Air Quality Impact Assessment for the Proposed Development of the Phakwe Richards Bay Gas Power 3 Combined Cycle Gas to Power Plant and associated Infrastructure on a site near Richards Bay, KwaZulu-Natal Province

Prepared for **Savannah Environmental (Pty) Ltd** on behalf of **Phakwe Richards Bay Gas Power 3 (Pty) Ltd**

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Report Details

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Revision Record

Revision Number	Date	Reason for Revision
Draft	19 April 2022	Original for client comment
Revision 1	25 April 2022	Results updated for corrected turbine stack heights
Revision 2	09 May 2022	Typographical updates after client review; expansion of impact description for hydrogen as fuel source.

Competency Profiles

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Dr Terri Bird holds a PhD from the School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg. The focus of her doctoral research was on the impact of sulfur and nitrogen deposition on the soil and waters of the Mpumalanga Highveld. Since March 2012 she has been employed at Airshed Planning Professionals (Pty) Ltd. In this time, she has been involved in air quality impact assessments for various industrial and mining operations. She has been a team member on the development of Air Quality Management Plans, both provincial and for specific industries. Recent projects include assessing the impact of Postponement and/or Exemption of Emission Standards for various Listed Activities.

NEMA Regulation (2017), Appendix 6

Regulation	Relevant section in report
Details of the specialist who prepared the report.	Report Details (page i)
The expertise of that person to compile a specialist report including curriculum vitae.	Appendix A: Author's Curriculum Vitae Appendix B: Competencies for Performing Air Dispersion Modelling
A declaration that the person is independent in a form as may be specified by the competent authority.	Report Details (page i) Appendix C
An indication of the scope of, and the purpose for which, the report was prepared.	Section 1.1: Background Section 1.2: Terms of Reference
An indication of quality and age of base data used.	Section **Error! Reference source not found.**: Management of Uncertainty Section 2.1: Data Gathering Section 5: Air Quality Baseline
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change.	Section 5: Air Quality Baseline Section 8: Impact Assessment: Cumulative Section 4: Applicable Legislation
The date and season of the site investigation and the relevance of the season to the outcome of the assessment.	A site investigation was not undertaken for this project, however, the neighbouring site (RBG2P) was visited on the 11 March 2021. Description of the current land use in the region, simulations undertaken for the current operations and meteorological data used in the study are considered representative of all seasons. Section **Error! Reference source not found.**
A description of the methodology adopted in preparing the report or carrying out the specialised process.	Section 2: Methodology
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure.	Section 5: Air Quality Baseline
An identification of any areas to be avoided, including buffers.	Not applicable
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers.	Section 3: Process Description
A description of any assumptions made and any uncertainties or gaps in knowledge.	Section **Error! Reference source not found.**: Management of Uncertainty
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 6: Impact Assessment: Project Construction Section 7: Impact Assessment: Operational Phase Section 9: Assessment of Impact
Any mitigation measures for inclusion in the EMPr.	Section 10: Air Quality Management Measures
Any conditions for inclusion in the environmental authorisation	Section 11: Findings and Recommendations
Any monitoring requirements for inclusion in the EMPr or environmental authorisation.	Section 10: Air Quality Management Measures
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised.	Section 11: Findings and Recommendations
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.	Section 11: Findings and Recommendations

Regulation	Relevant section in report
A description of any consultation process that was undertaken during the course of carrying out the study.	Not applicable.
A summary and copies if any comments that were received during any consultation process.	No comments received yet on draft report
Any other information requested by the competent authority.	No comments received yet on draft report

Executive Summary

Phakwe Richards Bay Gas Power 3 (Pty) Ltd proposes to operate a combined cycle gas power plant (the project) in the Richards Bay Industrial Development Zone (RBIDZ) within the uMhlathuze Municipality in the KwaZulu-Natal Province of South Africa. The plant will have a generating capacity up to 2 000 MW and will be fuelled by natural gas (in either liquid or gas forms) or a mixture of natural gas and hydrogen (in a proportion scaling up from 30% hydrogen - H_2).

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by Savannah Environmental to provide independent and competent services for the compilation of the air quality specialist study as part of the project authorisation process. As part of the authorisation process an air quality impact assessment (AQIA) report, an Atmospheric Impact Report (AIR) for the new Atmospheric Emission Licence (AEL) application and any recommendations for the updated Environmental Management Programme (EMPr) (if necessary) are required. This report serves as input into the environmental authorisation and thus conforms to the amended regulated format requirements for specialist reports as per Appendix 6 of the Environmental Impact Assessment Regulations, 2017 (Government Gazette No. 40772, 7 April 2017).

To achieve this objective, the following tasks were included in the scope of work (SoW):

1. A **review** of current operations in the area and proposed project activities in order to identify sources of emission and associated pollutants.
2. A study of **regulatory requirements and health thresholds** for identified key pollutants against which compliance need to be assessed and health risks screened.
3. A study of the **receiving environment** in the vicinity of the project; including:
    a. The identification of potential air quality sensitive receptors (AQSRs);
    b. A study of the atmospheric dispersion potential of the area taking into consideration local meteorology, land-use and topography; and
    c. The analysis of all available ambient air quality information/data to determine pre-development ambient pollutant levels and dustfall rates.
4. The compilation of a comprehensive **emissions inventory** including likely construction and operational emissions.
5. **Atmospheric dispersion modelling** to simulate ambient air pollutant concentrations and dustfall rates.
6. A **screening** assessment to determine:
    a. Compliance of criteria pollutants with ambient air quality standards;
    b. Compliance of dustfall rates to dust control standards;
    c. Potential health risks as a result of exposure to non-carcinogenic non-criteria pollutants;
    d. Potential increased lifetime cancer risks as a result of exposure to carcinogenic pollutants; and
7. The compilation of a comprehensive **air quality specialist report**.

The main findings of the simulated incremental assessment were:

1. The construction phase of the project could result in off-site exceedances of inhalable particulate matter of less than 10 µm in diameter - PM_{10} daily and annual National Ambient Air Quality Standards (NAAQS) over the 36-month construction phase.
    a. It is likely that the construction (and decommissioning) phase(s) may have a "low" impact on the ambient air quality before and after effective mitigation measures are implemented.
2. Compliance with hourly, daily and annual NAAQS under normal operations for hourly, daily and annual average pollutant concentrations as applicable to sulfur dioxide (SO_2), particulate matter (PM_{10} and $PM_{2.5}$ – inhalable and respirable particulate matter of less than 10 µm and 2.5 µm in diameter, respectively), carbon monoxide (CO) and total volatile organic compounds (TVOCs). Exceedances of the nitrogen dioxide (NO_2) NAAQ Limit Concentration

could result from the normal operation of the facility using natural gas, but the frequency of exceedance is likely to be within that allowed by the NAAQS.

   a. The operational phase of the project will have a *low* impact significance (based on design mitigation measures) on ambient SO_2, PM, CO, and VOC concentrations, with no additional mitigation required.
   b. The operational phase is likely to have a “medium” impact significance for NO_2; however, if additional mitigation measures are implemented, the significance could be reduced to “low”.

3. Due to the inherently low sulfur content of natural gas, SO_2 emissions from the turbines will not reach the emission standard and therefore the facility’s impact on SO_2 was also assessed using mass balance calculations for combined cycle turbines using the default sulfur content of the emission factor (4600 g/IE+06 Nm^3).
   a. Compliance the NAAQS was simulated for hourly, daily, and annual average SO_2 for the operational scenario based on emission factor calculations.
4. The impact of start-up on ambient nitrogen dioxide (NO_2) concentrations was estimated, and exceedances of the NAAQS could result at residential receptors, schools and medical facilities. The impacts can be reduced if the turbines reach Minimum Emission Standards in less than 30 minutes, and if the frequency of start-up events is reduced.
5. Annual SO_2 and NO_2 concentrations are unlikely to affect vegetation productivity or animal health off-site.
6. The impact of the facility was simulated to be below the National Dust Control Regulations (NDCR) acceptable dustfall rates for all project phases.
7. While hydrogen (or natural gas – hydrogen mixture) could significantly reduce emissions of SO_2, CO, PM and VOCs from the facility, emissions of oxides of nitrogen (NO_X) could potentially be similar to those from natural gas combustion.

The main findings of the cumulative assessment were:

1. Cumulative SO_2 concentrations (hourly, daily, and annual) are likely to be below the applicable NAAQS across the domain, however, elevated concentrations in some areas are likely to be associated with the existing sources contributing to baseline air quality.
2. Cumulative NO_2 concentrations may be higher than the applicable NAAQS in the long-term if all proposed large generating capacity gas-to-power projects are commissioned. The contribution of the PRBGP3 is likely to be less than 30% of the cumulative impact.
3. Cumulative PM_{10} concentrations (daily and annual) may exceed NAAQS at Harbour West, Scorpio, and Arboretum monitoring stations due to the elevated baseline concentrations. However, the contribution PRBGP3 is low and acceptable.
4. Cumulative impact of the facility and other projects in the area on the ambient air quality in the Richards Bay area is likely to be “medium” if unmitigated with the potential to reduce to low if industry and community initiatives can minimise the combined impact on air quality.

From an air quality perspective, it is the opinion of the specialist that the Phakwe Richards Bay Gas Power 3 Combined Cycle Gas to Power Plant be authorised, on condition that:

- Emissions be monitored as per standard practice for the appropriate listed activity;
- Emissions are maintained at or lower than the Minimum Emission Standards appropriate for the listed activity;
- Conformance with the other environmental management programme requirements for air quality (Section 10) are met.

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List of Abbreviations

AEL	Atmospheric emission licence
AIR	Atmospheric impact report
APPA	Atmospheric Pollution Prevention Act
AQA	Air quality act
AQIA	Air quality impact assessment
AQMS	Air quality monitoring station
AQO	Air quality officer
AQSR	Air quality sensitive receptor
ARM	Ambient ratio method
CBD	Central Business District
CLRTAP	Convention on Long Range Trans-boundary Air Pollution limits
CO	Carbon monoxide
DFFE	Department of Forestry, Fisheries and Environment (previously Department of Environmental Affairs – DEA)
DoE	Department of Energy
EA	Environmental authorisation
EIA	Environmental impact assessment
EMPr	Environmental management programme
g	Gram
GLCC	Global Land Cover Characterisation
g/s	Gram per second
HRSG	Heat Recovery Steam Generator
IFC	International Finance Corporation
IRP	Integrated Resource Plan
LFG	Liquified natural gas
m	Metre
m^2	Metre squared
m^3	Metre cubed
m/s	Metres per second
mamsl	Metres above mean sea level
MES	Minimum emission standards
MW	Mega Watt
NAAQ Limit	National ambient air quality limit concentration
NAAQS	National ambient air quality standards (as a combination of the NAAQ Limit and the allowable frequency of exceedance)
NAEIS	National atmospheric emissions inventory system
NDCR	National dust control regulations
NEMA	National Environmental Management Act
NEM:AQA	National Environmental Management: Air Quality Act
Nm^3	Cubic metres (at normal conditions: 273 K and 101.3 kPa)
NO_2	Nitrogen dioxide
NPI	National pollution inventory
NO_x	Oxides of nitrogen
OEM	Original Equipment Manufacturer
Pb	Lead
PM_{10}	Particulate matter with diameter of less than 10 µm
$PM_{2.5}$	Particulate matter with diameter of less than 2.5 µm
PPA	Power Purchase Agreement

PRBGP3	Phakwe Richards Bay Gas Power 3 (Pty) Ltd
RBCAA	Richards Bay Clean Air Association
RB IDZ	Richards Bay Industrial Development Zone
SAAQIS	South African air quality information system
SAWS	South African Weather Services
SO_2	Sulfur dioxide
SoW	Scope of work
SRTM	Shuttle radar topography mission
tpa	Tonnes per annum
tph	Tonnes per hour
TSP	Total suspended particulates
UNECE	United Nations Economic Commission for Europe
US EPA	United States Environmental Protection Agency
USGS	United States geological survey
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compounds (also TVOC – total volatile organic compounds)
WGS	World Geodetic System
WRF	Weather Research and Forecasting
µ	micro
°C	Degrees Celsius

Note:

The spelling of “sulfur” has been standardised to the American spelling throughout the report. "The International Union of Pure and Applied Chemistry, the international professional organisation of chemists that operates under the umbrella of UNESCO, published, in 1990, a list of standard names for all chemical elements. It was decided that element 16 should be spelled “sulfur”. This compromise was to ensure that in future searchable data bases would not be complicated by spelling variants. (IUPAC. Compendium of Chemical Terminology, 2nd ed. (the "Gold Book"). Compiled by A. D. McNaught and A. Wilkinson. Blackwell Scientific Publications, Oxford (1997). XML on-line corrected version: http://goldbook.iupac.org (2006) created by M. Nic, J. Jirat, B. Kosata; updates compiled by A. Jenkins. ISBN 0-9678550-9-8.doi: 10.1351/goldbook)"

Glossary

Air-shed	An area, bounded by topographical features, within which airborne contaminants can be retained for an extended period
Algorithm	A mathematical process or set of rules used for calculation or problem-solving, which is usually undertaken by a computer
Atmospheric dispersion model	A mathematical representation of the physics governing the dispersion of pollutants in the atmosphere
Atmospheric stability	A measure of the propensity for vertical motion in the atmosphere
Baseline	Information gathered at the beginning of a study which describes the environment prior to development of a project and against which predicted changes (impacts) are measured.
Building wakes	Strong turbulence and downward mixing caused by a negative pressure zone on the lee side of a building
Calm / stagnation	A period when wind speeds of less than 0.5 m/s persist
Cartesian grid	A co-ordinate system whose axes are straight lines intersecting at right angles
Causality	The relationship between cause and effect
Complex terrain	Terrain that contains features that cause deviations in direction and turbulence from larger-scale wind flows
Cumulative Impacts	Direct and indirect impacts that act together with current or future potential impacts of other activities or proposed activities in the area/region that affect the same resources and/or receptors.
Configuring a model	Setting the parameters within a model to perform the desired task
Construction Phase	The stage of project development comprising site preparation as well as all construction activities associated with the development.
Convection	Vertical movement of air generated by surface heating
Convective boundary layer	The layer of the atmosphere containing convective air movements
Data assimilation	The use of observations to improve model results – commonly carried out in meteorological modelling
Diffusion	Clean air mixing with contaminated air through the process of molecular motion. Diffusion is a very slow process compared to turbulent mixing.
Dispersion	The lowering of the concentration of pollutants by the combined processes of advection and diffusion
Environment	The external circumstances, conditions and objects that affect the existence of an individual, organism or group. These circumstances include biophysical, social, economic, historical and cultural aspects.
Environmental Authorisation	Permission granted by the competent authority for the applicant to undertake listed activities in terms of the NEMA EIA Regulations, 2014.
Environmental Impact Assessment	A process of evaluating the environmental and socio-economic consequences of a proposed course of action or project.
Environmental Impact Assessment Report	The report produced to relay the information gathered and assessments undertaken during the Environmental Impact Assessment.
Environmental Management Programme	A description of the means (the environmental specification) to achieve environmental objectives and targets during all stages of a specific proposed activity.
Impact	A change to the existing environment, either adverse or beneficial, that is directly or indirectly due to the development of the project and its associated activities.
Mitigation measures	Design or management measures that are intended to minimise or enhance an impact, depending on the desired effect. These measures are ideally incorporated into a design at an early stage.
Operational Phase	The stage of the works following the Construction Phase, during which the development will function or be used as anticipated in the Environmental Authorisation.
Specialist study	A study into a particular aspect of the environment, undertaken by an expert in that discipline.
Stakeholders	All parties affected by and/or able to influence a project, often those in a position of authority and/or representing others.

Air Quality Impact Assessment for the Proposed Development of the Phakwe Richards Bay Gas Power 3 Combined Cycle Gas to Power Plant and associated Infrastructure on a site near Richards Bay, KwaZulu-Natal Province

1 INTRODUCTION

Phakwe Richards Bay Gas Power 3 (Pty) Ltd (PRBGP3) intend on developing a combined cycle gas to power plant, with a generating capacity up to 2 000 MW, located on various erven within the Richards Bay Industrial Development Zone (RB IDZ) phase 1F, Richards Bay, KwaZulu-Natal. Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by Savannah Environmental (Pty) Ltd to address potential impacts on the atmospheric environment by conducting a comprehensive air quality impact assessment for the PRBGP3 Project.

As part of the authorisation process an air quality impact assessment (AQIA) report, an Atmospheric Impact Report (AIR) for the new Atmospheric Emission Licence (AEL) application and any recommendations for inclusion in the Environmental Management Programme (EMPr) (if necessary) are required. This report serves as input into the environmental authorisation process and thus conforms to the amended regulated format requirements for specialist reports as per Appendix 6 of the Environmental Impact Assessment Regulations, 2017 (Government Gazette No. 40772, 7 April 2017).

1.1 Background

The power plant will operate at mid-merit to baseload duty and will include the following main infrastructure:

- A number of gas turbines for the generation of electricity through the use of natural gas (liquid or gas forms), or a mixture of natural gas and hydrogen (in a proportion scaling up from 30% hydrogen - H_2) as fuel source, operating all turbines at mid-merit or baseload (estimated 16 to 24 hours daily operation).
- Exhaust stacks associated with each gas turbine.
- A number of Heat Recovery Steam Generator (HRSG) to generate steam by capturing the heat from the turbine exhaust.
- A number of steam turbines to generate additional electricity by means of the steam generated by the HRSG.
- The water treatment plant will demineralise incoming water from municipal, or similar supply, to the gas turbine and steam cycle requirements. The water treatment plant will produce two parts demineralised water and reject one-part brine, which will be discharged to the RB IDZ stormwater system.
- Steam turbine water system will be a closed cycle with air cooled condensers. Make-up water will be required to replace blow down.
- Air cooled condensers to condensate used steam from the steam turbine.
- Compressed air station to supply service and process air.
- Water pipelines and water tanks for storage and distributing of process water, with the potential for sourcing of alternative water outside RB IDZ or municipal supply.
- Water retention ponds for the treatment of turbine washout water prior to disposal of oily waste and clarified water.
- Closed fin-fan coolers to cool lubrication oil for the gas turbines.
- Gas generator lubrication oil system.
- Gas pipeline supply conditioning process facility. Please note that the gas supply will be via a dedicated pipeline from the proposed Transnet supply pipeline network of Richards Bay (the location of this network has not yet been

confirmed) or, alternatively directly from the regasification facilities in the Port of Richards Bay. The gas pipeline will be authorized separately.

- Site water facilities including potable water, storm water, and wastewater.
- Fire water (FW) storage and FW system.
- Diesel emergency generator for start-up operation.
- On-site fuel conditioning including heating system.
- All underground services, including stormwater and wastewater.
- Ancillary infrastructure including:
  - Roads (access and internal);
  - Warehousing and buildings;
  - Workshop building;
  - Fire water pump building;
  - Administration and Control Building;
  - Ablution facilities;
  - Storage facilities;
  - Guard House;
  - Fencing;
  - Maintenance and cleaning area;
  - Operational and maintenance control centre.
- Electrical facilities including:
  - Power evacuation infrastructure.
  - Generators and auxiliaries;
  - Subject to a separate environmental authorisation application:
  - Eskom 275 or 400 kV GIS interface Substation
  - Underground 275 or 400 kV power cabling connecting Power Plant GIS substation and Eskom GIS Interface substation.
  - an overhead 275 kV or 400 kV power line connecting the Eskom interface substation to the selected Eskom grid connection point.
- Service infrastructure including:
  - Stormwater channels;
  - Water pipelines;
  - Temporary work areas during the construction phase (laydown areas).

Fuel supply

- A dedicated pipeline to connect into an on-site gas receiving and conditioning station will provide the natural gas or the mixture of natural gas and hydrogen. The pipeline will be connected to the proposed Transnet supply pipeline network of Richards Bay (the location of this network has not yet been confirmed), or it will extend directly to the regasification facilities in the Port of Richards Bay.
- The dedicated pipeline will be separately environmentally authorized.

The development is proposed on erven 16820, 16819,1/16674 and a subdivision of erf 17442, and will occupy approximately 11ha, situated within Phase 1F of the RB IDZ located approximately 5 km northeast of Richards Bay and 1 km north of the suburb of Alton. The project site is situated in the City of uMhlathuze which falls within jurisdiction of the King Cetshwayo District Municipality, KwaZulu-Natal Province. The site has been zoned for IDZ Industrial development as part of the planning for this IDZ area.

Please note: while the facility will be connected to a dedicated fuel pipeline, and will have grid connection infrastructure towards connecting with the Eskom substation and the national grid, these infrastructure components do not form part of this application and are subject to separate authorisation processes.

1.2 Terms of Reference

The main objectives of the air quality specialist study were to identify and assess the potential impact of the PRBGP3 on air quality, as part of the Environmental Impact Assessment (EIA) process.

Figure 1-1: Location of the project in relation to the surrounding environment (regional setting)

1.3 Management of Uncertainty

The study is based on a number of assumptions and is subject to certain limitations, which should be borne in mind when considering information presented in this report. The validity of the findings of the study is not expected to be affected by these assumptions and limitations:

1. All project information required to calculate emissions for proposed operations were provided by the project engineers via Savannah Environmental.
2. The impact of the construction and operational phases were determined quantitatively through emissions calculation and simulation. No impacts are expected post-closure.
3. Meteorology:
    a. Modelled Weather Research and Forecasting (WRF) data for the period January 2017 to December 2019 was used in dispersion modelling.
    b. The National Code of Practice for Air Dispersion Modelling (Gazette No. 37804, vol 589; 11 July 2014) prescribes the use of a minimum of 1-year on-site data or at least three years of appropriate off-site data for use in Level 2 and 3 assessments. It also states that the meteorological data must be for a period no older than five years to the year of assessment. The dataset period is within the timeframe recommended by the National Code of Practice for Air Dispersion Modelling by being three years data less than five years old during the assessment period (2022).
4. Building downwash was not included in the dispersion model because equipment and building design had not yet been finalized. It was assumed that Good Engineering Practice guidelines will be applied, and the turbine stacks will be more than 3 m higher than the nearest equipment.
5. Emissions:
    a. The quantification of sources of emission during the construction phase excluded vehicle exhaust emissions and focused on airborne particulates associated with the major earth works and vehicle movement.
    b. For the purposes of assessment of impact, it is assumed that the decommissioning phase would have similar impacts to the construction phase, since activities are similar.
    c. The impact assessment mainly focuses on oxides of nitrogen (NO_X), sulfur dioxide (SO_2), carbon monoxide (CO), airborne particulates (including total suspended particulates - TSP, inhalable particulate matter of less than 10 µm in diameter -$PM_{10,}$ respirable particulate matter of less than 2.5 µm in diameter $PM_{2.5}$) and volatile organic compounds (VOCs) from the turbine operations. These pollutants are either regulated under the minimum emission standards (MES) for sub-category 1.4 and national ambient air quality standards (NAAQS) or considered key pollutants released by the facility.
    d. The quantification of sources of emission during the operational phase was restricted to the gas turbines.
        i. Turbines were assumed to operate continuously using natural gas only. Emissions due to hydrogen (or natural gas -hydrogen mixture) are likely to be lower (for SO_2, CO, PM, and VOCs) but could be similar or lower than natural gas only for NO_X.
        ii. The current site layouts provide for two water retention ponds (~3 000 m² each) that will be used for turbine washout. The washout water may contain oil from the turbines, and it is therefore not decanted directly into the sewerage system but first retained in the effluent ponds where it is treated to separate the oil waste. Oil waste is then directed to the waste disposal system and the clarified water will be decanted into the sewerage system. The water retention ponds are a potential source of malodourous compounds, however there was insufficient information available regarding the water quality to estimate emissions from these sources.
        iii. Although other existing sources of emission within the area were identified, e.g., other industries; these sources were not quantified as part of this emissions inventory and simulations. However,

the cumulative impacts are considered using measured ambient concentrations and publicly available information for authorised but not yet operational facilities.

e. For the estimation of stack emissions, the new plant minimum emission standards (MES) were used for all pollutants.

f. The Australian Department of the Environment National Pollutant Inventory emission estimation manual for Fossil Fuel Electric Power Generation (NPI, 2012) was used to estimate turbine emissions for key pollutants where MES are not defined (CO and VOCs).

    i. The same emissions estimation manuals were used for the estimation of SO_2 emissions based on fuel sulfur content because using the MES can over-estimate the impact for low sulfur fuels like natural gas. The default sulfur content of natural gas (4600 g/lE+06 Nm^3) stated for the emission factor was used, since the source of natural gas is yet known.

6. NO_2 emissions and impacts:
    a. Emissions of oxides of nitrogen were conservatively assumed to all convert to NO_2.
7. The Richards Bay baseline air quality was described based on measured air pollutant concentrations (2016 to 2021) and supported by baseline dispersion modelling. Other major sources in the domain were not re-quantified or re-simulated. The proposed project sources and the authorised (but not yet constructed) gas-to-power plants were included based on information available in the public domain.

Other assumptions made in the report are explicitly stated in the relevant sections.

2 METHODOLOGY

The air quality impact study includes both baseline and simulated impact assessment. The baseline characterisation includes the following enabling tasks:

- Assessment of dispersion potential for the site.
  - It is important to have a good understanding of the meteorological parameters governing the rate and extent of dilution and transportation of air pollutants that are generated by the proposed project.
  - The primary meteorological parameters to obtain from measurement include wind speed, wind direction and ambient temperature. Other meteorological parameters that influence the air concentration levels include rainfall (washout) and a measure of atmospheric stability. The latter quantities are normally not measured and are derived from other parameters such as the vertical height temperature difference or the standard deviation of wind direction. The depth of the atmosphere in which the pollutants can mix is similarly derived from other meteorological parameters by means of mathematical parameterizations.
  - WRF data for the period January 2017 to December 2019 was used in dispersion modelling.
- Identification of air quality sensitive receptors (AQSRs) within the study area.
  - AQSRs were identified and georeferenced for detailed analysis for the impact assessment calculations.
  - AQSRs generally include schools, medical facilities, places of residence and areas where members of the public may be affected by atmospheric emissions generated by industrial activities.
- Identification of characterization of ambient air quality and existing sources of emissions in the study area.

The impact assessment followed with the tasks below:

- The dispersion modelling was executed as per The Regulations Regarding Air Dispersion Modelling (Gazette No 37804 vol. 589; published 11 July 2014). Three *Levels of Assessment* are defined in the Regulations. Level 3 was deemed appropriate due to the influence of complex coastal and topographical influences. Level 3 being for assessment of air quality impacts as part of license application or amendment processes, where impacts are the greatest within a few kilometres downwind (less than 50 km).
- Preparation of the model input files for the CALPUFF dispersion modelling suite. This included the compilation of:
  - hourly sequential meteorological data for the atmospheric dispersion model using CALMET (which accounted for terrain, land use, albedo and surface roughness);
  - grid and receptor definitions; and
  - source configurations.
- Preparation of an emissions inventory for the proposed operations, including:
  - Point sources using the following source information:
    - Source locations identified using site layout maps;
    - Maximum allowable emission rates as stipulated by the MES, and design emission rates;
    - Exit temperature;
    - Exit velocity;
    - Release height; and
    - Stack-tip diameter.
- Using the emissions inventory, the simulations were conducted using the CALPUFF dispersion model, which allowed the calculations of the proposed ambient SO_2, NO_2, CO, $PM_{2.5}$, PM_{10}, and dustfall rates. The hourly, daily and annual concentrations and average daily dustfall rates were calculated. The model results were analysed against the NAAQS and national dust control regulations (NDCR) and relevant international criteria.

- The legislative and regulatory context, including emission limits, ambient air quality guidelines and dustfall classifications were used to assess the impact and recommend additional emission controls, mitigation measures and air quality management plans to maintain the impact of air pollution to acceptable limits in the study area.
- Based on the results of the dispersion modelling and using the Savannah Environmental (Pty) Ltd significance rating methodology the proposed operations impacts were determined.

2.1 Data Gathering

The following data sources were consulted for the project:

- WRF Model data (2017 to 2019).
- Richards Bay Clean Air Association (RBCAA) and City of uMhlathuze ambient air quality monitoring station data (2016 to 2021).
- Terrain and land use data, obtained from the United States Geological Survey (USGS) via the Earth Explorer website (U.S. Department of the Interior, U.S. Geological Survey, 2016). Use was made of Shuttle Radar Topography Mission (SRTM) (30 m, 1 arc-sec) data and Global Land Cover Characterisation (GLCC) data for Africa.
- Project specific data provided by Phakwe Richards Bay Gas Power 3 (Pty) Ltd and their Original Equipment Manufacturer (OEM) via Savannah Environmental (Pty) Ltd, in response to a detailed requirements list submitted by the specialist.

2.2 Analysis

The impact of the operations at the project on the atmospheric environment was determined through simulation of ambient pollutant concentrations. Simulated air quality impacts represent only those associated with the proposed plant.

The South African Regulations Regarding Air Dispersion Modelling (Government Notice no. R533, 11 July 2014) provide guidance on the use of a tiered approach in defining the levels of assessment required in a modelling application. This Code of Practice also recommends a number of dispersion models to be used in regulatory applications in South Africa. This requires a modeller to assess the application and identify which model would best provide the essential information to the regulatory authority with the detail and accuracy required in the application. Air quality assessments can vary in their level of detail and scope, which in turn is determined by the objectives of the modelling effort, technical factors and the level of risk associated with the emissions. Based on the surrounding land-use, a Level 3 study was conducted.

2.2.1 CALPUFF Model and Pre-processors

The CALPUFF/CALMET model suite was selected for use in the current investigation to predict maximum short-term (1 and 24-hour) and annual average ground-level concentrations at various receptor locations within the computational domain. The CALPUFF modelling system consists of a number of components, as summarised in Table 2-1; however, only CALMET and CALPUFF contain the simulation engines to calculate the three-dimensional atmospheric boundary layer conditions and the dispersion and removal mechanisms of pollutants released into this boundary layer. The other codes are mainly used to assist with the preparation of input and output data. Table 2-1 also includes the development versions of each of the codes used in the investigation.

Table 2-1: Model details

Module	Version	Description
Calpuff View	V9	Licensed graphical solution for the Calpuff modelling suite including pre- and post-processors (developed by Lakes Environmental)
CALMET	V7.2.1	Three-dimensional, diagnostic meteorological model
CALPUFF	V7.2.1	Non-steady-state Gaussian puff dispersion model with chemical removal, wet and dry deposition, complex terrain algorithms, building downwash, plume fumigation and other effects.
CALPOST	V7.1.0 V7.2.0	A post-processing program for the output fields of meteorological data, concentrations and deposition fluxes.
POSTUTIL	V7.1.0	Processes CALPUFF concentration and wet/dry flux files. Creates new species as weighted combinations of modelled species; merges species from different runs into a single output file; sums and scales results from different runs; repartitions nitric acid/nitrate based on total available sulfate and ammonia.
TERREL	V7.0.0	Combines and grids terrain data
CTGPROC	V7.0.0	Processes and grids land use data
MAKEGEO	V3.2	Merges land use and terrain data to produce the geophysical data file for CALMET

CALPUFF was selected for the following reasons:

- Recommended model for application in the study area. Since the dispersion model formulation in CALPUFF is based on a Lagrangian Gaussian Puff model, it is well-suited for complex modelling terrain when used in conjunction with CALMET. The latter code includes a diagnostic wind field model which contains treatment of slope flows, valley flows, terrain blocking effects and kinematic effects. This Lagrangian Gaussian Puff model is well suited to simulate low or calm wind speed conditions. Alternative regulatory models such as the US EPA AERMOD model treat all plumes as straight-line trajectories, which under calm wind conditions grossly over-estimate the plume travel distance.
- The dispersion of pollutants in CALPUFF is simulated as discrete "puffs" of pollutants emitted from the modelled sources. These puffs are tracked until they have left the modelling domain while calculating dispersion, transformation and removal along the way. An important effect of non-steady-state dispersion is that the puff can change direction with changing winds, allowing a curved trajectory. The winds can therefore vary spatially as well as with time; with the former typically a result of topographical features.
- CALPUFF is able to perform chemical transformations, such as the conversion of nitrogen oxide (NO) to NO_2 and the secondary formation of particulate matter from SO_2 and NO_2 emissions.
- As well as sea and land breeze circulation systems, the significant differences between the boundary layers of marine and overland means distinct changes occur to a dispersing plume moving from land to sea. The CALPUFF modelling system is well suited to handling these complex phenomena. The effects of land/sea breeze circulations on transport of the plume are addressed through use of the mesoscale prognostic meteorological data.
- Stagnation conditions, i.e., when the wind is zero or near to zero.

The execution phase (i.e., dispersion modelling and analyses) involves gathering specific information regarding the emission source(s) and site(s) to be assessed, and subsequently the actual simulation of the emission sources and determination of impacts significance. The information gathering included:

- Source information: Emission rate, exit temperature, volume flow, exit velocity and release height;
- Site information: Site building layout, terrain information, land-sea interface, and land use data;
- Meteorological data: Wind speed, wind direction, temperature, cloud cover and mixing height; and
- Receptor information: Locations using discrete receptors and/or gridded receptors.

2.2.1 Meteorological Requirements

An understanding of the atmospheric dispersion potential of the area is essential to an air quality impact assessment. In the absence of on-site surface and upper air (sounding) meteorological data required for atmospheric dispersion modelling use was made of WRF data for the period January 2017 to December 2019.

2.2.2 Topographical and Land Use Data

Readily available terrain and land use data was obtained from the United States Geological Survey (USGS) via the Earth Explorer website (U.S. Department of the Interior, U.S. Geological Survey, 2016). SRTM (30 m, 1 arc-sec) data and GLCC data for Africa were used.

2.2.3 Receptor Grid

The dispersion of pollutants expected to arise from operations was simulated for an area covering 16 km (east-west) by 16 km (north-south) (Table 2-2). The area was divided into a grid matrix with a resolution of 125 m. The individual sensitive receptors (schools and medical facilities) were included in the simulations as discrete receptors. CALPUFF calculates ground-level (0 to 10 m) concentrations at each grid receptor point.

Table 2-2: Simulation domain

Parameter	Simulation domain
Projection	Grid: UTM Zone 36S, Datum: WGS-84
South-western corner of computational domain	378.8186 km (Easting); 6791.4368 km (Northing)
Computational domain size	50 x 50 km
Grid resolution	200 m
South-western corner of sampling domain	396.719 km (Easting); 6811.338 km (Northing)
Sampling domain size	16 x 16 km
Mesh density	2
Grid resolution	125 m within sampling domain
Discrete receptors	98 schools, hospitals, air quality monitoring stations (AQMS), and residential areas

Nitrogen Dioxide Formation

Of the several species of nitrogen oxides, only NO_2 is specified in the NAAQS. Since most sources emit varying ratios of these species and these ratios change further in the atmosphere due to chemical reactions, a method for determining the amount of NO_2 in the plume must be selected. Estimation of this conversion normally follows a tiered approach, as discussed in the Regulations Regarding Air Dispersion Modelling (Government Gazette No. 37804, published 11 July 2014), which presents a scheme for annual averages:

Tier 1: Total Conversion Method

Use any of the appropriate models recommended to estimate the maximum annual average NO_2 concentrations by assuming a total conversion of NO to NO_2. If the maximum NO_x concentrations are less than the NAAQS for NO_2, then no further refinement of the conversion factor is required. If the maximum NO_x concentrations are greater than the NAAQS for NO_2, or if a more "realistic" estimate of NO_2 is desired, proceed to the second-tier level.

