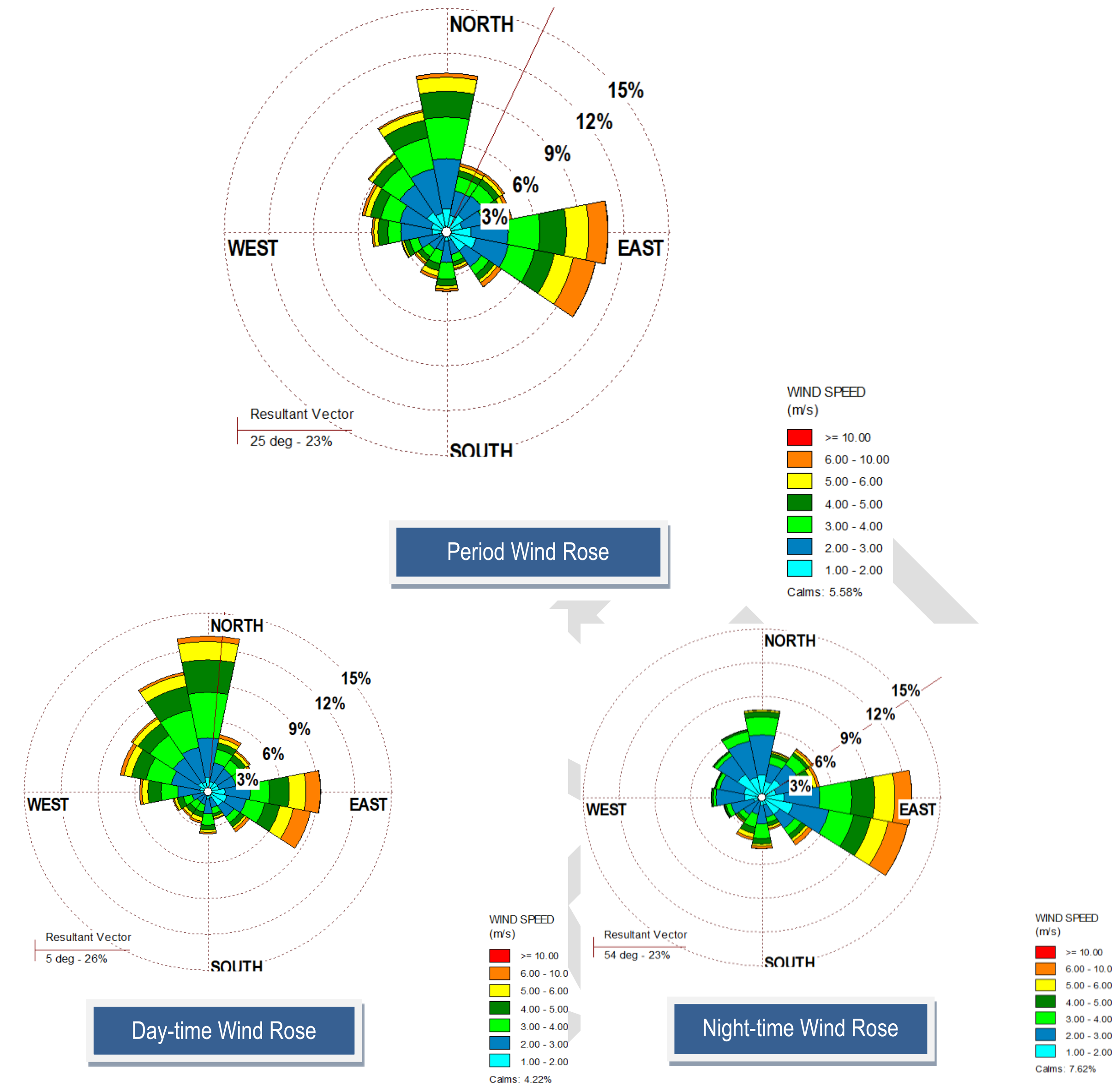


Figure 3: Period, day- and night-time wind roses (SAWS eMalahleni data, January 2016 to December 2018)

3.2.3 Temperature

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

Diurnal and average monthly temperature trends are presented in Figure 4. Monthly mean and hourly maximum and minimum temperatures are given in Table 5. Temperatures range between -2.3°C and 35.7°C. The highest temperatures occurred in January, and the lowest in July. During the day, temperatures increase to reach maximum at around 15:00 in the afternoon. Ambient air temperature decreases to reach a minimum at around 05:00 i.e. before sunrise.

Table 5: Monthly temperature summary (SAWS eMalahleni data, January 2016 to December 2018)

Hourly Minimum, Hourly Maximum and Monthly Average Temperatures (°C)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	8.9	11.8	7.8	5.7	2.3	0.0	-2.3	0.0	0.7	3.9	5.0	11.1
Average	20.5	20.4	19.2	17.2	13.6	11.8	11.3	14.2	18.2	18.4	19.2	20.7
Maximum	35.7	33.3	31.1	30.0	24.4	23.9	23.3	27.8	33.3	33.3	33.3	33.9

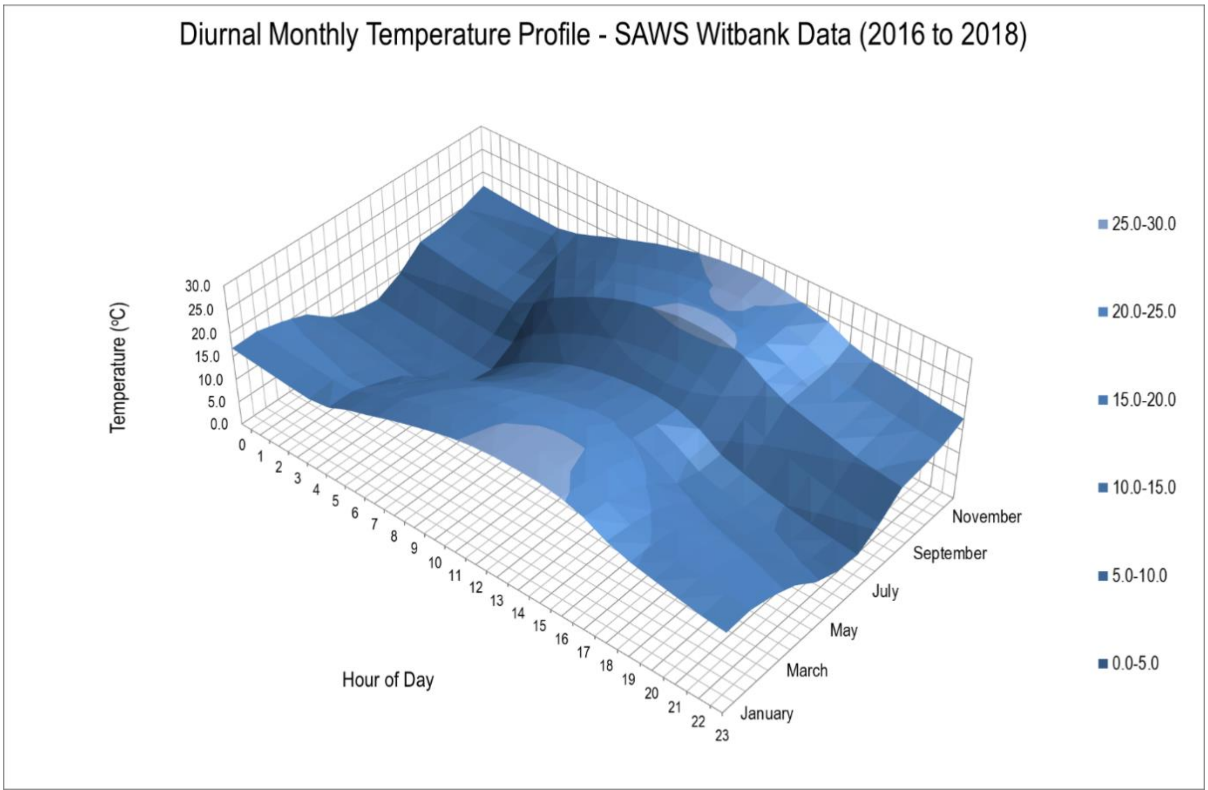


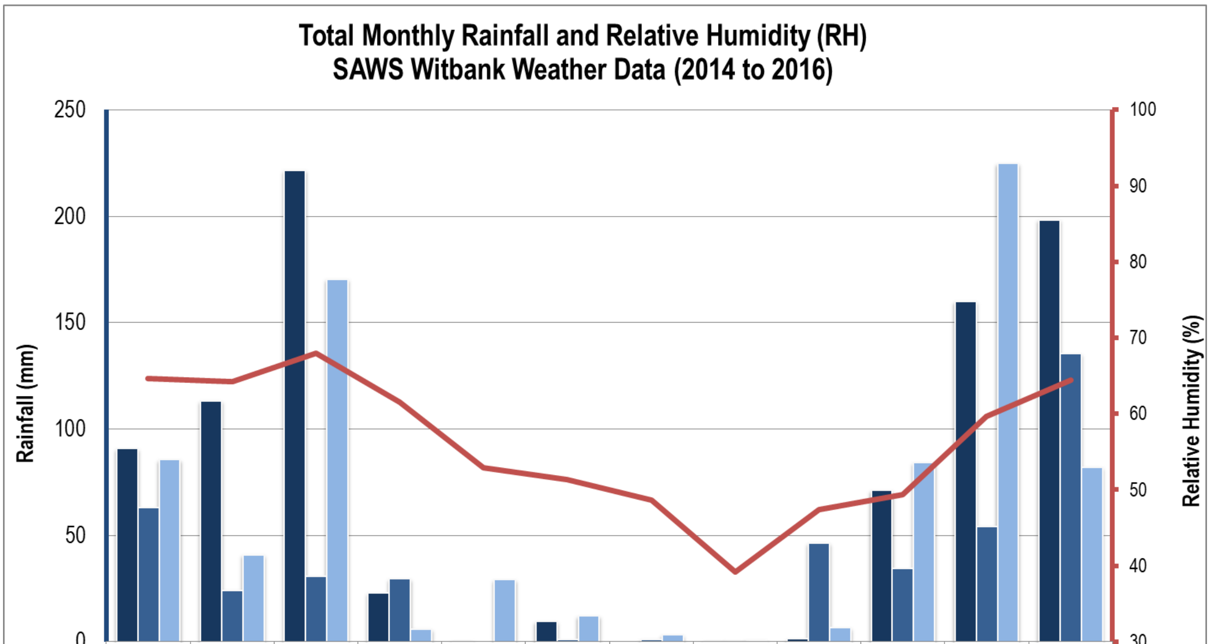
Figure 4: Monthly diurnal average temperature profile (SAWS eMalahleni data, January 2016 to December 2018)

3.2.4 Rainfall and Relative Humidity

Rainfall is important to air pollution studies since it represents an effective removal mechanism of atmospheric pollutants, and a natural dust suppression mechanism for fugitive dust sources. Rainfall and relative humidity data for the 2017 to 2018 period was not available, hence rainfall and relative humidity data for 2014 to 2016 period was analysed in this section.

The weather data at SAWS Witbank station recorded annual rainfall of 882 mm, 419 mm and 744 mm for the 2014, 2015 and 2016 period respectively. The amount of rainfall begins to increase during the spring months, reaching its peak by the summer months; and begins to dip by late autumn, hitting its lowest during the winter months. The number of days per year in which the rainfall amount exceeded the “trace of precipitation” amount of 0.254 mm is 90, 59 and 80, respectively for the years 2014, 2015 and 2016.

Relative humidity is the ratio of the actual water vapour content (moisture in the air) compared to the amount of water vapour required for saturation (maximum moisture the air can "hold") at a temperature and pressure. Humidity can influence the amount of precipitation recorded in a region and can also influence the impact of air pollution on visibility. For instance, a high relative humidity will significantly increase the adverse effects of pollution on visibility (Tiwary & Colls, 2010). The annual mean relative humidity recorded over the 2014, 2015 and 2016 period was ~ 53.8%, 55.4% and 58.8% respectively. Monthly rainfall and relative humidity obtained from SAWS Witbank weather station is presented in Figure 5.



	January	February	March	April	May	June	July	August	September	October	November	December
2014	90.6	113.0	221.4	22.8	0.4	9.4		0.4	1.2	71.0	159.8	198.2
2015	62.8	24.0	30.6	29.4		0.8	1.0	0.4	46.2	34.2	54.2	135.2
2016	85.4	40.8	170.2	5.8	29.0	12.0	3.0	0.6	6.4	84.0	224.6	81.8
RH	64.6	64.3	68.0	61.5	52.9	51.4	48.6	39.2	47.4	49.4	59.7	64.4

Figure 5: Monthly rainfall and relative humidity – SAWS Witbank weather data (2014 – 2016)

3.2.5 Atmospheric Stability

The new generation air dispersion models differ from the models traditionally used in several 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 Monin-Obukhov length, rather than in terms of the single parameter Pasquill Class.

The Monin-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.

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* and occurs mostly during daytime hours. Neutral conditions disperse the plume equally in both the vertical and horizontal planes and the plume shape is referred to as *coning*. Stable conditions prevent the plume from mixing vertically, although it can still spread horizontally and is called *fanning* (Tiwary & Colls, 2010). For ground level releases, such as fugitive dust from mining activities, the highest ground level concentrations will occur during stable night-time conditions.

3.3 Typical pollutants Associated with the Proposed Project

The establishment of a comprehensive emission inventory forms the basis for the assessment of the air quality impacts from proposed operations' emissions on the receiving environment. The establishment of an emissions inventory comprised the identification of sources of emission and the quantification of each source's contribution to total emissions.

Emissions are quantified for criteria pollutants associated with coal-fired power station (PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO and volatile organic compounds (VOC) such as benzene) and can be divided in two categories, namely; fugitive emissions and process emissions. Fugitive emissions refer to emissions that are spatially distributed over a wide area and not confined to a specific discharge point as would be the case for process related emissions (IFC, 2007). Typical pollutants, emissions and sources of atmospheric pollution associated with coal-fired power stations is summarised in Table 6.

Table 6: Typical pollutants, emissions and sources of atmospheric pollution

Activity/Source	TSP	PM_{10}	$PM_{2.5}$	NO_2	SO_2	VOC[a]
Construction [b]	✓[c]	✓	✓	-	-	-
Loading & Off-loading	✓	✓	✓	-	-	-
Stacks	✓	✓	✓	✓	✓	✓
Conveying	✓	✓	✓	-	-	-
Crushing	✓	✓	✓	-	-	-
Screening	✓	✓	✓	-	-	-
Hauling	✓	✓	✓	-	-	-
Vehicles Exhaust and Diesel Engines	✓	✓	✓	✓	✓	✓

Note: [a] Benzene and diesel particulate matter.

[b] Includes activities such as vegetation removal, surface levelling, construction of buildings and road construction

[c] Size of the tick indicates the expected extent of the emissions.

3.4 Sources of Air Pollution in the Region

Power generation, mining activities, farming and residential land-uses occur in the vicinity of the proposed Transalloys Power Project. These land-uses contribute to baseline pollutant concentrations via vehicle tailpipe emissions, household fuel combustion, biomass burning, various fugitive dust sources and industrial process emissions. Long-range transport of particulates, emitted from remote tall stacks and from large-scale biomass burning in countries to the north of South Africa, has been found to contribute to background fine particulate concentrations within the South African boundary (Andreae, et al., 1996; Garstang, Tyson, Swap, & Edwards, 1996; Piketh, Annegarn, & Kneen, 1996).

3.4.1 Power Generation

Operational power stations such as Kendal, Duvha, Matla and Hendrina are situated in the same region as the proposed Transalloys Power Project. The main emissions from such electricity generation operations are carbon dioxide (CO_2), SO_2, NOx and ash (PM). Fly-ash particles emitted comprise various trace elements such as arsenic, chromium, cadmium, lead, manganese, nickel, vanadium and zinc. Small quantities of volatile organic compounds are also released from such operations.

The power stations are large sources of SO_2, which oxidizes in the atmosphere to particulate sulfate at a rate of between 1% and 4% per hour. Fine particulate sulfate has been used to trace the transportation of power station plumes across the southern African sub-continent.

3.4.2 Mining Operations

Fugitive emissions from open cast and underground mining operations mainly comprise of land clearing operations (i.e. scraping, dozing and excavating), materials handling operations (i.e. tipping, off-loading and loading, conveyor transfer points), vehicle entrainment from haul roads, wind erosion from open areas, drilling and blasting. These activities mainly result in particulates and dust emissions, with small amounts of oxides of nitrogen (NO_x), carbon monoxide (CO), SO_2, methane and CO_2 being released during blasting operations.

3.4.3 Fugitive Dust Sources

These sources are termed fugitive because they are not discharged to the atmosphere in a confined flow stream. Sources of fugitive dust identified to potentially occur in the study area include paved and unpaved roads; agricultural tilling operations; and wind erosion of sparsely vegetated surfaces.

3.4.4 Unpaved and paved roads

Emissions from unpaved roads constitute a major source of emissions to the atmosphere in the South African context. The force of the wheels of a vehicle traveling on an unpaved road results in the 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 (including average vehicle speed, mean vehicle weight, average number of wheels per vehicle) and the silt loading on the 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. Major paved roads in the area include the N4, R547, R555 and R544.

3.4.5 Wind erosion of open areas

Windblown dust generates from natural and anthropogenic sources. For wind erosion to occur, the wind speed needs to exceed a certain threshold, called the threshold 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, its erosion potential must be restored; that is, the wind shear at the surface must exceed the gravitational and cohesive forces acting upon them, called the threshold friction velocity. Erodible surfaces may occur as a result of agriculture and/or grazing activities.

3.4.6 Domestic Fuel Combustion

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), particularly benzo(a)pyrene and formaldehyde. Particulate emissions from wood burning have been found to contain about 50% elemental carbon and about 50% condensed hydrocarbons.

Coal is relatively inexpensive in the Mpumalanga region and is easily accessible due to the proximity of the region to coal mines and the well-developed coal merchant industry. Coal burning emits a large amount of gaseous and particulate pollutants including SO_2, heavy metals, PM including heavy metals and inorganic ash, CO, PAHs (recognized carcinogens), NO_2 and various toxins. The main pollutants emitted from the combustion of paraffin are NO_2, particulates, CO and PAHs.

3.4.7 Biomass Burning

Biomass burning includes the burning of evergreen and deciduous forests, woodlands, grasslands, and agricultural lands. Within the project vicinity, crop-residue burning and wild fires (locally known as veld fires) may represent significant sources of combustion-related emissions. The frequency of wildfires in the Highveld 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. In addition to the impact of biomass burning within the vicinity of the proposed activity, long-range transported emissions from this source can be expected to impact on the air quality between the months of August to October. It is impossible to control this source of atmospheric pollution loading; however, it should be noted as part of the background or baseline condition before considering the impacts of other local sources.

3.4.8 Vehicle Tailpipe Emissions

Emissions resulting from motor vehicles can be grouped into primary and secondary pollutants. While primary pollutants are emitted directly into the atmosphere, secondary pollutants are formed in the atmosphere as a result of chemical reactions. Significant primary pollutants emitted by internal combustion engines include CO_2, CO, carbon (C), SO_2, oxides of nitrogen (mainly NO), particulates and lead. Secondary pollutants include NO_2, photochemical oxidants such as ozone, sulfur acid, sulfates, nitric acid, and nitrate aerosols (particulate matter). Vehicle type (i.e. model-year, fuel delivery system), fuel (i.e. oxygen content), operating (i.e. vehicle speed, load) and environmental parameters (i.e. altitude, humidity) influence vehicle exhaust emission rates. Both small and heavy private and industrial vehicles travelling along the N4, R547, R555 and R544 (public) roads as well as unpaved public and private roads, are notable sources of vehicle tailpipe emissions.

3.5 Site Visit

A site visit was not conducted for this air quality impact assessment. Adequate project information was obtained from Savannah and Transalloys, as well as from previous studies done in the area. Since ambient air quality monitoring was not included as part of the air quality assessment, a site visit will not have yielded any significant additional information from the baseline information received.

3.6 Measured Ambient Air Quality within the Region

Transalloys continuously measures PM_{10} concentrations and dustfall rates. In this assessment, reference is made to dustfall data measured from October 2015 to January 2019; and PM_{10} data measured intermittently between January 2012 and December 2015 and between August 2018 and January 2019 (all obtained from Transalloys). The locations of the sampling sites are shown in Figure 6. PM_{10} sampling is done at Transalloys Weighbridge and at Clewer Primary School. Dustfall is measured at the other seven locations in Figure 6. Trace metals are not currently sampled at Transalloys.

Figure 6: Dustfall sampling and PM_{10} continuous monitoring locations

3.6.1 Measured Ambient PM_{10} Concentrations

In the interpretation of this section, the reader should note that measured air pollutant concentrations reflect levels as a result of several sources of atmospheric emission in the Ferrobank and Highveld area, and **not concentrations only related to existing Transalloys operations**.

A summary of measured ambient PM_{10} concentrations is provided in Table 7. Results from 2013 and 2015 obtained from the Transalloys Weighbridge (Location A) and the Clewer Primary School (Location B) monitoring stations indicate elevated PM_{10} concentrations in exceedance of the 24-hour NAAQS (4 days exceeding 75 µg/m^3). Calculated period average PM_{10} concentrations of 37 µg/m^3 (Weighbridge) and 39.0 µg/m^3 (Clewer Primary School) did not exceed the annual average NAAQS of 40 µg/m^3, but only marginally.

Recent results (August 2018 to January 2019) obtained from Locations A and B did not exceed the daily or the annual NAAQS with a calculated periodic average of 18 µg/m^3 (Location A) and 25 µg/m^3 (Location B).

Table 7: Summary of measured ambient PM_{10} concentrations

Parameter	Transalloys Monitoring (Near Weighbridge / Truck Stop)	Transalloys Monitoring (Clewer Primary school) [a]
Reporting Period	**January 2015 to December 2015**	**30 March 2012 to 8 January 2013**
Data Availability During Reporting Period	53%	68%
Period Average PM_{10} Concentration	37 µg/m^3	39 µg/m^3
Maximum 24-hour Average PM_{10} Concentration	120 µg/m^3	1710 µg/m^3
No. of days exceeding 75 µg/m^3	20 days (10%)	36 days (22%)
Reporting Period	**August 2018 to January 2019**	**August 2018 to January 2019**
Data Availability During Reporting Period	67%	46%
Period Average PM_{10} Concentration	18 µg/m^3	25 µg/m^3
Maximum 24-hour Average PM_{10} Concentration	59 µg/m^3	57 µg/m^3
No. of days exceeding 75 µg/m^3	0 days (0%)	0 days (0%)

NOTE: [a] Monitoring data at Clewer Primary School for the January to December 2015 period is not available due to prolonged repair and maintenance of the sampling unit.

3.6.2 Measured Dustfall Rates

Dustfall rates measured between October 2015 and January 2019 are presented in Figure 7. The location of the Transalloys sampling sites have been shown in Figure 6. The residential dustfall limit of 600 mg/m^2-day was only exceeded at the FPP – Stand Block location (a non-residential location) during October 2016. FPP – Stand Block is located close to crushing and screening operations, as well as material handling activities at the siding and conveyors. All other dustfall measurements are below the residential dustfall limit of 600 mg/m^2-day for the period October 2015 to January 2019. Also, continuous improvement in dustfall rates are notable at most sites since 2015, with few exceptions.

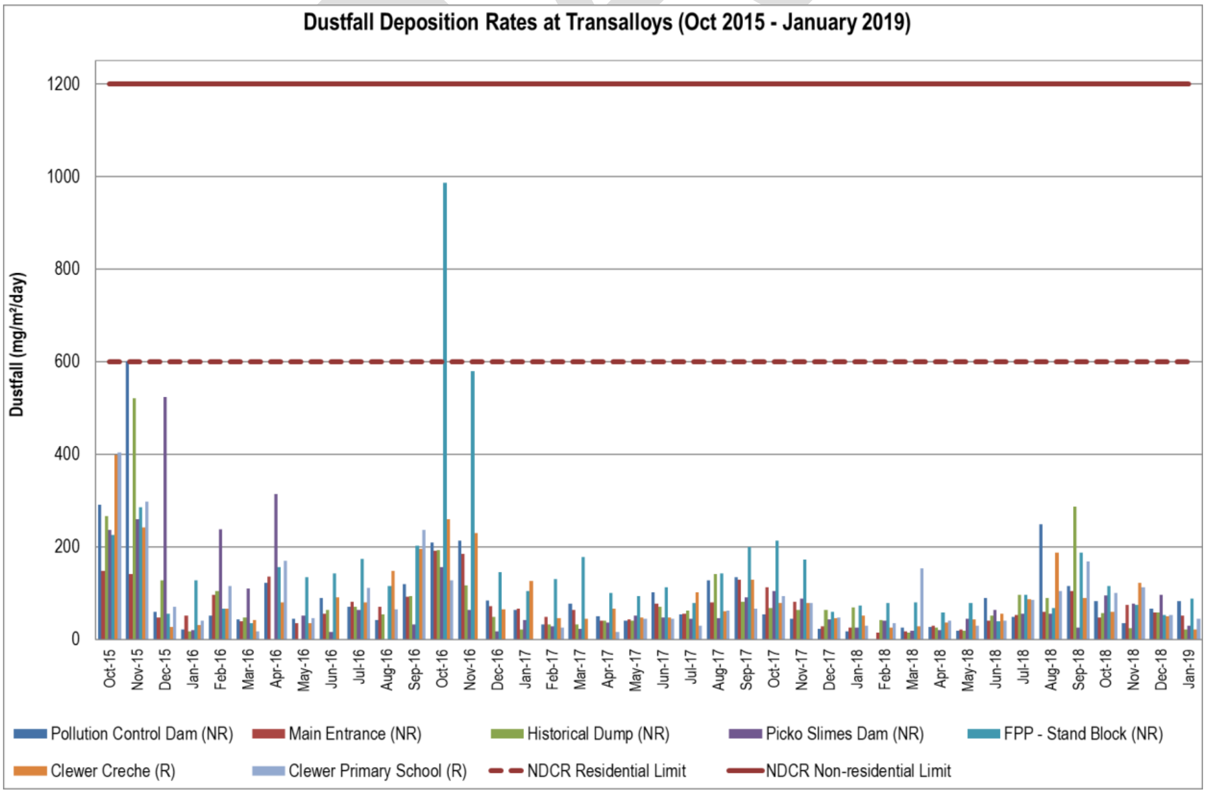


Figure 7: Measured dustfall rates at Transalloys for January 2016 to August 2017 ("NR" and "R" indicates non-residential and residential locations respectively)

3.7 Modelled Ambient Air Quality – Mpumalanga Highveld Priority Area

The Transalloys Power Project is situated in the Mpumalanga Highveld, within the boundaries of the Highveld Priority Area (HPA), which is an area that has been identified as characterized with poor air quality. As a result of the concerns over the poor ambient air quality over the Highveld area, the Minister of Environmental Affairs declared a portion of Mpumalanga and Gauteng provinces an air quality priority area in November 2007.

An emissions inventory was completed for the region as part of the HPA baseline study. The results of the inventory were used to carry out a comprehensive dispersion modelling study over the area using the CALPUFF model (DEA, 2011b). Results of this dispersion study are illustrated in Figure 8 and Figure 9 for SO_2 and PM_{10} respectively. These figures show areas over which NAAQS are exceeded, as determined through simulation. The eMalahleni area already experiences elevated PM_{10} and SO_2 concentrations. Based on these dispersion modelling results, the Air Quality Management Plan (AQMP) identified Baseline Hotspots for SO_2 and for PM_{10}. The project design should therefore also ensure minimal contribution to ambient SO_2 and PM_{10} concentrations.

Ambient CO concentrations were not included in the HPA ambient monitoring or simulation but in residential areas of high wood and coal combustion there is high potential for increased CO concentrations.

Power generation in the HPA is the major source of SO_2 (82%) and NOx emissions (73%) while it is only responsible for a relatively small contribution to the total PM_{10} (12%) (DEA, 2011b). Simulated source contributions to NOx, SO_2 and PM_{10} are shown in Figure 10. The largest contributors to all three pollutants are power generation, residential fuel burning and motor vehicles. The lowest contributors to NOx, SO_2 and PM_{10}, according to DEA (2011b), are coal mines and motor vehicles.

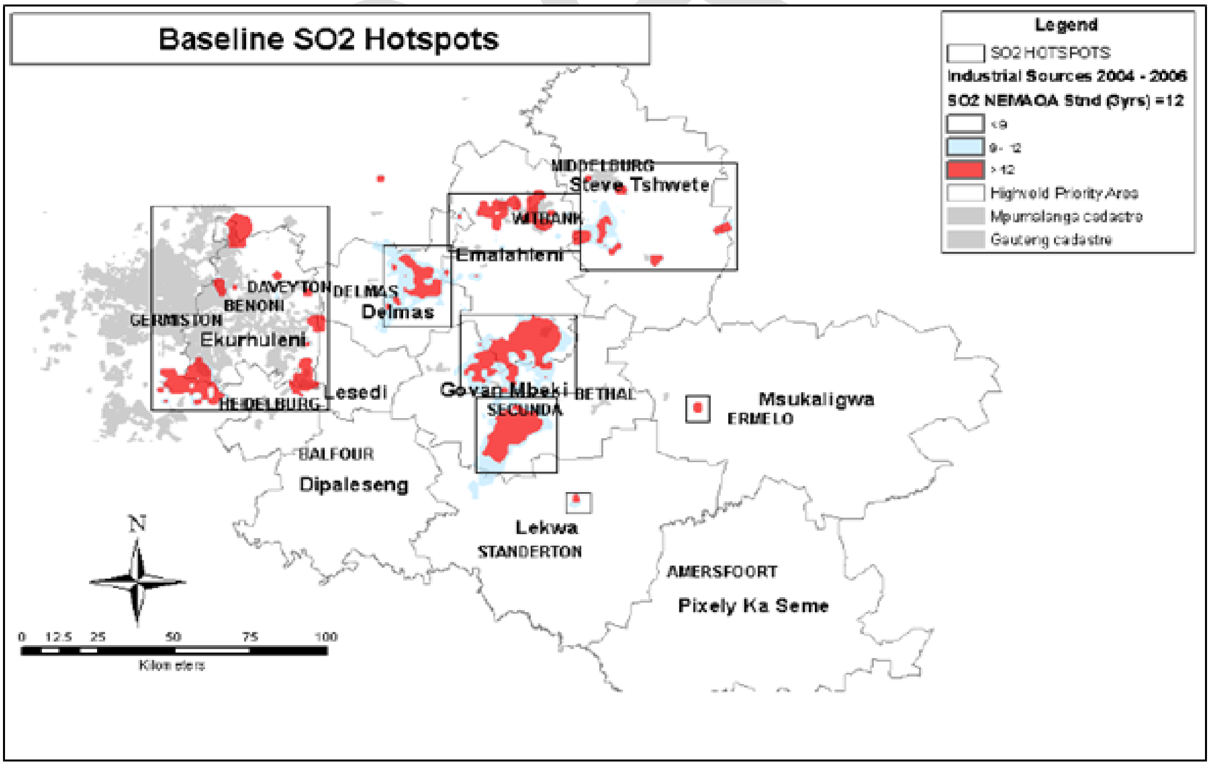


Figure 8: Simulated frequencies of exceedances of SA ambient SO_2 standards (DEA, 2010)

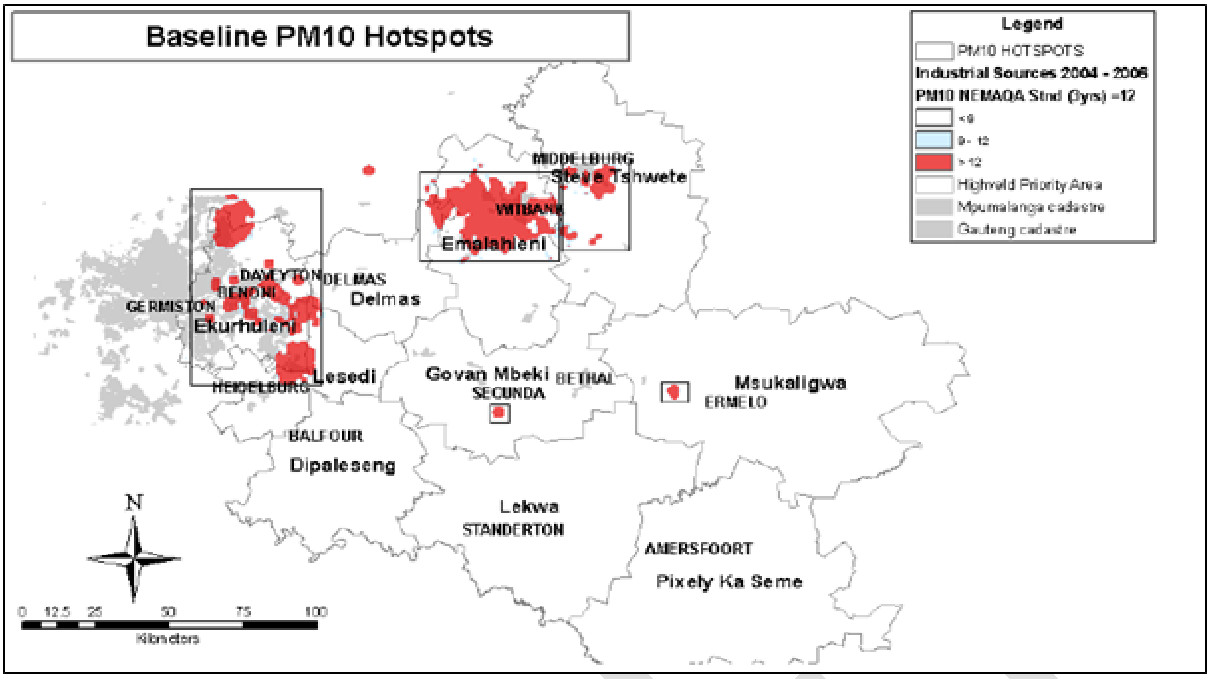


Figure 9: Simulated frequencies of exceedance of SA ambient PM_{10} standards (DEA, 2010)

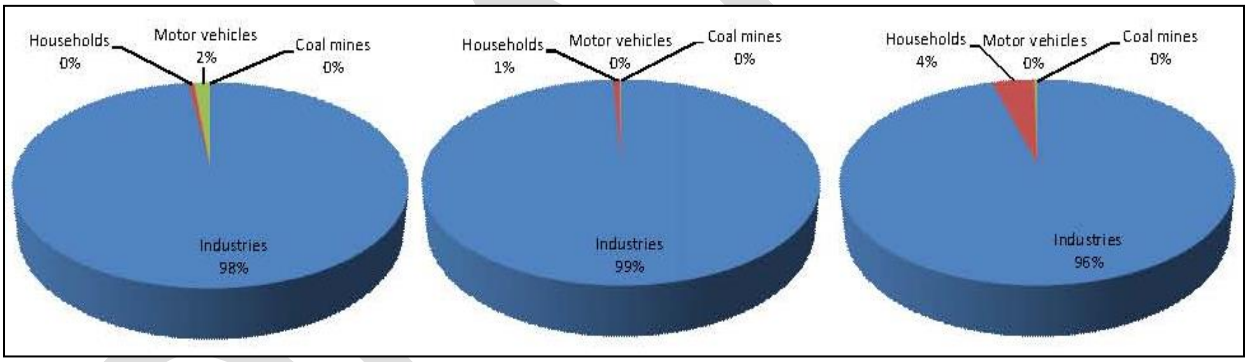


Figure 10: Contribution of different sources to ambient concentrations of NOx (left), SO_2 (middle) and PM_{10} (right) in the Kriel Hot Spot (DEA, 2011)

4 IMPACT ON THE RECEIVING ENVIRONMENT

4.1 Atmospheric Emissions

The establishment of a comprehensive emission inventory formed the basis for the assessment of the air quality impacts from the project's operations on the receiving environment. The proposed project operations will consist of a construction phase, an operational phase and a closure (decommissioning and post-closure) phase. Emissions are quantified for criteria pollutants associated with power plants (PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO and VOCs such as benzene) and can be divided into two categories, namely; fugitive emissions and process emissions. Fugitive emissions refer to emissions that are spatially distributed over a wide area and not confined to a specific discharge point as would be the case for process related emissions (IFC, 2007). A short discussion on the expected activities, typical of a power plant is provided in the sections below with a summary on the typical sources and associated activities for construction, operational and closure phase.

4.1.1 Construction Phase

Pollutants associated with the construction phase are typically $PM_{2.5}$, PM_{10} and TSP (dustfall). The activities associated with the release of these pollutants during the construction of the plant, associated infrastructure and overland conveyor include land clearing, topsoil removal, material loading and hauling, stockpiling, grading, bulldozing, compaction, etc. Each of these operations has its own duration and potential for dust generation. It is anticipated therefore that the extent of dust emissions would vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing meteorological conditions. This contrasts with most fugitive dust sources during operational phase where emissions are either relatively steady or follow a discernible annual cycle. It is therefore necessary to estimate area wide construction emissions, rather than attempt to quantify actual emissions based on construction plans and schedule which are unavailable and often not detailed enough to serve emission quantification purpose. Hence, area wide construction emissions for the Transalloys Power Project were quantified as indicated in Table 13.

4.1.2 Operational Phase

The identification and quantification of emissions in the operational phase are divided into point sources and fugitive sources. Fugitive sources are defined as sources where the emission releases are not discharged to the atmosphere in a confined flow stream. Two main sections are proposed for the operation of the Transalloys Power Project, namely the power plant site and the ash disposal facility. At the power plant site, the main sources of emissions would be the stack releases (point source). Fugitive sources will include materials handling operations (loading, tipping and off-loading), conveyor transfer points, vehicle entrainment on internal roads, emissions from diesel engine exhaust, as well as wind erosion from exposed coal and limestone storage piles.

At the ash disposal facility, the main sources of potential impact would be from the fugitive sources such as material handling operations, emissions from diesel engine exhaust, vehicle entrainment on internal roads, and wind-blown dust. Primary point sources of pollutants typical of power station operations are summarised in Table 8. All fugitive sources identified are listed in Table 9. Emissions quantification was based on the quantity of material handled as shown in Table 11.

Two operational phase scenarios were quantified to represent difference in emissions as follows:

- Design specification emissions – represents emissions based on Transalloys power plant and as disposal facility design specifications and MESs.

- Emissions due to additional mitigation – based on additional mitigation applied to fugitive emission sources beyond the design specifications.

Table 8: Point sources and associated pollutants applicable to the proposed Transalloys Power Project

Source	Pollutants emitted					
	SO_2	CO	NO_x	VOC's	PM	Other[a]
Boiler stacks	✓	✓	✓	✓	✓	✓
Auxiliary Stacks	✓	✓	✓	✓	✓	✓
Diesel Generator Stacks	✓	✓	✓	✓	✓	✓
Fire Pump Stack	✓	✓	✓	✓	✓	✓

<u>Notes:</u> [a] Other pollutants listed as applicable to power stations include hydrogen sulphide (H_2S), sulfuric acid (H_2SO_4), total reduced sulfur (S), fluorides and heavy metals such as Lead (Pb), mercury (Hg), arsenic (As), barium (Ba), bismuth (Bi), cobalt (Co), chromium (Cr), copper (Cu), gallium (Ga), germanium (Ge), Nickel (Ni), niobium (Nb), rhiobium (Rb), , selenium (Se), thorium (Th), tin (Sn), tungsten (W), uranium (U), vanadium (V), yiddium (Y), zinc (Zn) and zirconium (Zr).

Table 9: Fugitive sources and associated pollutants applicable to the proposed Transalloys Power Project

Aspect	Source	Activity
Fugitive dust (PM_{10}, $PM_{2.5}$ & TSP) and gaseous emissions (NO_x, SO_2 & CO)	Materials handling operations	Handling and conveying of coal, limestone and ash (trucks, hoppers and transfer points)
	Vehicle activity on unpaved and paved roads	Haul trucks transporting coal and limestone to storage pile Haul trucks transporting ash to ash disposal facility
	Wind erosion	Ash disposal facility Coal and limestone storage piles
	Crushing and Screening	Primary and secondary crushing of coal and limestone
	Vehicle and engine exhausts	Emissions from exhausts from diesel mobile and stationery equipment

4.1.2.1 Stack emissions

Stack emission represent the primary source of atmospheric emission from a coal-fired power station. The South Africa MESs for coal-fired power stations were utilized in the estimation of stack emissions, while other stack parameters and design specifications were utilized from Akinshipe & Liebenberg-Enslin (2014) as well as data supplied by Savannah (Table 10).

In simulation of upset (emergency) conditions for other point sources such as auxiliary boiler, diesel fire water pump and diesel engine generator, use was made of stack parameters obtained from similar industrial processes and projects.

Table 10: Stack and point source parameters for the proposed Transalloys Power Plant

Stack Names	Number of Stacks	Stack height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Temperature (K)
Boiler Stack	1	150	4	20	411.5
Auxiliary Boiler Stack	1	4	0.6	29.89	393.15
Diesel Generator Stack	1	3	0.154	71.04	796.75
Fire Water Pump Stack	1	3	0.089	33.22	728.35

4.1.2.2 Materials Handling Operations

Materials handling operations associated with the proposed activities at the proposed Transalloys Power Project include the transfer of material by means of tipping, loading and off-loading of trucks. The quantity of dust that will be generated from such loading and off-loading operations will depend on various climatic parameters, such as wind speed and precipitation, in addition to non-climatic parameters such as the nature (i.e. moisture content) and volume of the material handled. Fine particulates are most readily disaggregated and released to the atmosphere during the material transfer process, as a result of exposure to strong winds. Increases in the moisture content of the material being transferred would decrease the potential for dust emissions, since moisture promotes the aggregation and cementation of fines to the surfaces of larger particles.

The predictive US-EPA equation (US EPA, 2006) was used to estimate emissions from materials handling operations. The $PM_{2.5}$ and PM_{10} fraction of the TSP was assumed to be 7.2% and 47.3% respectively (US EPA, 2006). Hourly emission rates, varying according to the prevailing wind speed, were used as input in the dispersion simulations. Emissions quantification was based on the quantity of material handled as shown in Table 11. The moisture content and the quantity of materials were obtained from Savannah. In order to be conservative in simulation, use was made of the lower range of the moisture content supplied. Mitigation was accounted for in accordance with provisions of the NPI (2012). Mitigation was utilized as 50% for water sprayers, 90% for enclosure plus water sprayers.

Table 11: Quantity and moisture content of materials utilized or generated at the proposed Transalloys Power Project

Materials	Quantity (tons/annum)	Moisture content range supplied (%)	Moisture content Utilized (%)
Coal	927 000	5.0	5.0
Limestone	145 000	1.2 – 5.0	1.2
Ash	484 000	15.0 – 25.0	20.0

4.1.2.3 Vehicle-Entrained Emissions from Unpaved Roads

Vehicle-entrained dust emissions from unpaved haul roads represent a potentially significant source of fugitive dust. The force of the wheels of vehicles travelling on unpaved roadways causes pulverisation of surface material. Particles are lifted and dropped from the rotating wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to affect the road surface once the vehicle has passed. The quantity of dust emissions from unpaved roads varies linearly with the volume of traffic. In addition to traffic volumes, emissions also depend on a number of parameters which characterize the condition of a particular road and the associated vehicle traffic; including average vehicle speed, mean vehicle weight, average number of wheels per vehicle, road surface texture, and road surface moisture (US EPA, 2006).

The unpaved road size-specific emission factor equation specified by US-EPA (US EPA, 2006) was utilized in the quantification of emissions from unpaved roads at Transalloys. The particle size multiplier in the equation (k) varies with aerodynamic particle size range and is given as 0.15 for $PM_{2.5}$, 1.5 for PM_{10} and 4.9 for total suspended particulates (TSP). "*a*" is given as 0.9, 0.9, 0.7 for $PM_{2.5}$, PM_{10} and TSP; while *"b"* is 0.45 for $PM_{2.5}$, PM_{10} and TSP.

Silt content of 2.12% utilized for the study was obtained from the results of unpaved road sample analysis taken at the existing Transalloys ferromanganese plant during a study conducted in 2013 (Akinshipe & von Reiche, 2013). This is considered representative of the silt content at the proposed Transalloys Power Project site. The capacity of on-site trucks was given as 20 tons by Transalloys. For the initial assessment, mitigation was not accounted for. Continuous watering could however result in 75% control efficiency on the roads. This was assumed for the mitigated option.

Traffic activities on unpaved roads/sections at the proposed Transalloys Power Project are expected to be limited to the hauling of ash at the ash disposal facility. Based on 20 tons truck capacity, haul trucks are estimated to travel a total of 2.8 kilometres per hour on unpaved road section to the ash disposal facility.