Tier 2: Ambient Ratio Method (ARM) - Multiply NO_x by a national ratio of NO_2/NO. = 0.80

Assume a wide area quasi-equilibrium state and multiply the Tier 1 empirical estimate NO_x by a ratio of NO_2/NO_x = 0.80. The ratio is recommended for South Africa as the conservative ratio based on a review of ambient air quality monitoring data from the country. If representative ambient NO and NO_2 monitoring data is available (for at least one year of monitoring), and the data is considered to represent a quasi-equilibrium condition where further significant changes of the NO/NO_2 ratio is not expected, then the NO/NO_2 ratio based on the monitoring data can be applied to derive NO_2 as an alternative to the national ratio of 0.80.

Hourly and annual average NO_2 concentrations were calculated from simulated NO_X concentrations assuming a full 100% conversion ratio, i.e., the Tier 1 option was selected for this project as a conservative approach.

Secondary Particulates

CALPUFF includes two chemical transformation schemes for the calculation of sulfate and nitrate formation from SO_2 and NO_x emissions. These are the MESOPUFF II and the RIVAD / ARM3 chemical formulations. Whist the former scheme is not specifically restricted to urban or rural conditions; the latter was developed for use in rural conditions. Since the study area could be classified as urban, the RIVAD / ARM3 chemical formulations should not be used. The chemical transformation scheme chosen for this analysis was therefore the MESOPUFF II scheme. As described in the CALPUFF User Guide it is a "pseudo first-order chemical reaction mechanism" and involves five pollutant species namely SO_2, sulfates (SO_4), NO_x, nitric acid (HNO_3) and particulate nitrate (NO_3). CALPUFF calculates the rate of transformation of SO_2 to SO_4, and the rate of transformation of NO_x to NO_3, based on environmental conditions including the ozone concentration, atmospheric stability, solar radiation, relative humidity, and the plume NO_x concentration. The daytime reaction formulation depends on solar radiation and the transformation increases non-linearly with the solar radiation (see the SO_2 to SO_4 transformation rate equation (equation 2-253 in the CALPUFF User Guide). At night, the transformation rate defaults to a constant value of 0.2% per hour. Calculations based on these formulas show that the transformation rate can reach about 3 per cent per hour at noon on a cloudless day with 100 ppb of ozone.

With the MESOPUFF-II mechanism, NO_x transformation rates depend on the concentration levels of NO_x and O_3 (equations 2-254 and 2-255 in the CALPUFF User Guide) and both organic nitrates (RNO_3) and HNO_3 are formed. According to the scheme, the formation of RNO_3 is irreversible and is not subject to wet or dry deposition. The formation of HNO_3, however, is reversible and is a function of temperature and relative humidity. The formation of particulate nitrate is further determined through the reaction of HNO_3 and NH_3. Background NH_3 concentrations are therefore required as input to calculate the equilibrium between HNO_3 and particulate nitrate. At night, the NO_x transformation rate defaults to a constant value of 2.0% per hour. Hourly average ozone and ammonia concentrations were included as input in the CALPUFF model to facilitate these sulfate and nitrate formation calculations. Background ozone (O_3) and ammonia (NH_3) concentrations used for this project in CALPUFF are provided in Table 2-3. Monthly average ozone calculated from measured data at the Brackenham; Eskhaleni and Arboretum AQMS managed by the City of uMhlathuze for the year 2016. Monthly average ammonia (NH_3) concentrations estimated for Richards Bay from the seasonal values given in Warner *et al.* (2016).

Table 2-3: Monthly average ozone and ammonia concentrations used in the CALPUFF simulations

Pollutant	Month of year											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ozone	14.1	15.6	18.8	18.0	14.4	16.0	27.6	30.7	32.7	30.5	24.6	17.4
Ammonia	2.5	2.5	2	2	2	1	1	1	1.5	1.5	1.5	2.5

The limitation of the CALPUFF model is that each puff is treated in isolation, i.e., any interaction between puffs from the same or different points of emission is not accounted for in these transformation schemes. CALPUFF first assumes that ammonia reacts preferentially with sulfate, and that there is always sufficient ammonia to react with the entire sulfate present within a single puff. The CALPUFF model performs a calculation to determine how much NH_3 remains after the particulate sulfate has been formed and the balance would then be available for reaction with NO_3 within the puff. The formation of particulate nitrate is subsequently limited by the amount of available NH_3. Although this may be regarded a limitation, in this application the particulate formation is considered as a group and not necessarily per species.

2.2.4 Dispersion Results

Dispersion simulations were undertaken to determine second-highest hourly, first-highest daily average and first-highest annual average ground level concentrations and dustfall rates for each of the pollutants considered in the study as well as the frequency at which short term criteria are exceeded. Averaging periods were selected to facilitate the comparison of simulated pollutant concentrations to relevant ambient air quality criteria and dustfall regulations.

2.2.5 Presentation of Results

Ground-level concentration isopleths plots presented, depict interpolated values from the concentrations predicted by CALPUFF for each of the receptor grid points specified. Plots reflecting hourly (daily) averaging periods (other than frequency of exceedance) contain only the 99.99th percentile of predicted ground level concentrations, for those averaging periods, over the entire period for which simulations were undertaken. It is therefore possible that even though a high hourly average concentration is predicted to occur at certain locations, this may only be true for one hour during the year. Results are also provided in tabular form as discrete values predicted at selected AQSRs.

Ambient air quality criteria apply to areas where the Occupational Health and Safety regulations do not apply, which is generally outside the property or lease area. Ambient air quality criteria are therefore not occupational health indicators but applicable to areas where the public has access. In the case of this study the ambient criteria are seen to be applicable outside the boundary and at all AQSRs (inside or outside of the boundary). NO_2, SO_2, $PM_{2.5}$, PM_{10}, CO, and VOC concentrations are assessed on their impacts on human health. Dustfall is assessed for nuisance impact and not inhalation health impact.

2.2.6 Uncertainty of Modelled Results

There will always be some error in any geophysical model; however, modelling is recognised as a credible method for evaluating impacts, but it is desirable to structure the model in such a way to minimise the total error. A model represents the most likely outcome of an ensemble of experimental results. The total uncertainty can be thought of as the sum of three components: the uncertainty due to errors in the model physics; the uncertainty due to data errors; and the uncertainty due to stochastic processes (turbulence) in the atmosphere.

The stochastic uncertainty includes all errors or uncertainties in data such as source variability, observed concentrations, and meteorological data. Even if the field instrument accuracy is excellent, there can still be large uncertainties due to unrepresentative placement of the instrument (or taking of a sample for analysis). Model evaluation studies suggest that the data input error term is often a major contributor to total uncertainty. Even in the best tracer studies, the source emissions are known only with an accuracy of ±5%, which translates directly into a minimum error of that magnitude in the model predictions. It is also well known that wind direction errors are the major cause of poor agreement, especially for relatively short-term predictions (minutes to hourly) and long downwind distances. All of the above factors contribute to the inaccuracies not even associated with the mathematical models themselves.

2.3 Impact Assessment

Potential impacts of the proposed project were identified based on the baseline data, project description, review of other studies for similar projects and professional experience. The significance of the impacts was assessed using the prescribed Savannah Environmental impact rating methodology provided (Appendix D). The significance of an impact is defined as a combination of the consequence of the impact occurring and the probability that the impact will occur. The incremental impact significance was rated for the Construction (and Decommissioning) and Operational Phases along with cumulative impact and a no-go option.

2.4 Mitigation and Management Recommendations

Practical mitigation and optimisation measures that can be implemented effectively to reduce or enhance the significance of impacts, were identified.

3 PROCESS DESCRIPTION

The PRBGP3 project involves the installation and operation of gas turbine units for a total generating capacity of up to 2 000 MW. The power plant will include several gas- and steam turbine pairs for the generation of electricity through the use of natural gas (liquid or gas forms) or a mixture of natural gas and hydrogen (in a proportion scaling up from 30% H_2) as fuel source, operating all turbines at mid-merit to baseload duty (12 to 24 hours daily operation). No diesel (other than for plant start-up), heavy fuel oil, or light fuel oil will be used during normal operations, due to their high emissions.

The amount of fuel to be consumed will depend on the degree to which the plant is used (i.e., base load or mid-merit). The maximum fuel consumption of the power plant will be:

- at baseload duty: 116 million GJ /annum or 3 021 000 000 m^3/annum
- at mid-merit duty: 77 million GJ /annum or 2 014 000 000 m^3/annum.

Liquified natural gas (LNG) (or natural gas and H_2 mixture) will be received from a dedicated pipeline, from the Richards Bay harbour to the plant. LNG (or natural gas and H_2 mixture) may be purchased from Transnet or alternatively, fuel can be purchased from international suppliers.

Primary pollutants from gas turbine engines are NO_x, CO and to a lesser extent VOCs. NO_x formation is strongly dependent on the high temperatures developed in the combustor. CO, VOC, hazardous air pollutants, and particulate matter are primarily the result of incomplete combustion. Trace to low quantities of HAP and SO_2 are emitted from gas turbines. The expected operational lifetime of the proposed gas to power plant will be 25-40 years. Under the Department of Mineral Resources and Energy (DMRE) Independent Power Producer Programme, projects are provided with a 20 - 25-year Power Purchase Agreement (PPA). There are currently no guidelines provided by the DoE as to whether these contracts will be renewed after this term in the future. If an extension to the initial contract is provided by the DoE, then the developer will undertake an assessment of the plant facilities and the latest technology available at such a point in time, and this contract period may be extended subject to the DMRE requirements at the time and the findings of the assessment.

3.1 Identified Air Quality Aspects

Identified air quality aspects associated with the proposed PRBGP3 (up to 2 000 MW) power plant are listed in Table 3-1.

3.2 Visual Representations of Operations

The following visual representations of the operations are provided:

- Figure 1-1 is a map indicating location within the region;
- Figure 3-1 is a provisional site layout; and,
- Figure 5-2 is map indicating the location of the project in relation to AQSRs.

Table 3-1: Identified air quality aspects

Aspect or Project Phase	Expected Atmospheric Sources of Emissions and Associated Pollutants						Rationale
	Source	CO	NO_x	PM[a]	SO_2	VOC	
The construction phase of the PRBGP3 facility	Fugitive dust from civil and building work such as excavations, piling, foundations and buildings	n/a[b]	n/a	✓	n/a	n/a	The nature of emissions from construction activities is highly variable in terms of temporal and spatial distribution and is also transient. Fugitive dust emissions are, however, mostly generated by land-clearing and bulk earthworks.
	Exhaust gasses from diesel mobile construction equipment and trucks delivering materials.	✓	✓	✓	✓	✓	
The normal operation phase of the PRBGP3 facility	Exhaust gasses from the proposed turbine units	✓	✓	✓[c]	✓[c]	✓	The project is designed to operate on either natural gas or a mixture of natural gas and hydrogen in a proportion starting at 30% up to 100%. Emissions from the combustion of natural gas are notably lower than from the combustion of diesel or coal. While combustion of H_2 will release water (H_2O). The focus of the assessment is on the operation of the proposed turbine units since it triggers Subcategory 1.4 MES. Negligible fugitive losses of VOCs are expected from storage vessels, and from pipework and fittings.
	Fuel storage	n/a	n/a	n/a	n/a	✓	
Upset conditions that may result in atmospheric impacts	Unstable combustion conditions within turbine units	✓	✓	✓[c]	✓[c]	✓	Incomplete combustion and unstable combustion temperatures may result in higher than normal PM, CO, NO_x and VOC emissions. SO_2 emissions should not be affected. Additional VOC emissions because of the fuel leaks may occur but are unlikely.
	Fuel leaks	n/a	n/a	n/a	n/a	✓	
Decommissioning phase of the project	Fugitive dust from civil work such as rehabilitation and demolition.	n/a	n/a	✓	n/a	n/a	The nature of emissions from decommissioning activities is highly variable in terms of temporal and spatial distribution and is also transient. Detail regarding the extent of decommissioning activities and equipment movements was also not available for inclusion in the study. Fugitive dust emissions are, however, mostly generated by demolition and rehabilitation activities.
	Exhaust gasses from diesel mobile equipment and trucks removing materials.	✓	✓	✓	✓	✓	

Notes:

(a) PM includes PM_{10} and $PM_{2.5}$

(b) n/a – not applicable

(c) neg. negligible for natural gas

Figure 3-1: Provisional site layout (provided by Phakwe Richards Bay Gas Power 3 (Pty) Ltd)

3.3 Raw Materials Used and Production Rates

Raw material consumption and production rates for the project are tabulated in Table 3-2 and Table 3-3 below. Full details of the pollution abatement technologies which will be employed at the project will be provided in the AIR and AEL.

Table 3-2: Raw materials used

Raw Material Type	Design Maximum Consumption Rate	Rate Unit
Natural Gas[(a)]	11 140	m^3 per day
(a) With the potential for gradual replacement by hydrogen		

Table 3-3: Production Rates

Production Name	Design Production Capacity (Quantity)	Units (Quantity/Period)
Electricity	(up to) 2 000	MW

3.4 Emissions Inventory

The power station is planned to have two combined gas- and steam-cycle turbines venting off-gases via two stacks, with a release height of 18 m. The operating cycle of the power station was assumed to operate 24 hours per day, 7 days per week to meet base-load electricity demand. The possibility of a shorter operational cycle (16 hours per day, 7 days per week) to meet merit demand was considered under start-up emissions. This combination (24-hour operation for normal operation and 16-hour operation for start-up) would present the most conservative impact scenarios.

Normal operations are assumed to occur 99% of the operating cycle and were assessed in two emission scenarios: (1) at the Minimum Emission Standards (Table 3-5), and (2) using Australian National Pollution Inventory (NPI) emission factors for natural gas-fired combined cycle turbines (Table 3-7), as representations of the maximum allowable emissions (without being considered an emergency - MES) and typical operating emissions (using emission factors), respectively.

Emissions for the back-up diesel powered generator was not estimated since the generator will only be used for cold start-ups and based on the conservative operational cycles (described above) the use of the generator would be limited and for short periods of time.

Table 3-4: Parameters for point sources of atmospheric pollutant emissions at the project

Point Source code	Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Height Above Nearby Building (m)	Effective Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m^3/hr)	Actual Gas Exit Velocity (m/s)
STK1	Gas turbine Stack 1	-28.741703	32.028852	60	>3[(a)]	9.0	84	3 857 551	16.8
STK2	Gas turbine Stack 2	-28.743287	32.029562	60	>3[(a)]	9.0	84	3 857 551	16.8

Notes:
(a) Assumed parameter. Detail not yet available.

3.4.1 Point Source Emission Rates during Normal Operating Conditions - MES

Table 3-5: Atmospheric pollutant emission rates for the project (MES)

Point Source code	Pollutant Name	Maximum Release Rate				Emissions Hours	Type of Emissions (Continuous / Routine but Intermittent / Emergency Only)
		mg/Nm³	mg/Am³[(a)]	g/s	Averaging period		
STK1 – STK2	Sulfur dioxide (SO_2)	400	306.35	328.46	Hourly	24 hours per day; 7 days per week	Continuous during operation
	Oxides of Nitrogen (NO_X)	50	38.29	41.06	Hourly	24 hours per day; 7 days per week	Continuous during operation
	Particulate matter (PM)	10	7.66	8.21	Hourly	24 hours per day; 7 days per week	Continuous during operation

Note:
(a) Varies depending on actual temperature

Table 3-6: Point Source Emission Estimation Information during Normal Operating Conditions (MES)

Point Source code	Pollutants	Basis for Emission Rates
STK1 – STK2	PM, SO_2, NO_X	Minimum Emission Standards for Subcategory 1.4 – Gas Combustion Installations (as per Section 21 NEM:AQA)

3.4.2 Point Source Maximum Emission Rates during Normal Operating Conditions – based on emission factors

Table 3-7: Atmospheric pollutant emission rates for the project (Emission Factors)

Point Source code	Pollutant Name	Maximum Release Rate				Emissions Hours	Type of Emissions (Continuous / Routine but Intermittent / Emergency Only)
		mg/Nm³	mg/Am³(a)	g/s	Averaging period		
STK1 – STK2	Sulfur dioxide (SO_2)	0.02	0.014	0.0147	Hourly	24 hours per day; 7 days per week	Continuous during operation
	Oxides of Nitrogen (NO_X)	50	38.3	41.06	Hourly	24 hours per day; 7 days per week	Continuous during operation
	Particulates	10	7.7	8.21	Hourly	24 hours per day; 7 days per week	Continuous during operation
	Carbon monoxide (CO)	2.94	2.3	2.411	Hourly	24 hours per day; 7 days per week	Continuous during operation
	Total Volatile Organic Compounds (TVOCs)	0.16	0.13	0.135	Hourly	24 hours per day; 7 days per week	Continuous during operation

Note:
(a) Varies depending on actual temperature

Table 3-8: Point Source Emission Estimation Information during Normal Operating Conditions (Emission Factors)

Point Source code	Pollutants	Basis for Emission Rates
STK1 – STK2	PM, NO_X	Minimum Emission Standards for Subcategory 1.4 – Gas Combustion Installations (as per Section 21 NEM:AQA)
	SO_2, CO, TVOCs	Australian Department of the Environment National Pollutant Inventory emission estimation manual for Fossil Fuel Electric Power Generation (NPI, 2012). Assumed higher heating value of natural gas 38 MJ/Nm³. Natural gas combustion rate 5 570 m³ provided by PRBG3. The default sulfur content of natural gas (4600 g/IE+06 Nm³) stated for the emission factor was used, since the source of natural gas is yet known.

3.4.3 Start-Up, Shut Down and Emergency Events

In terms of Section 21 of the NEM:AQA (Government Gazette No. 37054), 'normal operating condition' is defined as any condition that constitutes operation as designed; where, 'upset conditions' are defined as any temporary failure of air pollution control equipment or process equipment or failure of process to operate in a normal or usual manner that leads to an emission standard being exceeded. If normal start-up, maintenance, upset, and shut-down conditions exceed a continuous period of 48 hours, Section 30 of the National Environmental Management, 1998 (Act no. 107 of 1998), shall apply unless otherwise specified by the Licensing Authority. The MES (as per Section 21 of NEM:AQA) (unless otherwise specified) are expressed on a daily average basis, under normal (reference) conditions of 273 K, 101.3kPa, specific oxygen percentage and dry gas.

The project turbine units are assumed to reach full combined cycle generating capacity – and compliance with the NO_X emission limit (50 mg/Nm³) – in less than 30 minutes[1]. Shut-down periods were assumed to be of similar duration (30 minutes) but are likely to be shorter. During these start-up and shut-down periods emissions may be higher than during normal operating conditions, however, the variance from normal operating conditions is dependent on type of start-up (hot, warm, or cold) and the pollutant of concern. For gas-fired power plants, emissions at lower generating loads (for example 50% load) are generally 1.5 to 15 times higher than those at full capacity (Gonzalez-Salazar, Kirsten, & Prchlik, 2018). Shut-down emissions can vary between 1.1 and 9.3 times higher than normal operating conditions (Obaid, Ramadan, Elkamel, & Anderson, 2017). Using the median of literature values (8.25-times normal NO_X emissions) a maximum emission concentration of 412.5 mg/Nm³ during turbine start-up was calculated for the project (Table 3-9). Potential start-up, shut-down, maintenance, and upset conditions related to the operations at the Project are qualitatively discussed in Table 3-9.

Table 3-9: Emission during start-up, shut-down, maintenance, and/or upset

Unit Process	ID	Description of Occurrence of Potential Releases	Pollutants and associated emissions		
			Pollutant	mg/Nm³	Duration
Gas turbines	STK1 – STK2	Start-up	NO_X	412.5	30 minutes
			PM, SO_2, CO, TVOCs	Likely similar to normal operational emissions	
		Shut-down	NO_X	412.5	30 minutes
			PM, SO_2, CO, TVOCs	Likely similar to normal operational emissions	
		Maintenance	No emission generated during maintenance		
		Upset/emergency	Plant shut-down during emergencies. No emissions after normal shut-down.		30 minutes

No emergency events were included in the emissions estimations or simulations. It was assumed that operation beyond normal capacities and emissions would result in generator unit shutdown until normal operations can be restored. The facility will shut down immediately should reserve fuel be insufficient or any unforeseen circumstance indicate that normal operation is not feasible. A Major Hazard Installation assessment will be prepared for the project, with specifics relating to the potential emergency events for the project and how they would be avoided. Regular maintenance, control and emergency prevention for the facility will thus be incorporated in the operational health and safety programme implemented during operation.

[1] Based on similar generating capacity combined cycle turbine design specification sheets (https://www.ge.com/gas-power/products/gas-turbines/9ha)

3.4.4 Fuel migration from natural gas to hydrogen gas

The combustion of hydrogen (H_2) in an atmosphere of pure oxygen will form water vapour as the reaction product. However, in most applications the combustion of H_2 is in the presence of air (not pure oxygen) and, therefore, the mixture is more accurately described as $H_2 + O_2 + N_2$ (hydrogen, oxygen, and nitrogen). This mixture burns with a very hot flame and the temperatures generated in that flame can be sufficiently high to split apart normally stable nitrogen molecules which can potentially lead to the formation of NO (nitrogen oxide) as a minor waste by-product (Lewis, 2021). Some regulated air pollutants that are emitted during fossil fuel combustion, such as SO_2 and CO, might show significant reductions in emissions and the resultant ambient concentrations with decreased fossil fuel use (AQEG, 2020) - in this case, natural gas. Nitrogen oxide (NO) is a critical air pollution emission which reacts rapidly in the atmosphere to form nitrogen dioxide (NO_2). NO_2 is a globally regulated air pollutant that is harmful to health, and which in turn contributes to the formation of photochemical ozone pollution and fine particulate matter ($PM_{2.5}$). The formation of thermal NO during combustion is related to combustion temperature: the hotter the flame, the more NO is produced (Lewis, 2021). The formation of NO typically occurs in all fuel–air mixed flames hotter than around 1300°C; below around 750°C virtually no oxides of nitrogen (NO_X) are formed (Lewis, 2021). The temperature of combustion can be managed through a number of mechanisms, most notably through changing the mixture of fuel to air (the equivalence ratio), by cooling the flame through the addition of other gases, or the design of the burner, for example premixing fuel and air (Lewis, 2021).

Because hydrogen combustion generates NOx in the same way as traditional fossil fuels (like natural gas), technical mitigation of NOx emissions can be achieved through methods used in traditional fossil fuel combustion appliances. Lean burn conditions, when the quantity of fuel is restricted relative to the quantity of air, combustion temperatures are reduced along with NO emissions (Lewis, 2021). Effective technologies exist for the after-treatment of exhaust gases to reduce NOx emissions after combustion has taken place. These include the selective catalytic reduction (SCR) and lean NOx traps (LNT) typically applied in combination with the previously described strategies associated with fuel mix and exhaust gas recirculation (Lewis, 2021). However, they can result in reduced performance and increased capital and operating costs. They also create a dilemma over whether to prioritise optimal energy efficiency or air quality emissions (Lewis, 2021).

Simplistically, hydrogen-fuelled appliances would perform no worse for NOx emissions than a contemporary fossil fuel alternative (AQEG, 2020; Lewis, 2021).

It is the intention of PRBGP3 to procure H_2-ready turbines that would allow for the use of a mixture of natural gas and hydrogen (in a proportion scaling up from 30% H_2), when an H_2 source is readily available. Any existing abatement technologies planned during design phase will likely be appropriate for the combustion of natural gas or hydrogen, or the mixture. If combustion zone temperatures can be controlled to below 750°C, NO_X emissions are likely to be minimal from the combustion of pure hydrogen (i.e, this would not apply to a natural gas – hydrogen mixture).

For this study, emission estimations were based on minimum emission standards for gas combustion installations, which are considered to be appropriate, and possibly conservative, for the combustion of natural gas, hydrogen, or the mixture.

4 Applicable Legislation

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

Emission standards are generally provided for point sources 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 and guideline values indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Air quality guidelines and standards are normally given for specific averaging or exposure periods.

The Atmospheric Pollution Prevention Act (APPA) of 1965 was repealed and the new National Environmental Management: Air Quality Act (NEM:AQA) of 2005 was brought into full force on the 1st of April 2010. Previously under APPA, the focus was mainly on sourced based control with permits issued for *Scheduled Processes*. Scheduled processes, referred to in this Act, were processes which emit more than a defined quantity of pollutants per year, including combustion sources, smelting and inherently dusty industries. Although emission limits and ambient concentration guidelines were published, no provision was made under the APPA for ambient air quality standards or emission standards. NEM:AQA shifted the approach of air quality management from source-based control to the control of the receiving environment. The new Act has also placed the responsibility of air quality management on the shoulders of local authorities that will be tasked with baseline characterisation, management and operation of ambient monitoring networks, licensing of listed activities, and emissions reduction strategies.

The National Framework for achieving the NEM:AQA was published in the Government Gazette on the 11th of September 2007. The National Framework is a medium- to long term plan on how to implement the NEM:AQA to ensure the objectives of the act are met. The National Framework states that aside from the various spheres of government responsibility towards good air quality, industry too has a responsibility not to impinge on everyone's right to air that is not harmful to health and well-being. Industries therefore should take reasonable measures to prevent such pollution degradation from occurring, continuing or recurring. In terms of NEM:AQA, certain industries have further responsibilities, including:

- Comply with any relevant national standards for emissions from point, non-point or mobile sources in respect of substances or mixtures of substances identified by the Minister, MEC or municipality.
- Comply with the measurement requirements of identified emissions from point, non-point or mobile sources and the form in which such measurements must be reported and the organs of state to whom such measurements must be reported.
- Comply with relevant emission standards in respect of controlled emitters if an activity undertaken by the industry and/or an appliance used by the industry is identified as a controlled emitter.
- Comply with any usage, manufacture or sale and/or emissions standards or prohibitions in respect of controlled fuels if such fuels are manufactured, sold or used by the industry.
- Comply with the Minister's requirement for the implementation of a pollution prevention plan in respect of a substance declared as a priority air pollutant.
- Comply with an Air Quality Officer's (AQOs) legal request to submit an AIR in a prescribed form (if required).
- Take reasonable steps to prevent the emission of any offensive odour caused by any activity on their premises.
- Furthermore, industries identified as Listed Activities have further responsibilities, including:
    - Making application for an AEL and complying with its provisions.

- Compliance with any minimum emission standards in respect of a substance or mixture of substances identified as resulting from a listed activity.
- Designate an Emission Control Officer if required to do so.

4.1 National Minimum Emission Limits (MES)

The Minister, in terms of *Section 21* of the NEM:AQA, published a list of activities which result in atmospheric emissions and which are believed to have significant detrimental effects on the environment, human health and social welfare. The *Listed Activities and Minimum National Emission Standards* were first published on the 31st of March 2010 (Government Gazette No. 33064), with a revision of the schedule on the 22nd of November 2013 (Government Gazette No. 37054) and an amendment of certain sections and annexure A on the 31st of October 2018 (Government Gazette No. 42013). The project processes fall under Category 1: Combustion Installations and Category 2: Petroleum Industry. Based on the nature of the operations and wording in the latest *Listed Activities and Minimum National Emission Standards,* the proposed project at the site should trigger Subcategories 1.4 of the listed activities (Table 4-1):

- **Gas Combustion Installations**– Gas combustion used primarily for steam raising or electricity generation (more than 50 mega Watt (MW) heat input per unit). MES subcategory 1.4 are applicable (Table 4-1) during normal operating conditions using natural gas.

Table 4-1: MES for gas combustion installations

Subcategory 1.4: Gas Combustion Installations		
Description	Gas combustion (including gas turbines burning natural gas) used primarily for steam raising or electricity generation.	
Application	All installations with design capacity equal to or greater than 50 MW heat input per unit based on the lower calorific value of the fuel used.	
Substance or mixture of substances		**mg/Nm³ under normal conditions of 3% O_2, 273 K and 101.3 kPa**
Common Name	**Chemical Symbol**	**New plant**
Particulate matter (PM)	Not applicable	10
Sulfur dioxide	SO_2	400
Oxides of nitrogen	NO_x expressed as NO_2	50

Notes:

(a) The following special arrangement shall apply:

i. Reference conditions for gas turbines shall be 15% O_2, 273 K and 101.3 kPa; and

ii. Where co-feeding with waste materials with calorific value allowed in terms of the Waste Disposal Standards published in terms of the Waste Act, 2008 (Act No.59 of 2008) occurs, additional requirements under subcategory 1.6 shall apply.

4.2 Atmospheric Emission Licence (AEL) Applications

The application for an AEL must include all sources of emission, not only those considered listed activities. In terms of the AEL application, the **applicant** should take into account the following sections of NEM:AQA:

37. Application for atmospheric emission licences:

(1) A person must apply for an AEL by lodging with the licencing authority of the area in which the listed activity is to be carried out, an application in the form required.

(2) An application for an AEL must be accompanied by –

(a) The prescribed processing fee; and

(b) Such documentation and information as may be required by the licencing authority.

38. Procedure for licence applications:

(1) The licencing authority –

(a) May, to the extent that is reasonable to do so, require the applicant, at the applicant's expense, to obtain and provide it by a given date with other information contained in or submitted in connection with the application;

(b) May conduct its own investigation on the likely effect of the proposed licence on air quality;

(c) May invite written comments from any organ of state which has an interest in the matter; and

(d) Must afford the applicant an opportunity to make representations on any adverse statements or objections to the application.

(2) Section 24 of the NEMA and section 22 of the Environmental Conservation Act apply to all applications for atmospheric emission licences, and both an applicant and the licencing authority must comply with those sections and any applicable notice issued or regulations made in relation to those sections.

(3) –

(a) An applicant must take appropriate steps to bring the application to the attention of relevant organs of state, interested persons and the public.

(b) Such steps must include the publication of a notice in at least two newspapers circulating the area in which the listed activity is applied for is or is to be carried out and must-

(i) Describe the nature and purpose of the licence applied for;

(ii) Give particulars of the listed activity, including the place where it is to be carried out;

(iii) State a reasonable period within which written representations on or objections to the application may be submitted and the address or place where it must be submitted; and

(iv) Contain such other particulars as the licencing authority may require.

46. Variation of provisional atmospheric emission licences and atmospheric emission licences

(1) A licensing authority may, by written notice to the holder of a provisional atmospheric emission licence or an atmospheric emission licence, vary the licence –

(a) if it is necessary or desirable to prevent deterioration of ambient air quality;

(b) if it is necessary or desirable for the purposes of achieving ambient air quality standards;

(c) if it is necessary or desirable to accommodate demands brought about by impacts on socioeconomic circumstances and it is in the public interest to meet those demands;

(d) at the written request of the holder of the licence;

(e) if it is transferred to another person in terms of section 44; or

(f) if it is reviewed in terms of section 45.

(2) The variation of a licence includes –

(a) the attaching of an additional condition or requirement to the licence;

(b) the substitution of a condition or requirement;

(c) the removal of a condition or requirement; or

(d) the amendment of a condition or requirement.

(3) If a licensing authority receives a request from the holder of a licence in terms of subsection (1)(d), the licensing authority must require the holder of the licence to take appropriate steps to bring the request to the attention of relevant organs of state, interested persons and the public if –

(a) the variation of the licence will authorise an increase in the environmental impact regulated by the licence;

(b) the variation of the licence will authorise an increase in atmospheric emissions; and

(c) the proposed variation has not, for any reason, been the subject of an authorisation in terms of any other legislation and public consultation.

(4) Steps in terms of subsection (3) must include the publication of a notice in at least two newspapers circulating in the area in which the listed activity authorised by the licence is, or will be, carried out –

(a) describing the nature and purpose of the request;

(b) giving particulars of the listed activity, including the place where it is or will be carried out;

(c) stating a reasonable period within which written representations on or objections to the request may be submitted, and the address or place where representations or objections must be submitted; and

(d) containing such other particulars as the licensing authority may require.

(5) Sections 38 and 40, read with the necessary changes as the context may require, apply to the variation of a licence.

4.3 Atmospheric Impact Report (AIR) Regulations

According to NEM:AQA in terms of *Section 30*, an AQO may require the submission of an AIR if:

- The AQO reasonably suspects that a person has contravened or failed to comply with the AQA or any conditions of an AEL and that detrimental effects on the environment occurred or there was a contribution to the degradation in ambient air quality.
- A review of a provisional AEL or an AEL is undertaken in terms of *Section 45* of NEM:AQA.

An AIR is often requested by the AQO if the applicant requests a new AEL. The format of the AIR is stipulated in the Regulations Prescribing the Format of the Atmospheric Impact Report, Government Gazette No. 36904, Notice Number 747 of 2013 (11 October 2013), it's amendment stipulated in Government Gazette No. 38633, No. R284 (2 April 2015). An AIR can be compiled prior to AEL application when plant design is finalised.

4.4 National Atmospheric Emissions Reporting Regulations

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

Emission sources and data providers are classified according to groups. The project would be classified under Group A ("Listed activity published in terms of section 21(1) of the Act"). Emission reports from this group must be made in the format required for NAEIS and if applicable should be in accordance with the AEL or provisional AEL.

As per the regulations, PRBGP3 and/or their data provider should register on the NAEIS system. Data providers must inform the relevant authority of changes if there are any:

- Change in registration details;
- Transfer of ownership; or
- Activities being discontinued.

A data provider must submit the required information for the preceding calendar year to the NAEIS by 31 March of each year. Records of data submitted must be kept for a period of 5 years and must be made available for inspection by the relevant authority.