4.1.2.4 Vehicle-Entrained Emissions from Paved Roads

The paved road size-specific emission factor equation specified by US-EPA (2011) was utilized in the quantification of emissions from paved roads at Transalloys. The particle size multiplier in the equation (k) varies with aerodynamic particle size range and is given as 0.15 for $PM_{2.5}$, 0.62 for PM_{10} and 3.23 for total suspended particulates (TSP). The silt content of 15.57 g/m^2 utilized for the study was obtained from the results of unpaved road sample analysis taken at Transalloys ferromanganese plant during a study conducted in 2013 (Akinshipe & von Reiche, 2013). The capacity of on-site trucks was given as 20 tons. For the initial assessment, mitigation was not accounted for. Water sprays to clean the road surface could result in 75% control efficiency on the roads. This was assumed for the additional mitigation option.

High traffic activities (including hauling of coal, limestone and ash material) are expected on paved roads at the proposed Transalloys Power Project. Based on 20 tons truck capacity, haul trucks are estimated to travel a total of 19.7 kilometres every hour on paved roads in and around the power station boundary.

4.1.2.5 Crushing Operations

Primary and secondary crushing represents significant dust-generating sources if uncontrolled. Dustfall in the vicinity of crushers also gives rise to the potential for the re-entrained of dust emitted by vehicles or by the wind later. The large percentage of fines in this dustfall material enhances the potential for it to become airborne.

The Australian NPI provides emission factor for low moisture (<4%) and high moisture (>4%) ore. A single valued emission factor was used in the quantification of possible emissions due to uncontrolled crushing activities for low and high moisture ore as provided by NPI (2011). Mitigation was accounted for in accordance with provisions of the NPI (2012). Mitigation was taken as 50% for water sprayers, 90% for enclosures (mitigated option).

4.1.2.6 Diesel Vehicle and Stationery Equipment Exhaust emissions

The Australian NPI (2008) provides emission factors for vehicle exhaust as well as stationary diesel equipment as follows. Emission factors for wheeled loader, track dozer, haul trucks and stationery mobile equipment (fire pumps, generators and auxiliary boilers) were obtained from Tables 26, 31, 33 and Table 43 of the NPI (2008). Pollutants quantified include TSP, PM_{10}, $PM_{2.5}$, NOx as NO_2, SO_2, CO and VOC. Emissions were quantified using estimated annual diesel fuel usage of 1,100 tons as supplied by Transalloys.

4.1.2.7 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 & Yaping, 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 threshold 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 & Yaping, 2008).

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. The shape of a storage pile or disposal dump influences the potential for dust emissions through the alteration of the airflow field. The particle size distribution of the material on the disposal site is important since it determines the rate of entrainment of material from the surface, the nature of dispersion of the dust plume, and the rate of deposition, which may be anticipated.

An hourly emissions file was created for the discard dump as well as storage pile. The calculation of an emission rate for every hour of the simulation period was carried out using the ADDAS model. This model is based on the dust emission model proposed by (Marticorena & Bergametti, 1995). The model attempts to account for the variability in source erodibility through the parameterisation of the erosion threshold (based on the particle size distribution of the source) and the roughness length of the surface. In the quantification of wind erosion emissions, the model incorporates the calculation of two important parameters, viz. the threshold friction velocity of each particle size, and the vertically integrated horizontal dust flux, in the quantification of the vertical dust flux (i.e. the emission rate).

The parameters used for the calculation of emissions from the stockpiles are given in Table 12. Coal parameters are provided by Savannah, while the ash and limestone parameters were obtained from studies involving similar processes. In order to conservatively simulate emissions, the moisture content utilized in the ADDAS model is lower than the given moisture content.

Table 12: Parameters pertaining to the stock piles utilized in the ADDAS model

Source	Density (kg/m^3)	Moisture (%)	Roughness Length (m)	Estimated Area (m^2)
Coal stockpile	960	6.0	0.0003	6,400
Limestone stockpile	1 360	1.2	0.0003	473
Ash disposal facility	1 000	1.0	0.0003	254,400

Notes:

[1] US-EPA default moisture content for Western surface coal mining

4.1.2.8 Summary of Emissions

Estimated annual average emissions, per source group, are presented in Table 13. The contributions of each source group's emissions to the total are graphically presented in Figure 11 and Figure 12.

Table 13: Estimated annual average emission rates per source group

Annual Emissions in tpa (with design specification mitigation)							
Sources	**$PM_{2.5}$**	**PM_{10}**	**TSP**	**CO**	**SO_2**	**NO_x**	**VOCs**
Plant stack [a]	262	262	262		2619	3929	
Crushing and Screening	0.86	1.72	4.29				
Materials handling	0.4	3.0	6.3				
Paved roads	14.2	58.8	306				
Unpaved roads	0.71	7.1	32.7				
Wind erosion	10.5	14.8	25.1				
Vehicle exhaust	5.38	5.85	5.85	37.5	0.06	90.1	4.84
Total	**294**	**353**	**643**	**37.6**	**2619**	**4019**	**4.84**
Construction	**52.4**	**105**	**349**				
Annual Emissions in tpa (with additional mitigation)							
Sources	**$PM_{2.5}$**	**PM_{10}**	**TSP**	**NOx**	**VOC**	**SO_2**	**CO**
Plant stack [a]	262	262	262		2619	3929	
Crushing and Screening	0.86	1.72	4.29				
Materials handling	0.45	2.96	6.27				
Paved roads	3.56	14.7	76.6				
Unpaved roads	0.18	1.77	8.2				
Wind erosion	5.24	7.38	12.6				
Vehicle exhaust	5.38	5.85	5.85	37.5	0.06	90.1	4.84
Total	**278**	**296**	**376**	**37.6**	**2619**	**4019**	**4.84**
Construction	**26.2**	**52.4**	**175**				

NOTE: [a] South African maximum emissions limits were used to calculate stack emissions (this ensures that the emissions quantification are conservative).

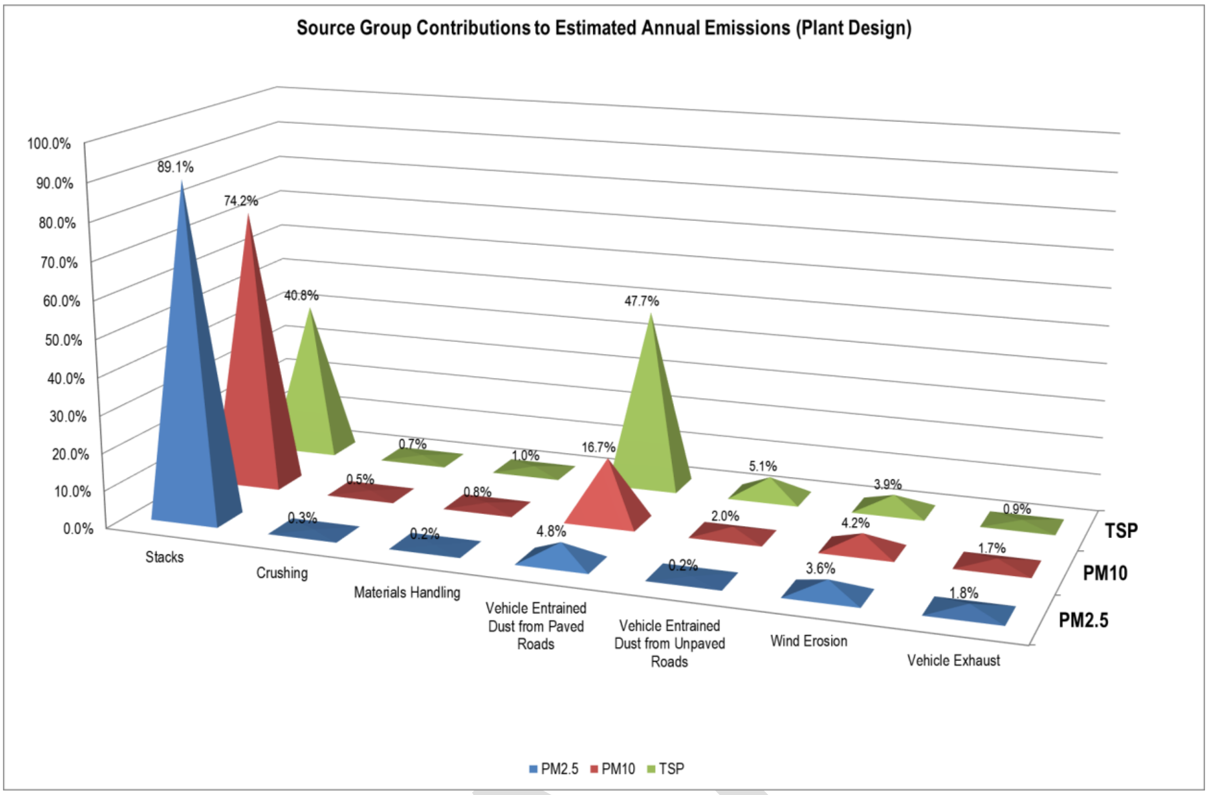


Figure 11: Source group contributions to estimated annual emissions (Pl design)

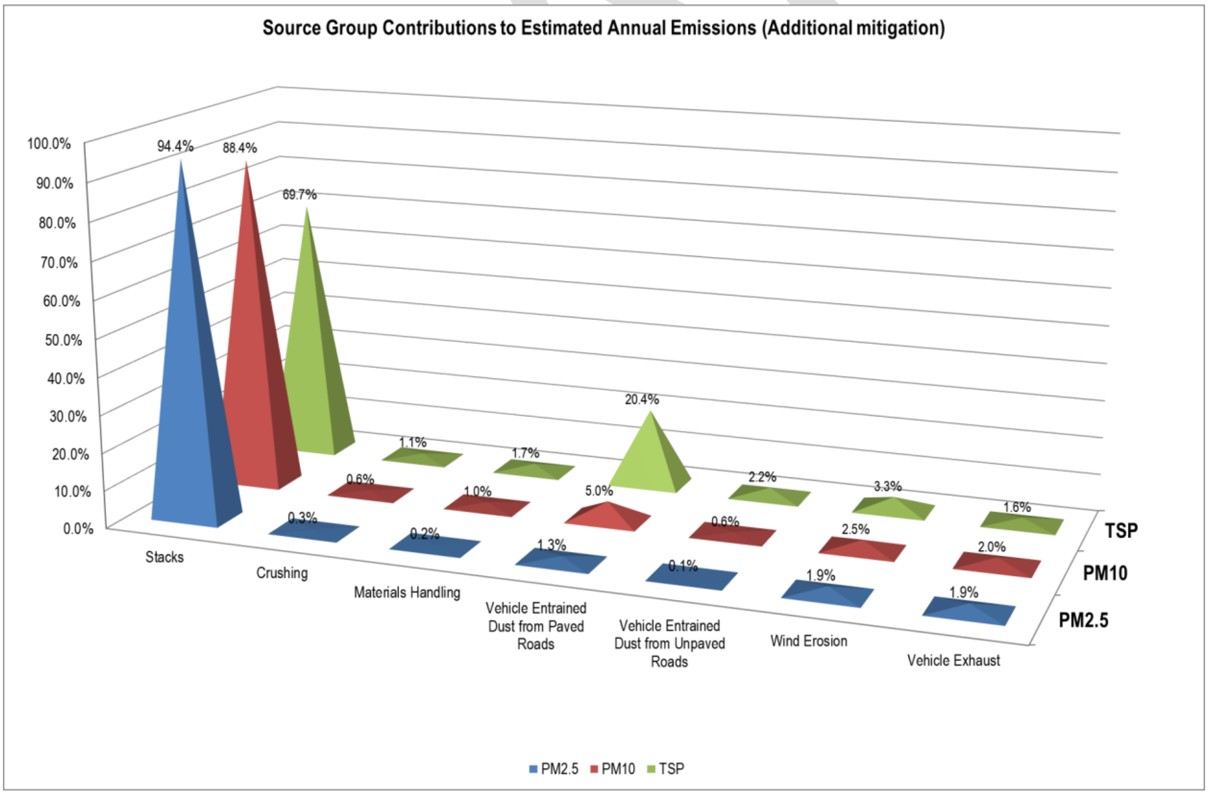


Figure 12: Source group contributions to estimated annual emissions (additional mitigation)

The following should be noted with regards to the emissions inventory:

- Stack emission contributes most notably to estimated PM emissions during the project's operational phase. About 40% to 89% of plant design emissions and 70% to 94% of mitigated emissions are expected to be from stacks. Vehicle emission from paved and unpaved roads contributes between 5% and 48% for plant design emissions and between 1% and 20% for additional mitigation. Paved roads are the second highest source of emissions due to very high traffic activities on paved site roads.
- Crushing and material handling emissions contribute less than 1% to total emissions.

4.1.3 Closure and Post-closure Phase

All operational activities will have ceased by the closure and post-closure phase of the project. This will obviously result in a positive impact on the surrounding environment and human health. The potential for impacts during the closure phase will therefore depend on the extent of rehabilitation efforts to be undertaken at the ADF, stockpiles, plant area and associated infrastructure. These impacts are generally lower than construction and operational phase impacts and are not easily quantifiable for dispersion modelling purpose since closure schedule are not detailed enough and activities do not follow a steady release of emissions. Aspects and activities associated with the closure phase of the proposed project are listed in Table 14.

Table 14: Activities and aspects identified for the closure and post-closure phase

Aspects	Activities
Fugitive dust	Demolition and stripping away of buildings and facilities
Fugitive dust	Wind-blown dust from ADF and exposed areas
Fugitive dust	Degradation of roads and other infrastructure resulting in exposed areas surfaces

4.2 Atmospheric Dispersion Modelling

The assessment of the impact of the project's operations on the environment is discussed in this section. To assess impact on human health and the environment the following important aspects need to be considered:

- The criteria against which impacts are assessed (Section 2);
- The potential of the atmosphere to disperse and dilute pollutants emitted by the project (Section 3.2); and
- The methodology followed in determining ambient pollutant concentrations and dustfall rates (Section 1.3)

The impact of operations on the atmospheric environment was determined through the simulation of dustfall rates and ambient pollutant concentrations. Dispersion models simulate ambient pollutant concentrations and dustfall rates 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.

4.2.1 Dispersion Model Selection

Gaussian-plume models are best used for near-field applications where the steady-state meteorology assumption is most likely to apply. One of the most widely used Gaussian plume model is the US EPA AERMOD model that was used in this study. AERMOD is a model developed with the support of AERMIC, whose objective has been to include state-of the-art science in regulatory models (Hanna, Egan, Purdum, & Wagler, 1999). 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 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 (pre-processed by the AERMET model), terrain data, information on the nature of the receptor grid and pre-development or background pollutant concentrations or dustfall rates. Version 7.9 of AERMOD and its pre-processors were used in the study.

4.2.2 Meteorological Requirements

For the purpose of the dispersion modelling, Meteorological data was obtained from eMalahleni monitoring station of the South African Weather Services (SAWS) for the period January 2014 to December 2016. The weather station is located ~9 km northeast of Transalloys and is considered representative of the weather conditions at the Transalloys site (Section 3.2).

4.2.3 Source and Emission Data Requirements

The AERMOD model is capable of modelling point, jet, area, line and volume sources. Sources were modelled as follows:

- Materials handling and crushing and screening – modelled as volume sources;
- Stack emissions – modelled as point sources; and
- Paved roads, unpaved roads, vehicle exhaust, and windblown dust – modelled as area sources.

4.2.4 Simulation of NO/NO_2 Transformation

Nitrogen monoxide (NO) emissions are rapidly converted in the atmosphere into the much more poisonous nitrogen dioxide (NO_2) which is regulated by SA NAAQS. NO_2 concentrations were calculated by AERMOD using the ozone limiting method and applying an annual average background O_3 concentration of 30 ppb (Zunckel, et al., 2004). A diesel exhaust NO_2/NO_x emission ratio of 0.2 (Howard, 1988) was used.

4.2.5 Modelling Domain

The dispersion of pollutants expected to arise from proposed activities was modelled for an area covering 10 km (east-west) by 10 km (north-south). The area was divided into a grid matrix with a resolution of 100 m, with the project located centrally. AERMOD calculates ground-level (1.5 m above ground level) concentrations and dustfall rates at each grid and discrete receptor point.

4.2.6 *Presentation of Results*

Dispersion modelling was undertaken to determine highest hourly, highest daily and annual average ground level concentrations as well as dustfall rates for each of the pollutants considered in the study. Averaging periods were selected to facilitate the comparison of predicted pollutant concentrations to relevant ambient air quality and inhalation health criteria as well as dustfall regulations.

Results are primarily provided in form of isopleths to present areas of exceedance of assessment criteria. Ground level concentration or dustfall isopleths presented in this section depict interpolated values from the concentrations simulated by AERMOD for each of the receptor grid points specified. The reader should take note that isopleths showing 1-hour, or 24-hour concentrations reflect the 2nd highest 1-hour or 24-hour concentration simulated at grid receptor locations and not the frequency at which the specific concentration occurred over the simulation period. Separate isopleth plots are given to indicate the frequencies of exceedance.

Isopleth plots reflect the incremental ground level concentrations (GLCs) for $PM_{2.5}$, PM_{10}, NO_2 and SO_2. Due to the unavailability of ambient baseline concentrations, the total cumulative pollutant concentrations could not be quantitatively determined but qualitative commentary is provided in the discussion of impact significance in section 5.

It should also be noted that ambient air quality criteria apply to areas where the Occupational Health and Safety regulations do not apply, thus outside the property or lease area. Ambient air quality criteria are therefore not occupational health indicators but applicable to areas where the general public has access i.e. off-site.

4.3 Operational Phase Dispersion Simulation Results, Health Risk and Nuisance Screening

Pollutants with the potential to result in human health impacts which are assessed in this study include NO_2, $PM_{2.5}$, PM_{10} and SO_2. Dustfall is assessed for its nuisance potential. The impact assessment methodology as discussed under section 4.2 was followed. Isopleth plots are provided for all pollutants where exceedances of the relevant NAAQSs were simulated. Isopleth plots reflect the incremental GLCs for $PM_{2.5}$, PM_{10}, SO_2 and TSP.

4.3.1 *Incremental $PM_{2.5}$ Impact*

The areas over which the 24-hour $PM_{2.5}$ NAAQS are exceeded are shown in Figure 13. Simulated $PM_{2.5}$ concentrations exceed the 24-hour SA NAAQS (4 days exceeding 40 µg/m³ permitted per year) for about 2 km to the west and 0.8 km to the east of the proposed power plant site, but not at any AQSRs. Simulations also indicate that exceedances of the annual SA NAAQS for $PM_{2.5}$ (20 µg/m³) occur beyond the boundaries of the proposed power plant, but not at any AQSRs (Figure 14). The incremental $PM_{2.5}$ GLCs are provided in Table 15.

It should be noted that the $PM_{2.5}$ modelling assumes that all PM emitted from the stack are $PM_{2.5}$. This ensures a conservative modelling approach.

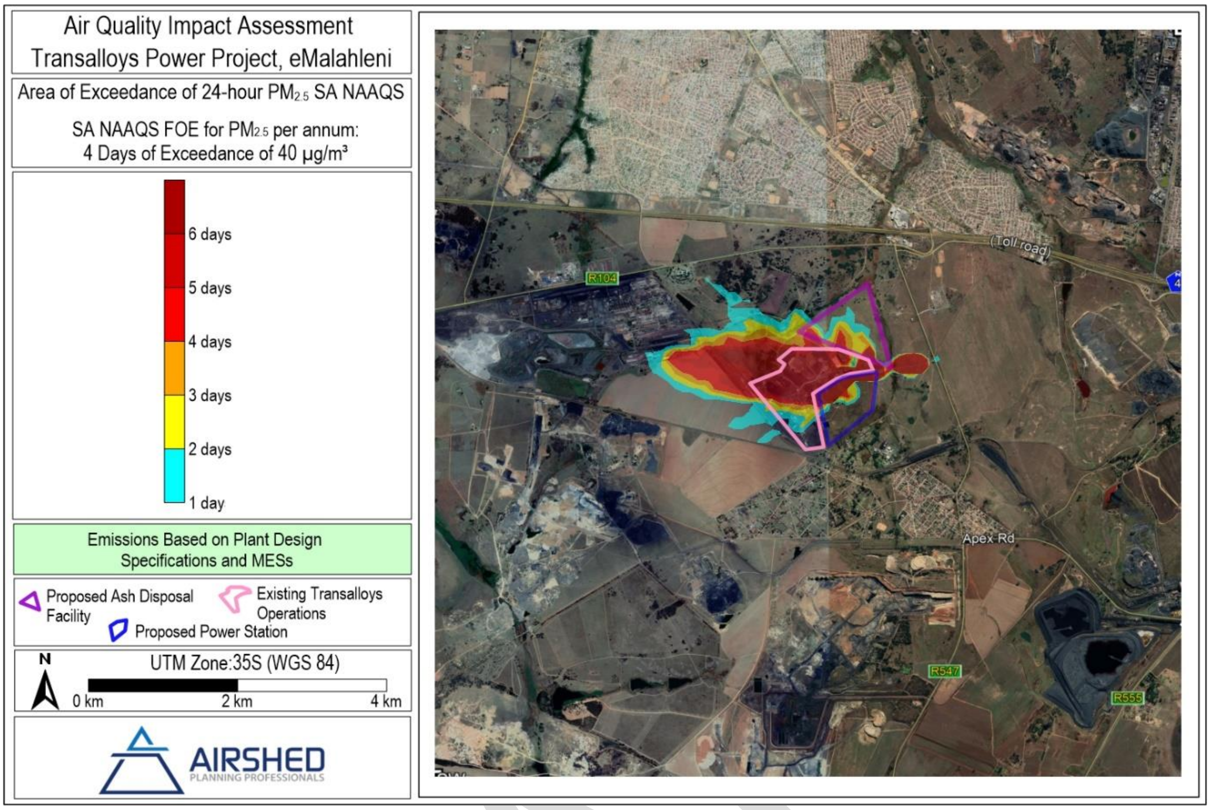


Figure 13: Area of exceedance of the 24-Hour SA NAAQS for $PM_{2.5}$ (due to plant design emissions)

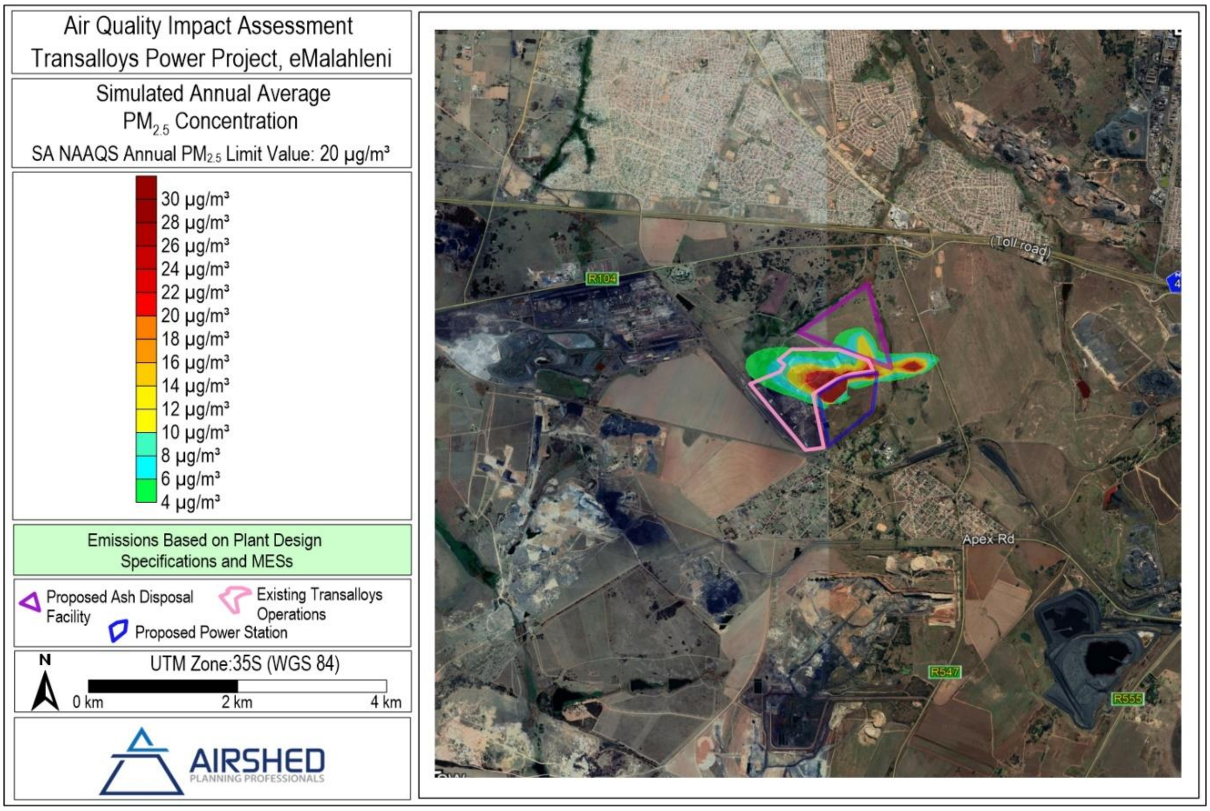


Figure 14: Simulated annual average ground level $PM_{2.5}$ concentration (due to plant design emissions)

Table 15: Summary of simulated $PM_{2.5}$ concentrations at AQSRs

AQSRs	Simulated Highest Annual Average $PM_{2.5}$ concentration (µg/m³)	FOE of the 24-hour $PM_{2.5}$ NAAQS Limit Value of 40 µg/m³ (days per year)
Clewer boundary	0.7	1
Kwa-Guqa boundary	0.4	0
Ackerville boundary	0.1	0
SA NAAQS Values	**20**	**4**

4.3.2 Incremental PM_{10} Impact

The areas over which the 24-hour $PM_{2.5}$ NAAQS are exceeded are shown in Figure 13. Simulated PM_{10} concentrations exceed the 24-hour SA NAAQS (4 days exceeding 75 µg/m³ permitted per year) for about 1.8 km to the west and 0.8 km to the east of the proposed power plant site, but not at any AQSRs. Simulations also indicate that exceedances of the annual SA NAAQS for PM_{10} (40 µg/m³) occur beyond the boundaries of the proposed power plant, but not at any AQSRs (Figure 14). The incremental PM_{10} GLCs are provided in Table 15.

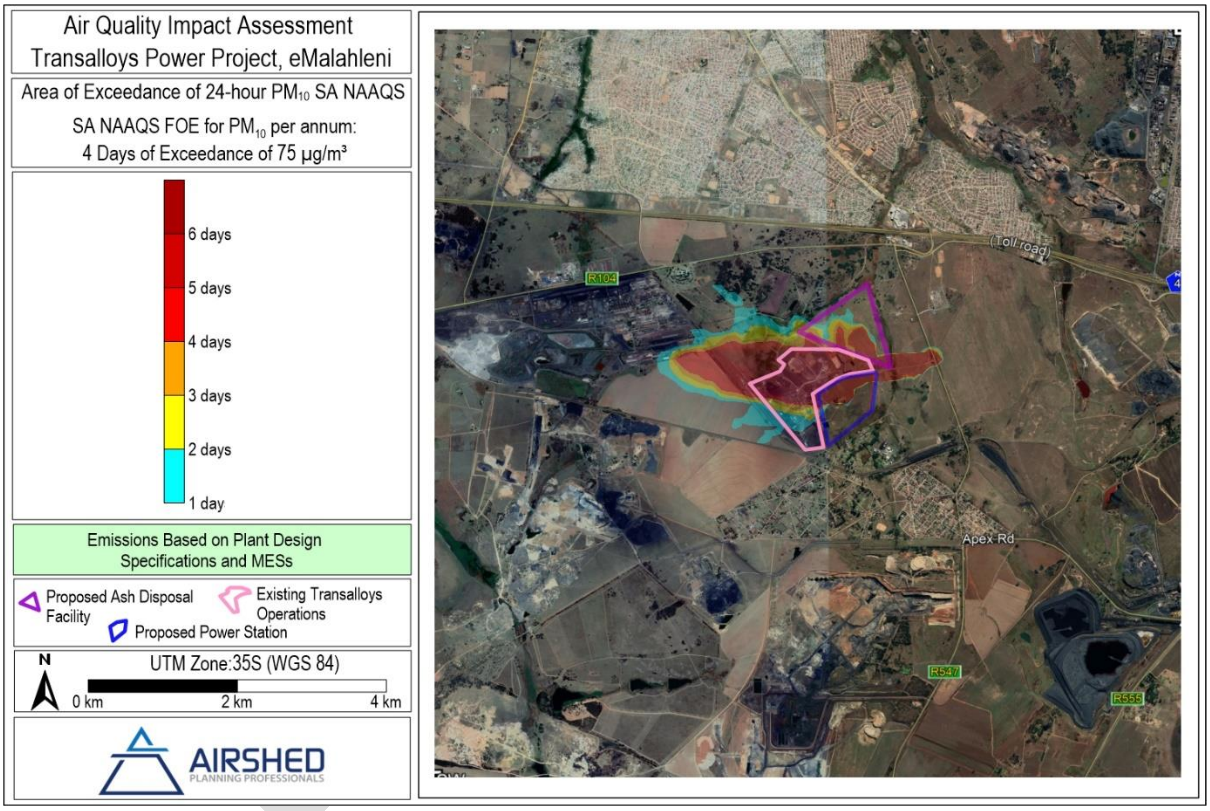


Figure 15: Area of exceedance of the 24-Hour SA NAAQS for PM_{10} (due to plant design emissions)

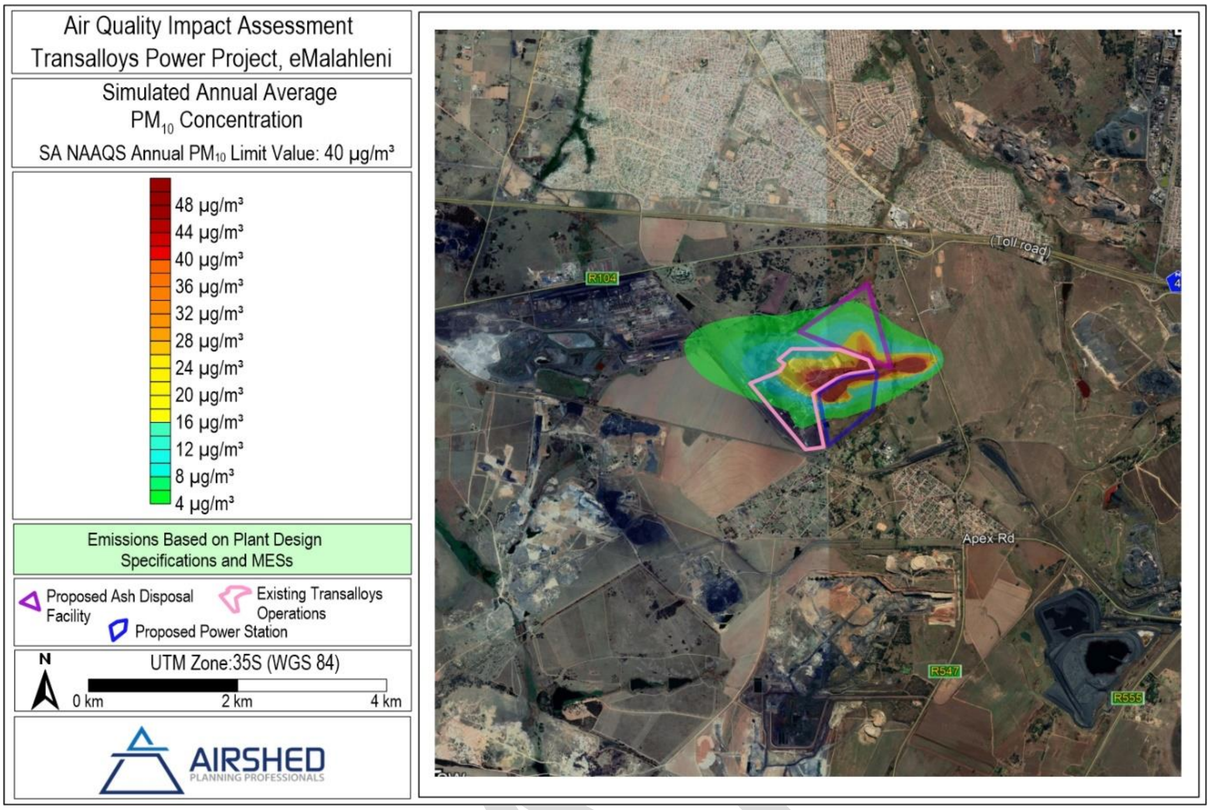


Figure 16: Simulated annual average ground level PM_{10} concentration (due to plant design emissions)

Table 16: Summary of simulated PM_{10} concentrations at AQSRs

AQSRs	Simulated Highest Annual Average PM_{10} concentration (µg/m³)	FOE of the 24-hour PM_{10} NAAQS Limit Value of 40 µg/m³ (days per year)
Clewer boundary	2.2	1
Kwa-Guqa boundary	1.3	0
Ackerville boundary	0.1	0
SA NAAQS Values	**40**	**4**

4.3.3 Incremental Dustfall Deposition Rate

Isopleth plots showing the area of exceedance of the residential and non-residential limits due to incremental dustfall deposition are provided in Figure 17. The simulated daily maximum off-site dustfall deposition rates are below the residential limit at nearby AQSRs (Clewer, Kwa-Guqa and Ackerville). The non-residential limits are exceeded offsite for 0.5 km at the eastern boundary of the proposed power station.

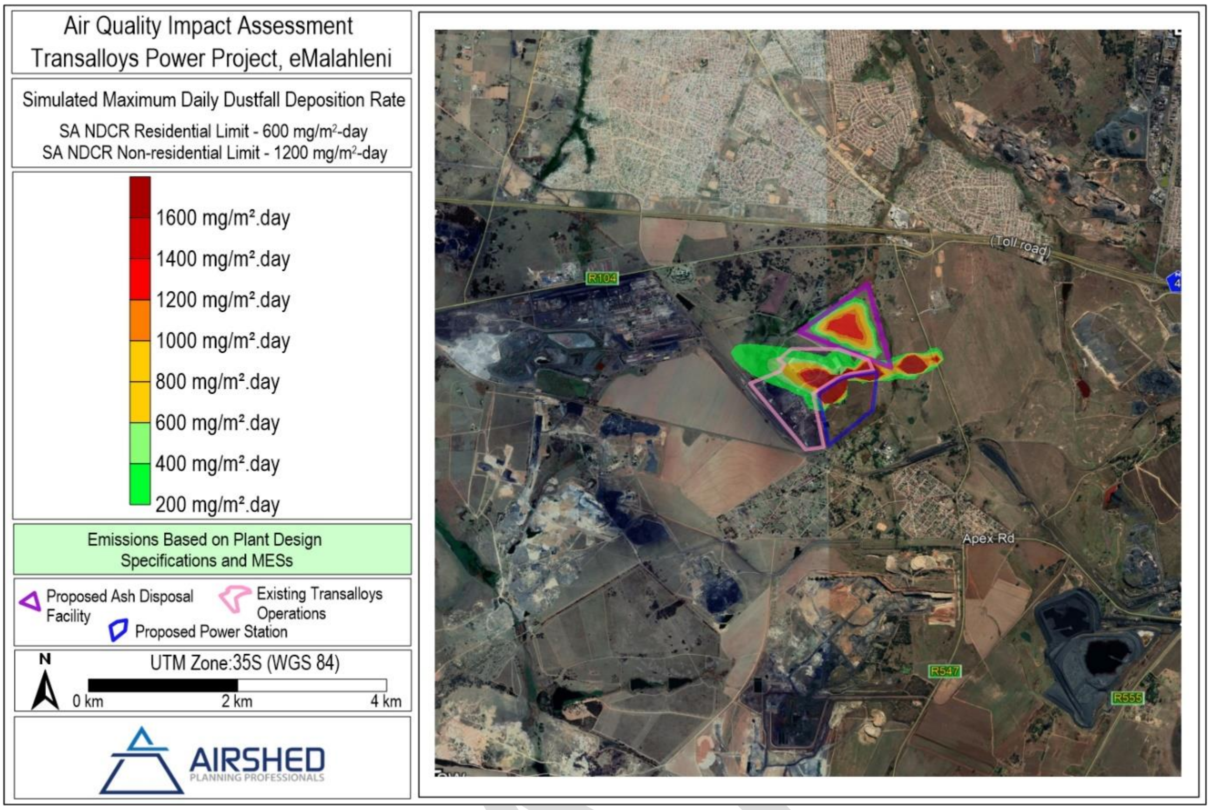


Figure 17: Simulated dustfall deposition rates (due to incremental plant design emissions)

Table 17: Summary of simulated dustfall deposition rates at AQSRs (due to incremental plant design emissions)

AQSRs	Simulated Highest Daily Dustfall Deposition Rate (mg/m^2-day)
Clewer boundary	47.8
Kwa-Guqa boundary	23.7
Ackerville boundary	7.5
SA NDCR Residential Limit / Non-residential Limit [a]	**600 / 1200**

Notes:

[a] Limits are in monthly averages.

4.3.4 Incremental NO_2, and SO_2 Impact

The areas over which the 1-hour NO_2 NAAQS are exceeded are shown in Figure 18. Simulated NO_2 concentrations exceed the 1-hour SA NAAQS (88 hours exceeding 200 µg/m³ permitted per year) for about 0.5 km to the east of the proposed power plant site, including exceedances at Clewer (but not at the other AQSRs). Simulations also indicate that exceedances of the annual SA NAAQS for NO_2 (40 µg/m³) occur beyond the eastern boundary of the proposed power plant, but not at any AQSRs (Figure 19).

Simulated annual average GLCs (Figure 20) are below the standard, with no exceedances on or off site. Incremental NO_2 and SO_2 GLCs are provided in Table 18.

Table 18: Summary of simulated NO_2 and SO_2 GLCs at AQSRs

AQSRs	Incremental NO_2 GLCs		Incremental SO_2 GLCs		
	Annual (µg/m³)	FOE (Hours)	Annual (µg/m³)	FOE (Days)	FOE (Hours)
Clewer boundary	10.8	119	1.6	0	0
Kwa-Guqa boundary	2.1	19	0.3	0	0
Ackerville boundary	0.5	0	0.2	0	0
SA NAAQS	**40**	**88**	**50**	**4**	**88**

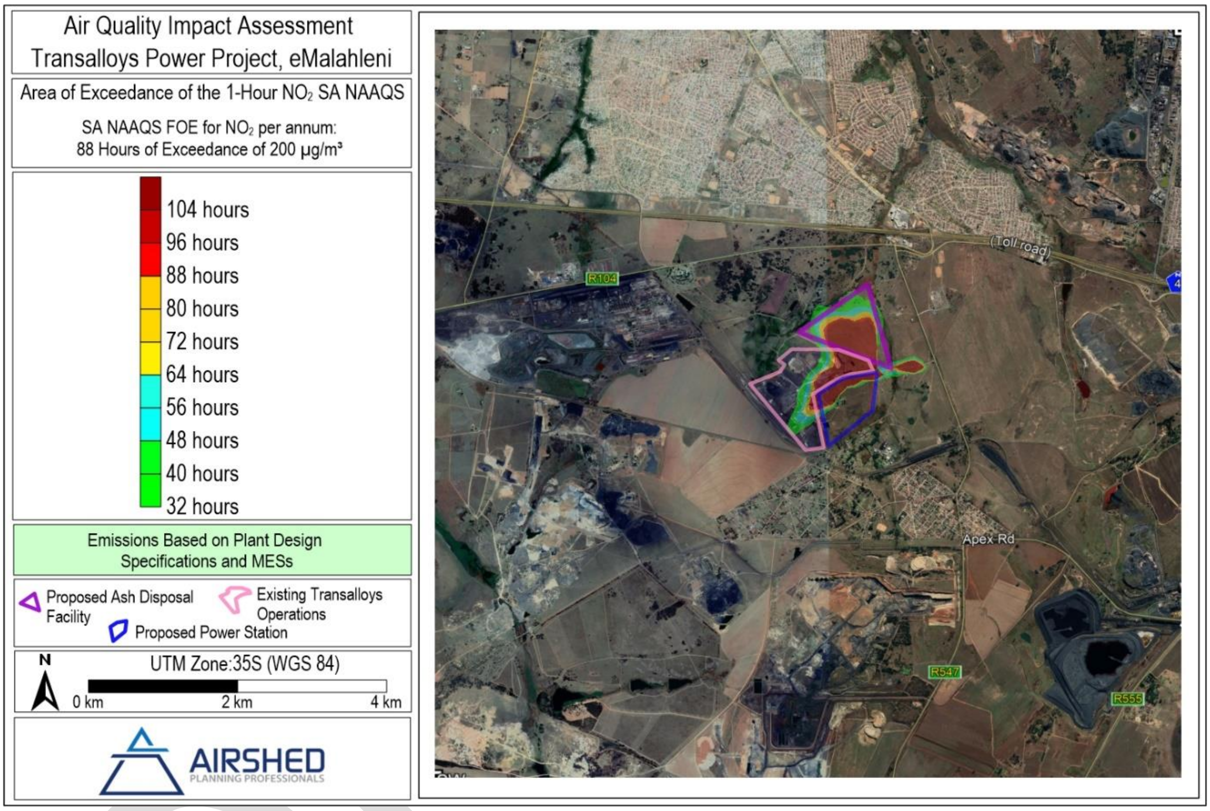


Figure 18: Area of exceedance of the 24-Hour SA NAAQS for NO_2 (due to plant design emissions)

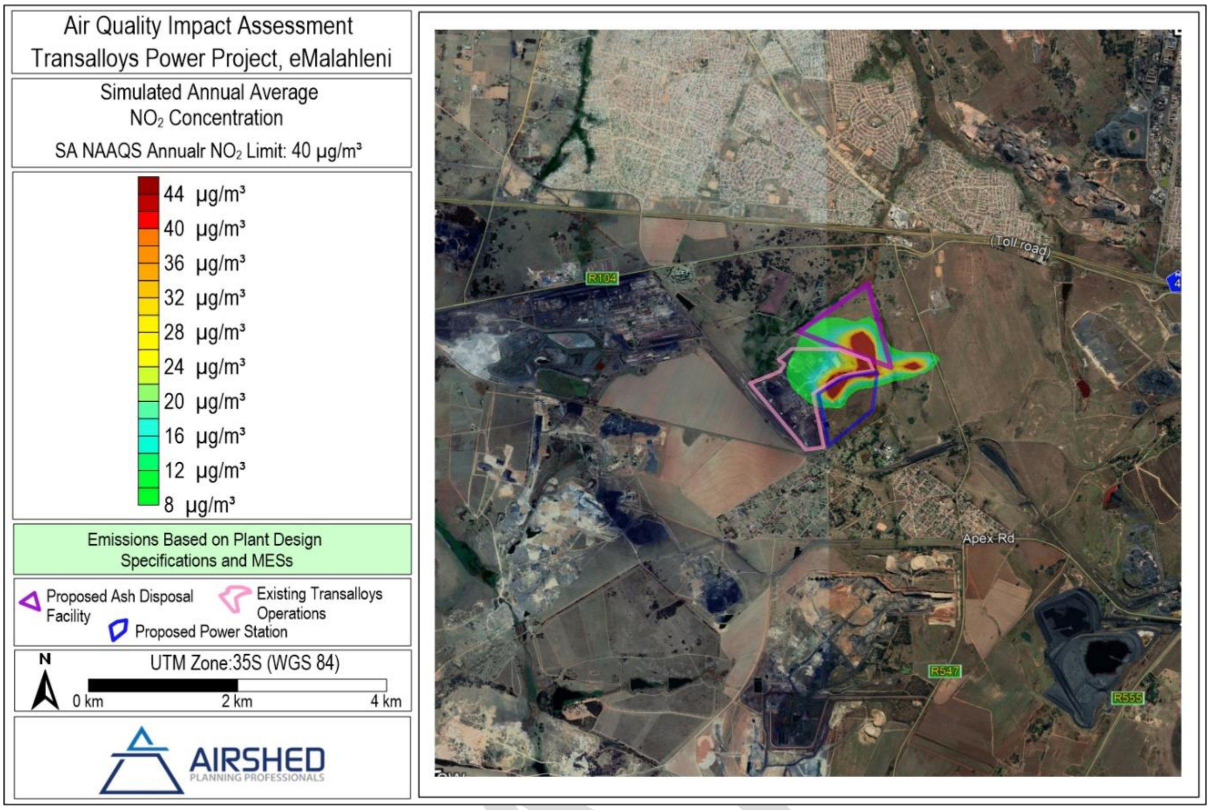


Figure 19: Simulated annual average ground level NO_2 concentration (due to plant design emissions)