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

4.5 Atmospheric Dispersion Modelling Regulations

Air dispersion modelling provides a cost-effective means for assessing the impact of air emission sources, the major focus of which is to determine compliance with the relevant ambient air quality standards. Dispersion modelling provides a versatile means of assessing various emission options for the management of emissions from existing or proposed installations. Regulations regarding Air Dispersion Modelling were promulgated in Government Gazette No. 37804 vol. 589; 11 July 2014, (Government Gazette, 2014) and recommend a suite of dispersion models to be applied for regulatory practices as well as guidance on modelling input requirements, protocols and procedures to be followed. The Regulations regarding Air Dispersion Modelling are applicable –

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

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

- Level 1: where worst-case air quality impacts are assessed using simpler screening models
- Level 2: for assessment of air quality impacts as part of license application or amendment processes, where impacts are the greatest within a few kilometres downwind (less than 50 km)
- Level 3: require more sophisticated dispersion models (and corresponding input data, resources and model operator expertise) in situation:
  - where a detailed understanding of air quality impacts, in time and space, is required;
  - where it is important to account for causality effects, calms, non-linear plume trajectories, spatial variations in turbulent mixing, multiple source types & chemical transformations;
  - when conducting permitting and/or environmental assessment process for large industrial developments that have considerable social, economic and environmental consequences;
  - when evaluating air quality management approaches involving multi-source, multi-sector contributions from permitted and non-permitted sources in an air-shed; or,
  - when assessing contaminants resulting from non-linear processes (e.g. deposition, ground-level O_3, particulate formation, visibility).

The first step in the dispersion modelling exercise requires a clear objective of the modelling exercise and thereby gives clear direction to the choice of the dispersion model most suited for the purpose. Accordingly, Level 3 was deemed appropriate for this study.

4.6 National Ambient Air Quality Standards (NAAQS)

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. South African NAAQS for SO_2, NO_2, PM_{10}, carbon monoxide (CO), ozone (O_3), benzene (C_6H_6), and lead (Pb) were published on 13 March 2009. Standards for $PM_{2.5}$ were published on 24 June 2012. NAAQS for atmospheric pollutants associated with the project, that is CO, NO_2, PM_{10}, $PM_{2.5}$ and SO_2, are listed in Table 4-2.

Table 4-2: NAAQS for criteria pollutants considered in the study

Pollutant	Averaging Period	Limit Value (µg/m³)	Limit Value (ppb)	Frequency of Exceedance	Compliance Date
CO	1 hour	30 000	26 000	88	Currently enforceable
	8 hour	10 000	8 700	11	Currently enforceable
NO_2	1 hour	200	106	88	Currently enforceable
	1 year	40	21	-	Currently enforceable
PM_{10}	24 hour	75	-	4	Currently enforceable
	1 year	40	-	-	Currently enforceable
$PM_{2.5}$	24 hour	40	-	4	Currently enforceable
	24 hour	25	-	4	1 Jan 2030
	1 year	20	-	-	Currently enforceable
	1 year	15	-	-	1 Jan 2030
SO_2	10 minutes	500	191	526	Currently enforceable
	1 hour	350	134	88	Currently enforceable
	24 hour	125	48	4	Currently enforceable
	1 year	50	19	-	Currently enforceable

4.7 National Dust Control Regulations (NDCR)

The National Dust Control Regulations (NDCR) was published on 1 November 2013. The draft NDCR, published in 2018, has not been finalised and is not discussed. The purpose of the regulations is to prescribe general measures for the control of dust in all areas including residential and non-residential areas. The standard for acceptable dustfall rates is set out in Table 4-3 for residential and non-residential areas. According to these regulations the dustfall rates at the boundary or beyond the boundary of the premises where it originates cannot exceed 600 mg/m²/day in residential and light commercial areas; or 1 200 mg/m²/day in areas other than residential and light commercial areas. In addition to the dustfall limits, the NDCR prescribe monitoring procedures and reporting requirements. This will be based on the measuring reference method ASTM D1739. Dustfall is assessed for nuisance impact and not inhalation health impact.

Table 4-3: Acceptable dust fall rates

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

4.8 International Health Criteria for Volatile Organic Compounds (VOC)

VOCs is the name given to a class of several hundred carbon-based chemical compounds that evaporate easily into the air. VOC sources include fuel additives, fuel evaporation, and incomplete combustion. Some VOCs have little or no known direct human health effects, while others are extremely toxic and/or carcinogenic. Very little is known about how various VOCs combine in the atmosphere or in the human body, or what the cumulative impacts of exposure might be.

As the term VOC refers to a group of pollutants, generally guidelines are not available for comparison to determine the health impacts due to exposure to these pollutants. To estimate the probable health impacts a breakdown of the types of pollutants, which dominate in a specific area is required, whereby their respective toxicities can be determined.

Although standards for exposure to VOCs in non-industrial settings do not exist, a number of exposure limits have been recommended. The European Concerted Action Report No. 11, entitled *Guidelines for Ventilation Requirements in Buildings* (European Concerted Action, 1992), lists the following Total VOC (TVOC) concentration ranges as measured with a flame ionisation detector calibrated to toluene. These recommendations are based on Mølhave's toxicological work on mucous membrane irritation (Mølhave, 1990).

Comfort range:	<200 µg/m³
Multifactoral exposure range:	200 to 3 000 µg/m³
Discomfort range:	3 000 to 25 000 µg/m³
Toxic range:	>25 000 µg/m³

The same European report also lists a second method based on Seifert's work (Seifert, 1990). This method established TVOC guidelines based on the ten most prevalent compounds in each of seven chemical classes. The concentrations in each of these classes should be below the maximums listed below.

Alkanes:	100 µg/m³
Aromatic hydrocarbons:	50 µg/m³
Terpenes:	30 µg/m³
Halocarbons:	30 µg/m³
Esters:	20 µg/m³
Aldehydes and ketones (excluding formaldehyde):	20 µg/m³
Other:	50 µg/m³

The VOC concentration is calculated by adding the totals from each class. Seifert gives a target TVOC concentration of 300 µg/m³, which is the sum of the above-listed target concentrations. The author also states that no individual compound concentration should exceed 50% of the guideline for its class or 10% of the TVOC guideline concentration. However, Seifert states that "…the proposed target value is not based on toxicological considerations but – to the author's best judgment."

The 1-year (annual average) inhalation criteria selected for this study is 200 µg/m³ (European Collaborative Action annual average concentration for comfort). It should be noted that this screening criteria is only a guideline and not a legal requirement.

4.9 Impacts on Flora and Fauna

4.9.1 Critical Levels for Vegetation

The impact of emissions associated with the project on the surrounding vegetation was assessed by comparing the simulated annual SO_2 and NO_2 concentrations for each of the emission scenarios against the critical levels for vegetation as defined by the United Nations Economic Commission for Europe (UNECE) Convention on Long Range Trans-boundary Air Pollution limits (CLRTAP, 2015) (Table 4-4).

Table 4-4: Critical levels for SO_2 and NO_2 by vegetation type (CLRTAP, 2015)

Pollutant	Vegetation type	Critical Level (µg/m³)	Time Period(a)
SO_2	Cyanobacterial lichens	10	Annual average
	Forest ecosystems (including understorey vegetation)	20	Annual average and Half-year mean (winter)
	(Semi-)natural vegetation	20	Annual average and Half-year mean (winter)
	Agricultural crops	30	Annual average and Half-year mean (winter)
NO_2	All	30	Annual average and Half-year mean (winter)
		75	Daily average

Notes:
(a) For the purposes of mapping of critical levels and exceedances CLRTAP recommend using only the annual average, due to increased reliability of mapped and simulated data for the longer period. It is also noted that long-term effects of NO_2 are more significant than short-term effects (CLRTAP, 2015).

4.9.2 Effects of SO_2 and NO_2 on Animals

In addition to potential exposure to outdoor environmental air pollution, animals kept in large-scale husbandry facilities are exposed to, and often diseased by, self-made indoor air pollution that is a function of the conditions under which the animals are reared (Van den Hoven, 2011).

Experimental studies on animals have shown the acute inhalation of SO_2 produces bronchoconstriction, increases respiratory flow resistance, increases mucus production and has been shown to reduce abilities to resist bacterial infection in mice (Costa & Amdur, 1996). Short exposures to low concentrations of SO_2 (~2.6 mg/m³) have been shown to have immediate physiological response without resulting in significant or permanent damage. Short exposures (<30 min) to concentrations of 26 mg/m³ produced significant respiratory changes in cats which were usually completely reversible once exposure had ceased (Corn *et al.*, 1972).

Sulfur dioxide can produce mild bronchial constriction, changes in metabolism and irritation of the respiratory tract and eyes in cattle (Blood and Radostits, 1989 as cited in Coppock and Nostrum, 1997). An increase in airway resistance was reported in sensitized sheep after four hours of exposure to 13 mg/m³. Studies report chronic exposure can affect mucus secretions and result in respiratory damage similar to chronic bronchitis. These effects were reported at concentrations above typical ambient concentrations (26-1 053 mg/m³) (Dalhamn, 1956 as cited in Amdur, 1978). Exposure to air pollutants is expected to result in similar adverse effects in wildlife as in laboratory and domestic animals (Newman, 1979).

The toxicity of NO_2 is related to oxidation processes that form nitric acid with water in the eyes, lungs, mucous membranes and on the skin of animals (MFE, 2004) and result in oxidation of cell membrane lipids and proteins triggering inflammation

(Menzel, 1994). Long term exposure to nitrogen oxides increases respiratory infections resulting in lowered resistance to diseases such as pneumonia and influenza (MFE, 2004). An acute association between ambient NO_2 concentrations and dairy cattle mortality was found in Belgium during cold and warm season exposure to NO_2, however, these acute associations did not influence cumulative exposure over a 26-day experimental period (Cox, et al., 2016). The daily average NO_2 concentrations to which for the dairy cattle studied by Cox *et al.* (2016) were exposed ranged between 7.8 and 60 $\mu g/m^3$ in the warm season and between 21 and 93 $\mu g/m^3$ in the cold season.

4.9.3 Effects of Particulate Matter on Animals

As presented by the Canadian Environmental Protection Agency (CEPA/FPAC Working Group, 1999) experimental studies using animals have not provided convincing evidence of particle toxicity at ambient levels. Acute exposures (4 – 6-hour single exposures) of laboratory animals to a variety of types of particles, almost always at concentrations well above those occurring in the environment have been shown to cause decreases in lung function, changes in airway defence mechanisms and increased mortality rates.

The epidemiological finding of an association between 24-hour ambient particle levels below 100 $\mu g/m^3$ and mortality has not been substantiated by animal studies as far as PM_{10} and $PM_{2.5}$ are concerned. With the exception of ultrafine particles (0.1 µm), none of the other particle types and sizes used in animal inhalation studies cause such dramatic acute effects, including high mortality at ambient concentrations. The lowest concentration of $PM_{2.5}$ reported that caused acute death in rats with acute pulmonary inflammation or chronic bronchitis was 250 g/m^3 (3 days, 6 hours/day), using continuous exposure to concentrated ambient particles.

5 AIR QUALITY BASELINE

5.1 Site Description

The City of uMhlathuze falls within the King Cetshwayo District Municipality (previously known as the uThungulu District Municipality) and includes the towns of Richards Bay and Empangeni and its surrounding rural and tribal areas. The topography of the area is fairly flat comprising of hills, ridges and undulating plains. The relief ranges from sea level on the eastern side to 296 metres above mean sea level (mamsl) to the western side. The current land uses in the region include industrial and commercial processes, surface mining activities, agricultural activities (mainly sugar cane), forestry, and formal and small residential communities. The proposed location of the PRBGP3 is north of the Richards Bay Alloys facility.

The proposed project site is located less than 2 km west of the Richards Bay Central Business District (CBD) and is located within Zone 1F of the Richards Bay Industrial Development Zone (IDZ) (Figure 1-1) and is located immediately to the north of Richards Bay Alloys. The nearest large residential areas to the project site are Wild-en-Weide (1.9 km east-north-east); Richards Bay CBD (1.9 km south-east); Brackenham (2.1 km north-east); Aquadene (3.5 km north) and Arboretum (4 km east-south-east). The location of the various AQMS is shown in Figure 5-1. There are several schools, hospitals and clinics located within 5 km of the proposed project site (Figure 5-2 and Table 5-1). Industrial areas (Alton and the Richards Bay CBD) are located within 5 km of the proposed project site.

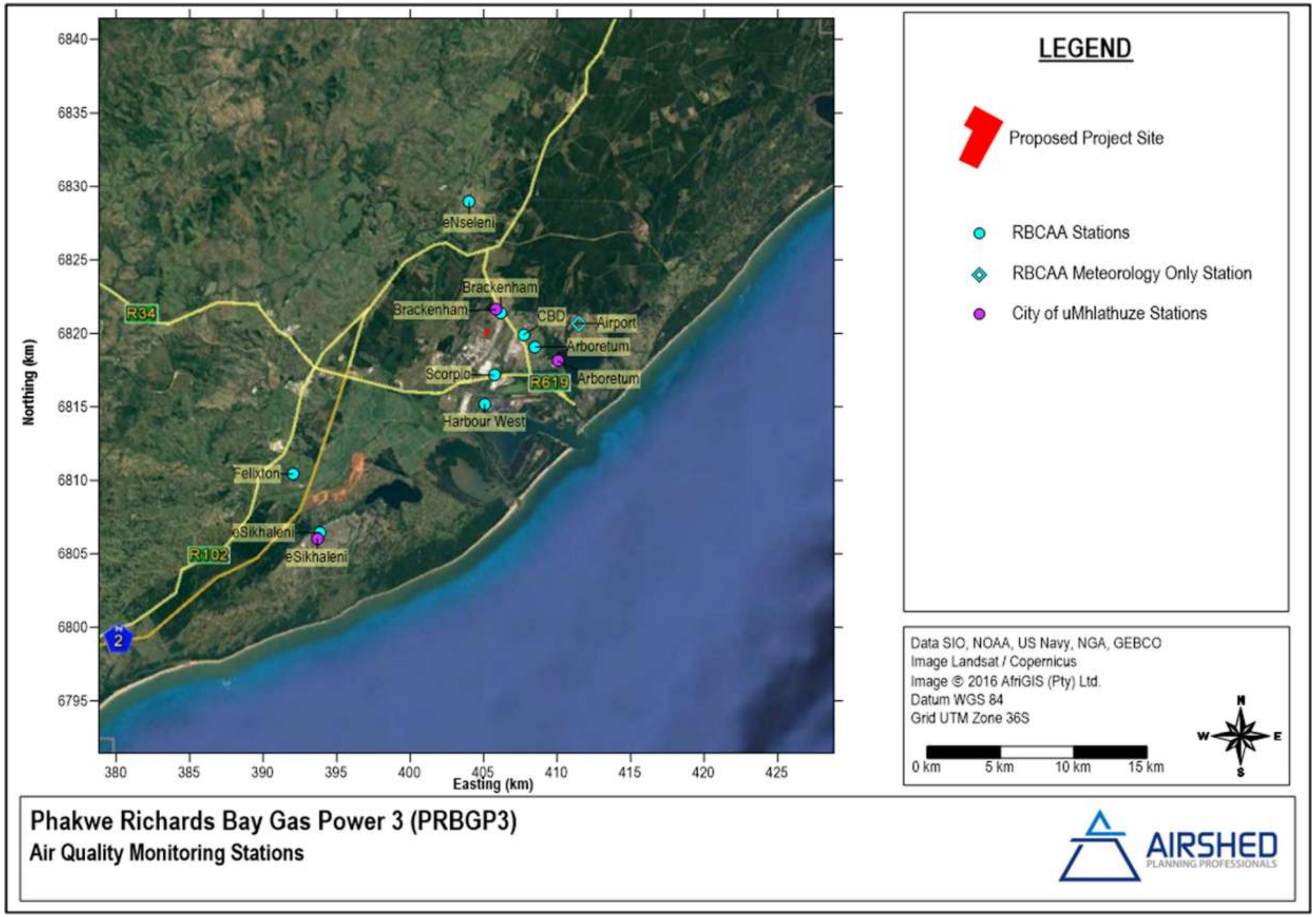

Figure 5-1: Location of the Proposed Project in relation to the AQMSs

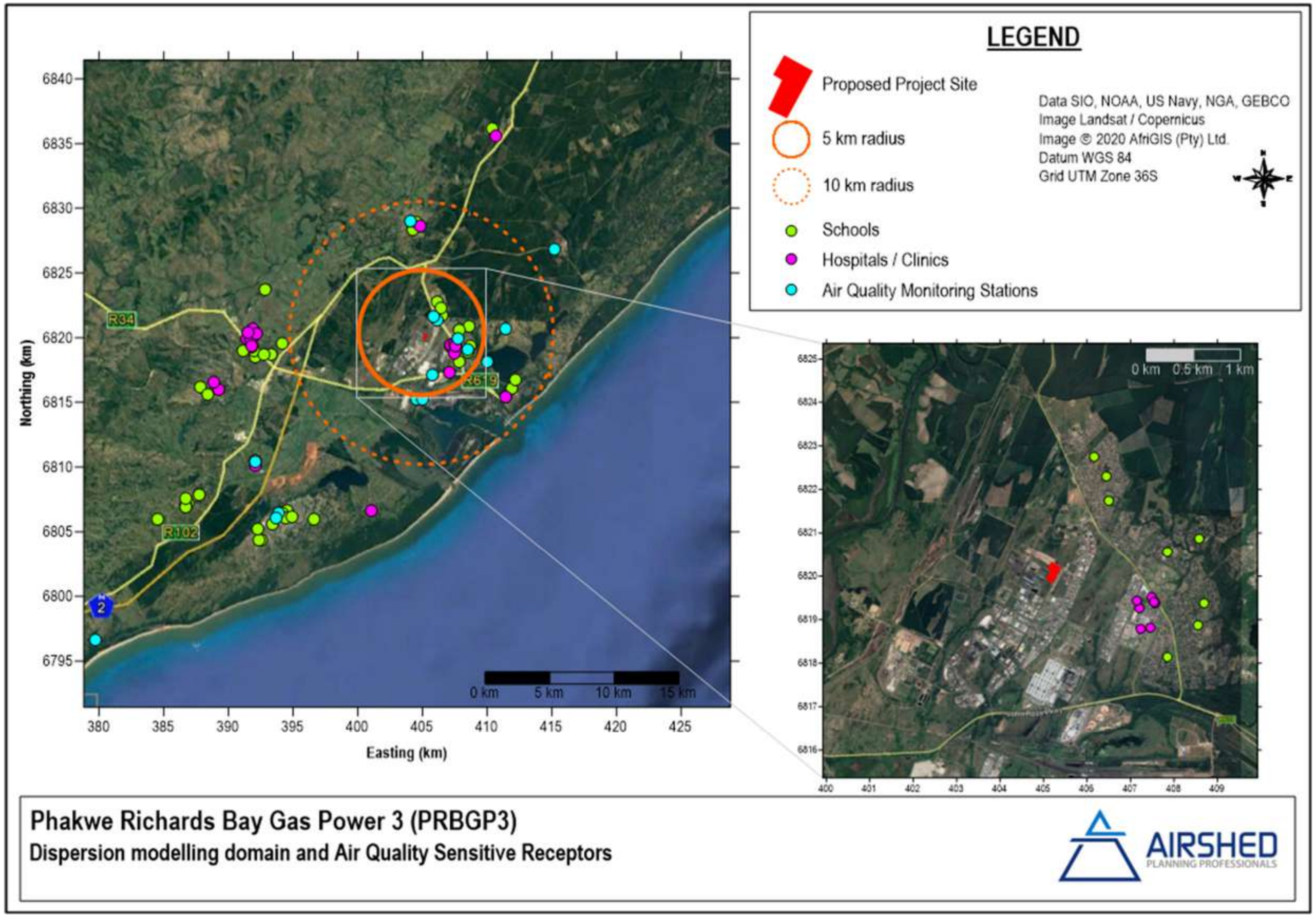

Figure 5-2: Location of the Proposed Project in relation to the AQSRs

Table 5-1: Distance to nearby air quality sensitive receptors

Air Quality Monitoring Station Name	Distance from proposed site (km)	Direction from proposed site
Brackenham (uMhlathuze)	1.5	NNE
Brackenham (RBCAA)	1.5	NE
CBD (RBCAA)	2.5	E
Scorpio (RBCAA)	3.1	S
Arboretum (RBCAA)	3.5	ESE
Bayside (RBCAA)	5.1	S
Harbour West (RBCAA)	5.0	S
Arboretum (uMhlathuze)	5.3	ESE
Airport (RBCAA)	6.3	E
eNseleni (RBCAA)	8.8	N
RBM (RBCAA)	12.0	ENE
Felixton (RBCAA)	16.4	SW
Esikhawini (RBCAA)	17.9	SW
eSikhaleni (uMhlathuze)	18.3	SW
Mtunzini (RBCAA)	34.8	SW
St Lucia (RBCAA)	55.7	NE
Receptor name / details	**Distance from proposed site (km)**	**Direction from proposed site**
Wild En Weide	1.9	ENE
Richards Bay Central	1.9	SE
Richards Bay Secondary School	2.0	NE
Better2Know Private STD Health Centre Richards Bay	2.1	ESE
Mens Clinic International - Richards Bay	2.2	ESE
Mandlazini Clinic	2.4	ESE
Brackenham Primary School	2.4	NNE
Richards Bay Medical Institute	2.4	ESE
Richards Bay Municipal Clinic	2.5	SE
The Bay Hospital	2.5	ESE
Umhlathuze Dental	2.6	ESE
Veldenvlei Primary School	2.7	E
Bay Primary School	2.7	NNE
John Ross College	3.4	SE
Richards Bay Christian School	3.4	E
Aquadene	3.5	N
Richardsbaai Hoerskool	3.6	ESE
Arboretum Primary School	3.6	ESE
Arboretum	4.0	ESE
Birdswood	5.0	E

5.2 Climate and 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.

This study accessed different sets of meteorological data: simulated meteorological data for the Richards Bay airshed, and, measured meteorological data at four locations in the Richards Bay domain. For the purposes of CALPUFF dispersion modelling, Weather Research and Forecasting model (WRF) data for the period 2017 to 2019 on a 4 km horizontal resolution for a 50 km by 50 km domain was used. Four RBCAA AQMS (Airport, Brackenham, CBD and Harbour West) were included for comparison to assess how representative the WRF data set is for the proposed project site. The meteorological data availability for the RBCAA stations is shown in Table 5-2.

5.2.1 Local Wind Field

WRF data was used to construct wind roses for the 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 below, reflect the different categories of wind speeds; the dark red area, for example, representing winds >10 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. For the comparison an extended data set was used for measured data (January 2016 to December 2019) to account for gaps in the data, while the simulated data set used for dispersion modelling was slightly shorter (January 2017 to December 2019).

The period, day-time and night-time wind roses for the WRF data is provided in Figure 5-3 to Figure 5-6. The data has a predominant south-south-westerly and north-easterly component over the period, and day-time. During night-time the wind is also predominantly from the south and south-south-west. The average period wind speed is 5.7 m/s. Night-time conditions reflect a decrease in wind speeds ranging mainly from 2-3 m/s in comparison to daily wind speeds of 3-4 m/s.

The seasonal variation in the wind field shows a slight northerly dominance in winter while north-northeasterlies are more dominant in summer and spring. Highest wind speeds are likely in spring.

Table 5-2: Parameters measured and data availability for the AQMS in Richards Bay (X indicates parameter not measured)

Owner	Monitoring Station	Easting (km)	Northing (km)	Year	Wind Speed	Wind Direction	Ambient Temperature	Relative Humidity	Pressure
RBCAA	Airport AWS	411.4467	6820.689	2016	17.3%	17.3%	49.6%	X	X
				2017	99.7%	79.0%	no data	X	X
				2018	98.9%	98.9%	98.9%	X	X
				2019	98.2%	98.2%	98.5%	X	X
RBCAA	Arboretum AQMS	408.497	6819.088	2016	75.6%	75.4%	75.6%	X	X
				2017	90.61%	90.61%	90.03%	X	X
				2018	94.24%	94.24%	94.25%	X	X
				2019	97.34%	97.34%	97.34%	X	X
				2020	96.51%	96.77%	96.77%	X	X
RBCAA	Brackenham AQMS	406.166	6821.399	2016	89.8%	89.8%	89.8%	X	X
				2017	82.7%	82.7%	84.8%	X	X
				2018	97.5%	97.5%	95.9%	X	X
				2019	96.4%	96.4%	96.4%	X	X
				2020	90.9%	90.9%	90.9%	X	X
RBCAA	CBD AQMS	407.714	6819.921	2016	87.3%	87.3%	87.3%	87.4%	X
				2017	73.8%	73.8%	87.1%	87.1%	X
				2018	78.7%	78.7%	98.0%	no data	X
				2019	98.6%	98.6%	98.6%	no data	X
				2020	86.7%	86.7%	86.7%	98.1%	X
RBCAA	Harbour West AQMS	405.05	6815.191	2016	49.8%	49.8%	88.8%	X	X
				2017	83.6%	83.6%	83.6%	X	X
				2018	99.5%	99.5%	99.5%	X	X
				2019	99.9%	78.2%	no data	X	X
				2020	49.7%	49.7%	99.9%	X	X
RBCAA	Felixton AQMS	392.06	6810.428	2016	X	X	no data	X	X
				2017	X	X	no data	X	X
				2018	X	X	99.3%	X	X
				2019	X	X	80.6%	X	X
				2020	X	X	92.2%	X	X
RBCAA	eNseleni AQMS	404.02	6828.96	2016	X	X	X	X	X
				2017	X	X	X	X	X
				2018	X	X	X	X	X
				2019	97.1%	97.1%	97.1%	X	X
				2020	91.3%	91.3%	91.3%	X	X
RBCAA		393.857	6806.453	2016	87.5%	87.5%	87.5%	X	X
				2017	82.0%	82.0%	82.0%	X	X

Owner	Monitoring Station	Easting (km)	Northing (km)	Year	Wind Speed	Wind Direction	Ambient Temperature	Relative Humidity	Pressure
	eSikhaleni AQMS			2018	95.5%	95.5%	95.5%	X	X
				2019	93.8%	93.8%	93.8%	X	X
				2020	85.3%	85.3%	85.3%	X	X
City of uMhlathuze	Arboretum AQMS	410.05	6818.14	2016	X	X	X	X	X
				2017	X	X	X	X	X
				2018	X	X	X	X	X
				2019	84.1%	no data	84.1%	84.1%	84.1%
				2020	83.8%	no data	83.8%	83.8%	83.8%
City of uMhlathuze	Brackenham AQMS	405.85	6821.62	2016	X	X	X	X	X
				2017	X	X	X	X	X
				2018	X	X	X	X	X
				2019	70.2%	70.2%	66.5%	70.2%	66.5%
				2020	97.8%	97.8%	97.8%	97.8%	97.8%
City of uMhlathuze	eSikhaleni AQMS	393.67	6806.05	2016	X	X	X	X	X
				2017	X	X	X	X	X
				2018	X	X	X	X	X
				2019	83.6%	83.6%	83.6%	83.6%	83.9%
				2020	94.0%	94.0%	94.0%	94.0%	94.0%

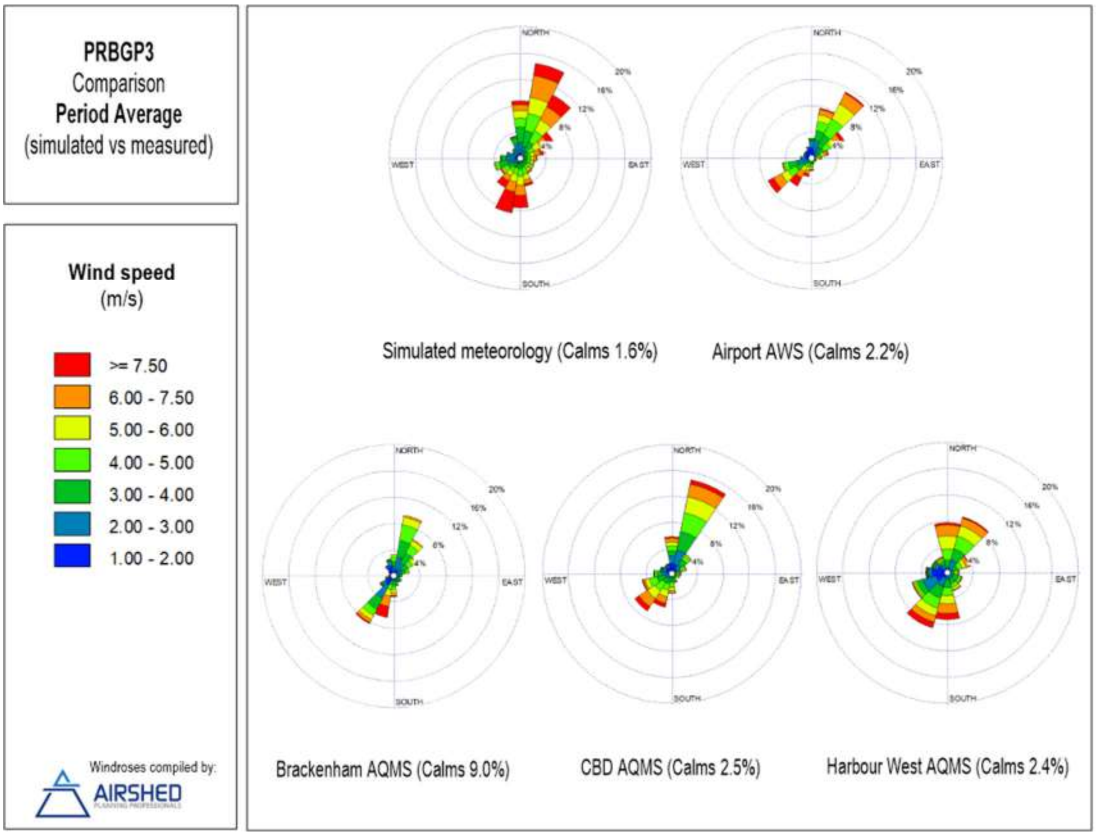

Figure 5-3: Period wind roses for the period January 2016 to December 2019

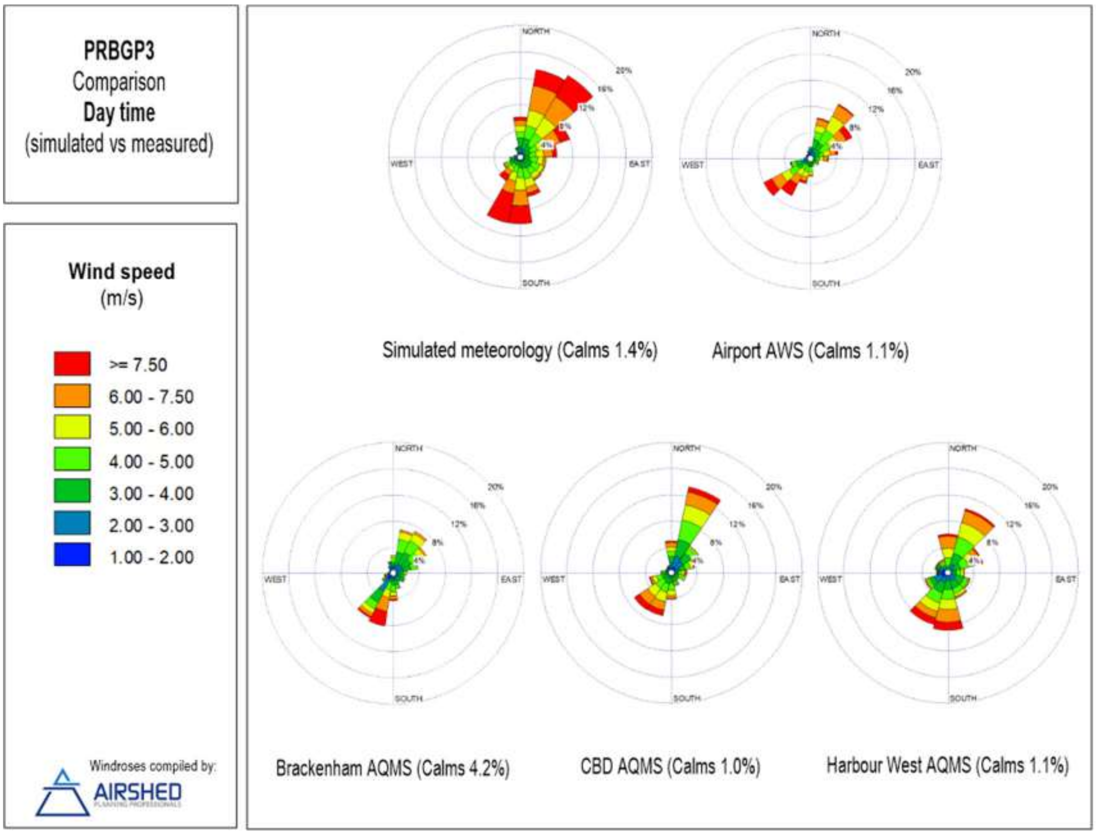

Figure 5-4: Day-time wind roses for the period January 2016 to December 2019

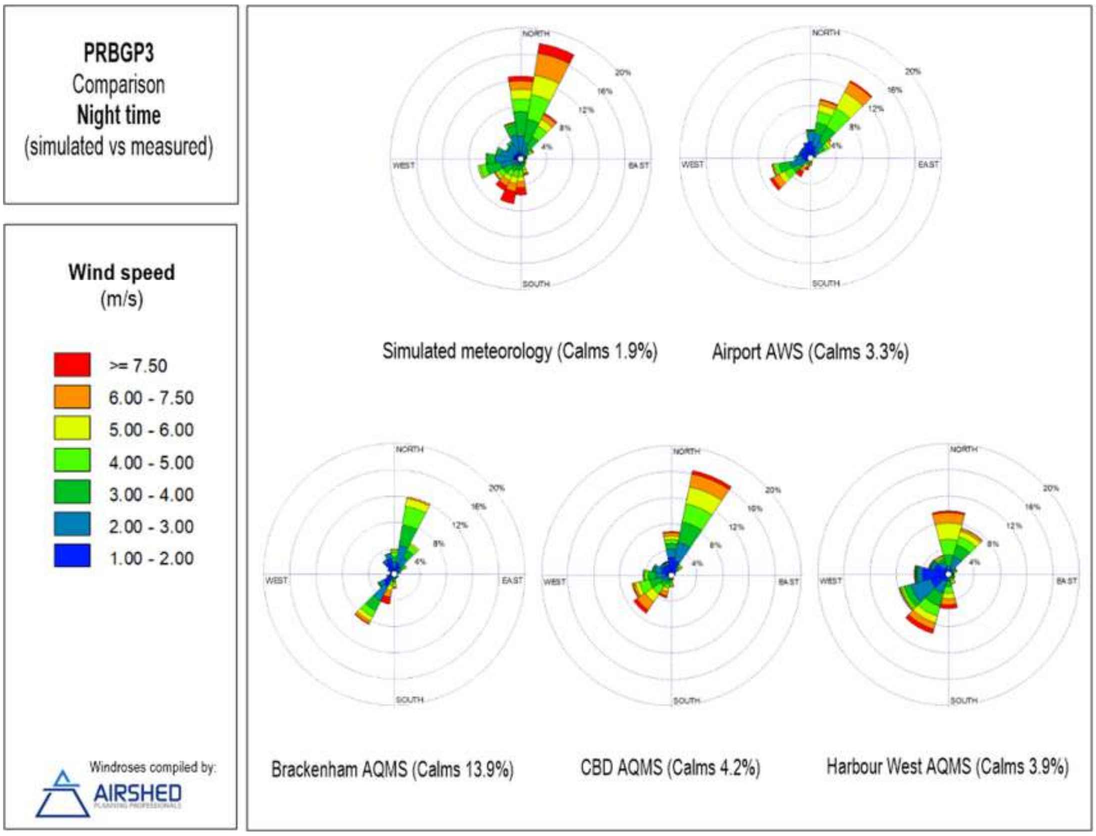

Figure 5-5: Night-time wind roses for the period January 2016 to December 2019

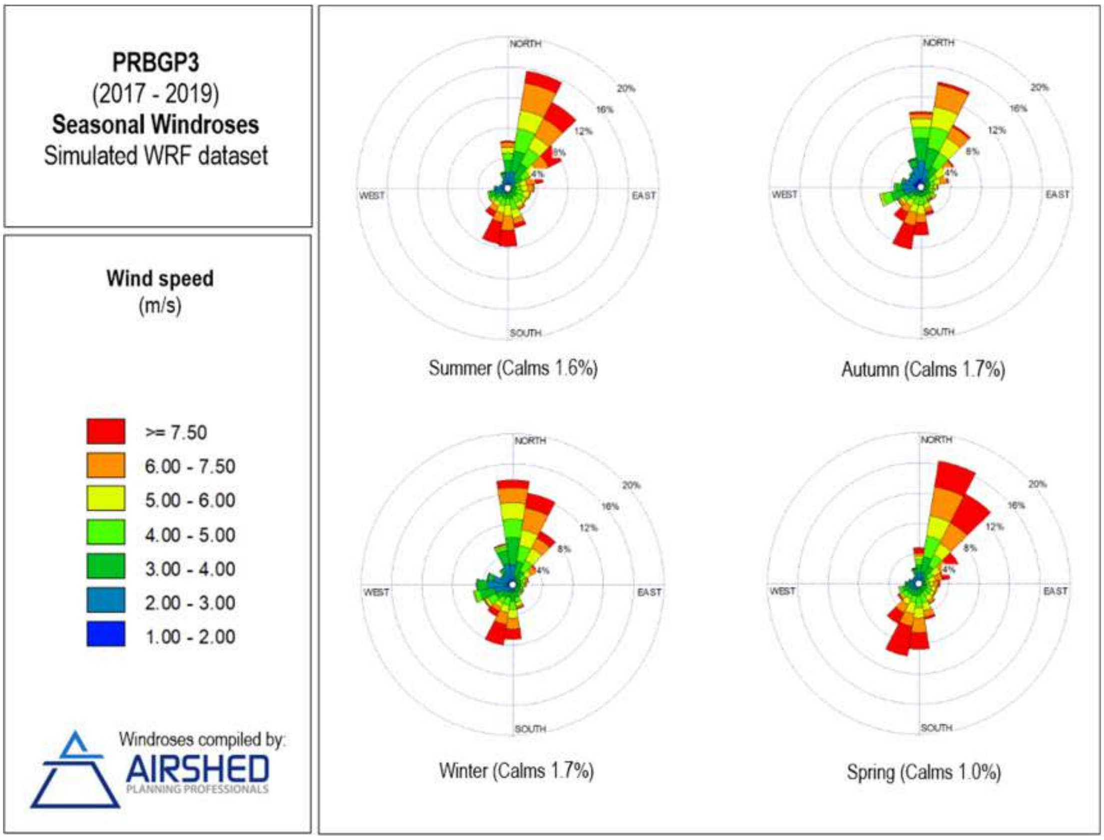

Figure 5-6: Seasonal wind roses for the period January 2017 to December 2019

5.2.2 *Precipitation*

Precipitation reduces erosion potential by increasing the moisture content of materials. This represents an effective mechanism for removal of atmospheric pollutants and is therefore considered during air pollution studies.