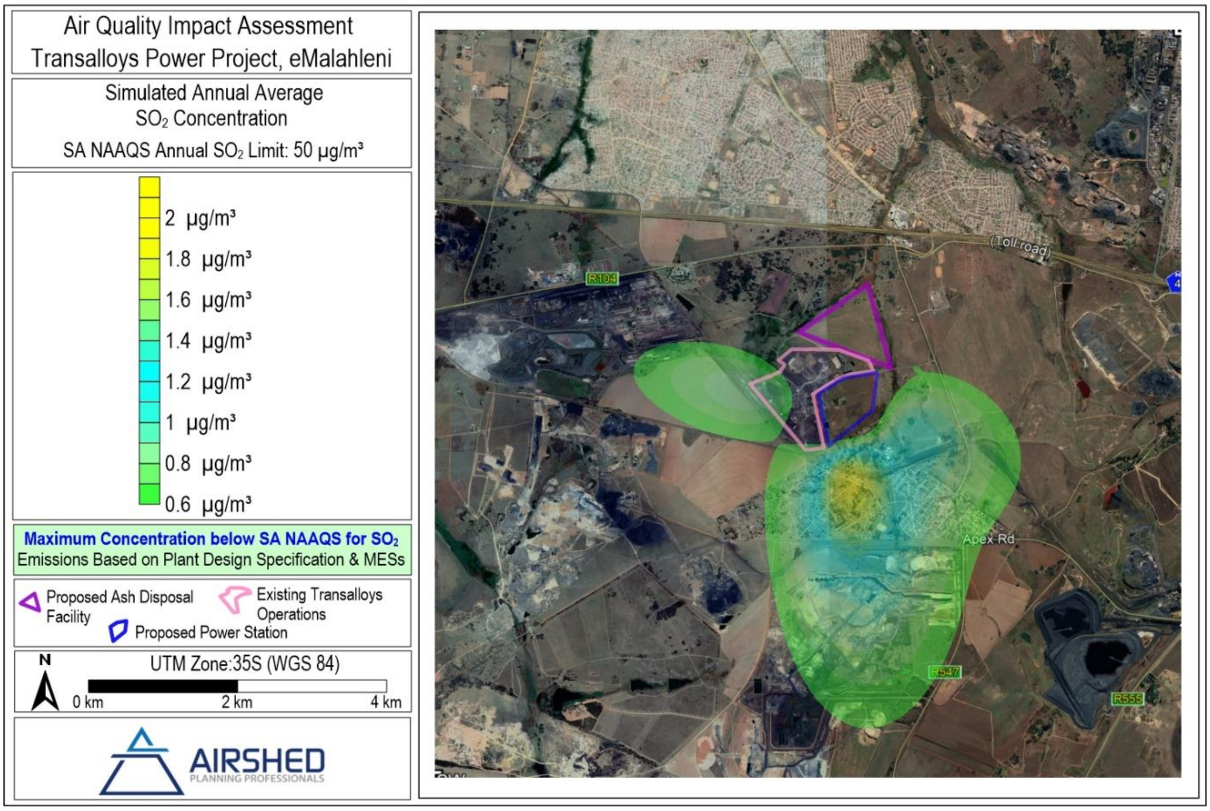


Figure 20: Simulated annual average ground level SO_2 concentration (due to plant design emissions)

4.4 Air Quality Impacts due to Application of Additional Mitigation

Sources of air pollutants that can undergo significant additional mitigation at the proposed Transalloys Power Project include paved roads, unpaved roads and wind erosion from stockpiles. The reader is reminded that the additional mitigation assessed in this section is in addition to mitigation measures integrated into the plant design specification as provided by Savannah and Transalloys. The additional mitigation provides for a control efficiency of 75% for paved and unpaved roads (based on level 2 watering at >2 litres/m^2/h) and 50% for wind erosion from stockpiles (based on use of water sprays). These mitigation measures are as estimated by NPI (2012). The source group contribution to estimated annual emissions with additional mitigation has been shown in Figure 12.

The areas over which the 24-hour $PM_{2.5}$ NAAQS are exceeded are shown in Figure 21. Simulated $PM_{2.5}$ concentrations due to additional mitigation exceed the 24-hour SA NAAQS (4 days exceeding 40 µg/m³ permitted per year) for about 1.5 km to the west of the proposed power plant site **but not at any AQSRs**. Simulations also indicate that exceedances of the annual SA NAAQS for $PM_{2.5}$ (20 µg/m³) occur beyond the boundaries of the proposed power plant, **but not at any AQSRs** (Figure 22).

Similarly, the areas over which the 24-hour PM_{10} NAAQS are exceeded are shown in Figure 21. Simulated PM_{10} concentrations due to additional mitigation exceed the 24-hour SA NAAQS (4 days exceeding 75 µg/m³ permitted per year) for about 1.5 km to the east of the proposed power plant site **but not at any AQSRs**. Simulations also indicate that exceedances of the annual SA NAAQS for PM_{10} (40 µg/m³) occur beyond the boundaries of the proposed power plant, **but not at any AQSRs** (Figure 22).

Isopleth plots showing the area of exceedance of the residential and non-residential limits due to mitigated incremental dustfall deposition are provided in Figure 17. The simulated daily maximum off-site dustfall deposition rates are below the residential limit at nearby AQSRs (Clewer, Kwa-Guqa and Ackerville). The non-residential limits are exceeded offsite for 0.5 km at the eastern boundary of the proposed power station.

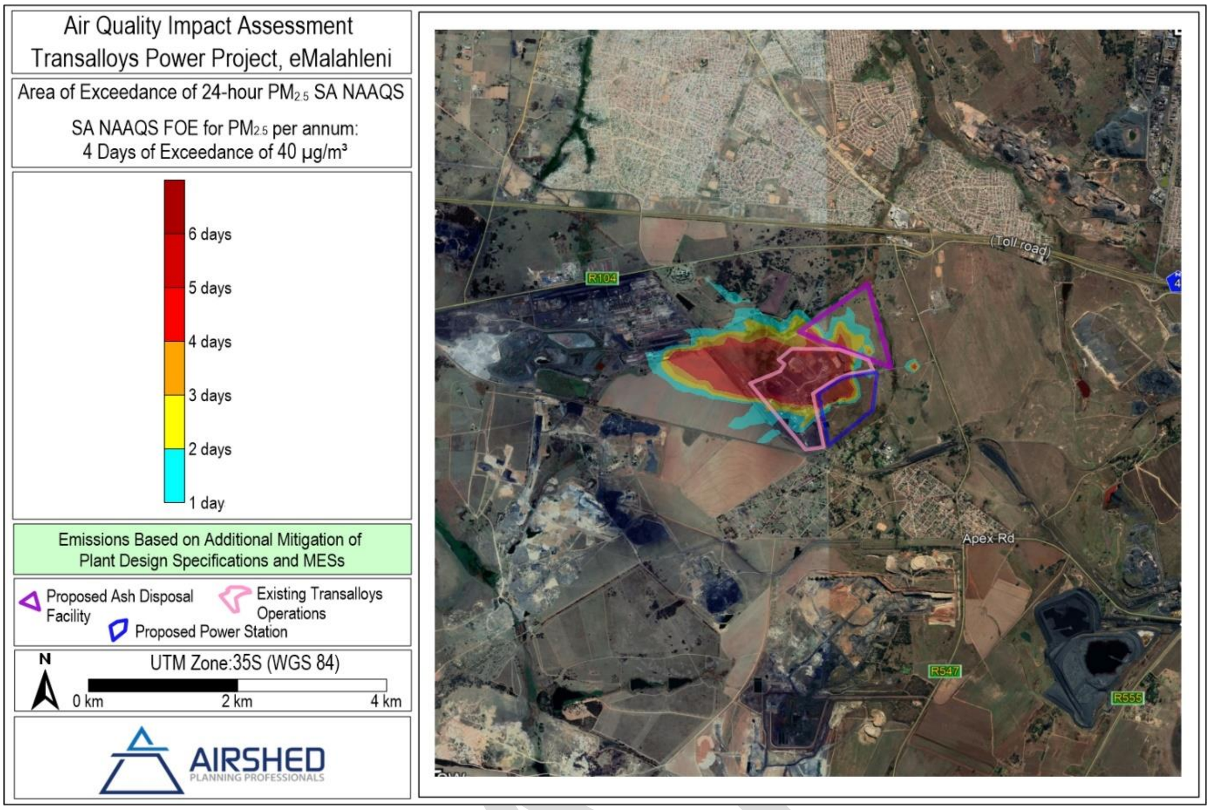


Figure 21: Area of exceedance of the 24-Hour SA NAAQS for $PM_{2.5}$ (emissions due to additional mitigation)

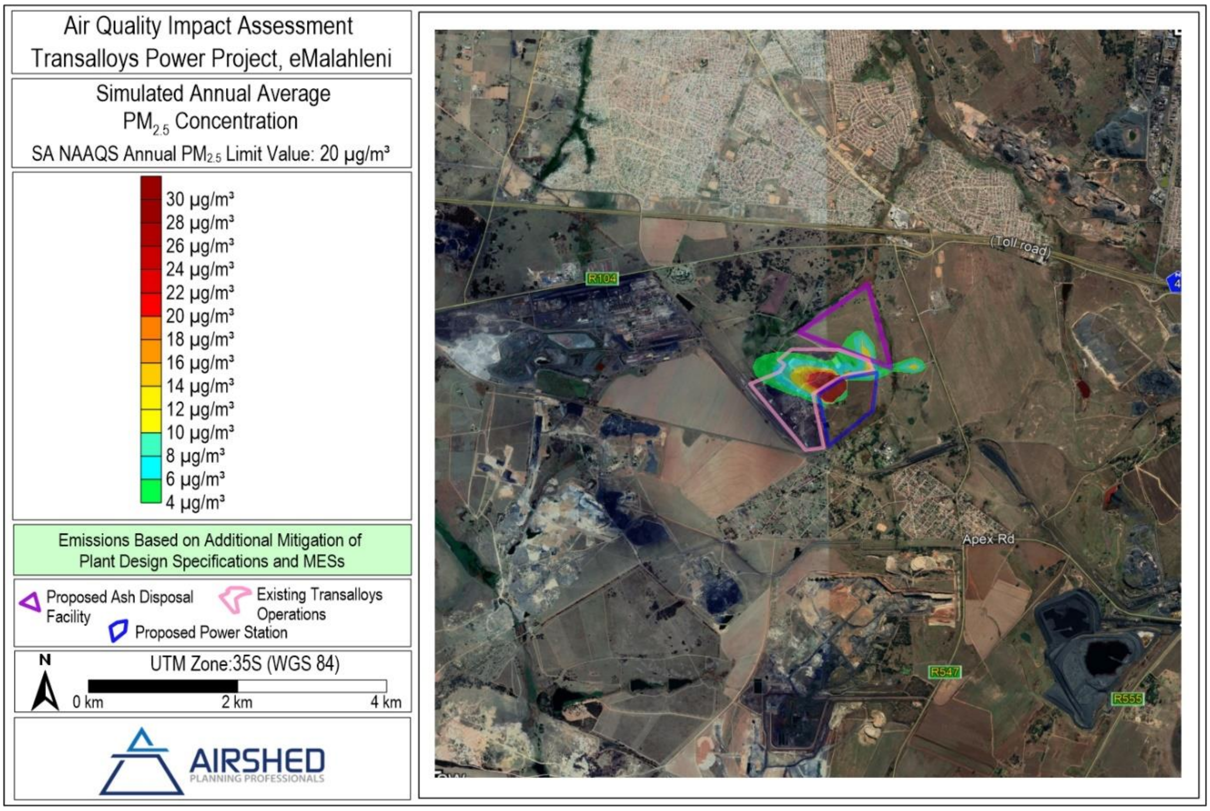


Figure 22: Simulated annual average ground level $PM_{2.5}$ concentration (emissions due to additional mitigation)

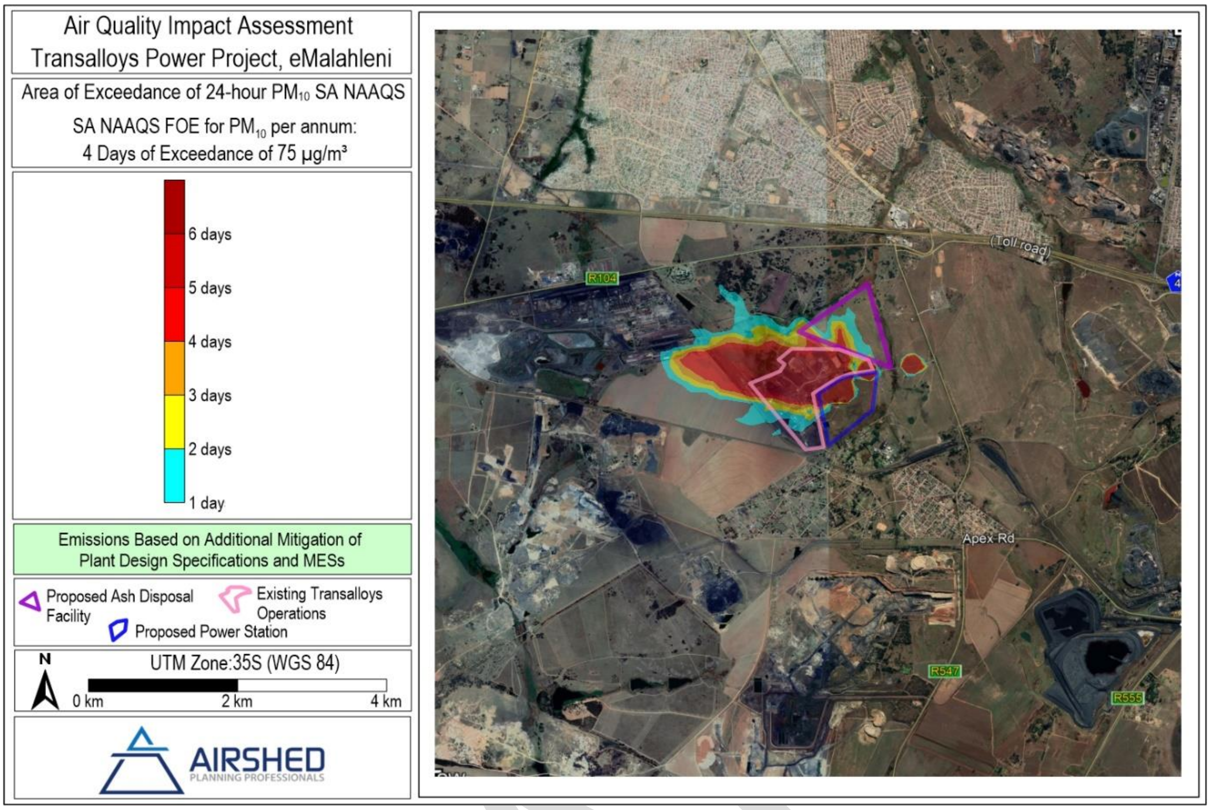


Figure 23: Area of exceedance of the 24-Hour SA NAAQS for PM_{10} (emissions due to additional mitigation)

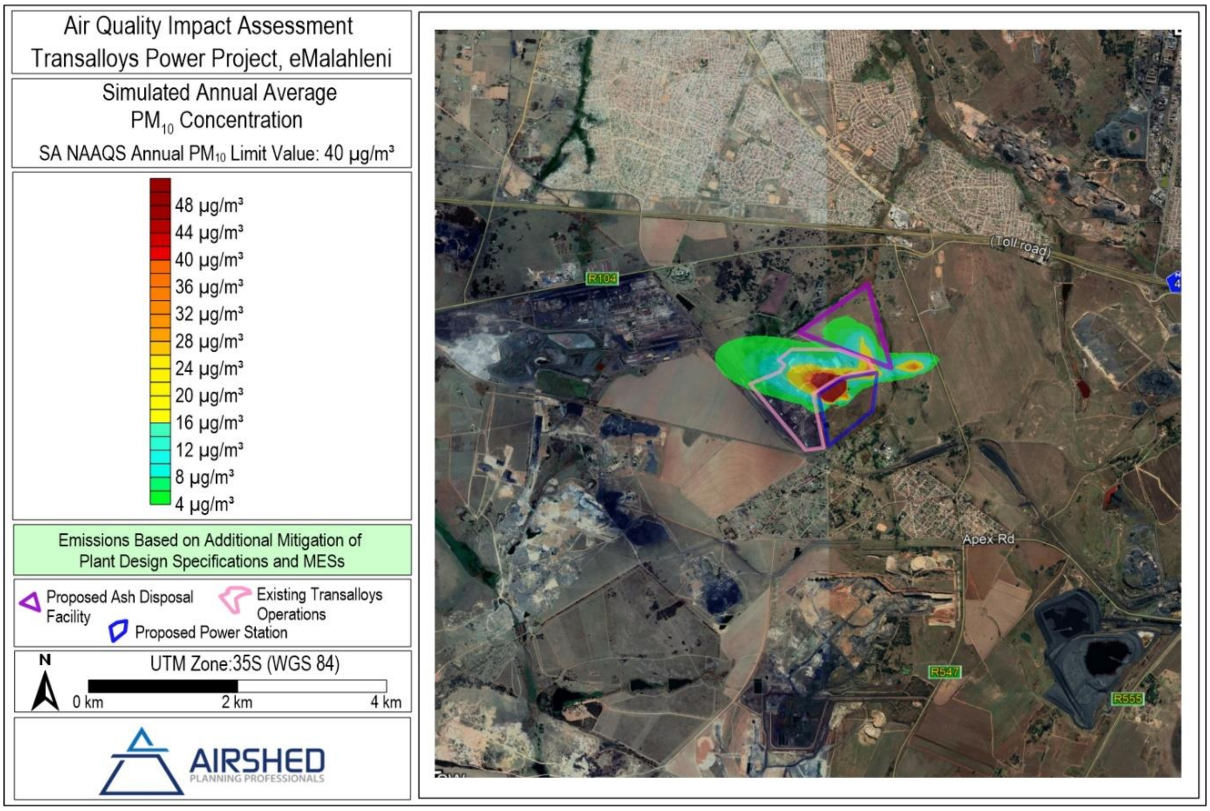


Figure 24: Simulated annual average ground level PM_{10} concentration (emissions due to additional mitigation)

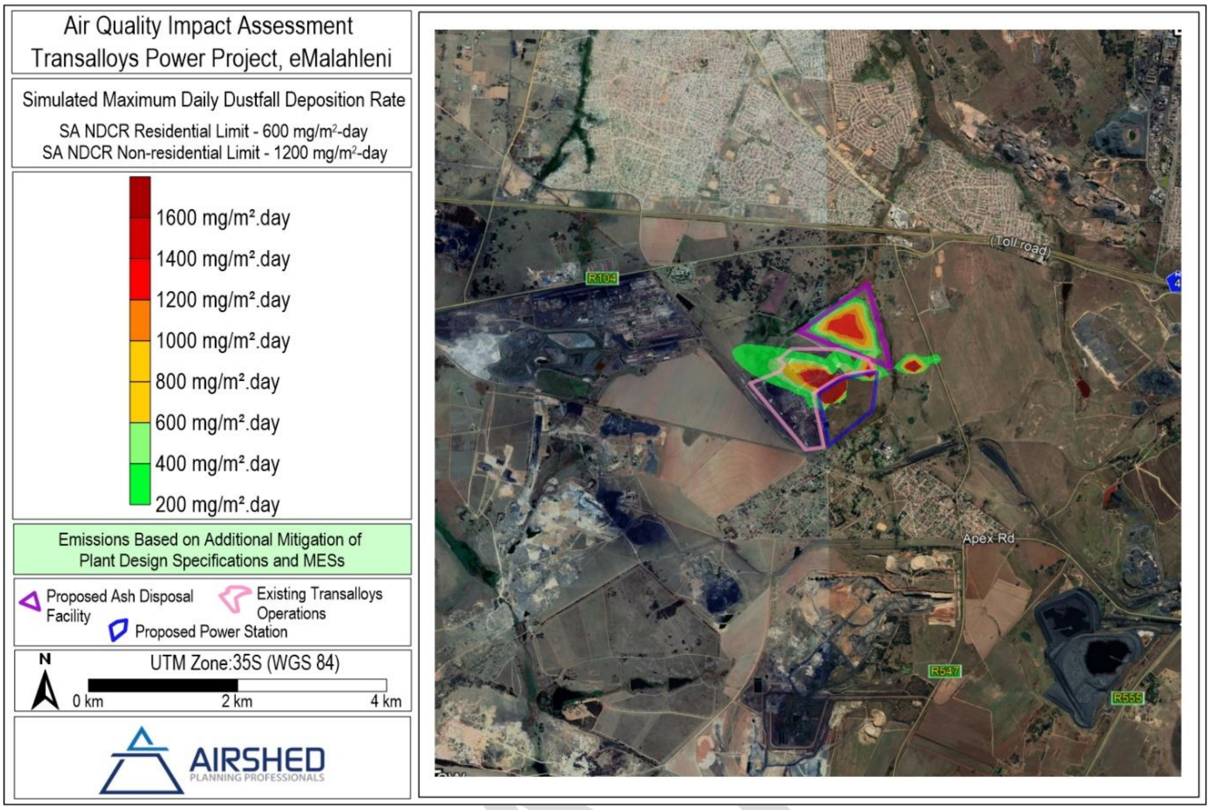


Figure 25: Simulated dustfall deposition rates (emissions due to additional mitigation)

4.5 Upset Conditions

Upset conditions during the operational phase of the proposed Transalloys Power Project may result in additional release of pollutants into the atmosphere. The use of diesel engines (generators, auxiliary boilers and fire pumps) will result in additional $PM_{2.5}$ PM_{10} and TSP as well as CO, SO_2 and VOC emissions. Upset condition was modelled for hourly maximum worst-case scenario only, due to the ephemeral nature of the release. The 1-hour maximum GLC due to NO_2 emissions is depicted in Figure 26. The impacts due to upset conditions are negligible when compared with the overall plant and process impacts, where the main contributing source is vehicle tailpipe emissions that mask the difference between normal and upset stack impacts. This will consequently not result in significant long-term increases in the incremental impacts associated with the proposed project. Thus, impacts during upset conditions are similar to normal conditions.

The impacts from other pollutants ($PM_{2.5}$, PM_{10} and TSP) due to upset conditions are similar to NO_2 impacts; hence they are not presented in this report.

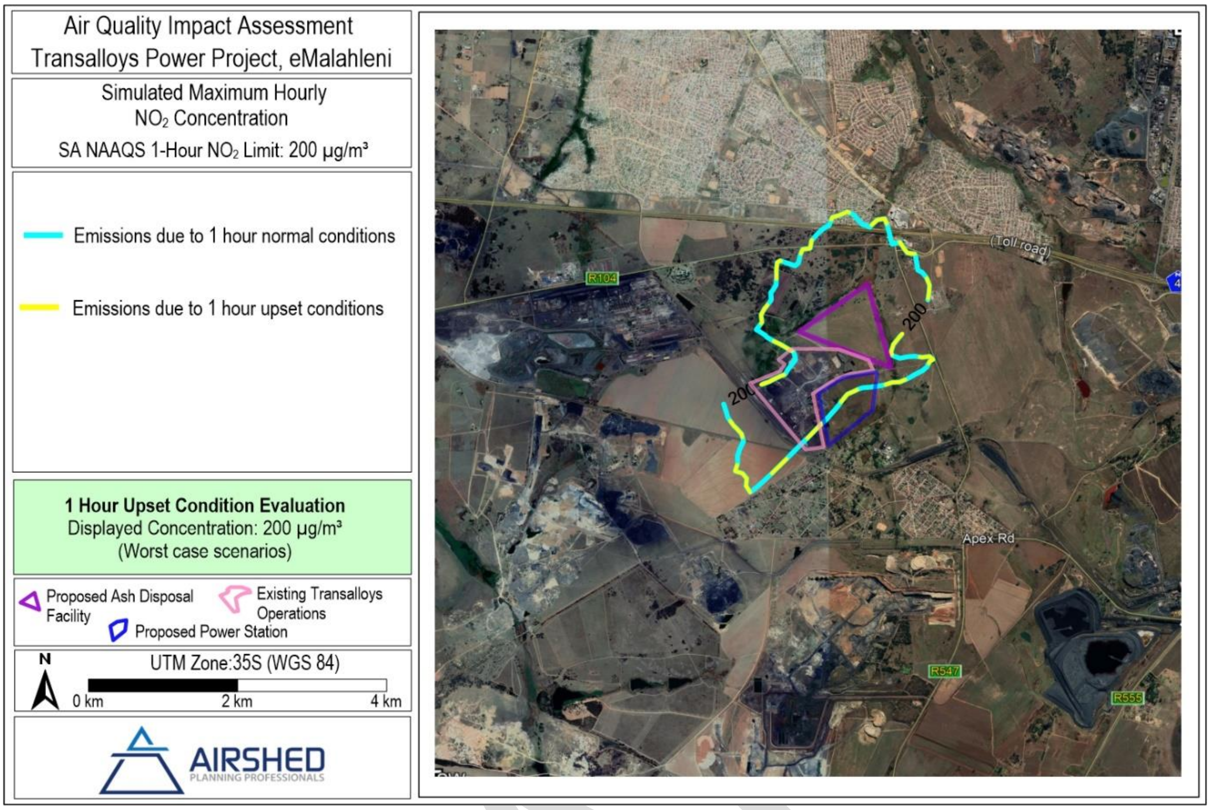


Figure 26: Simulated highest hourly ground level NO_2 concentration due to upset and normal conditions

4.6 Stack Sensitivity Study

A stack sensitivity study was undertaken using stack height varied at 100 m, 150 m and 200 m for stack emissions only. The result of this sensitivity study is depicted in Figure 27 for NO_2, indicating that a change in stack height between 100m and 200 m has little or no effect in GLCs. Also, since the contribution of stack emission to the overall plant impact is negligible, it is expected that the effect of stack sensitivity (between 100 m and 200 m) will be insignificant. Hence, a stack height between 100 m and 150m is considered adequate for the project.

The result of stack sensitivity study due to $PM_{2.5}$ and PM_{10} emissions are similar to NO_2 results; hence they are not presented in this report.

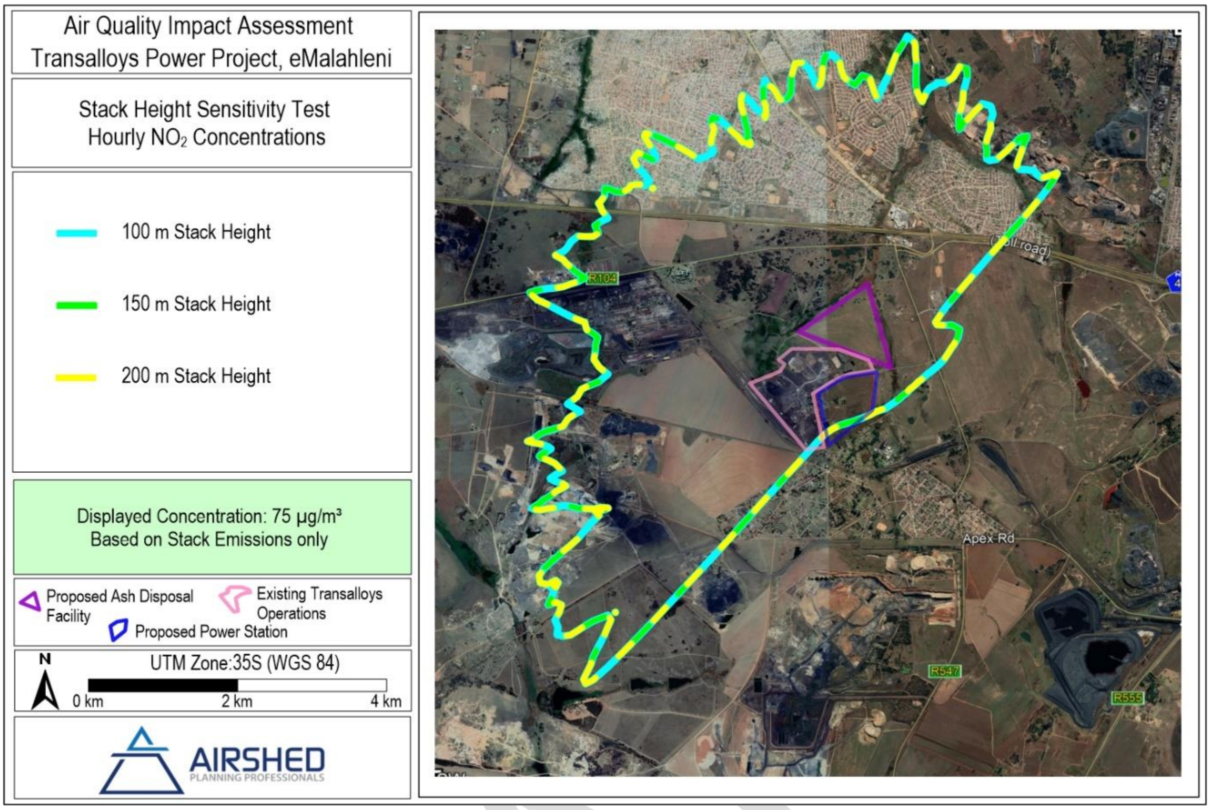


Figure 27: Stack sensitivity study showing hourly NO_2 GLCs at 75 µg/m³ for varying stack heights

4.7 Carbon Footprint Assessment (GHG Emissions)

The Intergovernmental Panel on Climate Change (IPCC) defines greenhouse gases (GHGs) as those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the earth's surface, the atmosphere and clouds. This property causes the greenhouse effect. Water vapour (H_2O), CO_2, N_2O, methane (CH_4) and Ozone (O_3) are the primary GHGs in the earth's atmosphere. Additionally, there are several entirely human made GHGs in the atmosphere, such as the halocarbons, and other chlorine- and bromine-containing substance.

The South African mandatory reporting guidelines focus on the reporting of Scope 1 emissions only. The three broad scopes for estimating GHG are:

- Scope 1: All direct GHG emissions.
- Scope 2: Indirect GHG emissions from consumption of purchased electricity, heat or steam.
- Scope 3: Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities not covered in Scope 2, outsourced activities, waste disposal, etc.

Sources of direct GHGs at the proposed Transalloys Power Project include the liberation of carbon dioxide (CO_2), CH_4 and N_2O during fossil fuel combustion (coal and diesel).

CO_2eq is a term for describing different GHG in a common unit. For any quantity and type of GHG, CO_2eq signifies the amount of CO_2 which would have the equivalent global warming impact. A quantity of GHG can be expressed as CO_2eq by multiplying the amount of the GHG by its global warming potential (GWP). E.g. if 1kg of CH_4 is emitted, this can be expressed as 23kg of CO_2eq (1kg CH_4 * 23 = 23kg CO_2eq). GWP for CH_4 and N_20 were obtained from the technical guidelines document (DEA, 2017b). It should be noted that only direct emissions relating to on-site activities are provided in Table 19.

Table 19: Summary of estimated greenhouse gas emissions for the proposed Transalloys power station

Sources	Activity	tpa	CO_2 equivalent
			tpa
Stationery and Mobile Diesel Engines	Tons of diesel	1 100	2.86
Boiler Stack	Tons of coal	927 000	1 816 802
Carbon footprint			1 816 804

In South Africa, GHGs – CO_2, CH_4, N_2O, hydrofluorocarbons (HFCs), perfluorocarbons (PFC's) and sulphur hexafluoride (SF6) – have been declared priority pollutants as described in section 2. Proponents with GHGs footprint in excess of 0.1 Megatons or 100 000 tons, measured as CO_2-equivalent, are required to submit a pollution prevention plan to the Minister for approval (DEA, 2017c).

The carbon footprint for the proposed Transalloys Power Project calculated is in excess of 100 000 tons CO_2 equivalent. However, the actual footprint of the proposed project can only be ascertained in a full carbon footprint assessment which will include the identification, documentation and assessment of GHG reduction and energy efficiency improvement opportunities, and the development of a GHG and energy efficiency action plan.

5 Impact Significance Rating

The significance of air quality related impacts was assessed in accordance with the procedure set out by Savannah. This assessment methodology enables the assessment of environmental issues including cumulative impacts, the severity of impacts (including the nature of impacts and the degree to which impacts may cause irreplaceable loss of resources), the extent of the impacts, the duration and reversibility of impacts, the probability of the impact occurring, and the degree to which the impacts can be mitigated.

5.1 Impact Ranking Criteria

Impacts are classified using criteria to determine the overall effect, i.e. the social or environmental consequence. The impacts are described using the following criteria: extent, duration, intensity and probability. These criteria are used to assess the consequence rating.

The final status of the impact is determined (as 'positive', 'neutral' or 'negative') based on the consequence rating and probability of the impact occurring. The criteria utilized in this assessment are defined as follows:

- The **nature**, a description of what causes the effect, what will be affected, and how it will be affected.

- The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development), regional, national or international. A score of between 1 and 5 is assigned as appropriate (with a score of 1 being low and a score of 5 being high).

- The **duration**, wherein it is indicated whether
  - The lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1
  - The lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2
  - Medium-term (5–15 years) – assigned a score of 3
  - Long term (> 15 years) - assigned a score of 4
  - Permanent - assigned a score of 5.

- The **magnitude**, quantified on a scale from 0-10, where a score is assigned:
  - 0 is small and will have no effect on the environment
  - 2 is minor and will not result in an impact on processes
  - 4 is low and will cause a slight impact on processes
  - 6 is moderate and will result in processes continuing but in a modified way
  - 8 is high (processes are altered to the extent that they temporarily cease)
  - 10 is very high and results in complete destruction of patterns and permanent cessation of processes.

- The **probability of occurrence**, which describes the likelihood of the impact occurring. Probability is estimated on a scale, and a score of 1–5 assigned:
  - 1 is very improbable (probably will not happen)
  - 2 is improbable (some possibility, but low likelihood)
  - 3 is probable (distinct possibility)
  - 4 is highly probable (most likely)
  - 5 is definite (impact will occur regardless of any prevention measures).

- The **significance**, which is determined through a synthesis of the characteristics described above (refer formula below) and can be assessed as low, medium or high.

The **significance** is determined by combining the criteria in the following formula:

S = (E+D+M) P

Where:
S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

- The **significance weightings** for each potential impact are as follows:
  - **< 30 points:** 'Low' (i.e. where this impact would not have a direct influence on the decision to develop in the area)
  - **30-60 points:** 'Medium' (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated)
  - **> 60 points:** 'High' (i.e. where the impact must have an influence on the decision process to develop in the area).

- The **status**, which is described as either positive, negative or neutral
  - The **reversibility**, which is the degree to which the impact can be reversed
  - **Irreplaceable loss of resources**, which is the degree to which the impact may cause irreplaceable loss of resources
  - **Mitigation**, which is the degree to which the impact can be mitigated.

5.2 Impact Significance Rating for the Proposed Transalloys Power Project

The significance ranking of the various impacts assessed in the study as well as the ranking criteria are presented in this section. The construction and closure phases impacts were assessed qualitatively, while the operational phase impacts were assessed quantitatively. Impacts due to $PM_{2.5}$, PM_{10}, NO_2 and dustfall are presented separately for the operational phase.

5.2.1 Assessing Cumulative Impacts (Qualitatively)

In assessing cumulative air quality impacts for this study, the following were considered:

- Measured ambient air quality results obtained from the Transalloys monitoring program (Section 3.6) – These results indicate low to moderate levels of PM_{10} concentrations at Transalloys and Clewer.
- Simulated air quality impacts from the existing Transalloys ferro-metal plant (Akinshipe & von Reiche, 2013; Akinshipe & von Reiche, 2017) – These reports indicate elevated levels of PM_{10}, $PM_{2.5}$, and NO_2 beyond the existing Transalloys ferro-metal plant.

It is therefore vital that incremental (quantitative) and cumulative (qualitative) impacts be assessed in order to provide impact significance ratings that truly reflect the current and future air quality impacts in the area.

5.2.2 Construction and Closure Phase

The significance of $PM_{2.5}$, PM_{10}, SO_2, NO_2 and dustfall impacts as a result of the construction and closure phases of the proposed Transalloys Power Project is presented in Table 20.

Table 20: Qualitative assessment of the significance of construction/closure air quality impacts

Activity: Construction/closure phase activities				
Description: All construction/closure activities that result in fugitive PM and gaseous pollutant emissions (including topsoil scraping, blasting, bulk earthworks, demolition etc.)				
Environmental impact: Increased ambient pollutant concentrations and dustfall rates. (Note: Qualitative Assessment)				
	Authorised (Previous study)		**Proposed amendment (current study)**	
	Without mitigation	**With mitigation**	**Without mitigation**	**With mitigation**
Extent (E)	2	1	2	1
Duration (D)	2	2	2	2
Magnitude (M)	2	2	2	2
Probability (P)	3	3	3	3
Significance (S = E+D+M)*P	**18 (Low)**	**15 (Low)**	**18 (Low)**	**15 (Low)**
Status (positive, neutral or negative)	Negative	Negative	Negative	Negative
Reversibility	Yes	Yes	Yes	Yes
Irreplaceable loss of resources?	No	No	No	No
Can impacts be mitigated?	Yes	Yes	Yes	Yes
Mitigation: Mitigation measures include the use of watering truck on haul roads, use of water sprayers for open surfaces, materials handling and construction activities involving dust emissions sources.				
Cumulative impacts: The proposed construction/closure activities will contribute to the baseline pollutant footprint. By qualitatively assessment (considered in Section 5.2.1), pre-mitigation and post-mitigation cumulative impacts are expected to be **'medium' and 'low'** respectively.				
Residual impacts: Residuals impact to air quality in the area will remain for the duration of the proposed operation, though effects of impacts are expected to be minimal. Impacts will recede when the activities cease.				

5.2.3 Operational Phase

The significance of $PM_{2.5}$, PM_{10}, NO_2 and dustfall impacts as a result of the operational phase of the proposed Transalloys Power Project is presented in Table 21, Table 22, Table 23, Table 24 and Table 25 respectively. The reader is reminded that cumulative impacts were qualitatively assessed as described in Section 5.2.1.

Table 21: Assessment of the significance of operational phase air quality impacts associated with $PM_{2.5}$ emissions

Activity: Operational phase activities				
Description: All operational activities that result in $PM_{2.5}$ emissions including transport, processing and power generation				
Environmental impact: Increased ambient pollutant concentrations.				
	Authorised (Previous study)		**Proposed amendment (current study)**	
	Without mitigation	**With mitigation**	**Without mitigation**	**With mitigation**
Extent (E)	3	3	4	3
Duration (D)	4	4	4	4
Magnitude (M)	6	4	6	4
Probability (P)	4	3	4	4
Significance (S = E+D+M)*P	**52 (Medium)**	**33 (Medium)**	**56 (Medium)**	**44 (Medium)**
Status (positive, neutral or negative)	Negative	Negative	Negative	Negative
Reversibility	Yes	Yes	Yes	Yes
Irreplaceable loss of resources?	No	No	No	No
Can impacts be mitigated?	Yes	Yes	Yes	Yes
Mitigation: Mitigation measures include the use of watering on unpaved and paved roads, use of water sprayers for stockpile areas, the ash disposal facility and materials handling activities involving dust emissions sources.				
Cumulative impacts: The proposed operational activities will contribute to the $PM_{2.5}$ baseline footprint. Impacts within the existing and proposed Transalloys premises are expected to increase and exceed the NAAQS limit on-site. $PM_{2.5}$ impacts in Clewer and environs will also increase; hence, pre-mitigation and post-mitigation cumulative impacts are expected to be **'high' and 'medium'** respectively.				
Residual impacts: Residuals impact to air quality in the area will remain for the duration of the proposed operation, though effects of impacts are expected to be 'medium'. Impacts will recede when the activities cease.				

Table 22: Assessment of the significance of operational phase air quality impacts associated with PM_{10} emissions

Activity: Operational phase activities				
Description: All operational activities that result in PM_{10} emissions including transport, processing and power generation				
Environmental impact: Increased ambient pollutant concentrations.				
	Authorised (Previous study)		**Proposed amendment (current study)**	
	Without mitigation	**With mitigation**	**Without mitigation**	**With mitigation**
Extent (E)	3	3	4	3
Duration (D)	4	4	4	4
Magnitude (M)	8	4	6	4
Probability (P)	4	3	4	4
Significance (S = E+D+M)*P	**60 (Medium)**	**33 (Medium)**	**56 (Medium)**	**44 (Medium)**
Status (positive, neutral or negative)	Negative	Negative	Negative	Negative
Reversibility	Yes	Yes	Yes	Yes
Irreplaceable loss of resources?	No	No	No	No
Can impacts be mitigated?	Yes	Yes	Yes	Yes
Mitigation: Mitigation measures include the use of watering on unpaved and paved roads, use of water sprayers for stockpile areas, the ash disposal facility and materials handling activities involving dust emissions sources.				
Cumulative impacts: The proposed operational activities will contribute to the $PM_{2.5}$ baseline footprint. Impacts within the existing and proposed Transalloys premises are expected to increase and exceed the NAAQS limit on-site. PM_{10} impacts in Clewer and environs will also increase; hence, pre-mitigation and post-mitigation cumulative impacts are expected to be **'high' and 'medium'** respectively.				
Residual impacts: Residuals impact to air quality in the area will remain for the duration of the proposed operation, though effects of impacts are expected to be 'medium'. Impacts will recede when the activities cease.				

Table 23: Assessment of the significance of operational phase air quality impacts associated with NO_2 emissions

Activity: Operational phase activities				
Description: All operational activities that result in NO_2 emissions including transport, processing and power generation				
Environmental impact: Increased ambient NO_2 concentrations.				
	Authorised (Previous study)		**Proposed amendment (current study)**	
	Without mitigation	**With mitigation**	**Without mitigation**	**With mitigation**
Extent (E)	3	3	4	4
Duration (D)	4	4	4	4
Magnitude (M)	4	4	4	4
Probability (P)	4	4	3 [(a)]	3
Significance (S = E+D+M)*P	**44 (Medium)**	**44 (Medium)**	**36 (Medium)**	**36 (Medium)**
Status (positive, neutral or negative)	Negative	Negative	Negative	Negative
Reversibility	Yes	Yes	Yes	Yes
Irreplaceable loss of resources?	No	No	No	No
Can impacts be mitigated?	No	No	No	No
Mitigation: None. The main contributor to NO_2 impacts is vehicle emissions. It should be noted that the emission factors for vehicle tailpipe emission quantification seem to result in unrealistically high emissions.				
Cumulative impacts: The proposed activities will contribute to the NO_2 footprint in the area. By qualitatively assessment, increase in impact is expected to be **medium.** This is based on qualitative assessment (considered in Section 5.2.1).				
Residual impacts: Residuals impact to air quality in the area will remain for the duration of the proposed operation, though effects of impacts are expected to be 'low'. Impacts will recede when the activities cease.				

Notes: [(a)] Due to the uncertainty around the vehicle tailpipe emissions from NO_2, the probability score was reduced by one score.

Table 24: Assessment of the significance of operational phase air quality impacts associated with SO_2 emissions

Activity: Operational phase activities				
Description: All operational activities that result in SO_2 emissions including transport, processing and power generation				
Environmental impact: Increased ambient SO_2 concentrations.				
	Authorised (Previous study)		**Proposed amendment (current study)**	
	Without mitigation	**With mitigation**	**Without mitigation**	**With mitigation**
Extent (E)	2	2	2	2
Duration (D)	4	4	4	4
Magnitude (M)	2	2	2	2
Probability (P)	4	4	4	4
Significance (S = E+D+M)*P	**32 (Medium)**	**32 (Medium)**	**32 (Medium)**	**32 (Medium)**
Status (positive, neutral or negative)	Negative	Negative	Negative	Negative
Reversibility	Yes	Yes	Yes	Yes
Irreplaceable loss of resources?	No	No	No	No
Can impacts be mitigated?	No	No	No	No
Mitigation: None. The main contributor to SO_2 impacts is vehicle emissions. It should be noted that the emission factors for vehicle tailpipe emission quantification seem to result in unrealistically high emissions.				
Cumulative impacts: The proposed activities will contribute to the SO_2 footprint in the area. By qualitatively assessment, increase in impact is expected to be **medium.** This is based on qualitative assessment (considered in Section 5.2.1).				
Residual impacts: Residuals impact to air quality in the area will remain for the duration of the proposed operation, though effects of impacts are expected to be 'low'. Impacts will recede when the activities cease.				