This WRF data rainfall pattern is observable in Figure 5-7. Rainfall peaks being between October and March, with approximately 1 070 mm of rainfall in a year. The lowest rainfall months are generally June and July.

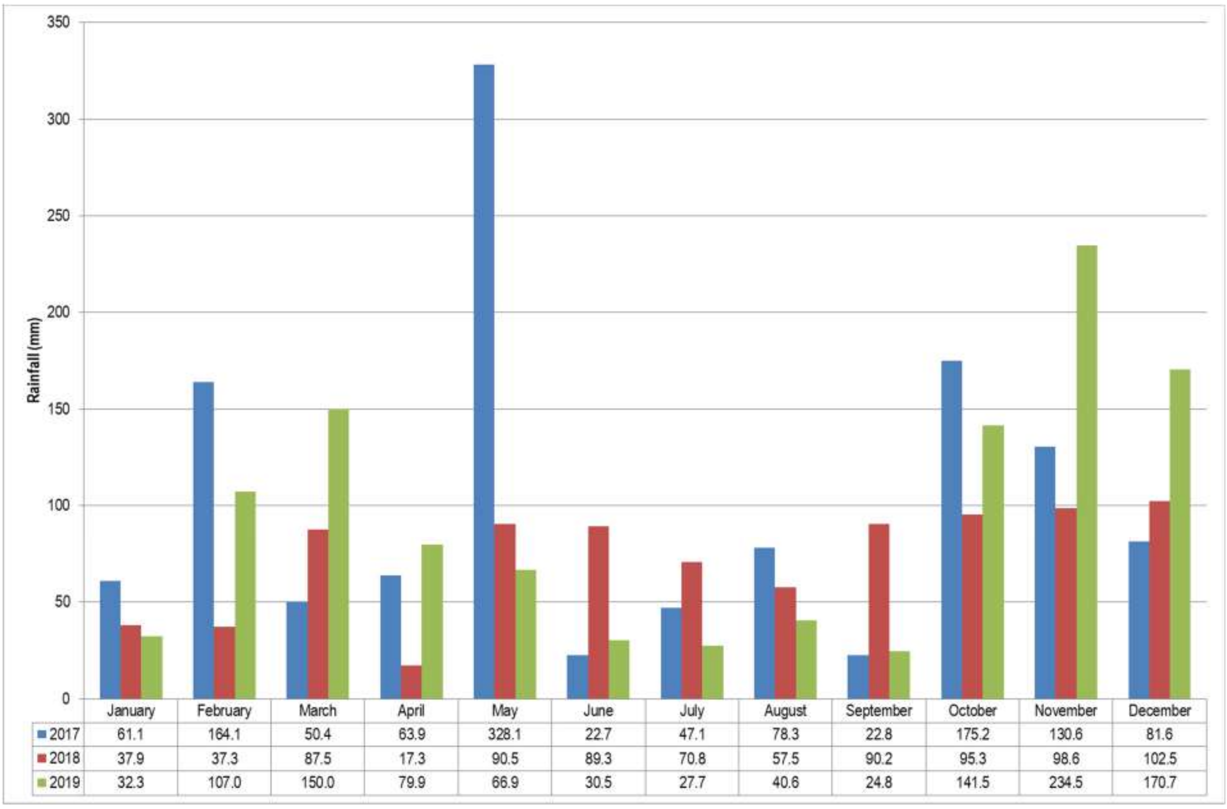

Figure 5-7: Monthly rainfall based on WRF data for the period January 2017 to December 2019

5.2.3 *Temperature*

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

Monthly mean, maximum and minimum temperatures from the WRF data are given in Table 5-3. Diurnal temperature variability is presented in Figure 5-8. Temperatures ranged between 10°C and 42°C. The highest temperatures occurred in September and the lowest in July. During the day, temperatures increase to reach maximum at around 14:00 in the afternoon. Ambient air temperature decreases to reach a minimum at around 06:00 i.e., just before sunrise.

Table 5-3: Monthly average, maximum and minimum temperatures based on WRF data for the period January 2017 to December 2019 (units: °C)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Minimum	15.6	16.7	14.1	13.4	11.0	10.8	10.4	11.7	11.8	11.5	12.3	15.5	15.6
Average	24.3	25.0	24.6	23.0	21.0	19.3	19.0	19.7	21.1	21.2	22.4	23.8	24.3
Maximum	37.0	38.4	35.0	35.2	32.5	30.3	33.9	33.3	42.3	38.3	38.0	40.2	37.0

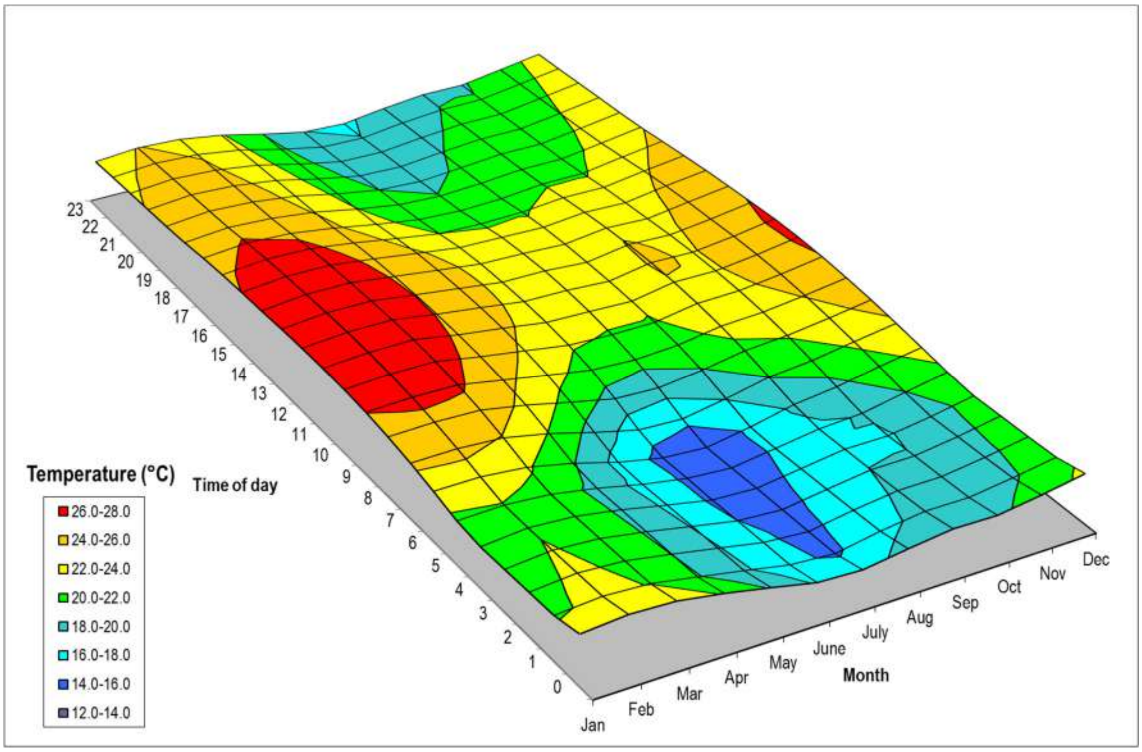

Figure 5-8: Diurnal temperature profile based on the WRF data for the period January 2017 to December 2019

5.2.4 Mixing Depth

The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. This layer is directly affected by the earth's surface, either through the retardation of flow due to the frictional drag of the earth's surface, or as result of the heat and moisture exchanges that take place at the surface. Typically, the temperature of the atmosphere decreases with height (termed the *environmental lapse rate*), and it decreases at a rate somewhere between 4°C per kilometre and 9.8°C per kilometre (the latter known as the *dry adiabatic rate*), i.e., the atmosphere is conditionally unstable much of the time. But this can change depending on how the temperature of the atmosphere changes at different levels.

During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface. Since warmer air is less dense than cold air, it will become buoyant and rise. If warm air lies above cold air, you can see that rising motion will be inhibited (any rising parcel will be colder than the warm overlying air). This situation is referred to as a surface inversion. An inversion can also form above the mixing layer, and this is termed an elevated inversion. The thickness of this mixing layer depends predominantly on the extent of solar radiation, growing gradually from sunrise to reach a maximum at about 5-6 hours after sunrise. This situation is more pronounced during the winter months due to strong night-time inversions and slower developing mixing layer.

During the night a stable layer, with limited vertical mixing, exists. Radiative flux divergence during the night usually results in the establishment of ground-based inversions and the erosion of the mixing layer. Low wind speeds are normally associated with these conditions and this result in less dilution potential. Stable conditions will cause pollutants to become trapped near ground level. Furthermore, the conditions associated with the nearby cold ocean could lead to overnight and morning fog.

Elevated inversions may occur for a variety of reasons, and on some occasions as many as five may occur in the first 1 000 m above the surface. The lowest-level elevated inversion is located at a mean height above ground of 1 550 m during winter months with a 78% frequency of occurrence. By contrast, the mean summer subsidence inversion occurs at 2 600 m with a 40% frequency.

5.2.5 Atmospheric Stability

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

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

Diurnal variation in atmospheric stability, as calculated from measured data, and described by the inverse Obukhov length and the boundary layer depth is provided in Figure 5-9. 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 fairly 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 the highest ground level concentrations will occur during stable night-time conditions.

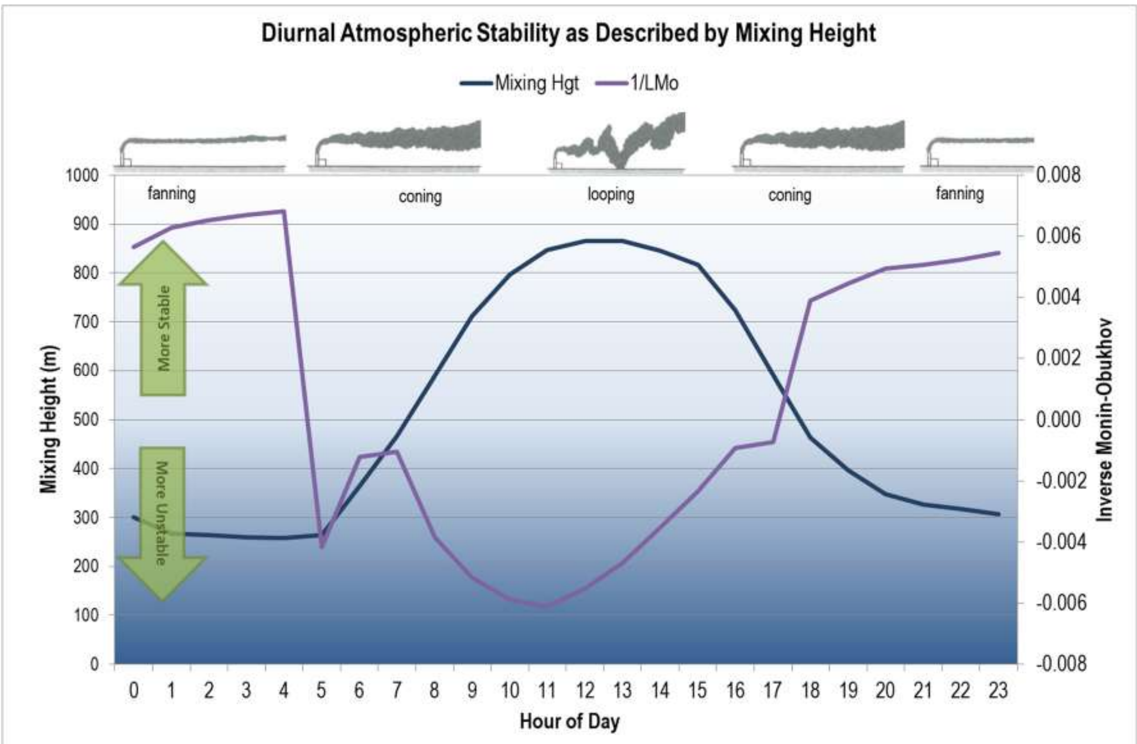

Figure 5-9: Diurnal atmospheric stability (CALMET processed WRF data, January 2017 to December 2019)

5.3 Ambient Air Quality Monitoring Data

The current air quality in the study area is mostly influenced by the industrial activities within the RB IDZ as well as farming activities, domestic fires, residential fuel burning, vehicle exhaust emissions and dust entrained by vehicles. These emission sources vary from activities that generate relatively course airborne particulates (such as farmland preparation dust from paved and unpaved roads) to fine PM such as that emitted by vehicle exhausts, power generators (at industrial operations). Other sources of PM include occasional fires in the residential areas and farming activities. Emissions from unpaved roads constitute a major source of emissions to the atmosphere in South Africa. When a vehicle travels on an unpaved road, the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong turbulent air shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. Dust emissions from unpaved roads are a function of vehicle traffic 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. Emissions generated by wind erosion are dependent on the frequency of disturbance of the erodible surface. Every time that a surface is disturbed e.g., by mining, agriculture and/or grazing activities, its erosion potential is restored. Combustion gases (CO, SO_2, NO_2 and hydrocarbons) are typically released from industrial areas, power generators, vehicle exhausts, and burning activities. Although these sources are not meant to be exhaustive, it represents the main contributors.

The RBCAA has the following AQMS: Arboretum, Brackenham, CBD, Harbour West, Felixton, eNseleni and eSikhaleni. The RBCAA also operates an automatic weather station (AWS) at the airport. The City of uMhlatuze has AQMS at Arboretum, Brackeham and eSikhaleni.

The location of the stations in given in Figure 5-1.

Diurnal and seasonal variation plots – generated using openair (Carslaw & Ropkins, 2012); and (Carslaw, 2019) - of ambient pollutant concentrations measured at the AQMS near Richards Bay show the variation of ambient concentrations over daily, weekly and annual cycles (mean with 95% confidence interval). The data have been normalised by dividing by the respective mean values to allow comparison of the shape of diurnal trends for the variables on very different measurement scales (Carslaw, 2019).

5.3.1 RBCAA Arboretum Station

The data availability for the RBCAA Arboretum Station is shown in Table 5-4. There was average to full data availability over the assessment period (2016 to 2021). There were no measured exceedances of the short-term or long-term NAAQS for SO_2 for the period 2016 to 2021. Higher concentrations of SO_2 occurred in the early mornings (Figure 5-10).

Table 5-4: Ambient concentrations and data availability for the pollutants measured at the RBCAA Arboretum Monitoring Station

RBCAA Arboretum AQMS						
Period	**Data Availability**	**Hourly**	**Daily**	**Annual Average**	**No of recorded hourly exceedances**	**No of recorded daily exceedances**
		99th Percentile	**99th Percentile**			
SO_2 (µg/m³)						
Criteria		*350 µg/m³*	*125 µg/m³*	*50 µg/m³*	*88 hours per year*	*4 days per year*
2016	75%	11.4	9.5	2.1	0	0
2017	94%	29.7	19.0	3.2	0	0
2018	94%	50.0	20.7	6.7	0	0
2019	97%	21.0	17.2	9.3	0	0
2020	100%	20.9	12.6	3.0	0	0
2021	88%	54.6	30.1	5	0	0

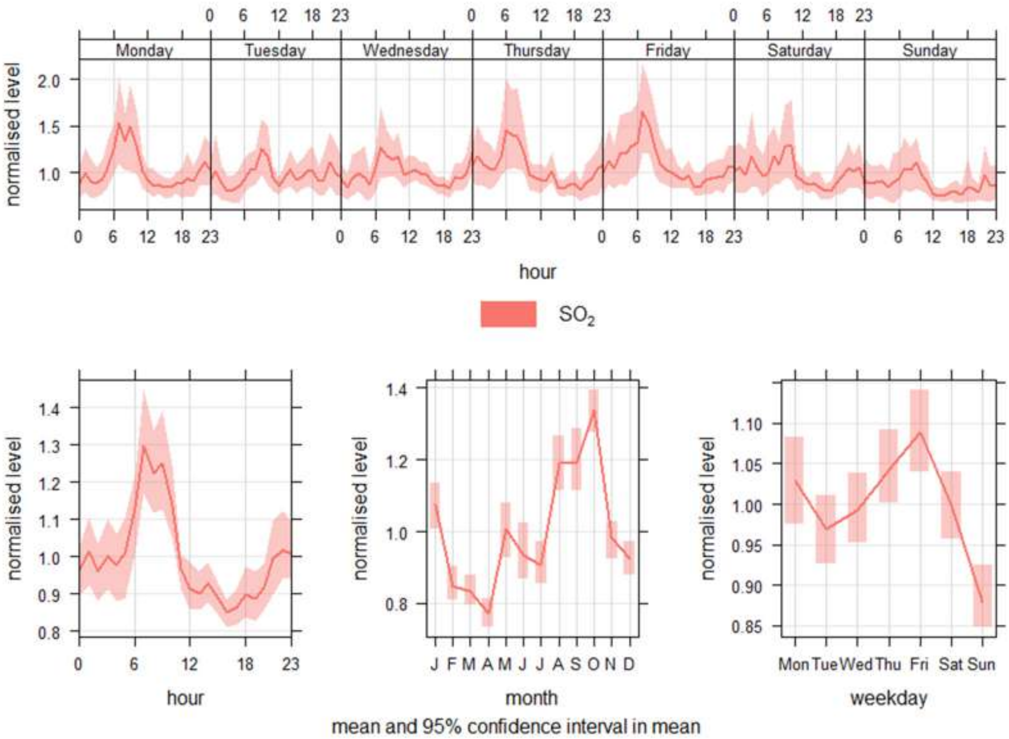

Figure 5-10: Time variation plot for the pollutants measured as RBCAA Arboretum Monitoring Station

5.3.2 RBCAA Brackenham Station

The ambient concentrations and data availability for the RBCAA Brackenham Station for the period 2016 to 2021 are shown in Table 5-5. The main surrounding influences on the air quality are residential activities and vehicle traffic. There were 6 exceedances of the 24-hour NAAQ limit value for PM_{10} in 2018, where four (4) are allowed per year. There were no exceedances of the 1-year NAAQS for PM_{10}. During 2021 the PM_{10} analyser at the station was replaced with a $PM_{2.5}$ analyser (AIMS, 2021), resulting in 76% data availability. However, no exceedances of the $PM_{2.5}$ NAAQS occurred during the partial year of analysis. The SO_2 1-hour, 24-hour and 1-year NAAQS were not exceeded. The higher PM_{10} concentrations occurred during weekdays between 06H00 and 18H00 and especially during winter when the area has lower rainfall (Figure 5-11). The higher concentrations of SO_2 occurred during weekdays between 06H00 and 18H00 (Figure 5-11).

Table 5-5: Ambient concentrations and data availability for the pollutants measured at the RBCAA Brackenham Monitoring Station (bold text indicates exceedance of the applicable NAAQS)

RBCAA Brackenham AQMS						
Period	**Data Availability**	**Hourly**	**Daily**	**Annual Average**	**No of recorded hourly exceedances**	**No of recorded daily exceedances**
		99th Percentile	**99th Percentile**			
SO_2 (µg/m³)						
Criteria		*350 µg/m³*	*125 µg/m³*	*50 µg/m³*	*88 hours per year*	*4 days per year*
2016	94%	17.5	13.1	2.8	0	0
2017	85%	11.1	9.2	2.3	0	0
2018	99%	18.3	14.1	3.4	0	0

RBCAA Brackenham AQMS						
Period	**Data Availability**	**Hourly**	**Daily**	**Annual Average**	**No of recorded hourly exceedances**	**No of recorded daily exceedances**
		99th Percentile	**99th Percentile**			
2019	97%	7.3	12.2	1.4	0	0
2020	82%	18.27	15.87	3.50	0	0
2021	100%	14.9	13.2	3.3	0	0
PM_{10} (µg/m³)						
Criteria			*75 µg/m³*	*40 µg/m³*		*4 days per year*
2016	90%		65.8	28.7		1
2017	85%		68.6	32.5		2
2018	89%		92.5	31.6		**6**
2019	96%		57.2	29.9		0
2020	90%		49.01	25.6		0
$PM_{2.5}$ (µg/m³)						
2021	72%		29.6	13.5		1

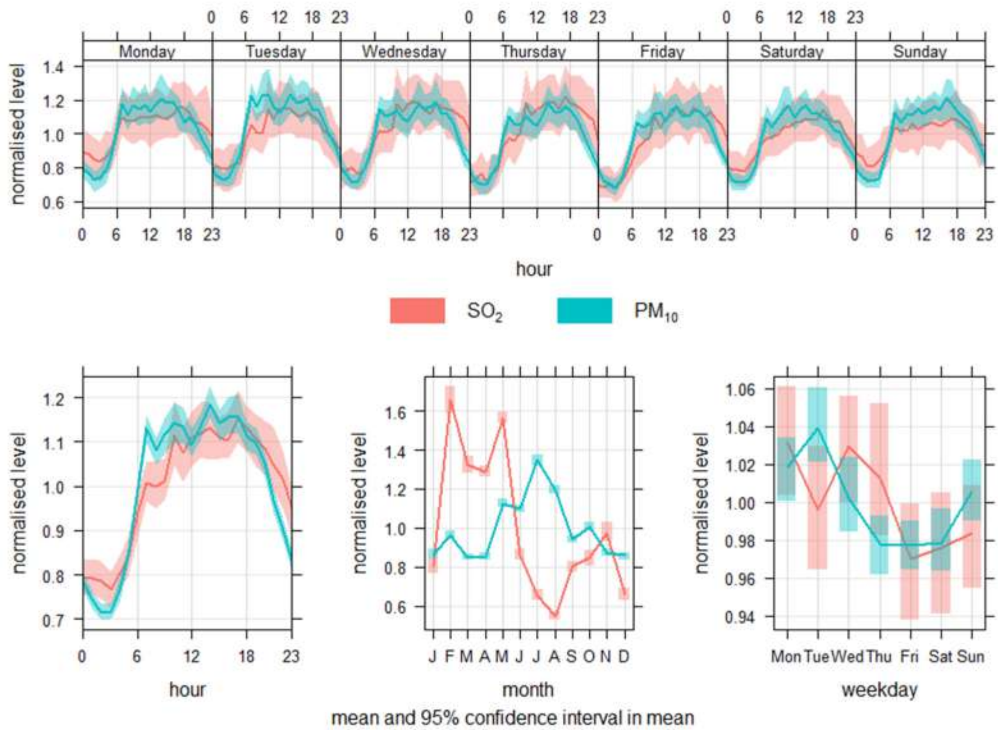

Figure 5-11: Time variation plot for the pollutants measured as RBCAA Brackenham Monitoring Station

5.3.3 RBCAA Central Business District (CBD) Station

The data availability for the RBCAA CBD Station for the period 2016 to 2021 is shown in Table 5-6. There was good data availability. The SO_2 1-hour, 24-hour and 1-year NAAQS were not exceeded, but in 2021 SO_2 concentrations were higher across the metrics summarised, when compared to the preceding years (2016 to 2020). There were also no exceedances of the 24-hour or 1-year NAAQS for PM_{10}. Higher concentrations of PM_{10} occurred in the afternoons and during winter and the beginning of spring (Figure 5-12). Higher concentrations of SO_2 occurred in the early mornings (Figure 5-12).

Table 5-6: Ambient concentrations and data availability for the pollutants measured at the RBCAA CBD Monitoring Station

RBCAA CBD AQMS						
Period	**Data Availability**	**Hourly 99th Percentile**	**Daily 99th Percentile**	**Annual Average**	**No of recorded hourly exceedances**	**No of recorded daily exceedances**
SO_2 (µg/m³)						
Criteria		*350 µg/m³*	*125 µg/m³*	*50 µg/m³*	*88 hours per year*	*4 days per year*
2016	86%	28.6	37.3	2.6	1	0
2017	87%	40.7	57.9	4.2	0	0
2018	99%	97.1	46.7	10.6	0	0
2019	98%	82.5	15.6	10.7	0	0
2020	96%	29.3	15.5	5.3	0	0
2021	93%	110.8	66.1	15.1	8	0
PM_{10} (µg/m³)						
Criteria			*75 µg/m³*	*40 µg/m³*		*4 days per year*
2016	85%		52.9	24.2		0
2017	87%		49.7	26.0		0
2018	97%		48.9	23.6		0
2019	97%		57.1	25.4		0
2020	94%		30.9	13.1		0
2021	98%		30.4	12.4		0

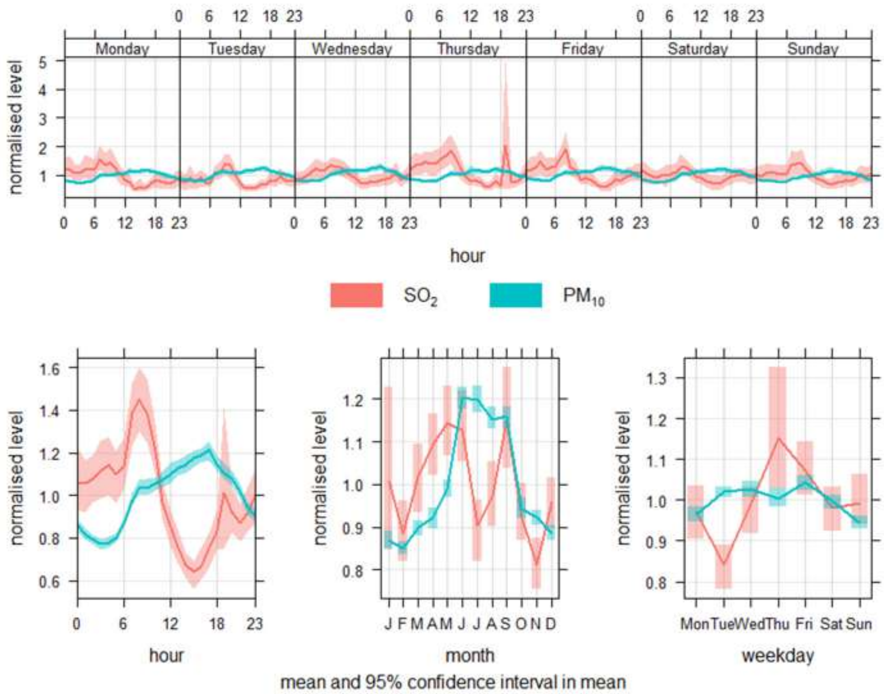

Figure 5-12: Time variation plot for the pollutants measured as RBCAA CBD Monitoring Station

5.3.4 RBCAA eNseleni Station

The data availability for the RBCAA eNseleni Station for the period 2019 to 2020 is shown in Table 5-7, where data availability was good for both pollutants in the first operational year, however, data availability dropped to 11% for SO_2 in 2020. The SO_2 1-hour, 24-hour and 1-year NAAQS were not exceeded. There was no SO_2 data available for 2021. There was one daily exceedance of the 24-hour NAAQ limit value for PM_{10}, however no exceedances of the annual NAAQS were recorded. Higher concentrations of PM_{10} and SO_2 occurred in the middle of the day (Figure 5-13).

Table 5-7: Ambient concentrations and data availability for the pollutants measured at the RBCAA eNseleni Monitoring Station

RBCAA eNseleni AQMS						
Period	**Data Availability**	**Hourly** 99th **Percentile**	**Daily** 99th **Percentile**	**Annual Average**	**No of recorded hourly exceedances**	**No of recorded daily exceedances**
SO_2 (µg/m³)						
Criteria		*350 µg/m³*	*125 µg/m³*	*50 µg/m³*	*88 hours per year*	*4 days per year*
2019	96%	19.1	14.4	3.4	0	0
2020	11%	27.7	8.1	3.5	0	0
PM_{10} (µg/m³)						
Criteria			*75 µg/m³*	*40 µg/m³*		*4 days per year*
2019	96%		58.1	29.1		1
2020	91%		49.6	24.9		0

RBCAA eNseleni AQMS						
Period	Data Availability	Hourly 99th Percentile	Daily 99th Percentile	Annual Average	No of recorded hourly exceedances	No of recorded daily exceedances
2021	82%		55.6	24.8		0

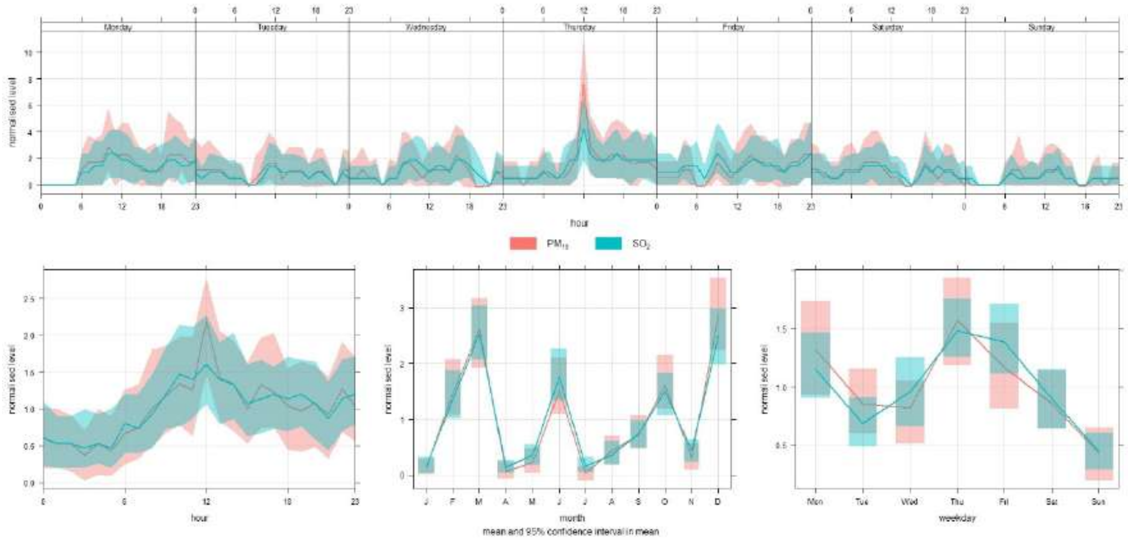

Figure 5-13: Time variation plot for the pollutants measured as RBCAA eNseleni Monitoring Station

5.3.5 RBCAA eSikhaleni Station

The SO_2 1-hour, 24-hour and 1-year NAAQS were not exceeded for the period 2016 to 2021. Despite 100% data availability during 2021, the SO_2 concentrations are unusually low for this station and compared with the historic data (2016 – 2020). No measurement or equipment concerns were raised in the most recent monthly report available on the RBCAA website (AIMS, 2021). Although exceedances of the 24-hour NAAQ limit value for PM_{10} were recorded in 2016, 2017, and 2019 they were always fewer than the allowable four (4) days per year (Table 5-8). Annual average concentrations were less than the NAAQS in all years assessed. Higher concentrations of PM_{10} and SO_2 occurred in the afternoons. Higher concentrations of PM_{10} occurred during winter and the beginning of spring (Figure 5-14).

Table 5-8: Ambient concentrations and data availability for the pollutants measured at the RBCAA eSikhaleni Monitoring Station

RBCAA eSikhaleni AQMS						
Period	Data Availability	Hourly 99th Percentile	Daily 99th Percentile	Annual Average	No of recorded hourly exceedances	No of recorded daily exceedances
SO_2 (µg/m³)						
Criteria		*350 µg/m³*	*125 µg/m³*	*50 µg/m³*	*88 hours per year*	*4 days per year*
2016	87%	107.6	10.4	3.6	0	0
2017	82%	89.3	13.7	5.3	0	0
2018	95%	89.0	15.5	5.4	0	0

RBCAA eSikhaleni AQMS						
Period	**Data Availability**	**Hourly**	**Daily**	**Annual Average**	**No of recorded hourly exceedances**	**No of recorded daily exceedances**
		99th Percentile	**99th Percentile**			
2019	94%	99.0	20.2	9.3	0	0
2020	85%	97.10	19.38	4.53	0	0
2021	100%	4.6	9.8	2.3	0	0
PM_{10} (µg/m³)						
Criteria			*75 µg/m³*	*40 µg/m³*		*4 days per year*
2016	87%		60.3	27.5		1
2017	82%		51.2	22.4		1
2018	95%		48.8	24.5		0
2019	94%		67.0	24.0		2
2020	85%		50.02	24.03		0
2021	98%		66.1	23.2		0

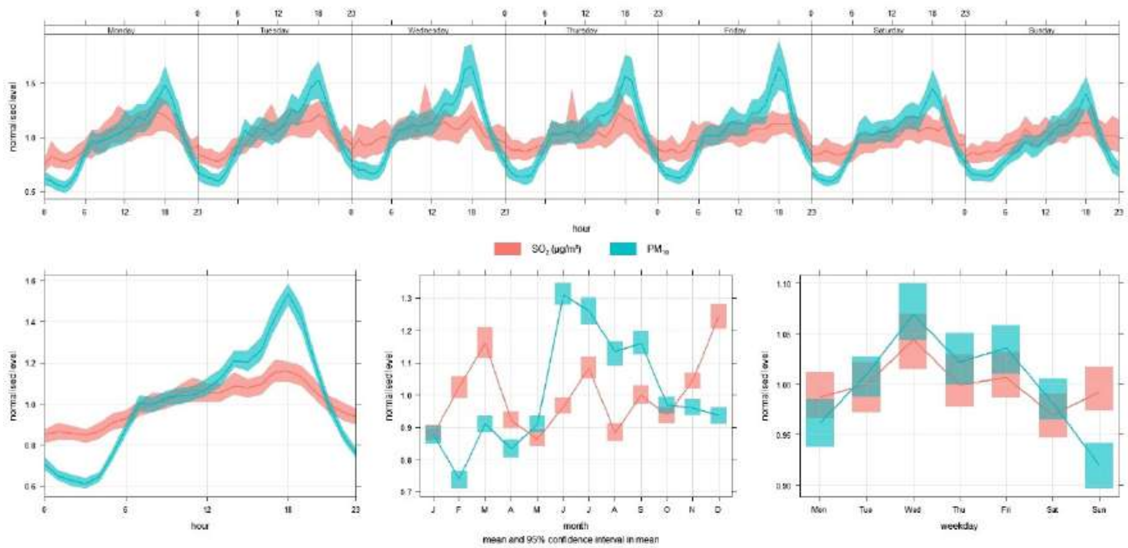

Figure 5-14: Time variation plot for the pollutants measured as RBCAA eSikhaleni Monitoring Station

5.3.6 RBCAA Felixton Station

There were no exceedances of the short-term or long-term NAAQS for any of the pollutants measured at the RBCAA Felixton Station for the period 2016 to 2021, although one exceedance of the daily PM_{10} NAAQ limit value occurred in 2018 (Table 5-9). SO_2 appears has higher concentrations occurring just after midday (Figure 5-15). The PM_{10} appears to have higher concentrations occurring in the afternoons and during winter and the beginning of spring (Figure 5-15). There was no PM_{10} data available for 2021 due to repairs required to the analyser pump (AIMS, 2021).

Table 5-9: Ambient concentrations and data availability for the pollutants measured at the RBCAA Felixton Monitoring Station

RBCAA Felixton AQMS						
Period	Data Availability	Hourly 99th Percentile	Daily 99th Percentile	Annual Average	No of recorded hourly exceedances	No of recorded daily exceedances
SO_2 (µg/m³)						
Criteria		*350 µg/m³*	*125 µg/m³*	*50 µg/m³*	*88 hours per year*	*4 days per year*
2016	85%	34.5	19.1	4.7	0	0
2017	83%	32.0	16.9	4.5	0	0
2018	98%	33.5	19.1	6.5	0	0
2019	69%	32.2	19.5	7.4	0	0
2020	96%	18.7	15.9	5.4	0	0
2021	95%	23.1	22.7	4.9	1	0
PM_{10} (µg/m³)						
Criteria			*75 µg/m³*	*40 µg/m³*		*4 days per year*
2016						
2017						
2018	99%		59.6	24.7		1
2019	81%		61.1	26.2		0
2020	91%		49.4	22.7		0

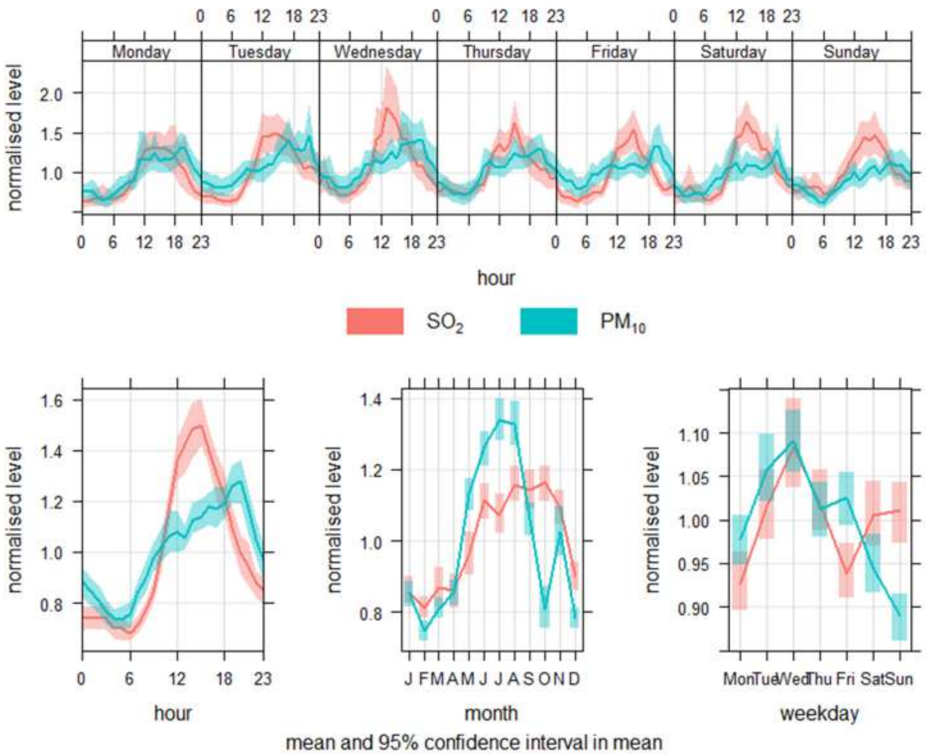

Figure 5-15: Time variation plot for the pollutants measured as RBCAA Felixton Monitoring Station

5.3.7 RBCAA Harbour West Station

Ambient data for the period 2016 to 2021 was assessed for the RBCAA Harbour West Station. There were exceedances of the 24-hour NAAQ limit value for SO_2 in 2018, however the number of exceedances were fewer than the allowable per year (88 hours per year allowed). During 2021, however, there were 52 hours that exceeded the 1-hourly NAAQ limit concentration. Daily average SO_2 concentrations exceeded the NAAQS limit value on 5-days during 2018 and 2021 – more than the allowable 4 days. There were no exceedances of the long-term NAAQS for SO_2 (Table 5-10). Higher concentrations of SO_2 occurred in the mornings and during winter when the rainfall is less (Figure 5-16).

Table 5-10: Ambient concentrations and data availability for the pollutants measured at the RBCAA Harbour West Monitoring Station (bold text indicates exceedance of the applicable NAAQS)

RBCAA Harbour West AQMS						
Period	**Data Availability**	**Hourly**	**Daily**	**Annual Average**	**No of recorded hourly exceedances**	**No of recorded daily exceedances**
		99th Percentile	**99th Percentile**			
SO_2 (µg/m³)						
Criteria		*350 µg/m³*	*125 µg/m³*	*50 µg/m³*	*88 hours per year*	*4 days per year*
2016	81%	119.9	71.7	19.1	1	0
2017	83%	140.8	80.8	17.7	0	0
2018	99%	246.2	102.8	23.6	22	**5**
2019	99%	137.5	78.4	17.3	0	1
2020	99%	150.0	82.6	19.9	4	0
2021	98%	232.9	138.6	31.2	53	**5**

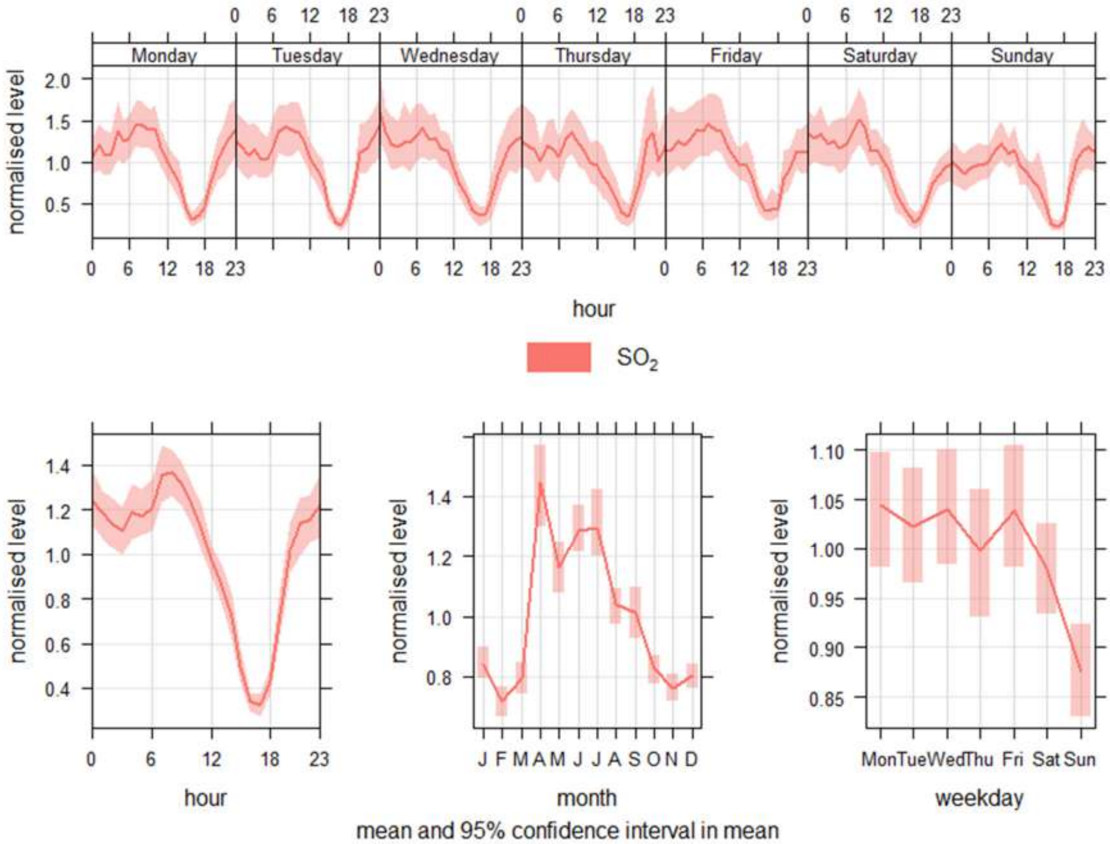

Figure 5-16: Time variation plot for the pollutants measured as RBCAA Harbour West Monitoring Station

5.3.8 RBCAA Scorpio Station

Exceedances of the hourly SO_2 NAAQ limit value occurred in all assessment years (2016 to 2021) with the exception of 2017, however, in all cases the number of exceedances was lower than the allowable 88 hours per year. In 2020 and 2021, the 24-hour NAAQS was exceeded, where 10 and 8 days - respectively - exceeded the applicable limit value (Table 5-11). Annual average SO_2 NAAQS was not exceeded during the 6 years of assessment. The SO_2 appears to have higher concentrations occurring between 07H00 and 10H00 and especially during winter when the area has lower rainfall (Figure 5-17).

Table 5-11: Ambient concentrations and data availability for the pollutants measured at the RBCAA Scorpio Monitoring Station

RBCAA Scorpio AQMS						
Period	**Data Availability**	**Hourly**	**Daily**	**Annual Average**	**No of recorded hourly exceedances**	**No of recorded daily exceedances**
		99th Percentile	**99th Percentile**			
SO_2 (µg/m³)						
Criteria		*350 µg/m³*	*125 µg/m³*	*50 µg/m³*	*88 hours per year*	*4 days per year*
2016	84%	141.3	62.7	19.2	2	0

RBCAA Scorpio AQMS						
Period	Data Availability	Hourly	Daily	Annual Average	No of recorded hourly exceedances	No of recorded daily exceedances
		99th Percentile	99th Percentile			
SO_2 (µg/m³)						
Criteria		*350 µg/m³*	*125 µg/m³*	*50 µg/m³*	*88 hours per year*	*4 days per year*
2017	84%	187.5	74.8	19.8	0	0
2018	98%	232.3	115.6	22.9	12	1
2019	99%	182.9	88.9	17.8	5	0
2020	96%	324.3	195.8	29.5	70	**10**
2021	85%	297.0	156.8	30.7	41	**8**

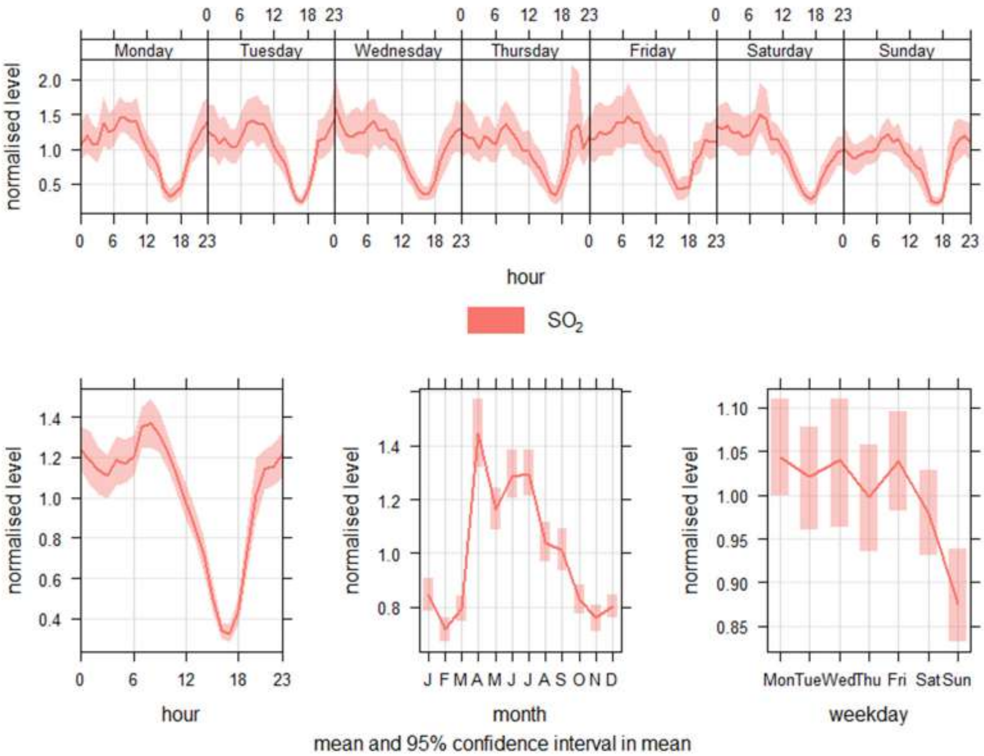

Figure 5-17: Time variation plot for the pollutants measured as RBCAA Scorpio Monitoring Station

5.3.9 uMhlathuze Local Municipality Arboretum Station

There were no exceedances of the short-term or long-term NAAQS for any of the pollutants (Table 5-12). Higher concentrations of NO_2 occur in the mornings around 07H00 and the evenings around 18H00 (Figure 5-18); this could be indicative of traffic as the main contributing source. Higher concentrations of SO_2 occur mid-morning and during the autumn and winter (Figure 5-18). Higher concentrations of $PM_{2.5}$ and PM_{10} occur during late night and early morning and April to July (Figure 5-19). No PM_{10} or $PM_{2.5}$ data were available for 2021.

Table 5-12: Ambient concentrations and data availability for the pollutants measured at the uMhlathuze Local Municipality Arboretum Monitoring Station

City of uMhlathuze Arboretrum AQMS						
Period	Data Availability	Hourly	Daily	Annual Average	No of recorded hourly exceedances	No of recorded daily exceedances
		99th Percentile	99th Percentile			
SO_2 (µg/m³)						
Criteria		*350 µg/m³*	*125 µg/m³*	*50 µg/m³*	*88 hours per year*	*4 days per year*
2019	84%	31.4	16.6	8.2	0	0
2020	98%	37.2	15.5	4.5	0	0
2021	97%	37.0	27.8	6.6	2	0
NO_2 (µg/m³)						
Criteria		*200 µg/m³*		*40 µg/m³*	*88 hours per year*	
2019	84%	32.0		7.5	0	
2020	97%	31.2		6.9	0	
2021	77%	31.9		10.4	0	
PM_{10} (µg/m³)						
Criteria			*75 µg/m³*	*40 µg/m³*		*4 days per year*
2019	84%		31.5	8.1		1
2020	29%		2.1	1.1		0
$PM_{2.5}$ (µg/m³)						
Criteria			*40 µg/m³*	*20 µg/m³*		*4 days per year*
2019	84%		27.5	6.7		0
2020	29%		1.9	1.0		0

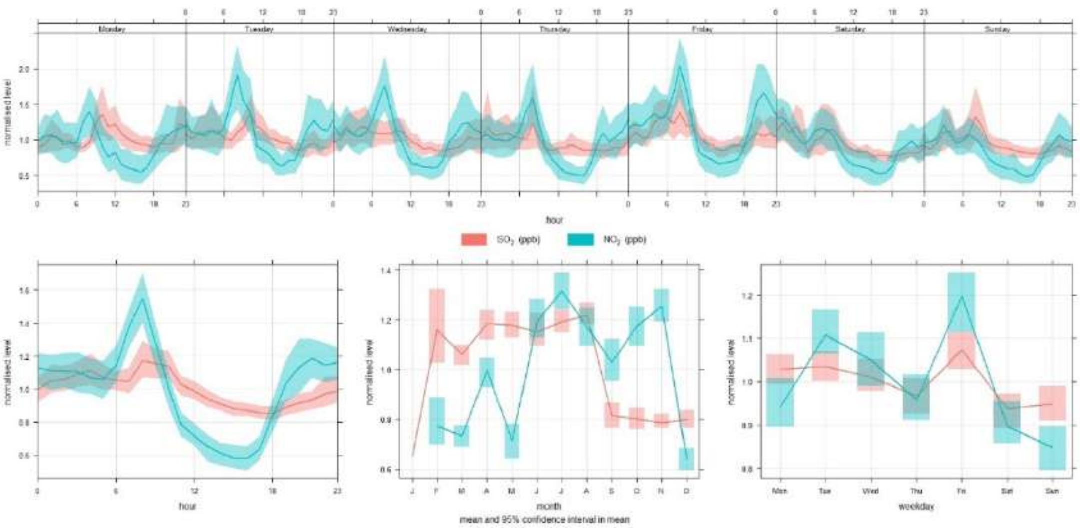

Figure 5-18: Time variation plot for the measured SO_2 and NO_2 at uMhlathuze Local Municipality Arboretum Monitoring Station

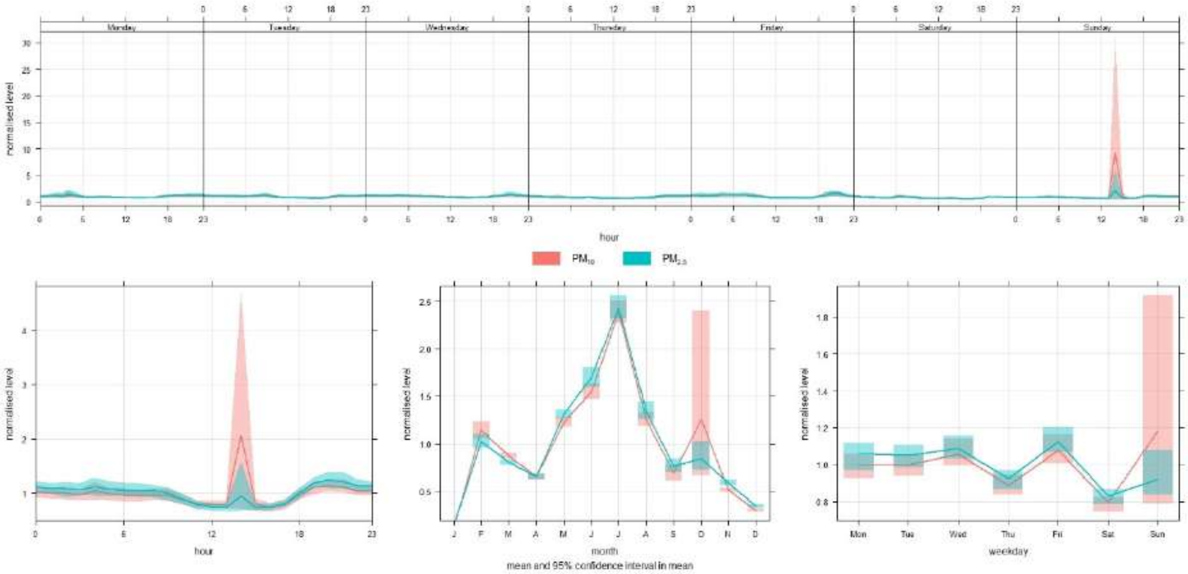

Figure 5-19: Time variation plot for the measured PM at uMhlathuze Local Municipality Arboretum Monitoring Station

5.3.10 uMhlathuze Local Municipality Brackenham Station

There were no exceedances of the short-term or long-term NAAQS for any of the pollutants (Table 5-13). An unusually high (for the Richards Bay network) number of hours had NO_2 concentrations above the NAAQ limit concentration in 2020 (54 hours), possibly associated with two events: between the 17th and 19th March; and between the 14th and 15th May 2020. These However, these exceedances were within the frequency of exceedance allowed by the NAAQS (88 hours per year). Data availability for SO_2 and NO_2 in 2021 was poor (4%). Higher concentrations of PM_{10} occur midday and July (Figure 5-20). Higher concentrations of NO_2 and $PM_{2.5}$ occurring in the mornings and the evenings around 18H00 (Figure 5-20); this could be indicative of traffic as the main contributing source. Higher concentrations of SO_2 occurring between 06H00 and 18H00, peaking at 15H00 and during the winter (Figure 5-20).

Table 5-13: Ambient concentrations and data availability for the pollutants measured at the uMhlathuze Local Municipality Brackenham Monitoring Station

City of uMhlathuze Brackenham AQMS						
Period	**Data Availability**	**Hourly**	**Daily**	**Annual Average**	**No of recorded hourly exceedances**	**No of recorded daily exceedances**
		99th Percentile	**99th Percentile**			
SO_2 (µg/m³)						
Criteria		*350 µg/m³*	*125 µg/m³*	*50 µg/m³*	*88 hours per year*	*4 days per year*
2019	80%	2.0	14.8	4.1	0	0
2020	95%	2.3	22.9	5.9	0	0
2021	4%	40.7	20.2	7.0	0	0
NO_2 (µg/m³)						
Criteria		*200 µg/m³*		*40 µg/m³*	*88 hours per year*	
2019	80%	25.0		9.8	0	
2020	95%	33.4		15.6	54	

City of uMhlathuze Brackenham AQMS						
Period	Data Availability	Hourly	Daily	Annual Average	No of recorded hourly exceedances	No of recorded daily exceedances
		99th Percentile	99th Percentile			
2021	4%	47.3		14.8	0	
PM_{10} (µg/m³)						
Criteria			*75 µg/m³*	*40 µg/m³*		*4 days per year*
2019	83%		34.3	9.3		0
2020	46%		13.9	5.1		0
$PM_{2.5}$ (µg/m³)						
Criteria			*40 µg/m³*	*20 µg/m³*		*4 days per year*
2019	83%		23.5	7.1		0
2020	46%		10.7	4.1		0

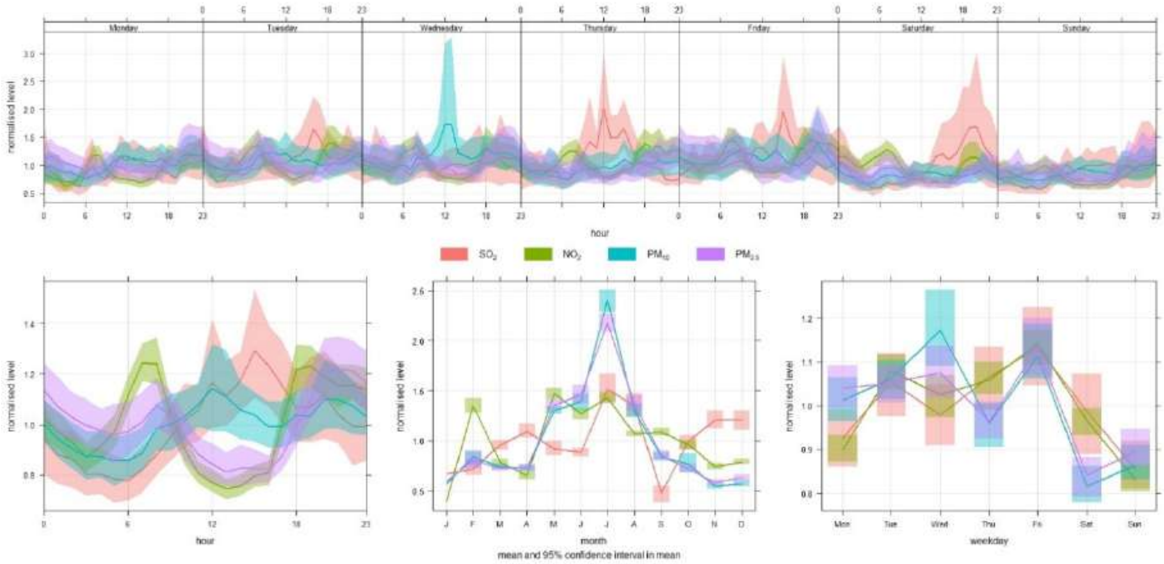

Figure 5-20: Time variation plot for the pollutants measured at uMhlathuze Local Municipality Brackenham Monitoring Station

5.3.11 uMhlathuze Local Municipality eSikhaleni Station

There were exceedances of the 24-hour NAAQS for both $PM_{2.5}$ and PM_{10} in 2019 and 2020. The annual NAAQS was also exceeded for $PM_{2.5}$ in 2019. There was one exceedance of the hourly SO_2 limit concentration in 2021. of the short-term or long-term NAAQS for SO_2 or NO_2 (Table 5-14). Higher concentrations of PM_{10} and $PM_{2.5}$ occur during late night and early morning and during winter months (Figure 5-21). Higher concentrations of NO_2 occurring in the mornings around 06H00 and the evenings around 18H00 (Figure 5-21); this could be indicative of traffic as the main contributing source. No PM_{10} or $PM_{2.5}$ data were available for 2021.

Table 5-14: Ambient concentrations and data availability for the pollutants measured at the uMhlathuze Local Municipality eSikhaleni Monitoring Station (bold text indicates exceedance of the applicable NAAQS)

City of uMhlathuze eSikhaleni AQMS						
Period	**Data Availability**	**Hourly**	**Daily**	**Annual Average**	**No of recorded hourly exceedances**	**No of recorded daily exceedances**
		99th Percentile	**99th Percentile**			
SO_2 (µg/m³)						
Criteria		*350 µg/m³*	*125 µg/m³*	*50 µg/m³*	*88 hours per year*	*4 days per year*
2019	77%	21.0	17.8	10.0	0	0
2020	89%	16.5	14.0	4.5	0	0
2021	83%	22.8	19.3	10.6	1	0
NO_2 (µg/m³)						
Criteria		*200 µg/m³*		*40 µg/m³*	*88 hours per year*	
2019	82%	43.2		9.8	0	
2020	93%	40.4		8.5	0	
2021	50%	29.9		7.2	0	
PM_{10} (µg/m³)						
Criteria			*75 µg/m³*	*40 µg/m³*		*4 days per year*
2019	78%		117.9	30.1		**20**
2020	70%		77.5	15.6		4
$PM_{2.5}$ (µg/m³)						
Criteria			*40 µg/m³*	*20 µg/m³*		*4 days per year*
2019	68%		148.8	**27.4**		**66**
2020	70%		62.4	12.8		**16**

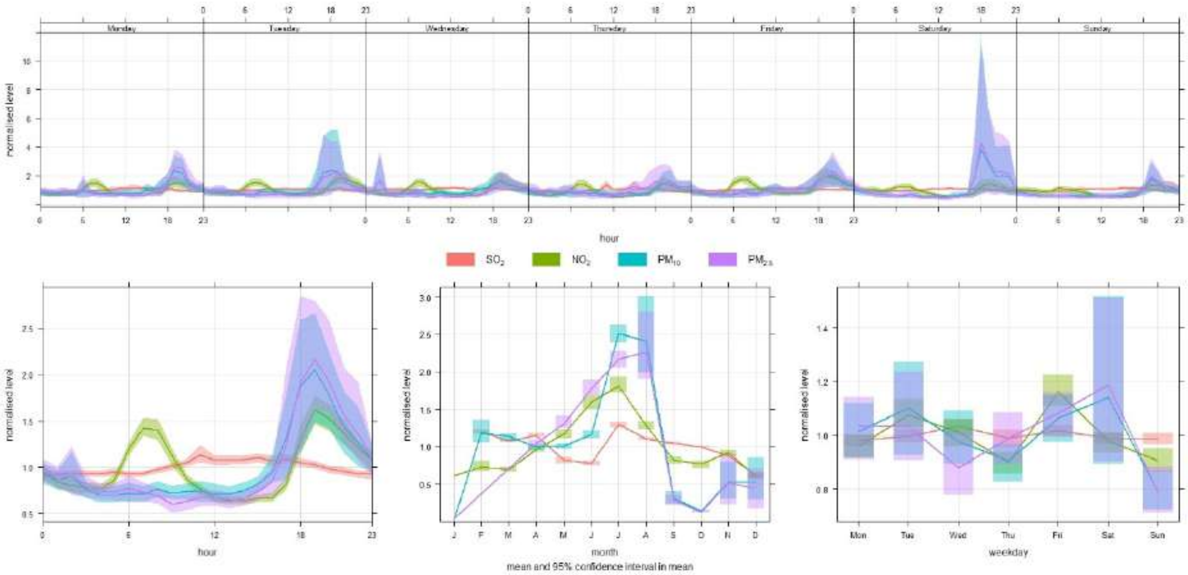

Figure 5-21: Time variation plot for the pollutants measured at uMhlathuze Local Municipality eSikhaleni Monitoring Station

5.3.12 Summary of Ambient Air Quality

In general, the ambient air quality in Richards Bay is in compliance with NAAQS, with the exception of Harbour West and Scorpio for daily SO_2, Brackenham for daily PM_{10}, and eSikhaleni for $PM_{2.5}$ and PM_{10}.

Table 5-15: NAAQS Compliance Summary for Ambient monitoring network of Richards Bay (2016-2020)

Monitoring Station	SO_2			NO_2		PM_{10}		$PM_{2.5}$	
	hour	day	annual	hour	annual	day	annual	day	annual
Arboretum (RBCAA)	√	√	√						
Brackenham (RBCAA)	√	√	√			**X 2018**	√		
CBD (RBCAA)	√	√	√			√	√		
eNseleni (RBCAA)	√	√	√			√	√		
eSikhawini (RBCAA)	√	√	√			√	√		
Felixton (RBCAA)	√	√	√			√	√		
Harbour West (RBCAA)	√	**X 2018 2020**	√						
Scorpio (RBCAA)	√	**X 2020 2021**	√						
Arboretum (uMhlathuze)	√	√	√	√	√	√	√	√	√
Brackenham (uMhlathuze)	√	√	√	√	√	√	√	√	√
eSikhaleni (uMhlathuze)	√	√	√	√	√	**X 2019**	√	**X 2019 2020**	**X 2019**

5.4 Dispersion Modelling Results for Richards Bay Baseline

A recent air quality dispersion modelling study assessing the cumulative impact of operations within the Richards Bay domain was consulted with permission of the authors (WSP Environment and Energy) and the RBCAA (under request for confidentiality of its members). The report is considered by the RBCAA to be the most comprehensive assessment of normal operations of the industries in the Richards Bay airshed, although limitations of the assessment are detailed in the report. These include omission of some industrial sources (where information was not available); exclusion of vehicular traffic emissions; and intermittent sources such as sugarcane burning. Simulated annual average concentrations of PM_{10}, NO_2, and SO_2 were provided for cumulative assessment of the baseline conditions and the proposed facility.

5.4.1 Emissions Quantification

Emissions were quantified from 11 industries within the Richards Bay airshed, based on information provided by the industries and the AELs. Total annual point source emissions for the pollutants of concern are summarised in Table 5-16.

Table 5-16: Baseline annual pollutant emission rates in the Richards Bay airshed

Source group	Annual emission rates (tonnes per year)		
	SO_2	NO_X	PM_{10}
Point sources	23 252.97	8.452.15	3 411.15
Area sources	(not reported)		

5.4.2 Simulated Annual Average Respirable Particulate Matter (PM_{10})

The baseline operations were simulated to result in exceedances of the currently enforceable NAAQS (40 µg/m³) across much of the port area and adjacent areas mainly due to coal stockpiling and handling operations (Figure 5-22).

5.4.3 Simulated Annual Average Sulfur dioxide (SO_2)

Annual average SO_2, due to normal operations of the industrial sources in Richards Bay, were simulated to comply with the NAAQS across the domain, where the highest concentrations are expected close to Richards Bay central, Alton, and Brackenham (Figure 5-23).

5.4.4 Simulated Annual Average Nitrogen dioxide (NO_2)

Annual average NO_2 was simulated to comply with the NAAQS across the domain for normal operation of the industries operating in Richards Bay, with maximum concentrations occurring near Alton and Richards Bay Central (Figure 5-24).