Table 25: Assessment of the significance of operational phase impacts associated with dustfall deposition

Activity: Operational phase activities				
Description: All operational activities that result in dustfall deposition including transport, processing and power generation				
Environmental impact: Increased ambient dustfall deposition rates.				
	Authorised (Previous study)		Proposed amendment (current study)	
	Without mitigation	With mitigation	Without mitigation	With mitigation
Extent (E)	3	3	3	3
Duration (D)	4	4	4	4
Magnitude (M)	2	2	4	2
Probability (P)	4	3	4	3
Significance (S = E+D+M)*P	**36 (Medium)**	**27 (Low)**	**44 (Medium)**	**27 (Low)**
Status (positive, neutral or negative)	Negative	Negative	Negative	Negative
Reversibility	Yes	Yes	Yes	Yes
Irreplaceable loss of resources?	No	No	No	No
Can impacts be mitigated?	Yes	Yes	Yes	Yes
Mitigation: Mitigation measures include the use of watering on unpaved and paved roads, use of water sprayers for stockpile areas, the ash disposal facility and materials handling activities involving dust emissions sources.				
Cumulative impacts: The proposed activities will contribute to the dustfall impacts in the area. Dustfall impacts within the existing and proposed Transalloys premises are expected to increase and exceed the NDCR non-residential limit on-site. Dustfall impacts in Clewer and the immediate area will also increase; hence, pre-mitigation and post-mitigation cumulative impacts are expected to be **'medium' and 'low'** respectively. This is based on qualitative assessment (considered in Section 5.2.1).				
Residual impacts: Residuals impact to air quality in the area will remain for the duration of the proposed operation, though effects of impacts are expected to be 'low'. Impacts will recede when the activities cease.				

6 RECOMMENDED AIR QUALITY MANAGEMENT MEASURES

In the light of the potential exceedances of the air quality limits ($PM_{2.5}$, PM_{10} and potentially NO_2) in the immediate surroundings of the proposed Project, it is recommended that Transalloys commit itself to adequate air quality management planning throughout the life of the proposed Project. The air quality management plan provides options on the control of dust particles and gases at the main sources, while the monitoring network is designed to track the effectiveness of the mitigation measures.

Based on the findings of the impact assessment, the following mitigation, management and monitoring recommendations are proposed.

6.1 Air Quality Management Objectives

The main objective of the proposed air quality management measures for the project is to ensure that operations result in ambient air concentrations (specifically $PM_{2.5}$, PM_{10} and NO_2) and dustfall rates that are within the relevant ambient air quality standards at the relevant off-site receptors. In order to define site specific management objectives, the main sources of pollution need to be identified. Once the main sources have been identified, target control efficiencies for each source can be defined to ensure acceptable cumulative ground level concentrations.

6.1.1 Ranking of Sources

The ranking of sources serves to confirm the current understanding of the significance of specific sources, and to evaluate the emission reduction potentials required for each. Sources ranking can be established on:

- Emissions ranking; based on the comprehensive emissions inventory established for the operations, as published in Figure 12; and
- Impacts ranking; based on the simulated pollutant GLCs.

The source impact ranking with respect to entire study area and AQSRs are presented in Figure 28 and Figure 29. The major source contributors to PM_{10} GLCs are vehicle entrained dust from paved and unpaved roads. Therefore, in order to most effectively reduce impacts on the receiving environment, efforts should be directed at further reducing emissions from road surfaces. The main contributing source to NO_2 GLCs is vehicle tailpipe emissions. As indicated before, the emission factors used in the quantification of vehicle tailpipe emissions seem to overestimate NO_2 emissions. Impacts due to plant stack emissions are insignificant, furthering the notion that additional mitigation at the power plant will not yield any significant reduction in total ground level impacts.

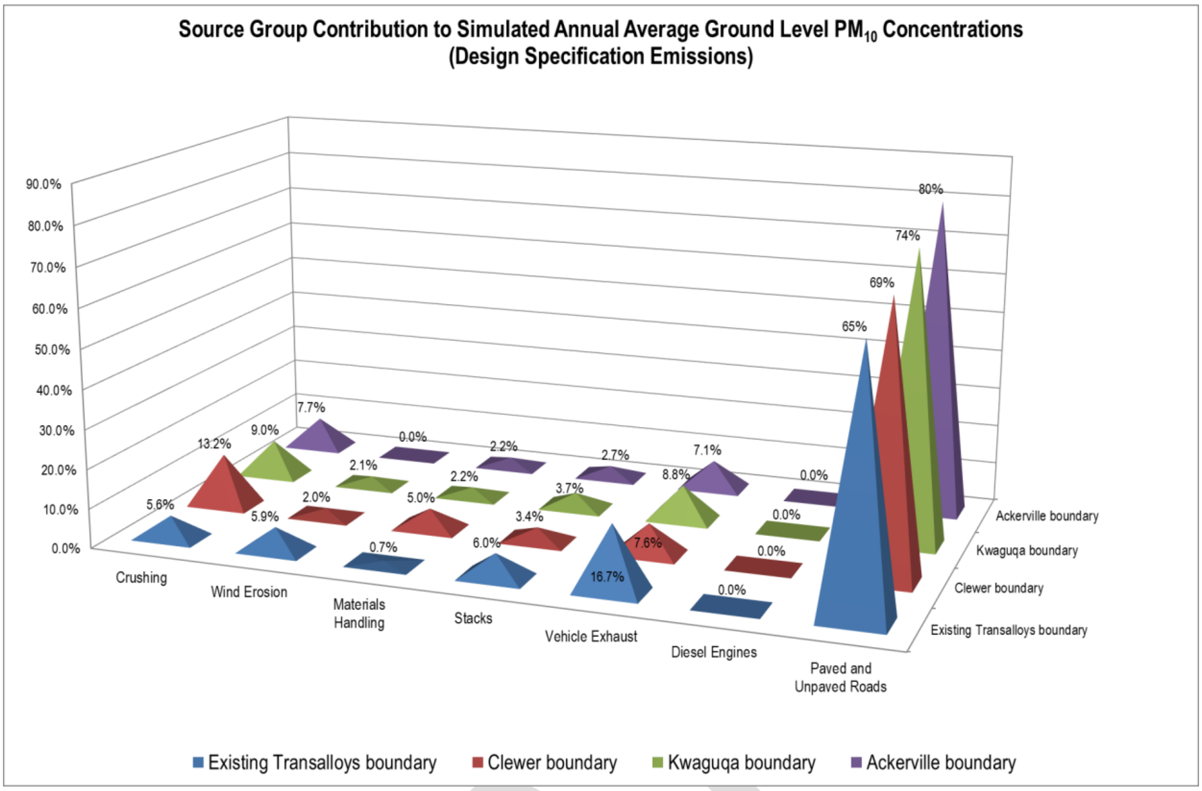


Figure 28: Source group contribution to simulated annual average ground level PM_{10} concentrations (design emissions)

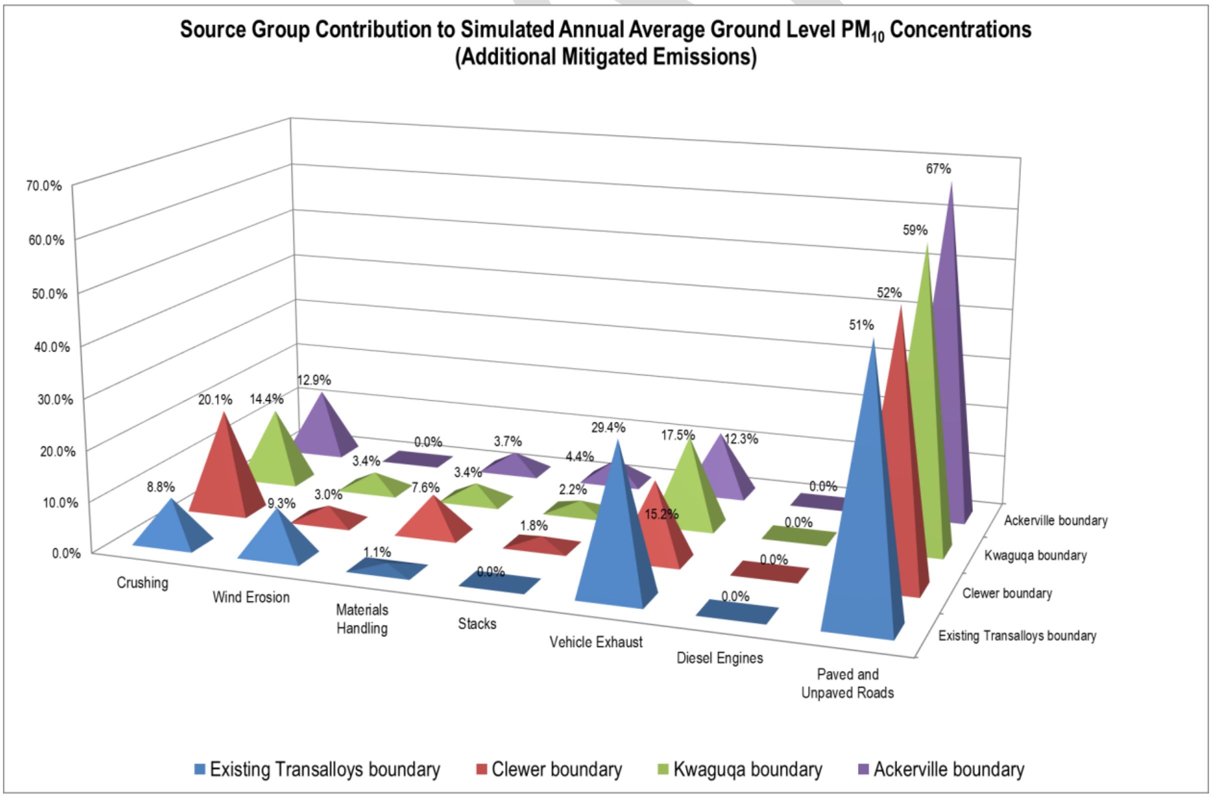


Figure 29: Source group contribution to simulated annual average ground level PM_{10} concentrations (mitigated emissions)

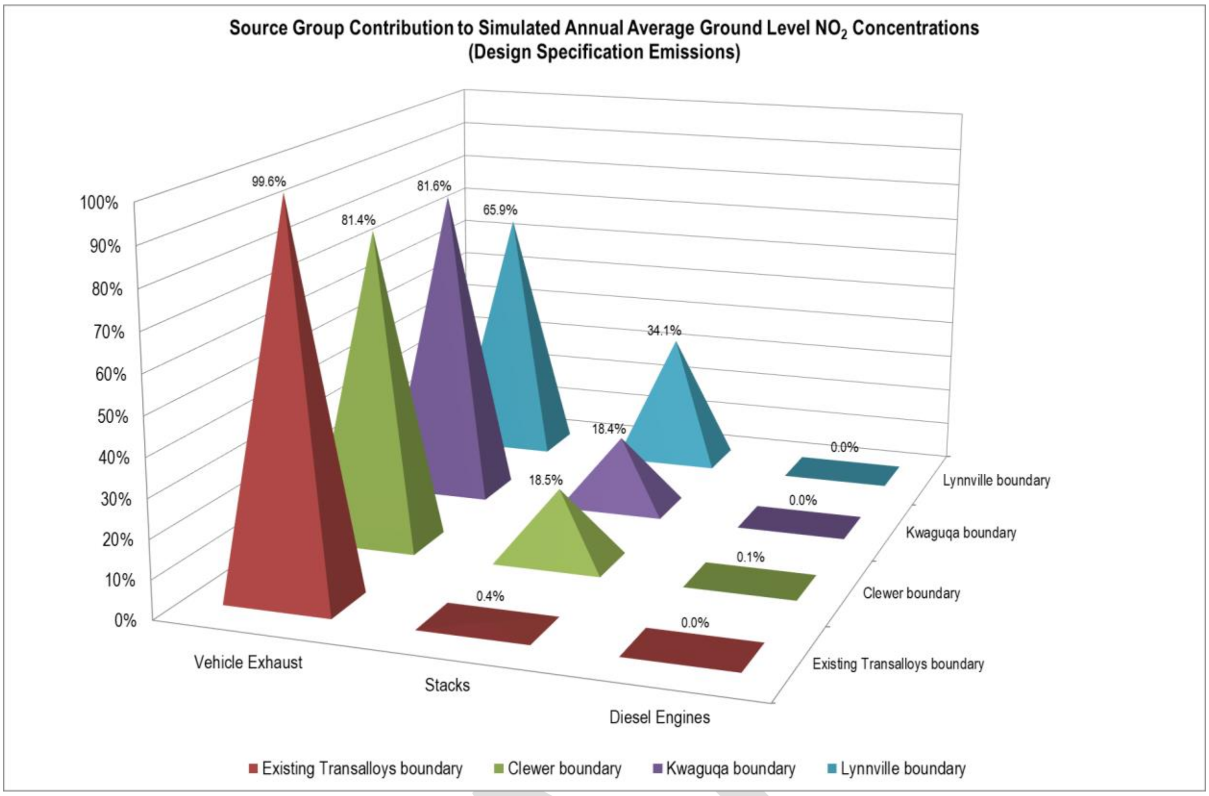


Figure 30: Source group contribution to simulated annual average ground level NO_2 concentrations (plant design emissions)

6.2 Proposed Mitigation and Management Measures

6.2.1 Proposed Mitigation Measures and/or Target Control Efficiencies

From the above discussion it is recommended that the project include the following measure:

- Construction and closure phase:
  - Air quality impacts during construction could be reduced through basic control measures such as limiting the speed of haul trucks and mobile equipment; limiting unnecessary travelling of vehicles on untreated roads; and applying water sprays on regularly travelled, unpaved sections.
  - When haul trucks need to use public roads, the vehicles need to be cleaned of all mud and haul material covered to minimise any fly-off dust. The access road to the Project also needs to be kept clean to minimise carry-through of mud on to public roads.

- Operational phase:
  Ensuring compliance with NAAQS at both the existing Transalloys ferro-metal plant boundary and the proposed Transalloys Power Project (when operational), will result in significant reduction in elevated levels measured at Clewer.

  Therefore, management and mitigation of operational phase impacts should ensure concerted efforts to mitigate impacts at the existing Transalloys ferro-metal plant as well as the proposed Transalloys Power Project. As a management measure, ambient PM and NO_2 concentrations at Clewer and other AQSRs such as Kwa-Guga should be targeted to comply with the NAAQS during the construction phase of the proposed project. On-site emissions monitoring during the construction phase will provide insight as to the levels to be anticipated during operation (since construction phase emissions are generally lower than operational phase and often intermittent in nature).

The following mitigation measures are offered for the operational phase of the proposed Transalloys Power Project:

- In minimizing windblown dust from stockpile and exposed areas, water sprays should be continuously used to keep surface material moist (application rate of 2 litre/m^2-hour) and wind breaks installed to reduce wind speeds over the area. A mitigation efficiency of 50% is anticipated. (NPI, 2011). Furthermore, as soon as a portion of the area has reached the end of its active life i.e. it should be rehabilitated and re-vegetated. If this is done consistently, a 90% reduction in emissions is anticipated (NPI, 2011).
- In mitigating air quality impacts due to material handling and transfer points, it is recommended material handling and transfer points be controlled using water sprays resulting in 50% control efficiency (NPI, 2011).
- To ensure minimum emissions from paved and unpaved road surfaces, the following mitigation measures should be maintained:
  - The regular and efficient application of water/chemical at an application rate greater than 2 litre/m^2-hour (literature reports control efficiency of 75% and up to 90% when water and chemicals are adequately utilized (NPI, 2012; Cecala, et al., 2012)).
  - Avoiding spillages of dusty materials onto road surfaces by covering trucks and keeping trucks dust free;
  - Frequent sweeping of paved road surfaces, e.g. PM_{10} certified sweeper (to ensure that dust is not simply re-deposited elsewhere).
  - Traffic control measures aimed at reducing the entrainment of material by restricting traffic volumes and reducing vehicle speeds.

A summary of the air quality management objectives is presented in Table 26.

Table 26: Air Quality Management Plan: operational phase of the Project

Aspect	Impact	Management Actions/Objectives	Responsible Person(s)	Target Date
Wind erosion	PM_{10} and $PM_{2.5}$ concentrations and dustfall rates	**Mitigation:** Ensure exposed areas remain moist through regular water spraying during dry, windy periods (CE 50%). Rehabilitation and revegetation of inactive areas or portions Monthly dustfall rates should not exceed 600 mg/m².day at off-site dustfall units [(a)].	Transalloys Environmental Manager	On-going during operational phase
Materials handling, transfer points, paved and unpaved roads	PM_{10} and $PM_{2.5}$ concentrations and dustfall rates	**Mitigation:** Material handling and transfer points to be controlled using water sprays resulting in 50% CE. The regular and efficient application of water/chemical at an application rate greater than 2 litre/m^2-hour (literature reports control efficiency of 75% and up to 90% when water and chemicals are adequately utilized (NPI, 2012; Cecala, et al., 2012)). Monthly dustfall rates should not exceed 600 mg/m².day at off-site dustfall units [(a)].		
General	PM_{10}, $PM_{2.5}$, SO_2 and NO_2 concentrations; and dustfall rates	Continuous PM_{10} and $PM_{2.5}$ ambient monitoring systems to be implemented at Kwa-Guga. $PM_{2.5}$ ambient monitoring to be implemented in addition to PM_{10} monitoring at Clewer. Quarterly NO_2 and SO_2 passive sampling to be conducted at a Clewer and Kwa-Guga.		
Stack emissions	PM, SO_2 and NO_x	The monitoring of stack emissions (PM, SO_2 and NO_x) should be done annually (as a minimum) to comply with the requirements of the Listed Activities and National Minimum Emission Standards.		

6.2.2 Air Quality Management within the Highveld Priority Area

The DEA published the management plan for the HPA in September 2011. Included in this management plan are 7 goals, each of which has a further list of objectives that must be met. The 7 goals for the HPA are as follows:

- **Goal 1:** By 2015, organisational capacity in government is optimised to efficiently and effectively maintain, monitor and enforce compliance with ambient air quality standards.
- **Goal 2:** By 2020, industrial emissions are equitably reduced to achieve compliance with ambient air quality standards and dustfall limit values.
- **Goal 3:** By 2020, air quality in all low-income settlements is in full compliance with ambient air quality standards.
- **Goal 4:** By 2020, all vehicles comply with the requirements of the National Vehicle Emission Strategy.
- **Goal 5:** By 2020, a measurable increase in awareness and knowledge of air quality exists.
- **Goal 6:** By 2020, biomass burning, and agricultural emissions will be 30% less than current.
- **Goal 7:** By 2020, emissions from waste management are 40% less than current.

The proposed Transalloys Power Project falls within the HPA footprint and will contribute to the pollution within the Highveld airshed. It is recommended that the afore-mentioned goals for the HPA as published by the DEA be considered in all management plans implemented for the Project.

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 to below 600 mg/m²-day represents an impact- or receptor-based performance indicator.

Except for stack emission testing, source monitoring at other activities can be challenging due to the fugitive and wind-dependant 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

Ambient air quality monitoring can serve to meet various objectives, such as:

- Compliance monitoring;
- Validate dispersion model results;
- Use as input for health risk assessment;
- Assist in source apportionment;
- Temporal and spatial trend analysis;
- Source quantification; and,
- Tracking progress made by control measures.

Based on the simulated incremental impacts from the proposed Transalloys Power Project's operations on the surrounding environment and the qualitatively assessed cumulative impacts at Clewer and Kwa-Guga, the following monitoring requirements should be considered:

- The Transalloys monitoring network already measures PM_{10} and dustfall, hence, continuous monitoring of $PM_{2.5}$ and quarterly passive sampling of NO_2 and SO_2 should be included in the monitoring programme. This should continue throughout the life of the proposed Project.
- Continuous $PM_{2.5}$, and quarterly NO_2 and SO_2 monitoring should be added to the current PM_{10} monitoring at Clewer to determine the actual GLCs at Clewer. GLCs are to comply with the NAAQS during the construction phase of the proposed project, in order to provide an indication of the concentration levels to be anticipated during the operational phase.
- The Transalloys monitoring network may also be extended to Kwa-Guga, an AQSR to the north of Transalloys. PM_{10}, and $PM_{2.5}$ GLCs should be monitored continuously or intermittently until trends become apparent. Passive sampling of NO_2 and SO_2 should also be undertaken annually or bianually until trends become apparent.

Recommended PM_{10}, $PM_{2.5}$, NO_2 and SO_2 sampling methodology is provided in Appendix A.

6.3.2 Source Monitoring

The Transalloys Power Project falls under a listed activity (fuel combustion), hence, it is compulsory by law that emission monitoring of PM, SO_2 and NOx from the power station stack is done annually.

6.4 Buffer Zone Delineation

Buffer zones, or set back distances, represent separations between a project site boundary and any adjacent residential areas or sensitive developments. Such buffer zones are established to ensure that operations associated with the project does not have an adverse impact on quality of life and/or public health. The delineation of a buffer zone for the proposed Project is not deemed necessary provided the mitigation and management measures described in the preceding sections are implemented.

6.5 Periodic Inspections, Audits and Community Liaison

6.5.1 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, including authorities and persons affected by pollution.

The criteria to be considered 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 if progress towards targets is indicated by the quarterly/annual reviews to be unsatisfactory.

6.5.2 Consultation with Stakeholders

Stakeholders' forums provide possibly the most effective mechanisms for information dissemination and consultation to interested and affected parties. Consultations with stakeholders are ongoing and should continue as part of the EIA and EMP process for the Transalloys Power Project.

7 CONCLUSIONS AND RECOMMENDATION

7.1 Main Findings

A quantitative air quality impact assessment was conducted for the operational phase activities planned for the proposed Transalloys Power Project in eMalahleni. Construction and closure activities were assessed qualitatively. The assessment included a study of the receiving environment as well as the estimation of atmospheric emissions, the simulation of pollutant levels and determining the significance of impacts.

In quantification of operational phase impacts, design specification as provided by Transalloys, excluding the primary boiler stack emissions were utilized. Emissions from the primary boiler stack will comprise of PM, as well as gaseous pollutants. These stack emissions are expected to comply with the MESs set out in Section 21 of the National Environmental Management Air Quality Act (sub-section 1.1). In the absence of actual stack measurements, these emission standards were used in lieu of actual measurement values.

This section summarises the main findings of the assessment.

- The receiving environment:
  - The area is dominated by winds from the north, north-northwest, east, east-southeast and west, with an average wind speed of 3.3 m/s measured over the 2016 to 2018 period.
  - Ambient air pollutant levels in the proposed Project area are currently affected by the following sources of emission: the existing Transalloys ferro-metal plant; mining activities to the east, south-east and south; and a steel processing plant to the west. Ferrobank, an Industrial area hosting various manufacturing and processing plants, is situated about 5 km to the north east. Other activities and sources of pollution in the region include mining; chemical and metallurgical industries; vehicle tailpipe emissions; agriculture; domestic fuel combustion; and open areas exposed to wind erosion.
  - Pollutants released in the region include but are not limited to, fugitive $PM_{2.5}$, PM_{10} and TSP, as well as metallic and gaseous pollutants, which are products of the processing of ore and combustion of petrol, diesel and coal.
  - Transalloys continuously measures PM_{10} concentrations and dustfall rates. Analysis of the results are discussed as follows:
    - Results from 2013 and 2015 obtained at Transalloys Weighbridge (on-site) and the Clewer Primary School (residential) monitoring stations indicate elevated PM_{10} concentrations in exceedance of the 24-hour NAAQS. Calculated period average PM_{10} concentrations did not exceed the annual average NAAQS of 40 µg/m^3, but only marginally.
    - More recent results (August 2018 to January 2019) obtained from both locations did not exceed the daily or the annual NAAQS.
    - Dustfall results from October 2015 to January 2019 indicate compliant dustfall deposition rates at five on-site and two residential sampling locations. Dustfall rates are generally low.
  - The nearest AQSRs are Clewer and Kwa-Guqa. Clewer is immediately adjacent to the existing Transalloys premises and the proposed power station location. Kwa-Guqa is situated north of the proposed project.

- Impact of the proposed Project:
  - Construction/closure phases:

    - Construction and closure phase emissions were not quantified since, as for most power plant projects, the emissions are expected to be less than the operational phase. Unmitigated and mitigated incremental significance rating due to construction phase emissions were assigned a *'**low'*** rating. Post-mitigation cumulative impacts were qualitatively assigned a ***'low'*** rating.
  - Operational phase:
    - Sources of emission quantified included crushing and screening, materials handling, vehicles travelling on unpaved and paved roads, windblown dust from stock piles and the ash disposal facility, vehicle exhaust and stack emissions.
    - Operational phase PM emissions ($PM_{2.5}$, PM_{10} and TSP) and gaseous emissions (CO, NO_x, SO_2 and VOC) were quantified and used in simulations.
    - The release of $PM_{2.5}$, PM_{10} and NO_2 during the operational phase are expected to result in exceedances of both long term (annual) and short term (1-hour and/or 24-hour) ambient air quality criteria off-site. A significance weighting of ***'medium'*** was assigned to potential inhalation health impacts associated with unmitigated incremental $PM_{2.5}$, PM_{10} and NO_2 emissions.
    - The study assumed some basic fugitive dust mitigation measures (mostly dust suppression with water) to reduce PM emissions from fugitive sources. Whereas the impact significance associated with $PM_{2.5}$ and PM_{10} may reduce, the significance still indicates a ***'medium'*** weighting. Post-mitigation cumulative $PM_{2.5}$ and PM_{10} impacts were assigned a ***'medium'*** impact rating due to background elevated levels in the area.
    - Although mitigation options for NO_2 were not quantified, the impact significance thereof can be reduced by looking at technology options to reduce emissions from vehicle exhaust and diesel engines.
    - Dustfall as a result of unmitigated PM emissions may exceed the criteria for residential areas at the closest residences of Clewer. Hence, an impact significance rating of ***'medium'*** was assigned. With basic mitigation measures in place to suppress fugitive dust, the impact significance rating can be reduced to ***'low'.*** Cumulative impacts were qualitatively assigned a ***'medium'*** rating.
    - Simulated CO, SO_2 and VOC concentrations are very minimal with impact significance ratings expected to be ***'low".*** Cumulative impacts were qualitatively assigned a ***'medium'*** rating due to elevated levels in the area.
    - A stack sensitivity study was conducted utilizing varying stack heights from 100 m to 200 m. The result of the sensitivity study indicates that a change in stack height between 100 m and 200 m has little or no effect in GLCs. Also, since the contribution of stack emission to overall plant impact is negligible, it is expected that the effect of stack height (between 100 m and 200 m) will be insignificant. Hence, a stack height between 100 m and 150m is considered adequate for the project.
    - Additional impacts due to upset conditions are also expected to be insignificant. The impact contribution due to upset conditions is expected to be negligible when compared to the overall plant impacts. Thus, impacts during upset conditions will be similar to normal conditions.
    - Carbon footprint (direct emissions only) calculated for the proposed Transalloys Power Project was in excess of the 100 000 tons CO_2 equivalent, beyond which a pollution prevention plan is required to be submitted to the Minister of Environment. However, the actual footprint of the proposed project can only be ascertained in a full carbon footprint assessment which will include the identification, documentation

and assessment of GHG reduction and energy efficiency improvement opportunities, and the development of a GHG and energy efficiency action plan.

7.2 Recommendations

In this study, the proposed amendment to the layout (power plant and ADF), as well as the amendment to the range in output capacity (120 MW to 150 MW) did not result in any significant change to the pollutants impact rating assessed in the 2014 study. Hence, it is the specialist opinion that the proposed amendment be authorised, provided the recommended air quality mitigation and management measures are implemented to ensure the lowest possible impact on Clewer, Kwa-Guqa and the environment. The recommended management measures include the following:

- The mitigation and management of sources of major emissions – ensuring compliance with NAAQS at both the existing Transalloys ferro-metal plant boundary and the proposed Transalloys Power Project (when operational), will result in significant reduction in elevated levels measured at Clewer.

  Therefore, management and mitigation of operational phase impacts should ensure concerted efforts to mitigate impacts at the existing Transalloys ferro-metal plant as well as the proposed Transalloys Power Project. As a management measure, ambient PM and NO_2 concentrations at Clewer and other AQSRs such as Kwa-Guga should be targeted to comply with the NAAQS during the construction phase of the proposed project. On-site emissions monitoring during the construction phase will provide insight as to the levels to be anticipated during operation (since construction phase emissions are generally lower than operational phase and intermittent in nature.

- Ambient air quality monitoring – Ambient PM, SO_2 and NO_2 concentrations at Clewer and other areas need to comply with the NAAQS during the construction phase of the proposed project, in order to provide an indication of the concentration levels to be anticipated during the operational phase.

Also, with the proposed project located within the Highveld Priority Area, where the background concentrations of PM_{10} and SO_2 are already elevated, it is recommended that the management plan for the Highveld Priority Area outlined in this report be included in all management plan proposed for the project.

Finally, the findings from the study are only valid provided that the MESs set out in Section 21 of the National Environmental Management Air Quality Act (sub-section 1.1) are not exceeded for the boiler stack emissions. It is recommended, therefore, that a stack emission measurement campaign be conducted once the proposed power project is fully operational. This is to confirm that the emissions fall within their required standards.

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9 APPENDIX

9.1 Appendix A – Ambient Air Quality Monitoring Methodology

9.1.1 PM_{10}/$PM_{2.5}$ Sampling

Ambient PM_{10}/$PM_{2.5}$ concentrations can be determined through the use a MiniVol sampler (Figure 31). In summary, the monitoring methodology is as follows:

- The MiniVol sampler is programmed to draw air over a pre-weighed filter at a constant rate over a 24-hour period.
- At a specific interval (for instance, 1 in 3 days or 1 in 6 days), the used filter is removed, a new filter put in place, the battery exchanged (each MiniVol is equipped with two batteries) and the MinVol re-programmed.
- The used filter is removed from the filter holder assembly in a clean environment and sealed in its dish.
- At each exchange, the date, location, filter number, pump run time etc. need to be noted in the data sheet that will be sent to an accredited laboratory with the sealed samples for gravimetric analysis.

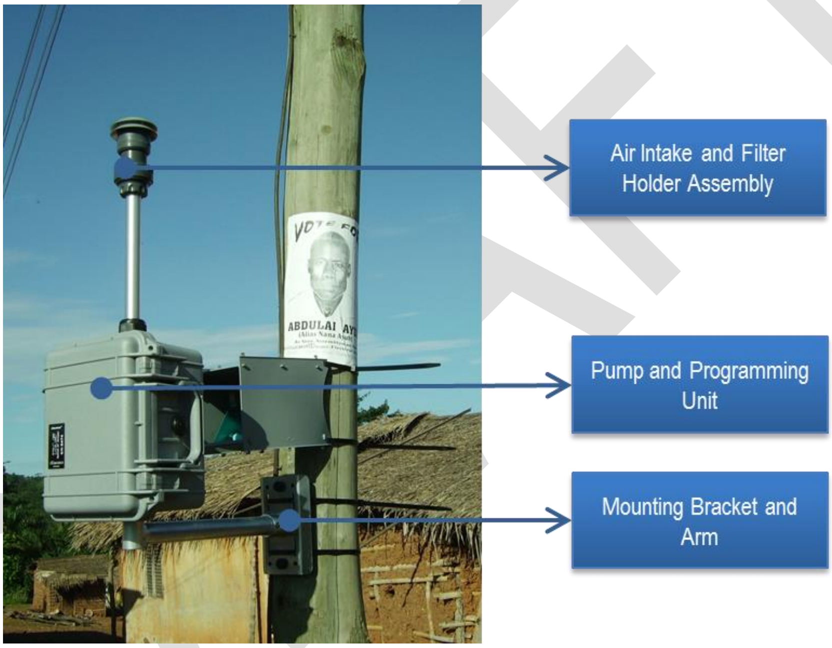

Figure 31: Example of a typical PM_{10}/$PM_{2.5}$ MiniVol setup

9.1.2 NO_2 Passive sampling

Passive diffusive sampling relies on the diffusion of analytes through a diffusive surface onto an adsorbent. After sampling, the analytes are chemically desorbed by solvent extraction or thermally desorbed and analysed. Passive sampling does not involve the use of pumping systems and does not require electricity. Passive diffusive samplers are exposed to ambient air for anything between a few days to several weeks (Figure 32). NO_2, SO_2 and VOC sampling should also be done continuously on a seasonal or annual basis.

Although the supporting plate with diffusive tube can simply be tied (using cable ties) onto a pole, it is advisable to shelter it from excessive wind, rain and sunlight with a cover as shown in Figure 32c.

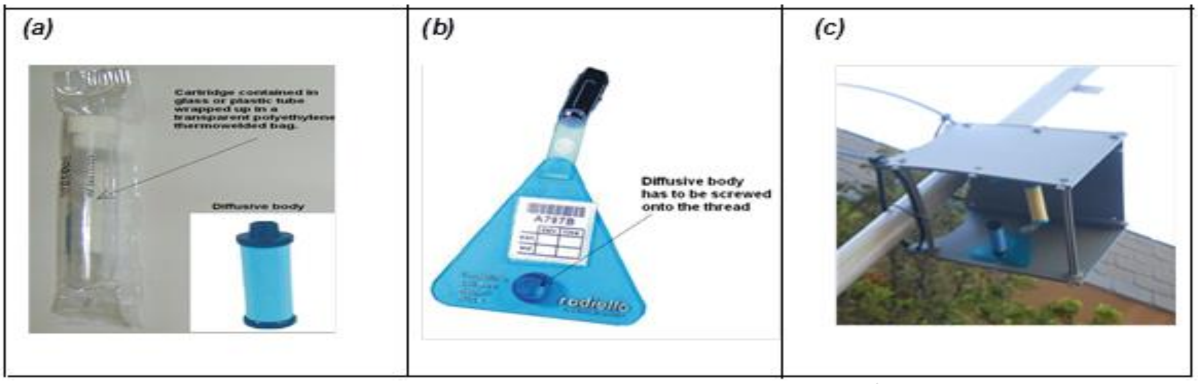

Figure 32: Radiello passive sampling tubes

9.1.3 Dustfall Sampling

The ASTM method covers the procedure of collection of dustfall and its measurement and employs a simple device consisting of a cylindrical container (not less than 150 mm in diameter) exposed for one calendar month (30 ±2 days). Even though the method provides for a dry bucket, de-ionised (distilled) water can be added to ensure the dust remains trapped in the bucket.

The bucket stand includes a wind shield at the level of the rim of the bucket to provide an aerodynamic shield. The bucket holder is connected to a 2 m galvanized steel pole, which is either planted and cemented or directly attached to a fence post (Figure 33). This allows for a variety of placement options for the fallout samplers. Two buckets are usually provided for each dust bucket stand. Thus, after the first month, the buckets get exchanged with the second set.

Collected sampled are sent to an accredited laboratory for gravimetric analysis. At the laboratory, each sample is rinsed with clean water to remove residue from the sides, and the contents filtered through a coarse (>1 mm) filter to remove insects and other course organic detritus. The sample is then filtered through a pre-weighed paper filter to remove the insoluble fraction. This residue and filter are dried, and gravimetrically analysed to determine total dustfall.

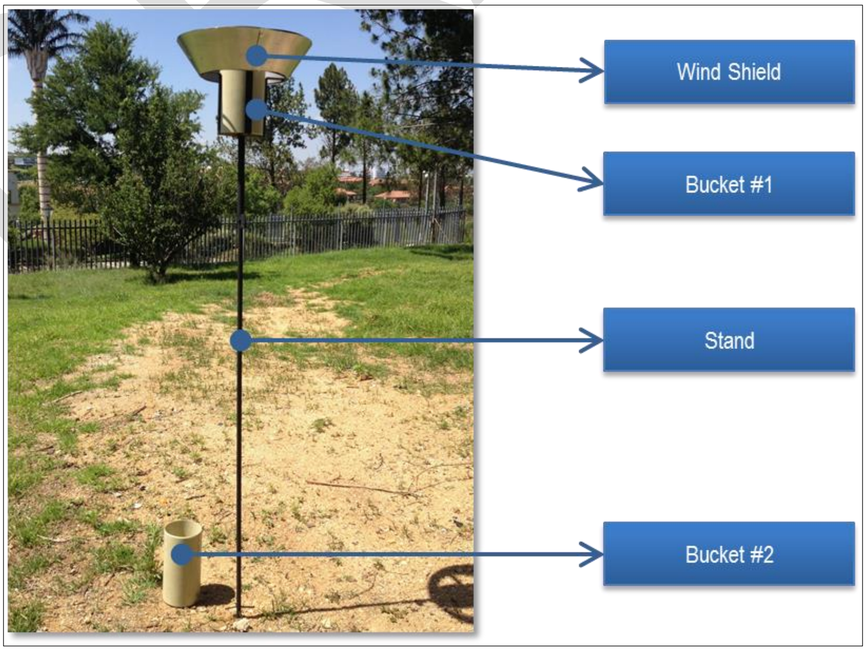

Figure 33: Example of a dustfall collection unit setup

9.2 Appendix B – Description of Wind Erosion Estimation Technique

Significant emissions arise due to the mechanical disturbance of granular material from open areas and storage piles. 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. The shape of a storage pile or disposal dump influences the potential for dust emissions through the alteration of the airflow field. The particle size distribution of the material on the disposal site is important since it determines the rate of entrainment of material from the surface, the nature of dispersion of the dust plume, and the rate of deposition, which may be anticipated

An hourly emissions file was created for the discard dump as well as storage pile. The calculation of an emission rate for every hour of the simulation period was carried out using the ADDAS model. This model is based on the dust emission model proposed by (Marticorena & Bergametti, 1995). The model attempts to account for the variability in source erodibility through the parameterisation of the erosion threshold (based on the particle size distribution of the source) and the roughness length of the surface.

In the quantification of wind erosion emissions, the model incorporates the calculation of two important parameters, viz. the threshold friction velocity of each particle size, and the vertically integrated horizontal dust flux, in the quantification of the vertical dust flux (i.e. the emission rate). The equations used are as follows:

$$E(i) = G(i)10^{(0.134(\%clay)-6)}$$

for

$$G(i) = 0.261\left[\frac{P_a}{g}\right]u^{*3}(1+R)(1-R^2)$$

$$R = \frac{u_*^t}{u^*}$$

And where,

$E_{(i)}$	=	emission rate (g/m²/s) for particle size class i
P_a	=	air density (g/cm³)
g	=	gravitational acceleration (cm/s³)
u_*^t	=	threshold friction velocity (m/s) for particle size i
u^*	=	friction velocity (m/s)

Dust mobilisation occurs only for wind velocities higher than a threshold value, and is not linearly dependent on the wind friction and velocity. The threshold friction velocity, defined as the minimum friction velocity required to initiate particle motion, is dependent on the size of the erodible particles and the effect of the wind shear stress on the surface. The threshold friction velocity decreases with a decrease in the particle diameter, for particles with diameters >60 µm. Particles with a diameter <60 µm result in increasingly high threshold friction velocities, due to the increasingly strong cohesion forces linking such particles to each other (Marticorena & Bergametti, 1995). The relationship between particle sizes ranging between 1 µm and 500 µm and threshold friction velocities (0.24 m/s to 3.5 m/s), estimated based on the equations proposed by (Marticorena & Bergametti, 1995), is illustrated in Figure 34.

The wind speed variation over the storage piles is based on the work of Cowherd et al. (1988). With the aid of physical modelling, the US-EPA has shown that the frontal face of an elevated pile (i.e. windward side) is exposed to wind speeds of the same order as the approach wind speed at the top of the pile. The ratios of surface wind speed (us) to approach wind speed (ur), derived from wind tunnel studies for two representative pile shapes, are illustrated in Figure 35 (viz. a conical pile, and an oval pile with a flat top and 37° side slope). The contours of normalised surface wind speeds are indicated for the oval, flat top pile for various pile orientations to the prevailing direction of airflow (the higher the ratio, the greater the wind exposure potential). These flow patterns are only applicable with piles that have a height to base ratio of more than 0.25.

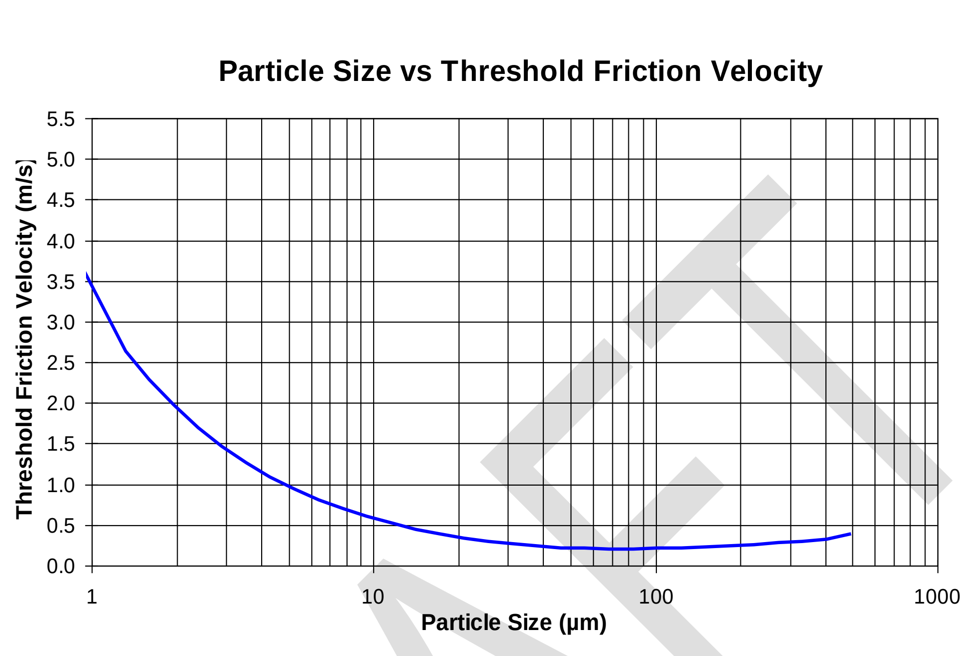

Figure 34: Relationship between particle sizes and threshold friction velocities using the calculation method proposed by Marticorena and Bergametti (1995)

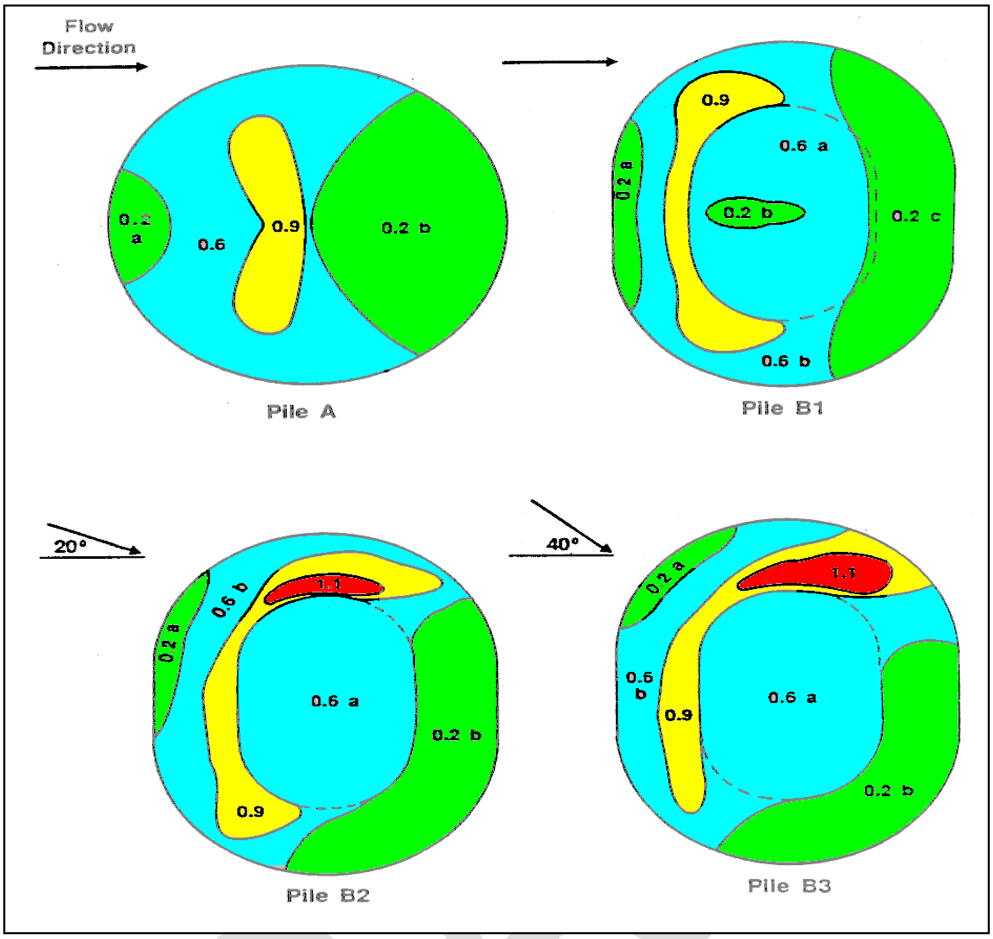

Figure 35: Contours of normalised surface wind speeds – surface wind speed/approach wind speed (US EPA, 2006)

9.3 Appendix C – Curriculum Vitae of Author