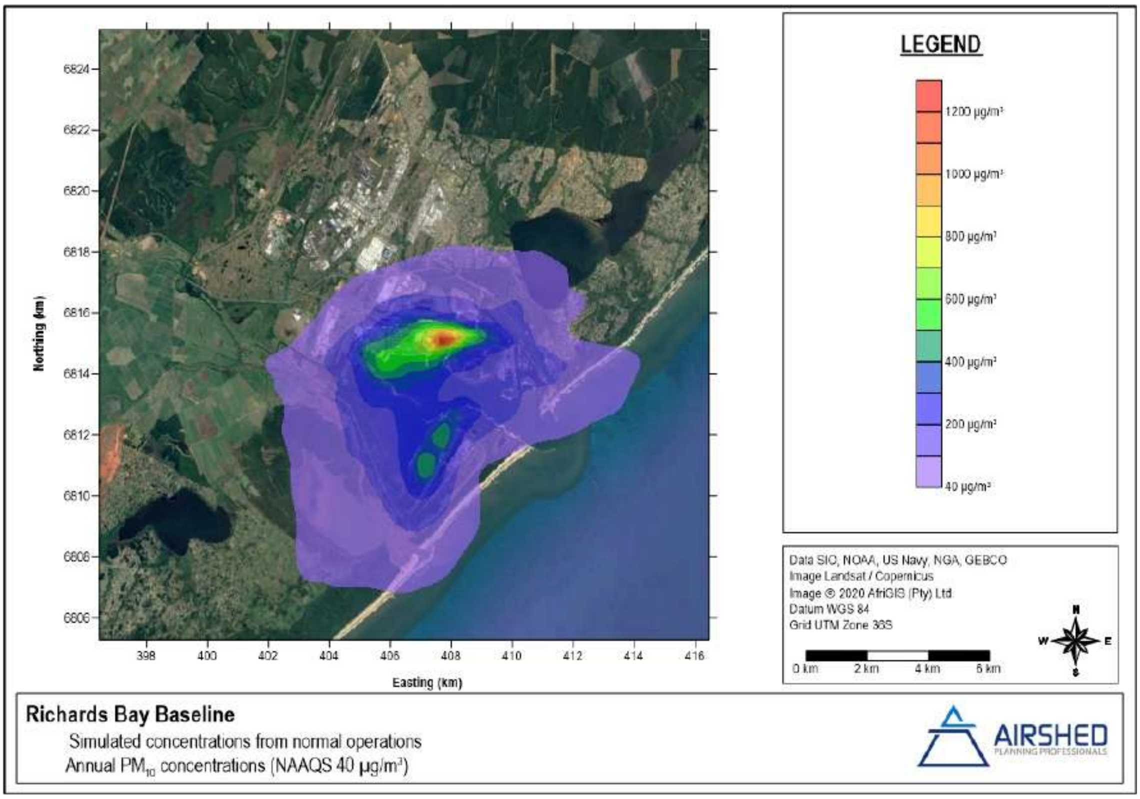

Figure 5-22: Simulated annual average PM_{10} concentrations for the Richards Bay baseline

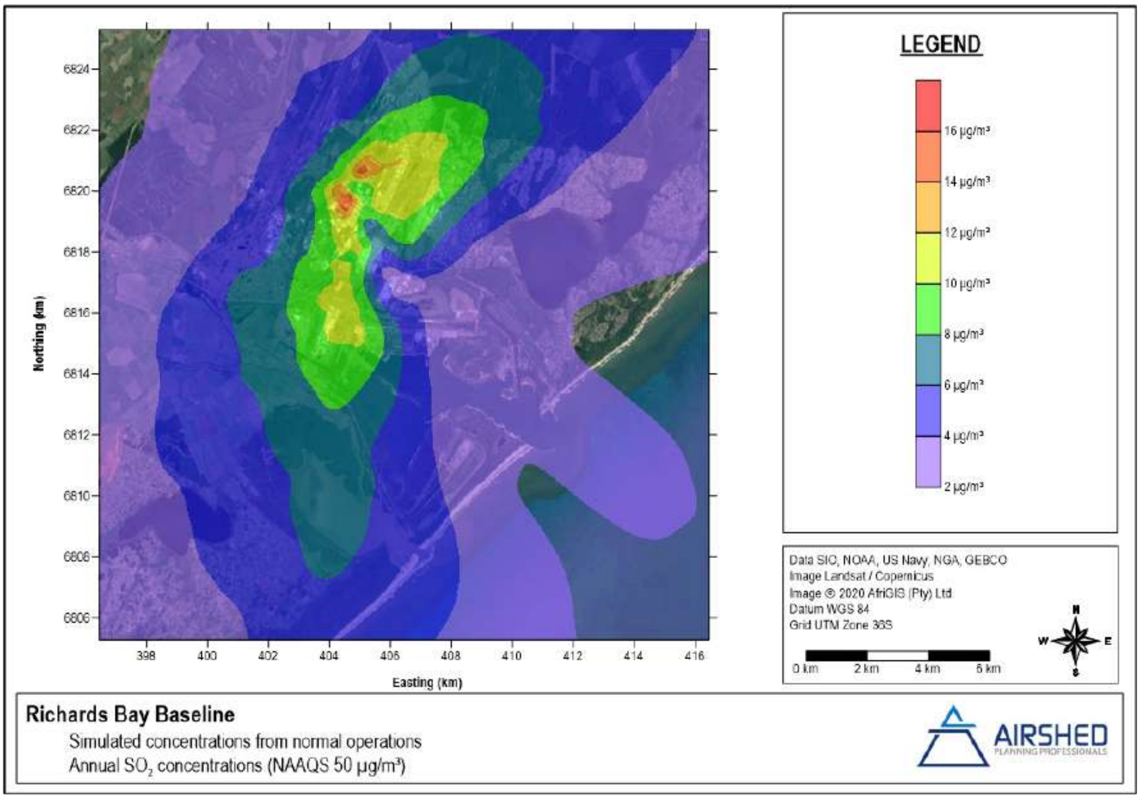

Figure 5-23: Simulated annual average SO_2 concentrations for the Richards Bay baseline

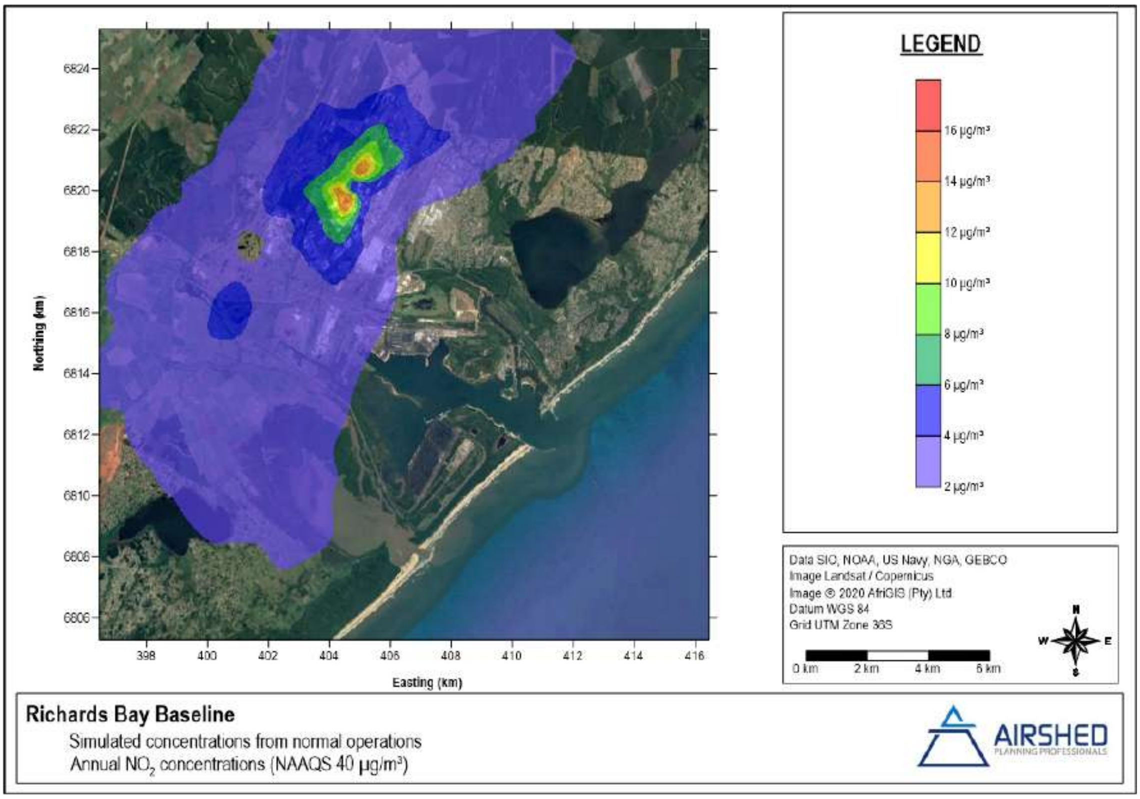

Figure 5-24: Simulated annual average NO_2 concentrations for the Richards Bay baseline

6 IMPACT ASSESSMENT: PROJECT CONSTRUCTION

During the construction phase several facilities need to be established including the plant area. In order to establish the above facilities, the following activities are proposed:

- Site establishment of construction phase facilities;
- Stripping and stockpiling of soil resources and earthworks;
- Collection, storage and removal of construction related waste;
- Construction of all infrastructure required for the operations; and
- Operation of mechanical equipment.

Fugitive PM emissions will be released to atmosphere during these activities. 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). It should be noted that in the discussion regarding, regulation and estimation of PM emissions and impacts, a distinction is made between different particle size fractions. Whereas PM_{10} and $PM_{2.5}$ fractions are taken into account to determine the potential for human health risks, TSP is included to assess nuisance dustfall.

In addition to fugitive PM emissions, combustion related PM and gaseous emissions will also be released from construction equipment. Key pollutants from combustion of fossil fuels include PM_{10} and $PM_{2.5}$, CO, formaldehyde, NO_x, SO_2 and VOC. PM emitted from diesel combustion will mostly be in the form of black carbon, commonly referred to as diesel particulate matter (DPM).

Construction activities are potentially significant sources of dust emissions that may have a substantial temporary impact on local air quality where emissions result from general site preparation. Construction activities that contribute to air pollution typically include: land clearing, excavation, material handling activities, wheel entrainment, operation of diesel or petrol engines etc. If not properly mitigated, construction sites could generate high levels of dust (typically from concrete, cement, wood, stone, silica) and this has the potential to travel for large distances.

Construction dust, in the larger TSP fraction, will generally impact close to the construction activities and is more responsible for soiling than health issues. Health impacts are more associated with the finer PM_{10} and $PM_{2.5}$ fractions, both of which are invisible to the naked eye. Combustion engines also emit emissions of CO, hydrocarbon, NOx and CO_2. However, these gaseous emissions may often not be as significant when compared to particulate emissions, and the quantification of particulate matter emissions (and the atmospheric dispersion thereof) is generally considered a better key-indicator pollutant for construction phase impacts than gaseous emissions.

Dust emissions can also vary substantially from day to day, depending on the level of activity, the specific operations, and the prevailing meteorological conditions. It is therefore often necessary to estimate area wide construction emissions, without regard to the actual plans of any individual construction process.

The US EPA documents emissions factors which aim to provide a general rule-of-thumb as to the magnitude of emissions which may be anticipated from construction operations. The quantity of dust emissions is assumed to be proportional to the area of land being worked and the level of construction activity. Based on field measurements of TSP concentrations surrounding apartment and shopping centre construction projects, the approximate emission factors for construction activity operations are given as:

$$E_{TSP} = 2.69 \text{ Mg/hectare/month of activity } (269 \text{ g/m}^2\text{/month})$$

The PM_{10} fraction is given as approximately 35% of the US EPA total suspended particulate factor. These emission factors are most applicable to construction operations with (i) medium activity levels, (ii) moderate silt contents, and (iii) semiarid climates. The emission factor for TSP considers 42 hours of work per week of construction activity. Test data were not sufficient to derive the specific dependence of dust emissions on correction parameters. Because the above emission factor is referenced to TSP, use of this factor to estimate PM_{10} emissions will result in conservatively high estimates. Also, because derivation of the factor assumes that construction activity occurs 30 days per month, the above estimate is somewhat conservatively high for TSP as well.

The information in Table 6-1 was used to estimate emissions during the Construction Phase.

Table 6-1: Parameters used to estimate Construction Phase emissions

<table>
<tr><th>Parameter</th><th>Value</th><th>Units of measurement</th><th>Source</th></tr>
<tr><td>Total construction area</td><td>11</td><td>hectares</td><td>given (by PRBGP3)</td></tr>
<tr><td>Period of construction</td><td>36</td><td>months</td><td>given (by PRBGP3)</td></tr>
<tr><td rowspan="2">Construction operations</td><td>9</td><td>hours</td><td rowspan="2">assumed</td></tr>
<tr><td>21</td><td>days per month</td></tr>
<tr><td>Emission rate – TSP</td><td>3.95×10^{-4}</td><td>g/s.m²</td><td>calculated</td></tr>
<tr><td>Emission rate – PM_{10}</td><td>1.38×10^{-4}</td><td>g/s.m²</td><td>calculated</td></tr>
</table>

The unmitigated emissions associated with construction of the proposed project may impact daily PM_{10} concentrations near site depending on the location of activities but exceedances outside of the RBIDZ at the AQMS or receptors is unlikely (Figure 6-1). Simulated annual PM_{10} as a result of construction activities are below the NAAQS across the domain (Figure 6-2).

Simulated dustfall rates for the construction phase were compared to the acceptable dustfall rates defined in the NDCR (Section 4.7). Daily dustfall rates as a result of the Construction Phase of the project are likely to be lower than 50 mg/m^2.day and no exceedances of the NDCR were simulated (Figure 6-3).

Dust control measures that can be implemented during the construction phase are outlined in Table 6-2. Control techniques for fugitive dust sources generally involve watering, chemical stabilization, keeping cleared areas as small as possible to limit exposed areas, and the reduction of surface wind speed through the use of windbreaks and source enclosures.

Table 6-2: Dust control measures that can be implemented during construction activities

<table>
<tr><th>Construction Activity</th><th>Recommended Control Measure(s)</th></tr>
<tr><td rowspan="2">Debris handling</td><td>Wet suppression (hourly watering recommended)</td></tr>
<tr><td>Storage of debris in containers (skips) prior to waste removal. Cover containers when not in use (as far as practical).</td></tr>
<tr><td rowspan="4">Truck transport and road dust entrainment</td><td>Wet suppression (hourly watering recommended) or chemical stabilization of unpaved roads.</td></tr>
<tr><td>Haul trucks to be restricted to specified haul roads using the most direct route.</td></tr>
<tr><td>Reduction of unnecessary traffic</td></tr>
<tr><td>Strict on-site speed control (i.e. 20 km/hr for haul trucks)</td></tr>
<tr><td rowspan="3">Materials storage, handling and transfer operations</td><td>Cover materials stockpiles with tarpaulins or store in protected temporary bunkers</td></tr>
<tr><td>Wet suppression, where feasible.</td></tr>
<tr><td>Use the minimum safe drop-heights for materials transfer.</td></tr>
<tr><td>Earthmoving operations</td><td>Wet suppression (hourly watering recommended), where feasible outside of rainy season.</td></tr>
</table>

Construction Activity	Recommended Control Measure(s)
	Use the minimum safe drop-heights for materials transfer.
	Limited area of bulk earthworks
Open areas (wind-blown emissions)	Reduction of extent of open areas to minimise the time between clearing and infrastructure construction; and/or use wind breaks and water suppression to reduce emissions from open areas
	Restriction of disturbances, such as materials transfer, to periods of low wind speeds (less than 5 m/s), where feasible.
	Stabilisation (chemical, rock cladding or vegetative) of disturbed soil
	Re-vegetation of cleared areas as soon as practically feasible

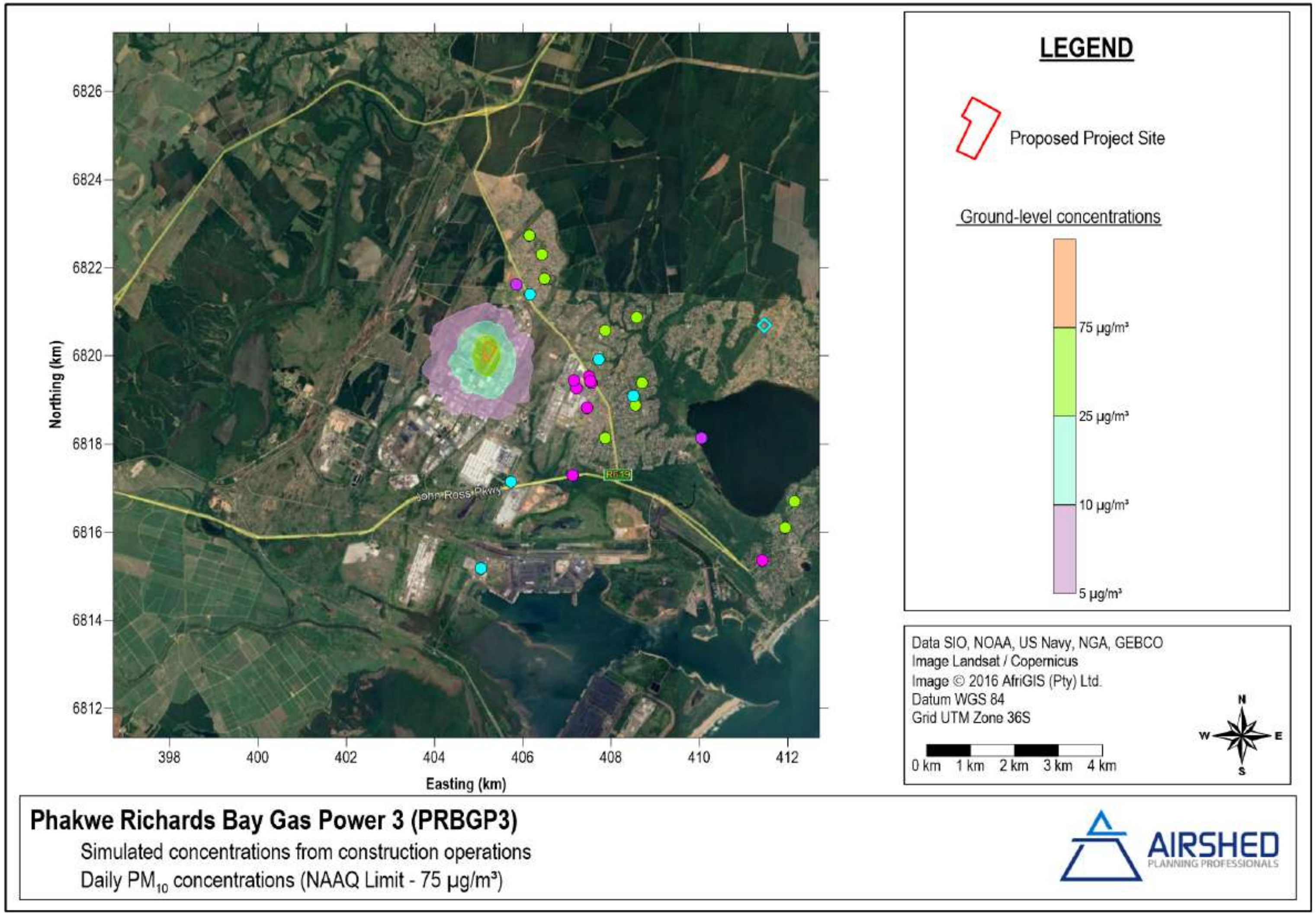

Figure 6-1: Simulated daily average PM_{10} concentrations due to construction phase emissions

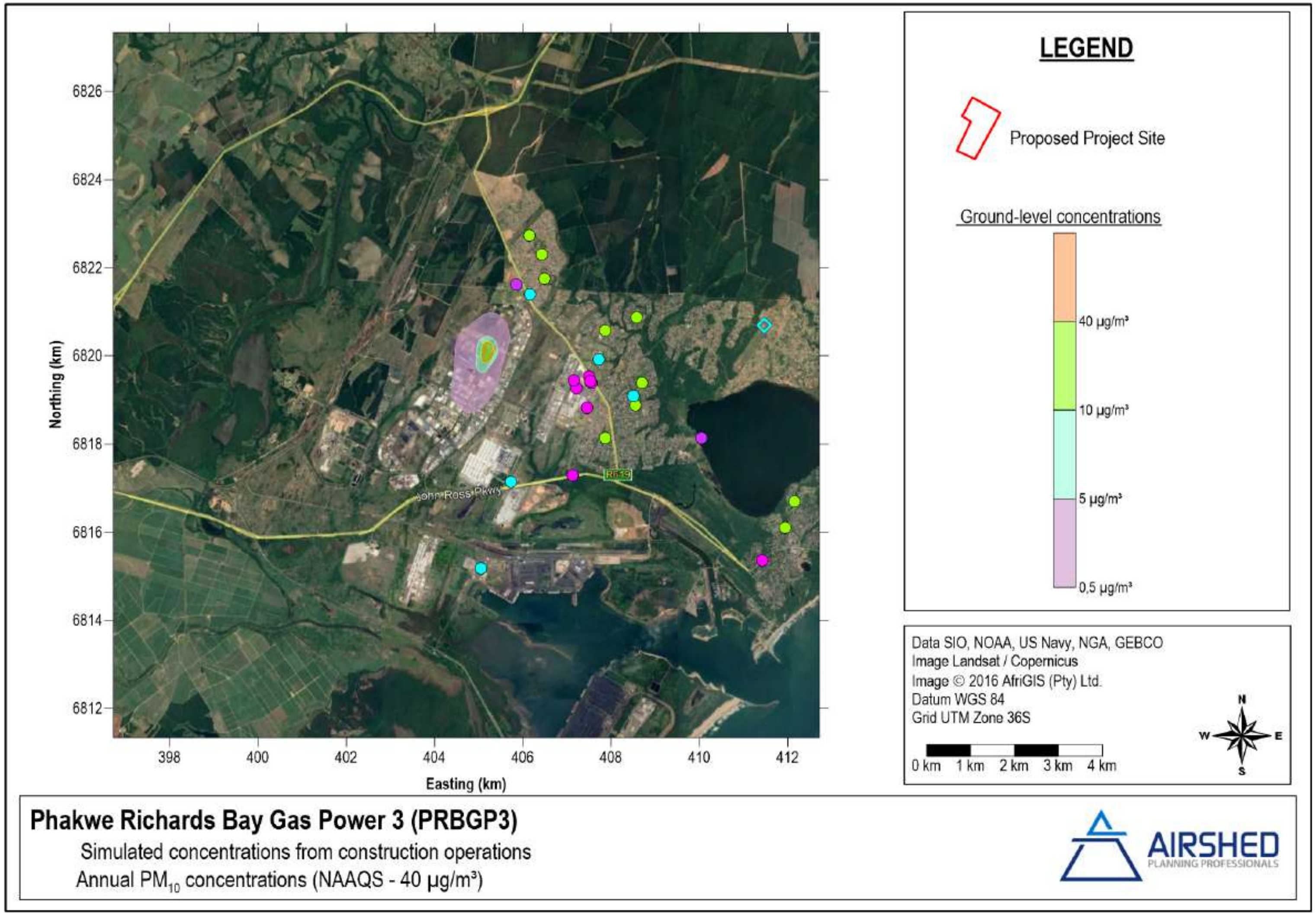

Figure 6-2: Simulated annual average PM_{10} concentrations due to construction phase emissions

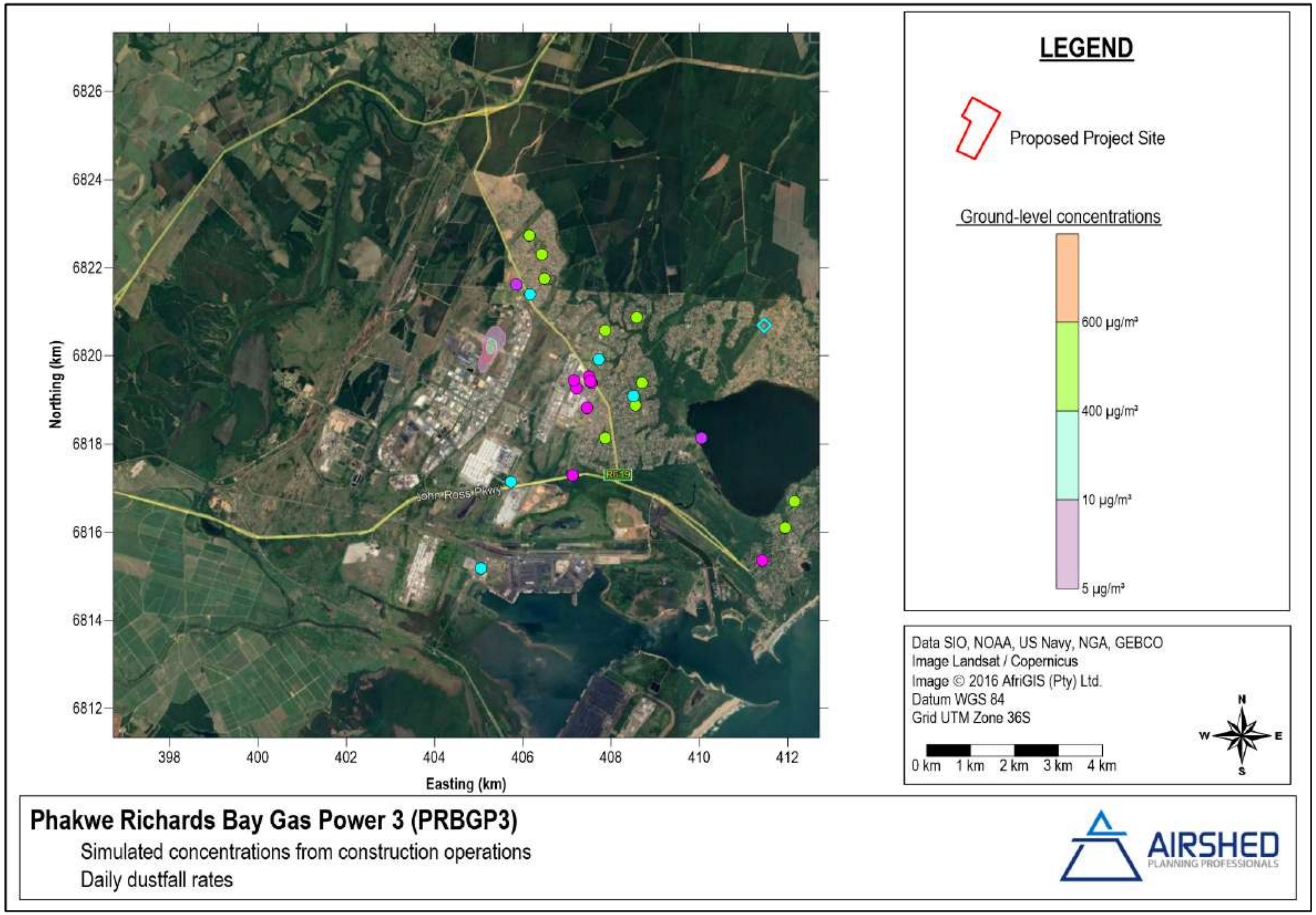

Figure 6-3: Simulated daily dustfall rates based on emission factors for construction phase emissions

7 IMPACT ASSESSMENT: OPERATIONAL PHASE

Impact of the Operational Phase of the project was simulated using the parameters and emission rates given in Section 3.4. Short-term (hourly or daily) concentrations were extracted at the 2nd rank per meteorological year and the maximum of the three-year modelling period was calculated for the presentation of results. All sensitive receptors – as defined in Section 5.1 - were included in the CALPUFF model setup as discrete receptors (Figure 5-1 and Table 5-1).

7.1.1 Simulated Incremental SO_2 Impacts

Two emission scenarios were considered in the simulation of SO_2 impacts: a) emissions based on MES, and, b) emissions calculated based on emission factors (Section 3.4).

Simulated SO_2 concentrations were higher under the MES scenario, where simulated ambient concentrations could exceed the hourly National Ambient Air Quality (NAAQ) limit value up to 6 km from the project site, resulting in up to 4 exceedances per year at the nearest receptors and AQMS (Table 7-1, Figure 7-1 and Figure 7-3). Exceedances of the daily NAAQ limit values were simulated to extend up to 1 km from site (Figure 7-5), however, there were no exceedances at the receptors or monitoring stations (Table 7-2, and Figure 7-2). There were no exceedances of the annual SO_2 NAAQS across the domain (Table 7-2 and Figure 7-7).

Emissions calculated based on emission factors represent a more realistic emission scenario, due to the inherently low sulfur content in natural gas. The simulated impacts in the emission factor scenario show concentrations below the hourly, daily, and annual NAAQ limit values across all sensitive receptors and monitoring stations (Table 7-1, Table 7-2, Figure 7-1, and Figure 7-2) and across the domain (Figure 7-4, Figure 7-6, and Figure 7-8).

Table 7-1: Simulated hourly average SO_2 concentrations and frequency of exceedance at the 20 closest receptors and all AQMS

Receptor	Hourly SO_2			
	Minimum Emission Standards	Operational Emissions	Minimum Emission Standards	Operational Emissions
	Concentration (µg/m³)		Frequency of Exceedance	
Richards Bay Municipal Clinic	106.2	0.005	1	0
Mens Clinic International - Richards Bay	16.9	0.001	4	0
Better2Know Private STD Health Centre Richards Bay	129.0	0.006	2	0
Umhlathuze Dental	16.4	0.001	4	0
Richardsbay Medical Institute	132.5	0.006	1	0
Mandlazini Clinic	16.5	0.001	2	0
The Bay Hospital	16.0	0.001	3	0
John Ross College	19.5	0.001	0	0
Richards Bay Secondary School	16.4	0.001	2	0
Veldenvlei Primary School	14.1	0.001	0	0
Arboretum Primary School	16.3	0.001	2	0
Brackenham Primary School	13.7	0.001	0	0
Richardsbaai Hoerskool	13.3	0.001	0	0
Bay Primary School	13.1	0.001	0	0
Richards Bay Christian School	13.2	0.001	1	0
Headache Clinic | Bay Chiropractic | Smile Dent	45.4	0.002	0	0
Richards Bay Primary School	7.2	0.000	0	0
St Francis Pre-Primary School	8.3	0.000	0	0
Old Mill High School	7.6	0.000	0	0
Empangeni Christian School	47.1	0.002	0	0
Scorpio (RBCAA)	170.6	0.008	3	0

Receptor	Hourly SO_2			
	Minimum Emission Standards	Operational Emissions	Minimum Emission Standards	Operational Emissions
	Concentration (µg/m³)		Frequency of Exceedance	
Bayside (RBCAA)	110.4	0.005	2	0
Harbour West (RBCAA)	15.5	0.001	1	0
Brackenham (RBCAA)	65.2	0.003	0	0
Brackenham (uMhlathuze)	14.0	0.001	0	0
CBD (RBCAA)	117.9	0.005	0	0
Arboretum (RBCAA)	105.1	0.005	0	0
Arboretum (uMhlathuze)	10.1	0.000	0	0
eNseleni (RBCAA)	41.0	0.002	0	0
Felixton (RBCAA)	17.8	0.001	0	0
eSikhaleni (RBCAA)	20.5	0.001	0	0
eSikhaleni (uMhlathuze)	20.6	0.001	0	0

Table 7-2: Simulated daily and annual average SO_2 concentrations and frequency of exceedance at the 20 closest receptors and all AQMS

Receptor	Daily SO_2 Concentration (µg/m³)		Annual SO_2 Concentration (µg/m³)	
	Minimum Emission Standards	Operational Emissions	Minimum Emission Standards	Operational Emissions
Richards Bay Municipal Clinic	30.8	0.0014	3.99	1.79E-04
Mens Clinic International - Richards Bay	14.6	0.0007	0.78	3.51E-05
Better2Know Private STD Health Centre Richards Bay	41.5	0.0019	6.45	2.89E-04
Umhlathuze Dental	16.6	0.0007	0.79	3.56E-05
Richardsbay Medical Institute	47.9	0.0021	8.21	3.68E-04
Mandlazini Clinic	13.6	0.0006	0.73	3.26E-05
The Bay Hospital	14.5	0.0007	0.74	3.31E-05
John Ross College	17.0	0.0008	0.87	3.89E-05
Richards Bay Secondary School	13.7	0.0006	0.74	3.31E-05
Veldenvlei Primary School	12.6	0.0006	0.67	2.99E-05
Arboretum Primary School	14.1	0.0006	0.76	3.42E-05
Brackenham Primary School	11.5	0.0005	0.60	2.68E-05
Richardsbaai Hoerskool	13.4	0.0006	0.69	3.09E-05
Bay Primary School	10.0	0.0004	0.57	2.53E-05
Richards Bay Christian School	9.9	0.0004	0.59	2.65E-05
Headache Clinic | Bay Chiropractic | Smile Dent	15.2	0.0007	2.23	9.98E-05
Richards Bay Primary School	5.5	0.0002	0.30	1.36E-05
St Francis Pre-Primary School	6.5	0.0003	0.35	1.55E-05
Old Mill High School	6.3	0.0003	0.32	1.42E-05
Empangeni Christian School	18.2	0.0008	2.42	1.08E-04
Scorpio (RBCAA)	64.5	0.0029	9.36	4.19E-04
Bayside (RBCAA)	35.5	0.0016	4.37	1.96E-04
Harbour West (RBCAA)	12.9	0.0006	0.67	3.01E-05
Brackenham (RBCAA)	25.5	0.0011	1.95	8.72E-05
Brackenham (uMhlathuze)	9.9	0.0004	0.60	2.70E-05
CBD (RBCAA)	27.7	0.0012	4.68	2.09E-04
Arboretum (RBCAA)	23.9	0.0011	3.28	1.47E-04
Arboretum (uMhlathuze)	7.5	0.0003	0.41	1.82E-05
eNseleni (RBCAA)	14.0	0.0006	2.00	8.97E-05
Felixton (RBCAA)	5.6	0.0003	0.66	2.98E-05
eSikhaleni (RBCAA)	6.2	0.0003	0.97	4.32E-05
eSikhaleni (uMhlathuze)	6.3	0.0003	0.96	4.32E-05

Figure 7-1: Time series of the hourly SO_2 concentrations simulated at the nearest AQMS and receptor

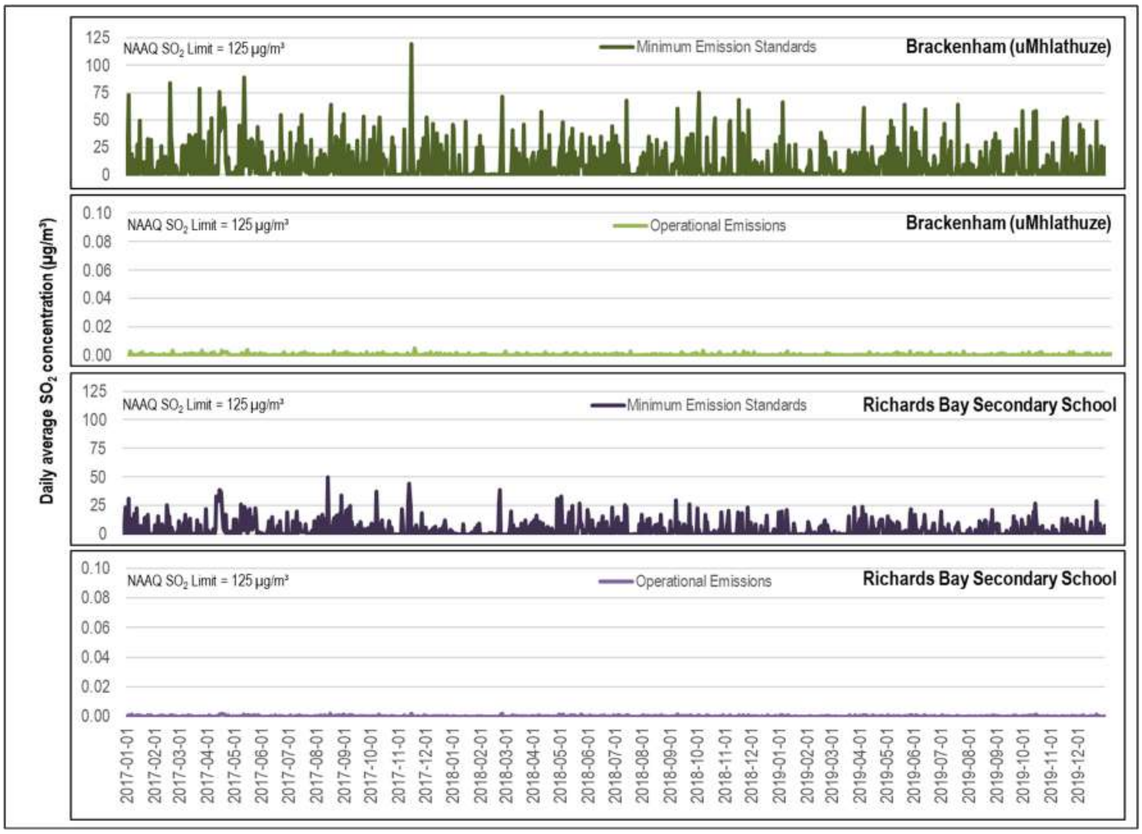

Figure 7-2: Time series of the daily SO_2 concentrations simulated at the nearest AQMS and receptor

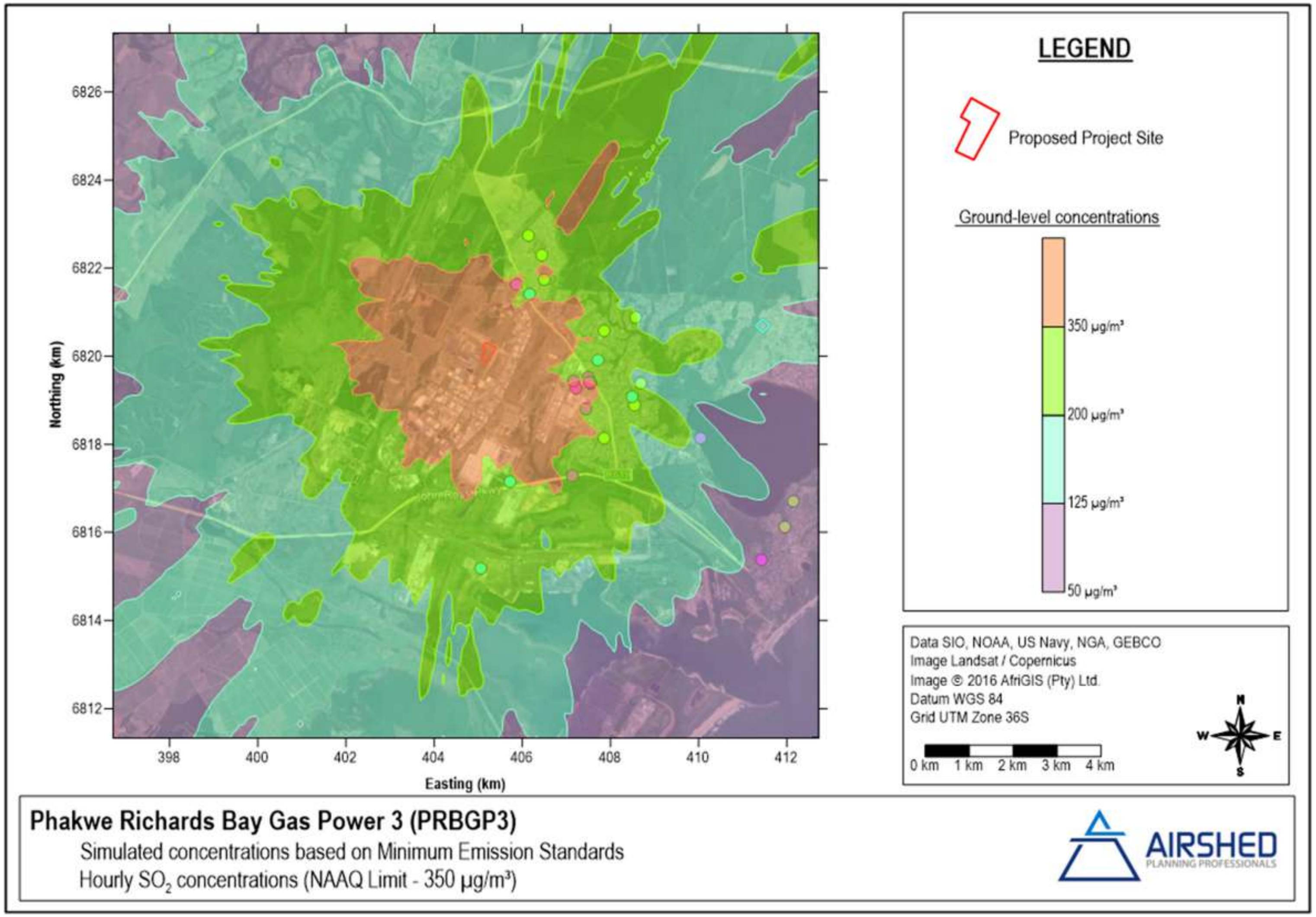

Figure 7-3: Simulated hourly average SO_2 concentrations based on Minimum Emission Standards

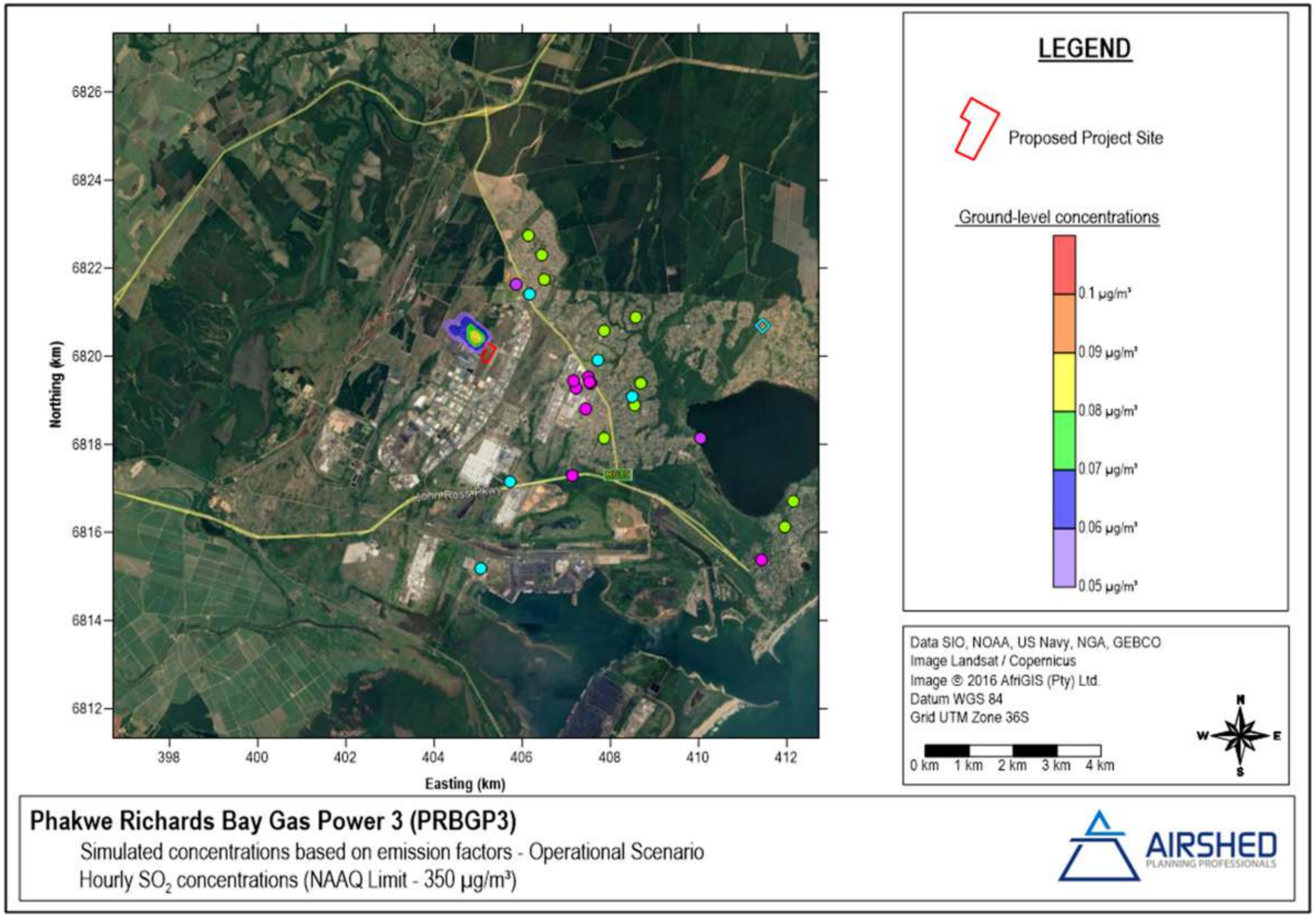

Figure 7-4: Simulated hourly average SO_2 concentrations based on emission factors

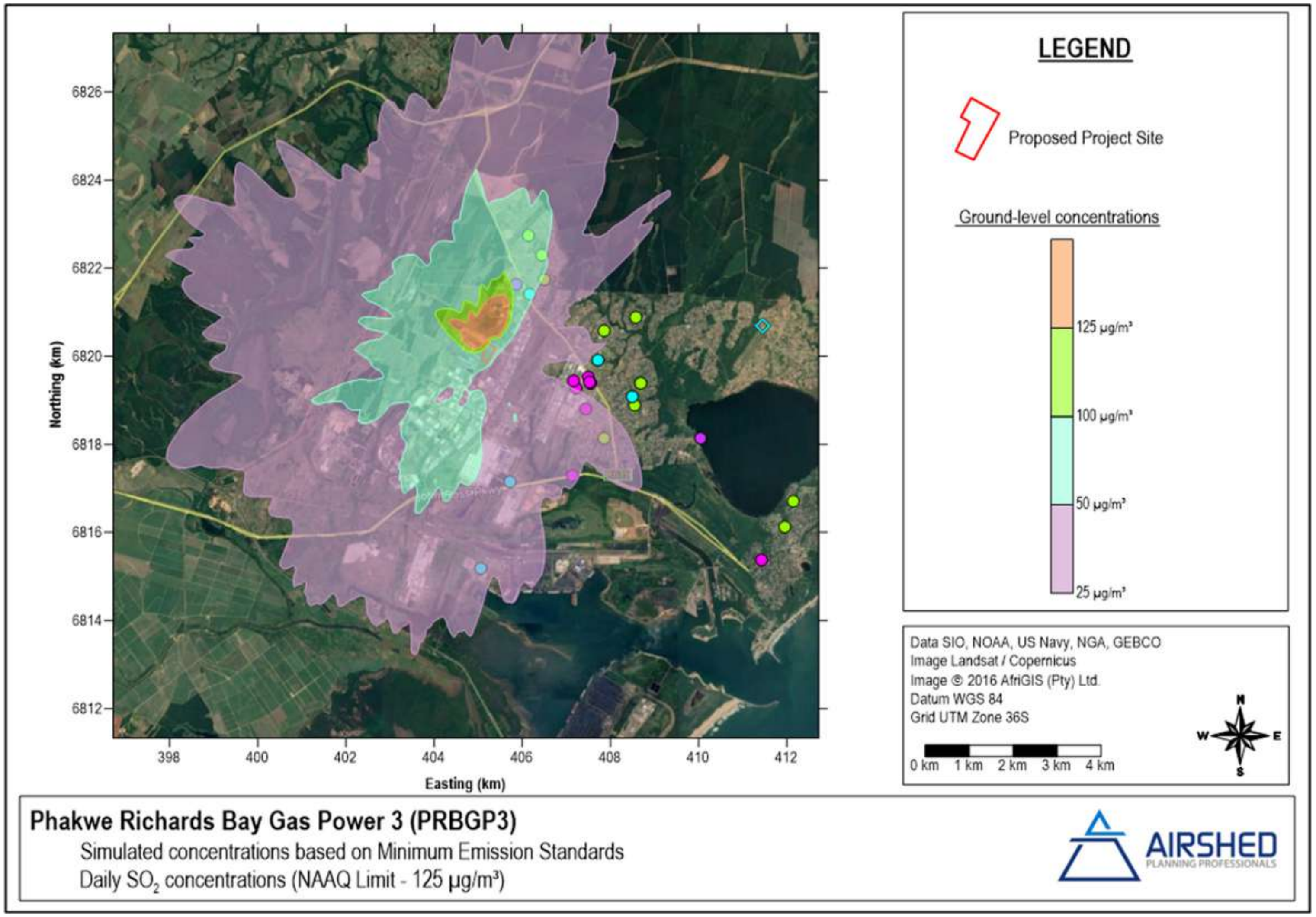

Figure 7-5: Simulated daily average SO_2 concentrations based on Minimum Emission Standards

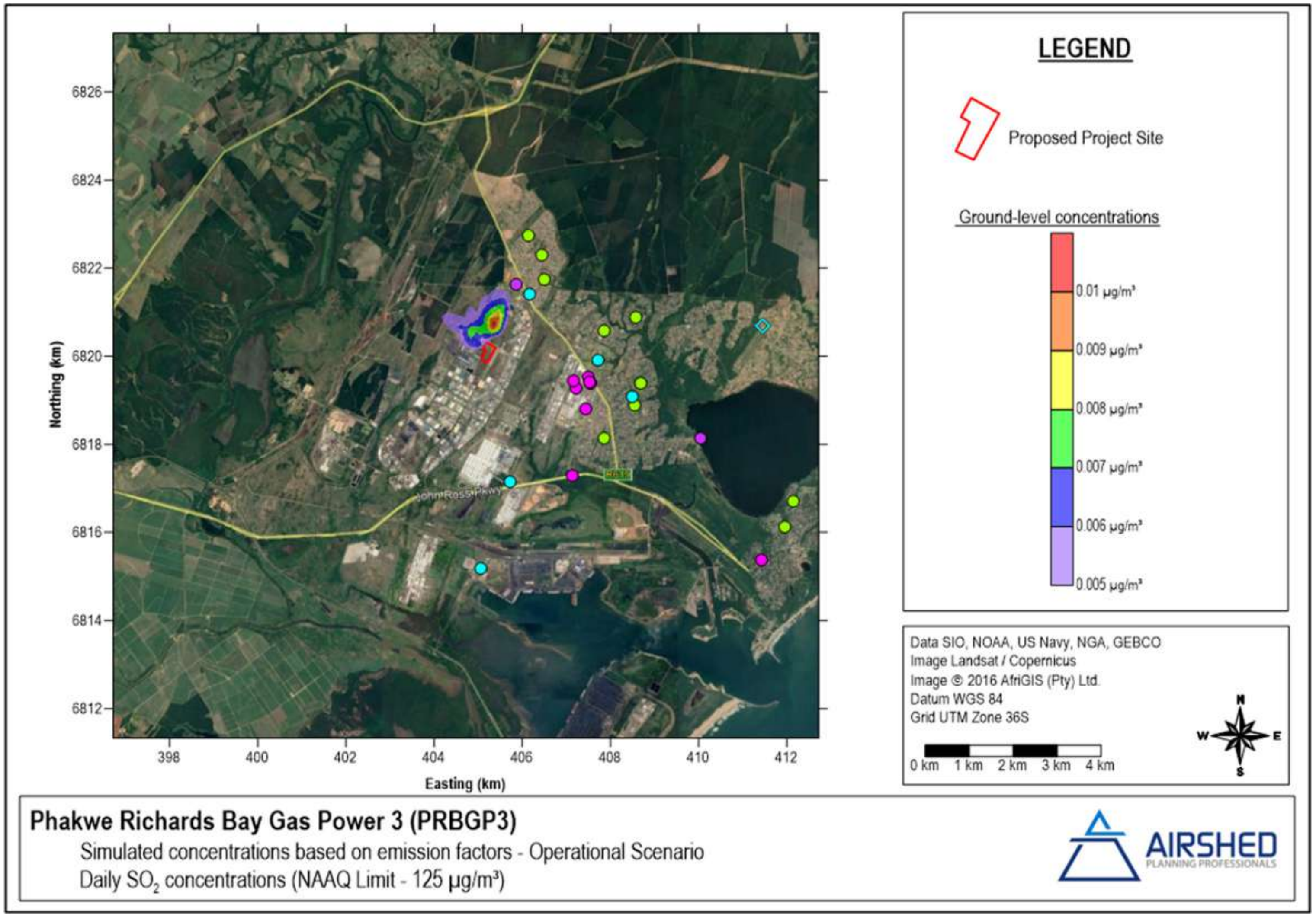

Figure 7-6: Simulated daily average SO_2 concentrations based on emission factors

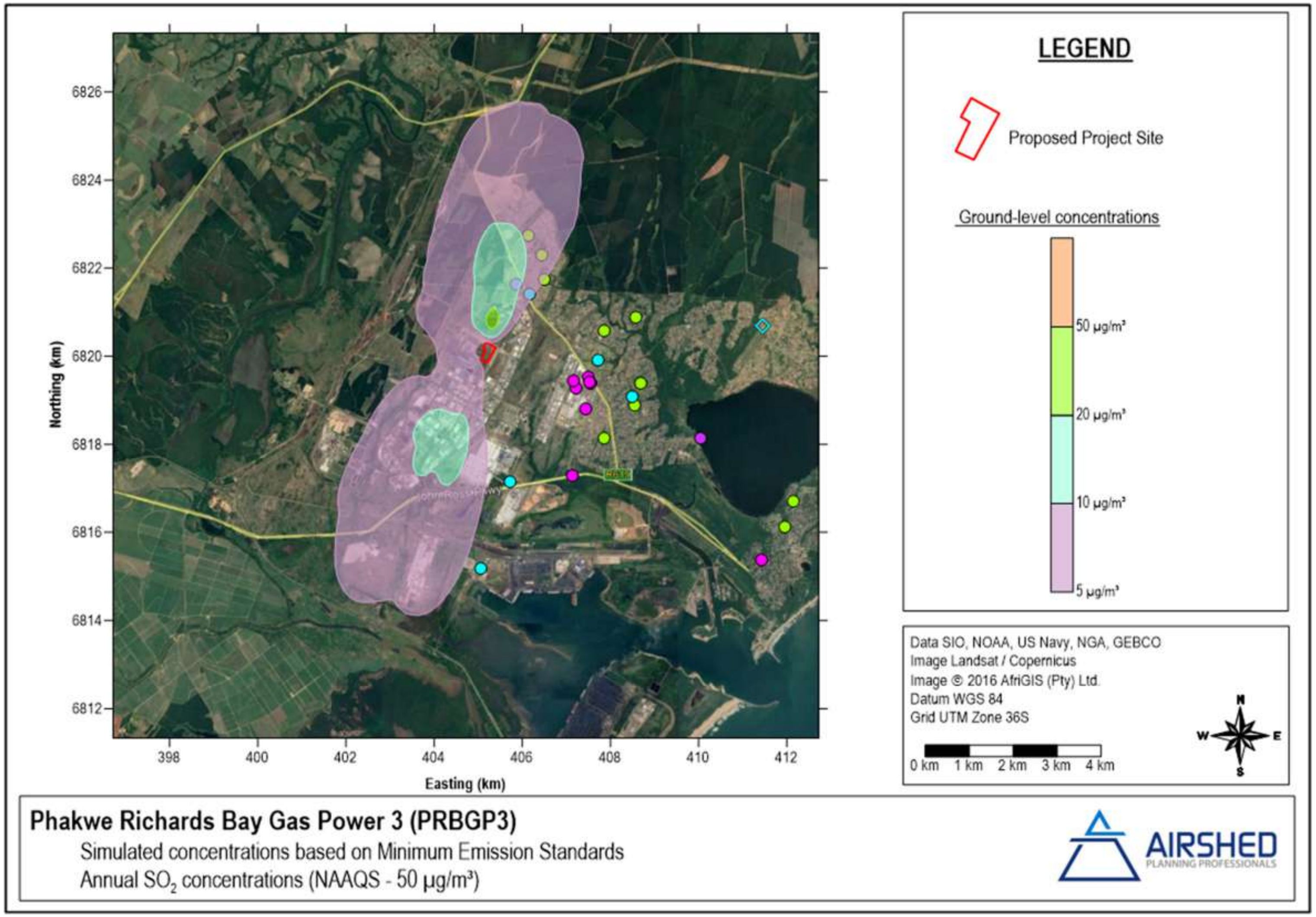

Figure 7-7: Simulated annual average SO_2 concentrations based on Minimum Emission Standards

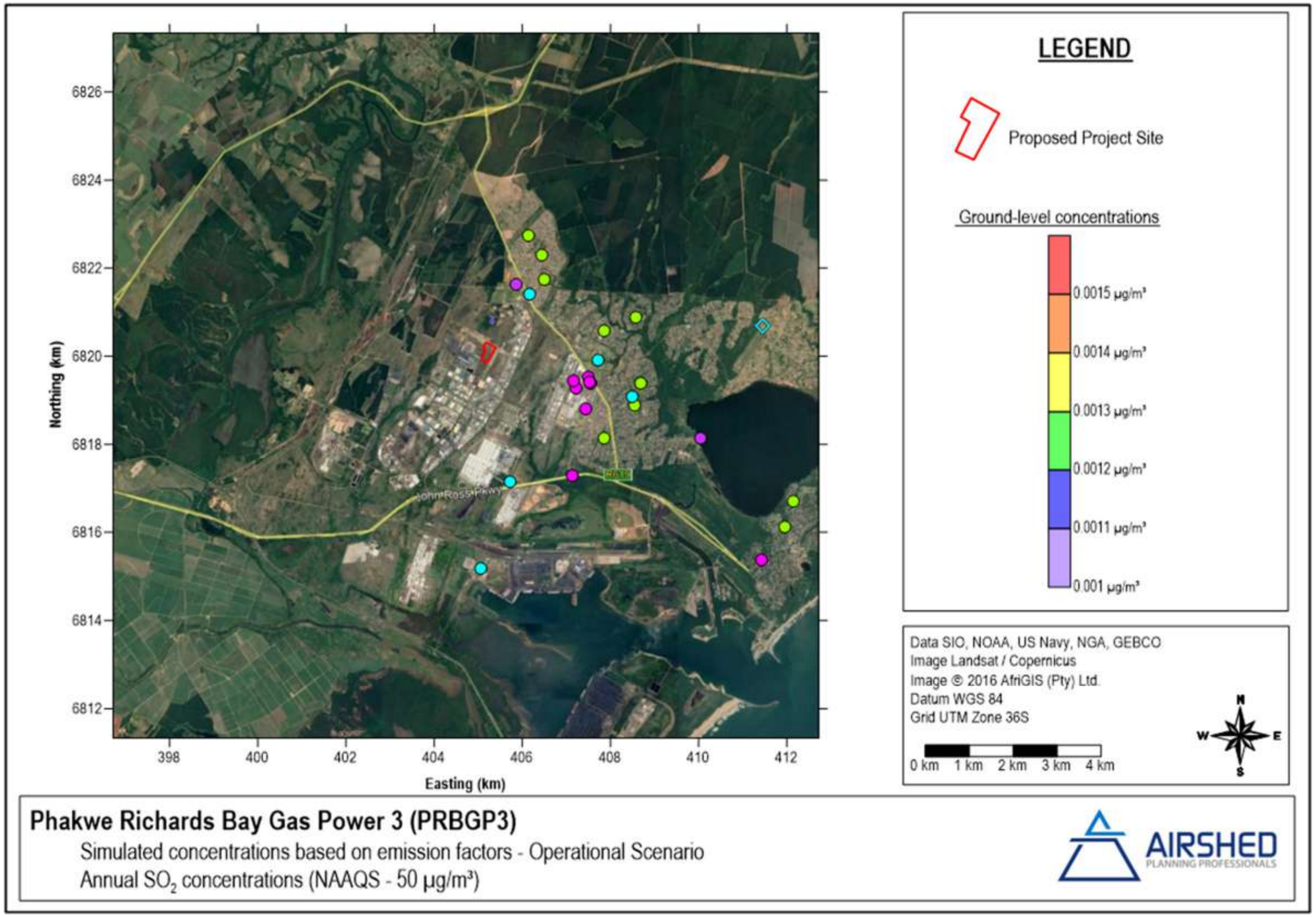

Figure 7-8: Simulated annual average SO_2 concentrations based on emission factors

7.1.2 Simulated Incremental NO_2 Impacts – Normal Operations

The CALPUFF model simulated oxides of nitrogen (NO_X). Hourly and annual average NO_2 concentrations were calculated from simulated NO_X concentrations assuming a full 100% conversion ratio (Tier 1 as described in the Regulations regarding Air Dispersion Modelling - Government Gazette No. 37804 vol. 589; 11 July 2014). No exceedances of the hourly NAAQ limit concentration were simulated at any sensitive receptors and monitoring stations (Table 7-3 and Figure 7-9), however, NO_2 concentrations within 500 m of the project could exceed the hourly NAAQ limit value (Figure 7-10). Simulated annual average NO_2 concentrations are below the NAAQS across the domain (Table 7-3 and Figure 7-11).

Table 7-3: Simulated hourly (including frequency of exceedance) and annual average NO_2 concentrations at the 20 closest receptors and all AQMS

Receptor	Hourly NO_2 Concentration (µg/m³)	Frequency of Exceedance	Annual NO_2 Concentration (µg/m³)
Richards Bay Municipal Clinic	13.19	0	0.49
Mens Clinic International - Richards Bay	1.69	0	0.09
Better2Know Private STD Health Centre Richards Bay	16.02	0	0.79
Umhlathuze Dental	1.72	0	0.09
Richardsbay Medical Institute	16.50	0	1.01
Mandlazini Clinic	1.65	0	0.08
The Bay Hospital	1.67	0	0.08
John Ross College	2.00	0	0.10
Richards Bay Secondary School	1.66	0	0.08
Veldenvlei Primary School	1.43	0	0.07
Arboretum Primary School	1.61	0	0.08
Brackenham Primary School	1.35	0	0.07
Richardsbaai Hoerskool	1.33	0	0.08
Bay Primary School	1.34	0	0.06
Richards Bay Christian School	1.34	0	0.06
Headache Clinic | Bay Chiropractic | Smile Dent	5.53	0	0.27
Richards Bay Primary School	0.73	0	0.03
St Francis Pre-Primary School	0.83	0	0.04
Old Mill High School	0.78	0	0.03
Empangeni Christian School	5.75	0	0.29
Scorpio (RBCAA)	21.29	0	1.16
Bayside (RBCAA)	13.69	0	0.53
Harbour West (RBCAA)	1.49	0	0.07
Brackenham (RBCAA)	7.50	0	0.23
Brackenham (uMhlathuze)	1.43	0	0.07
CBD (RBCAA)	14.59	0	0.57
Arboretum (RBCAA)	12.83	0	0.39
Arboretum (uMhlathuze)	0.99	0	0.04
eNseleni (RBCAA)	4.98	0	0.24
Felixton (RBCAA)	1.89	0	0.07
eSikhaleni (RBCAA)	2.26	0	0.11
eSikhaleni (uMhlathuze)	2.23	0	0.11

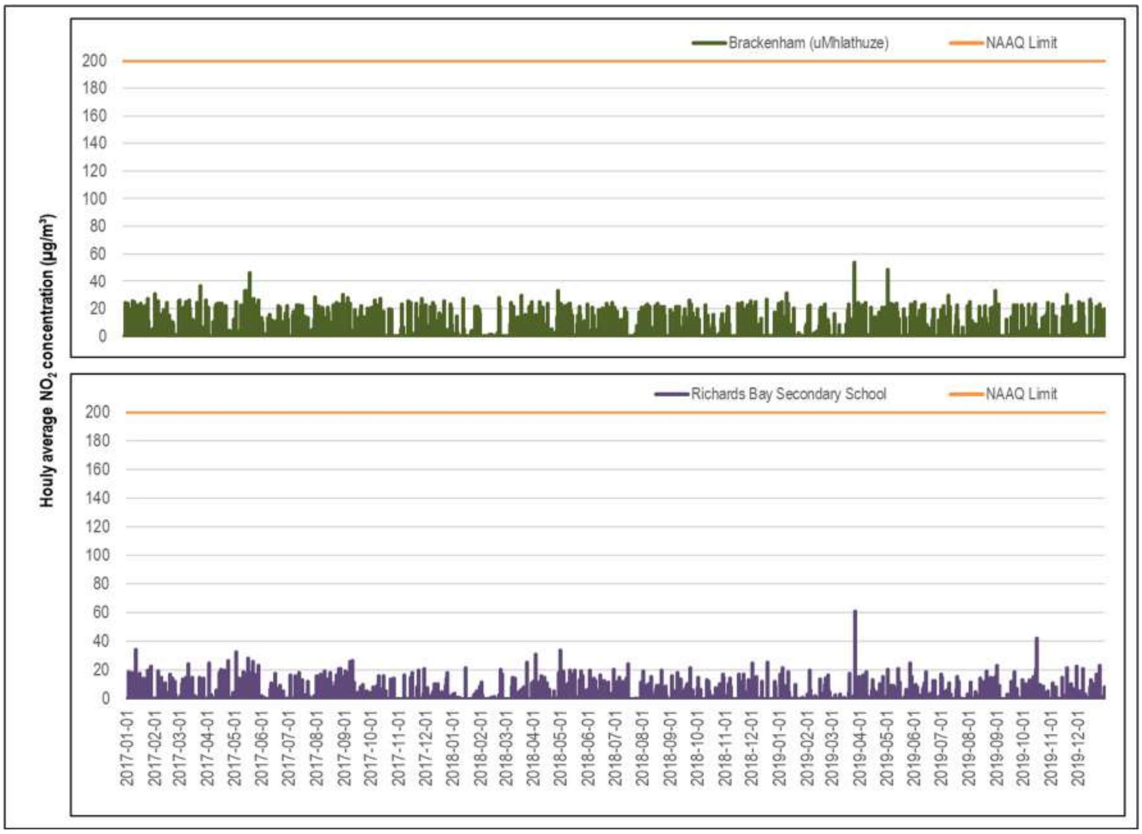

Figure 7-9: Time series of the hourly NO_2 concentrations simulated at the nearest AQMS and receptor

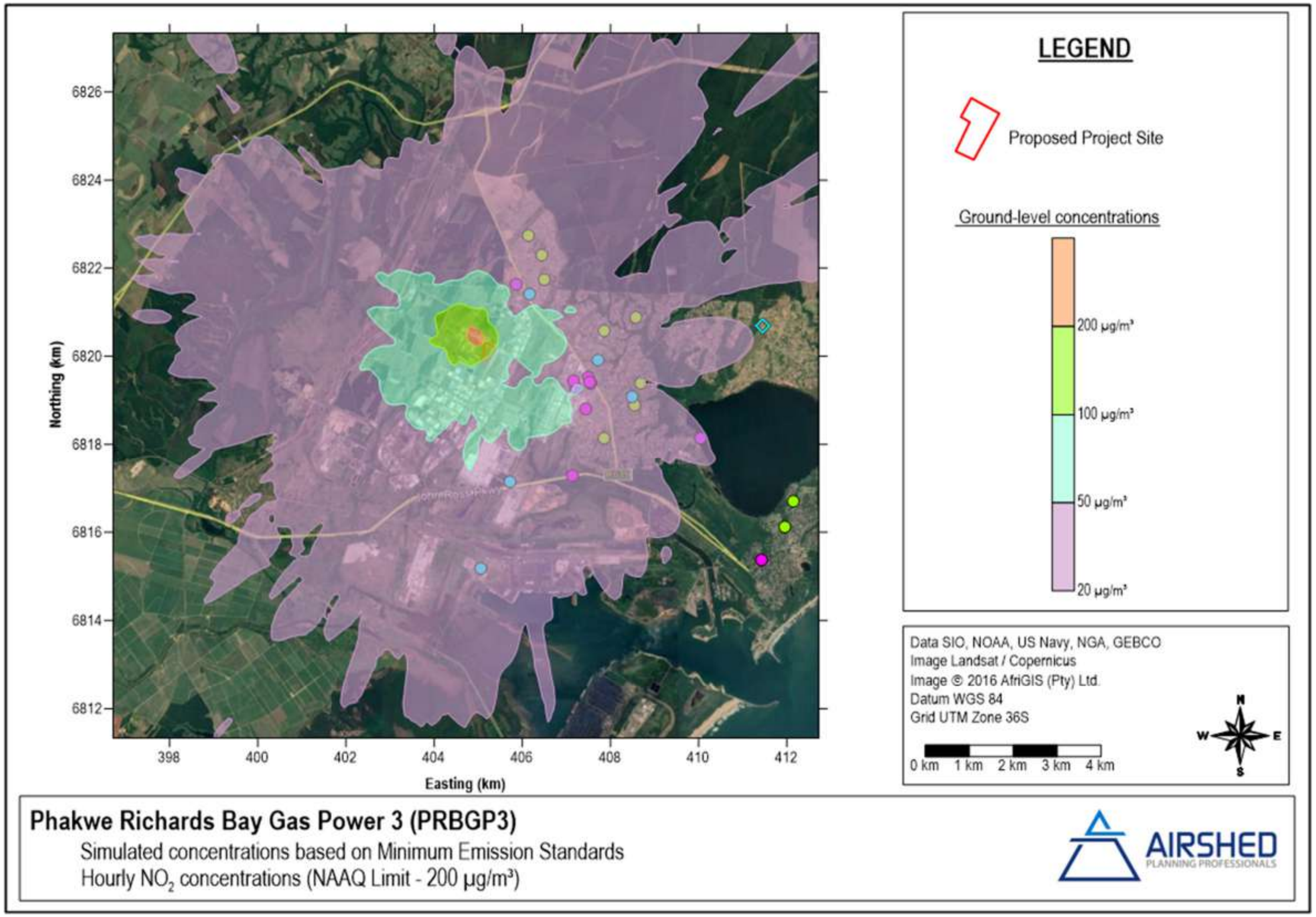

Figure 7-10: Simulated hourly average NO_2 concentrations due to emissions based on Minimum Emission Standards

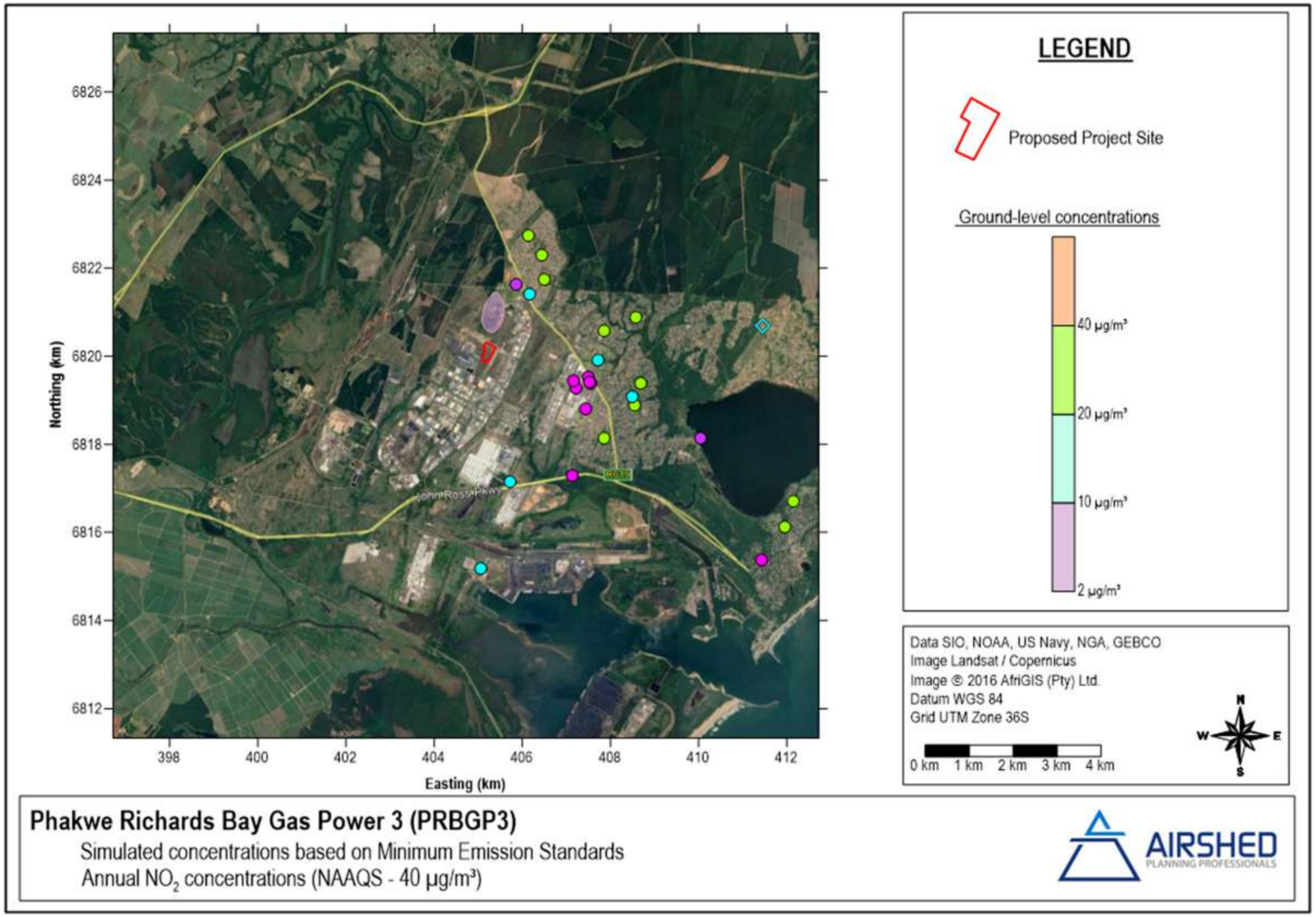

Figure 7-11: Simulated annual average NO_2 concentrations based on Minimum Emission Standards

7.1.3 Simulated Incremental NO_2 Impacts – Start-up

Emissions of NO_X are likely to be higher than normal operation during start-up periods. The impact of ambient concentrations during these periods was estimated at the 20 nearest sensitive receptors and all AQMS using the parameters described in Section 3.4.3 (Table 7-4). Simulated NO_X concentrations were assumed to completely convert to NO_2 (Tier 1 screening method as described in the Regulations regarding Air Dispersion Modelling - Government Gazette No. 37804 vol. 589; 11 July 2014). Simulated NO_2 concentrations due to start-up were corrected to hourly and annual average concentrations for comparison against the NAAQS.

Based on the information available and assumptions made, the hourly NO_2 concentrations associated with start-up could exceed the NAAQ limit concentrations at 15 receptors and 8 AQMS (Table 7-4).

Annual NO_2 concentrations associated with start-up were calculated based on a 16-hour operational period (5840 operational hours annually) with a total of 365 start-ups per year. This scenario was selected because meeting mid-merit load requirements will require more start-ups and therefore have a larger impact on air quality than continuous (24 hours per day) operation. The contribution of start-up emissions to the annual NO_2 concentration at receptors and AQMS was 4.87 µg/m³ or lower (Table 7-4). No exceedances of the annual NO_2 NAAQS (40 µg/m³) are expected due to the combined impact of start-up and normal operations (additive effect of annual concentrations in Table 7-3 and Table 7-4).

Table 7-4: Simulated NO_2 concentrations for emissions associated with plant start-up (bold text indicates exceedance of NAAQ limit concentration)

Receptor	Hourly NO_2 concentration (µg/m³) due to start-up (30 mins)	Annual start-up scenarios
		16 hours per day; 365 starts per year
Richards Bay Municipal Clinic	**294.81**	0.50
Mens Clinic International - Richards Bay	**434.06**	0.46
Better2Know Private STD Health Centre Richards Bay	**429.94**	0.46
Umhlathuze Dental	**403.57**	0.45
Richardsbay Medical Institute	**372.69**	0.43
Mandlazini Clinic	**388.52**	0.43
The Bay Hospital	**377.78**	0.44
John Ross College	**347.87**	0.41
Richards Bay Secondary School	**500.90**	2.10
Veldenvlei Primary School	**323.50**	0.40
Arboretum Primary School	**378.77**	0.36
Brackenham Primary School	**563.75**	3.37
Richardsbaai Hoerskool	**226.99**	0.35
Bay Primary School	**377.29**	4.27
Richards Bay Christian School	**284.66**	0.37
Headache Clinic | Bay Chiropractic | Smile Dent	130.41	0.25
Richards Bay Primary School	135.48	0.24
St Francis Pre-Primary School	109.33	0.23
Old Mill High School	91.85	0.41
Empangeni Christian School	78.06	0.38
Scorpio (RBCAA)	**337.59**	1.04
Bayside (RBCAA)	**251.64**	2.44
Harbour West (RBCAA)	**264.63**	1.73
Brackenham (RBCAA)	**689.75**	2.30
Brackenham (uMhlathuze)	**443.14**	4.87
CBD (RBCAA)	**374.29**	0.40

Receptor	Hourly NO_2 concentration (µg/m³) due to start-up (30 mins)	Annual start-up scenarios
		16 hours per day; 365 starts per year
Arboretum (RBCAA)	**337.67**	0.37
Arboretum (uMhlathuze)	**219.97**	0.27
eNseleni (RBCAA)	161.19	1.08
Felixton (RBCAA)	67.62	0.39
eSikhaleni (RBCAA)	86.95	0.54
eSikhaleni (uMhlathuze)	83.26	0.54

7.1.4 Simulated Incremental Particulate Matter Impacts

Simulated particulate matter concentrations, in both the PM_{10} and $PM_{2.5}$ fractions, as a result of the project were below all the respective NAAQ limit values at all sensitive receptors and monitoring stations (Table 7-5, Table 7-6, Figure 7-12, and Figure 7-13) and across the domain (Figure 7-14, Figure 7-15, Figure 7-16, and Figure 7-17).

Table 7-5: Simulated daily (including frequency of exceedance) and annual average PM_{10} concentrations at the 20 closest receptors and all AQMS

Receptor	Daily PM_{10} Concentration (µg/m³)	Annual PM_{10} Concentration (µg/m³)
Richards Bay Municipal Clinic	0.9	0.13
Mens Clinic International - Richards Bay	0.7	0.04
Better2Know Private STD Health Centre Richards Bay	1.1	0.19
Umhlathuze Dental	0.7	0.04
Richardsbay Medical Institute	1.3	0.24
Mandlazini Clinic	0.7	0.04
The Bay Hospital	0.6	0.04
John Ross College	0.7	0.04
Richards Bay Secondary School	0.6	0.04
Veldenvlei Primary School	0.6	0.04
Arboretum Primary School	0.7	0.04
Brackenham Primary School	0.6	0.04
Richardsbaai Hoerskool	0.7	0.04
Bay Primary School	0.5	0.03
Richards Bay Christian School	0.6	0.03
Headache Clinic | Bay Chiropractic | Smile Dent	0.6	0.09
Richards Bay Primary School	0.4	0.02
St Francis Pre-Primary School	0.4	0.02
Old Mill High School	0.4	0.02
Empangeni Christian School	0.6	0.09
Scorpio (RBCAA)	1.7	0.27
Bayside (RBCAA)	1.1	0.14
Harbour West (RBCAA)	0.6	0.04
Brackenham (RBCAA)	0.9	0.08
Brackenham (uMhlathuze)	0.6	0.04
CBD (RBCAA)	0.8	0.15
Arboretum (RBCAA)	0.8	0.11
Arboretum (uMhlathuze)	0.4	0.03
eNseleni (RBCAA)	0.5	0.08
Felixton (RBCAA)	0.4	0.04
eSikhaleni (RBCAA)	0.4	0.05
eSikhaleni (uMhlathuze)	0.4	0.05

Table 7-6: Simulated daily (including frequency of exceedance) and annual average $PM_{2.5}$ concentrations at the 20 closest receptors and all AQMS

Receptor	Daily $PM_{2.5}$ Concentration (µg/m³)	Annual $PM_{2.5}$ Concentration (µg/m³)
Richards Bay Municipal Clinic	0.9	0.13
Mens Clinic International - Richards Bay	0.7	0.04
Better2Know Private STD Health Centre Richards Bay	1.1	0.19
Umhlathuze Dental	0.7	0.04
Richardsbay Medical Institute	1.3	0.24
Mandlazini Clinic	0.7	0.04
The Bay Hospital	0.6	0.04
John Ross College	0.7	0.04
Richards Bay Secondary School	0.6	0.04
Veldenvlei Primary School	0.6	0.04
Arboretum Primary School	0.7	0.04
Brackenham Primary School	0.6	0.04
Richardsbaai Hoerskool	0.7	0.04
Bay Primary School	0.5	0.03
Richards Bay Christian School	0.6	0.03
Headache Clinic | Bay Chiropractic | Smile Dent	0.6	0.09
Richards Bay Primary School	0.4	0.02
St Francis Pre-Primary School	0.4	0.02
Old Mill High School	0.4	0.02
Empangeni Christian School	0.6	0.09
Scorpio (RBCAA)	1.7	0.27
Bayside (RBCAA)	1.1	0.14
Harbour West (RBCAA)	0.6	0.04
Brackenham (RBCAA)	0.9	0.08
Brackenham (uMhlathuze)	0.6	0.04
CBD (RBCAA)	0.8	0.15
Arboretum (RBCAA)	0.8	0.11
Arboretum (uMhlathuze)	0.4	0.03
eNseleni (RBCAA)	0.5	0.08
Felixton (RBCAA)	0.4	0.04
eSikhaleni (RBCAA)	0.4	0.05
eSikhaleni (uMhlathuze)	0.4	0.05

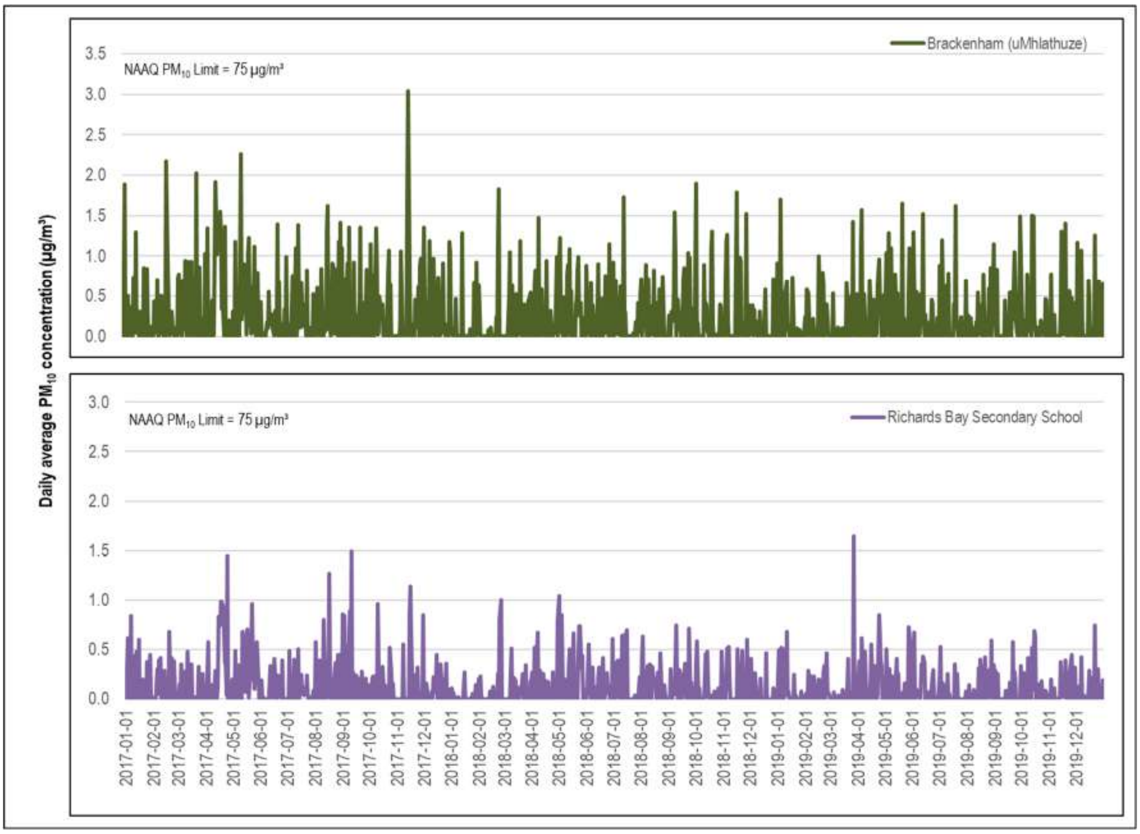

Figure 7-12: Time series of the daily average PM_{10} concentrations simulated at the nearest AQMS and receptor

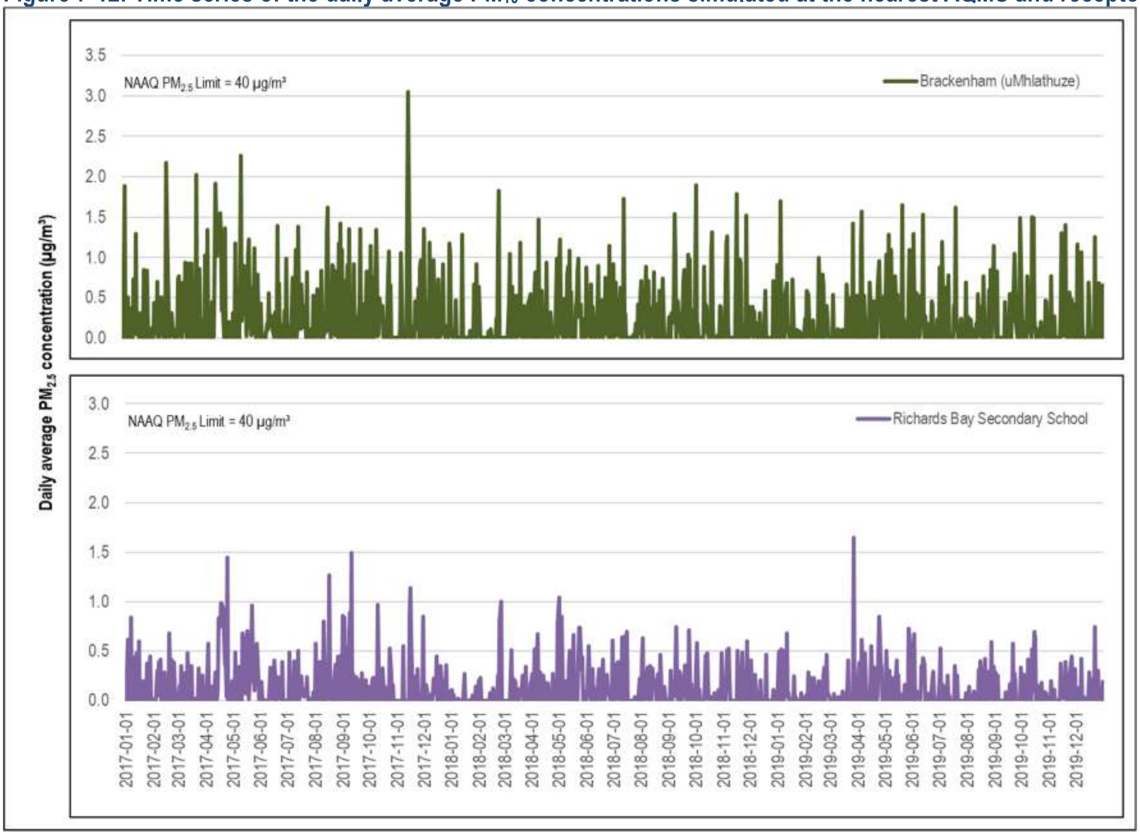

Figure 7-13: Time series of the daily average $PM_{2.5}$ concentrations simulated at the nearest AQMS and receptor

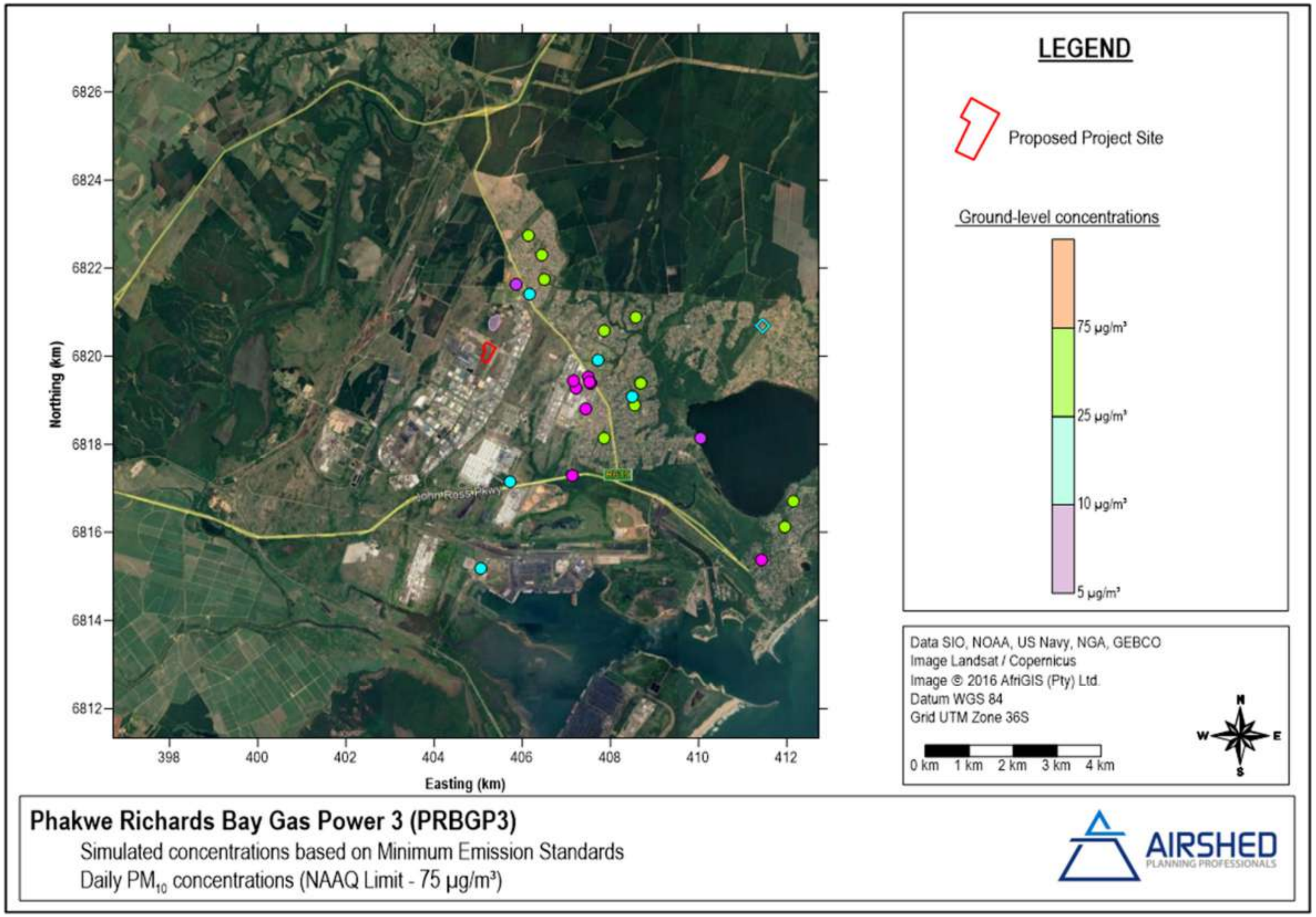

Figure 7-14: Simulated daily average PM_{10} concentrations based on Minimum Emission Standards

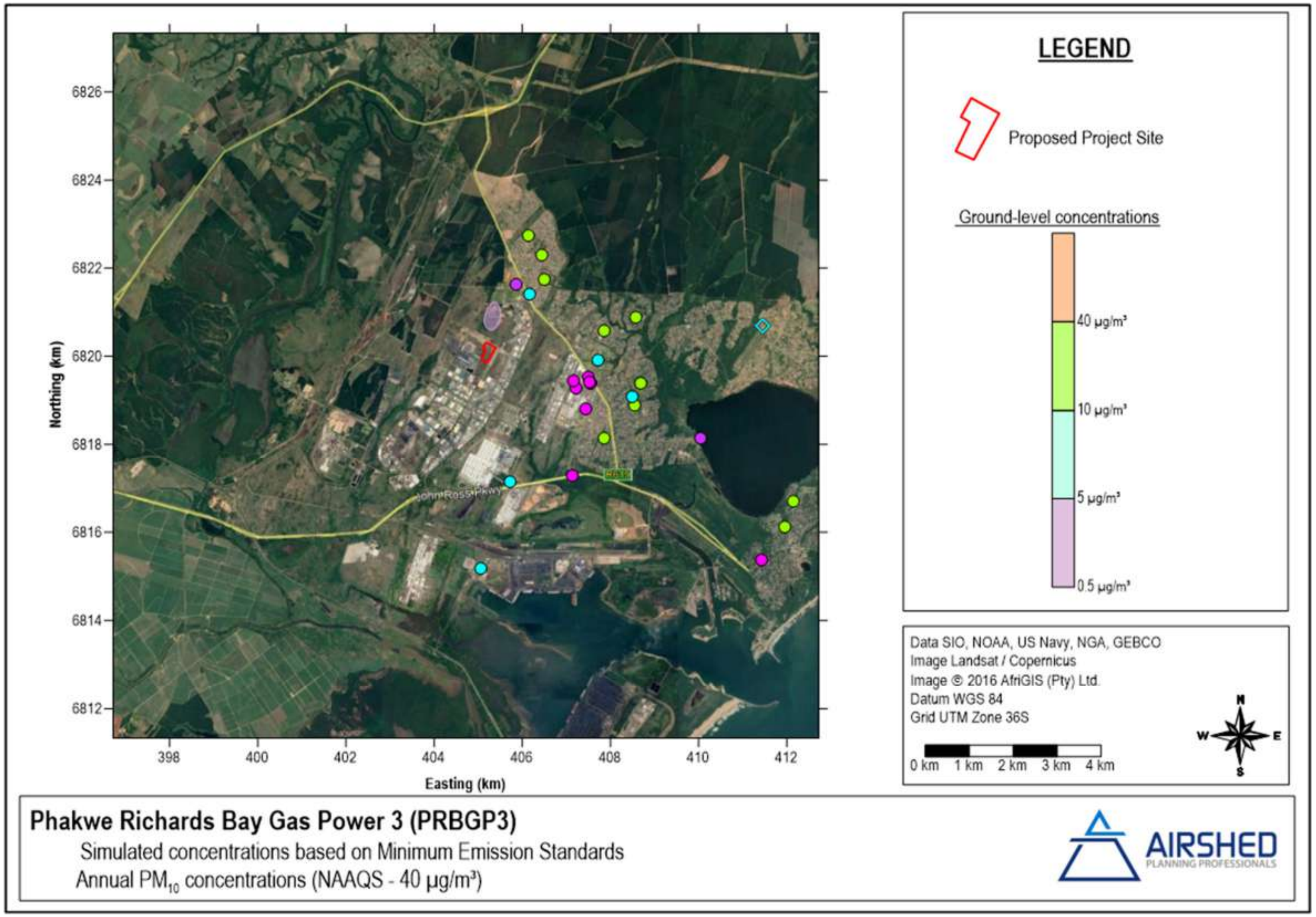

Figure 7-15: Simulated annual average PM_{10} concentrations based on Minimum Emission Standards

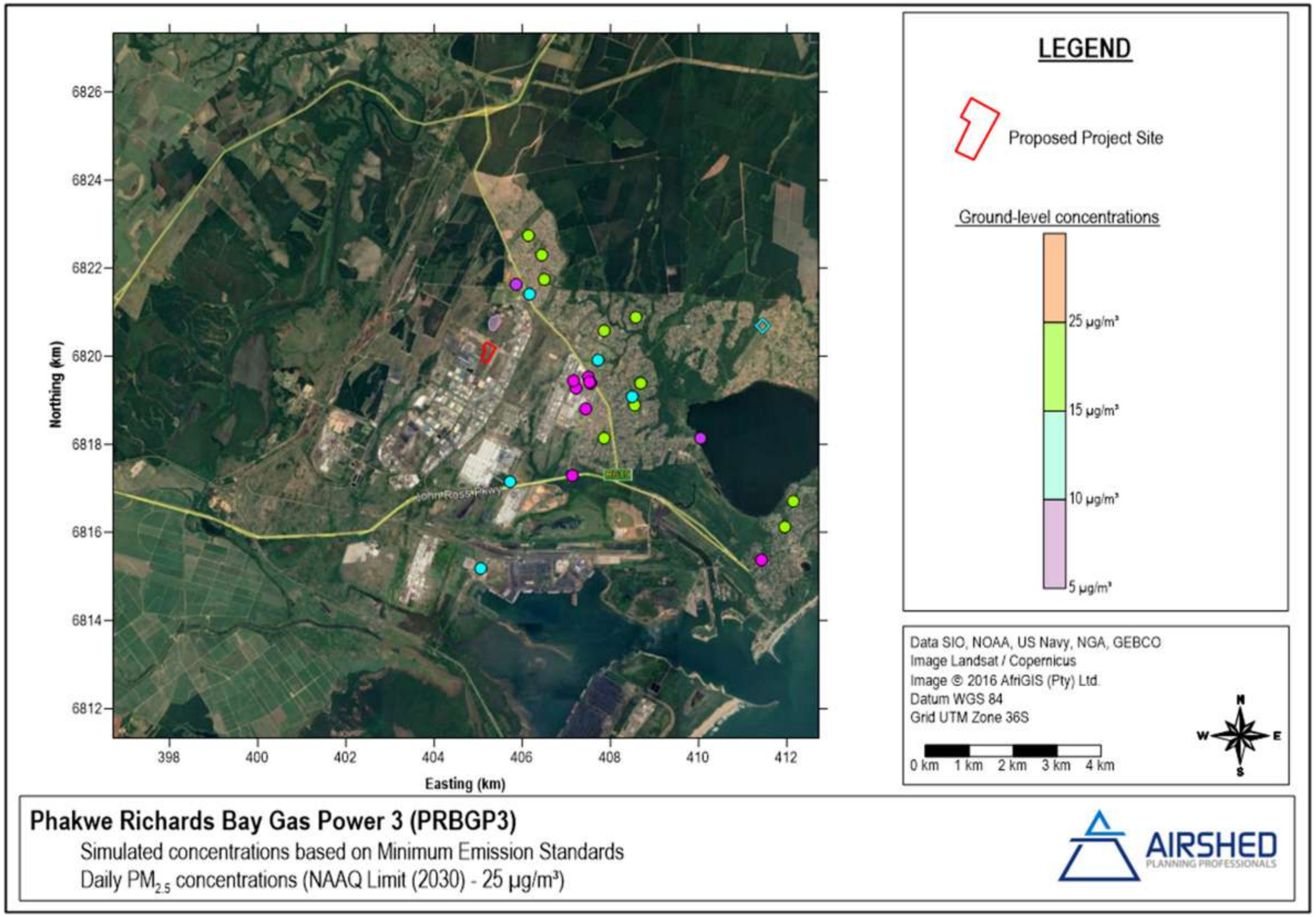

Figure 7-16: Simulated daily average $PM_{2.5}$ concentrations based on Minimum Emission Standards

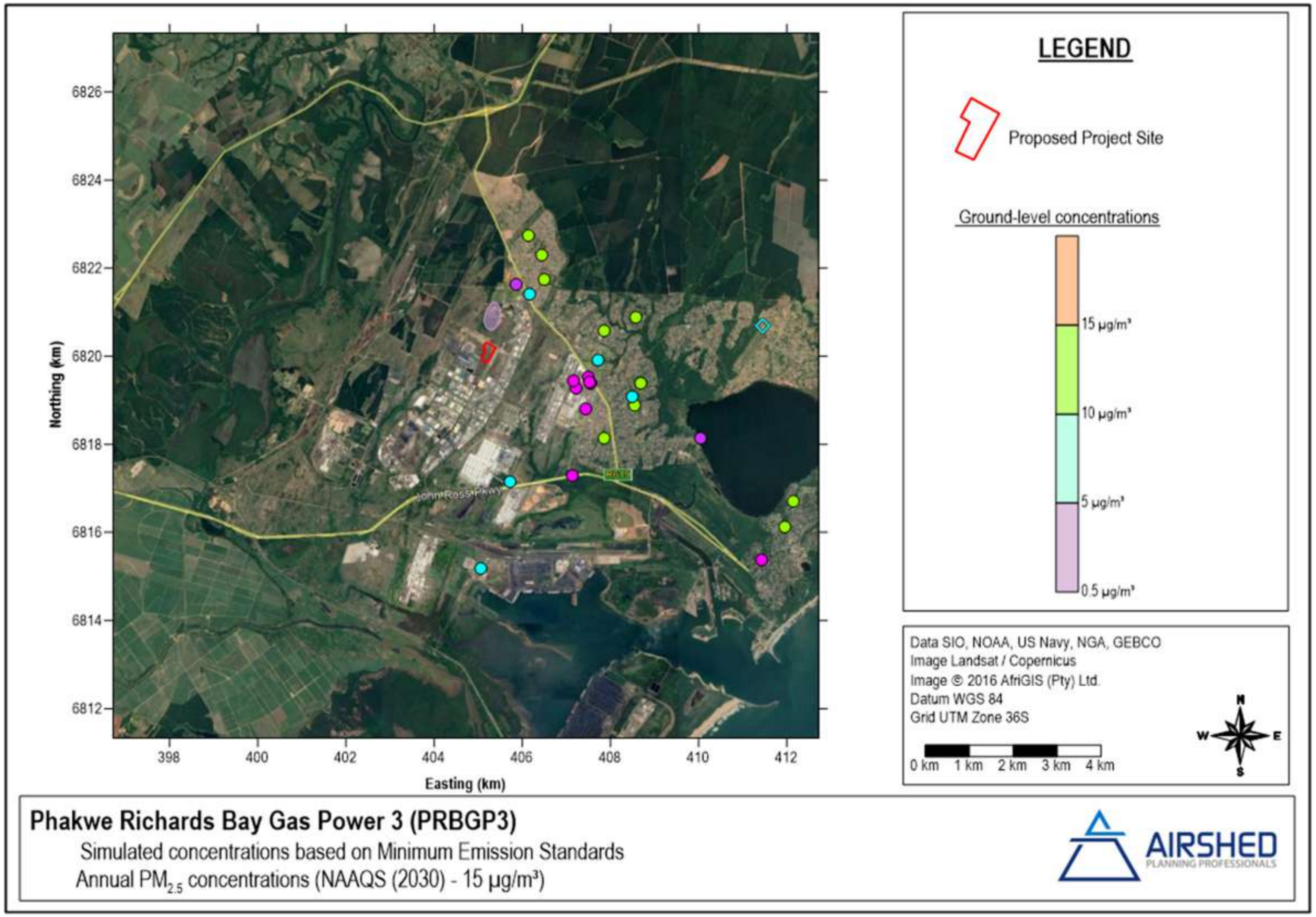

Figure 7-17: Simulated annual average $PM_{2.5}$ concentrations based on Minimum Emission Standards

7.1.5 Simulated Incremental CO Impacts

Simulated hourly CO concentrations as a result of the project are lower than the NAAQ limit values across the domain (Figure 7-18) including at all sensitive receptors and monitoring stations.

7.1.6 Simulated Incremental VOC Impacts

Simulated total VOC emissions were concentrations as a result of the project are lower than the European Collaborative Action annual average concentration for comfort (200 µg/m³ - Figure 7-19). If total VOCs were all conservatively assumed to be benzene, the simulated concentrations as a result of the project are lower than the NAAQS at all sensitive receptors and monitoring stations and across the domain (Figure 7-19).

7.1.7 Simulated Incremental Nuisance Dustfall Impacts

Simulated operational phase dustfall rates were compared to the acceptable dustfall rates defined by the NDCR (Section 4.7). Daily dustfall rates as a result of the project are likely to be lower than 60 mg/m^2.day and no exceedances of the NDCR were simulated (Figure 7-20).

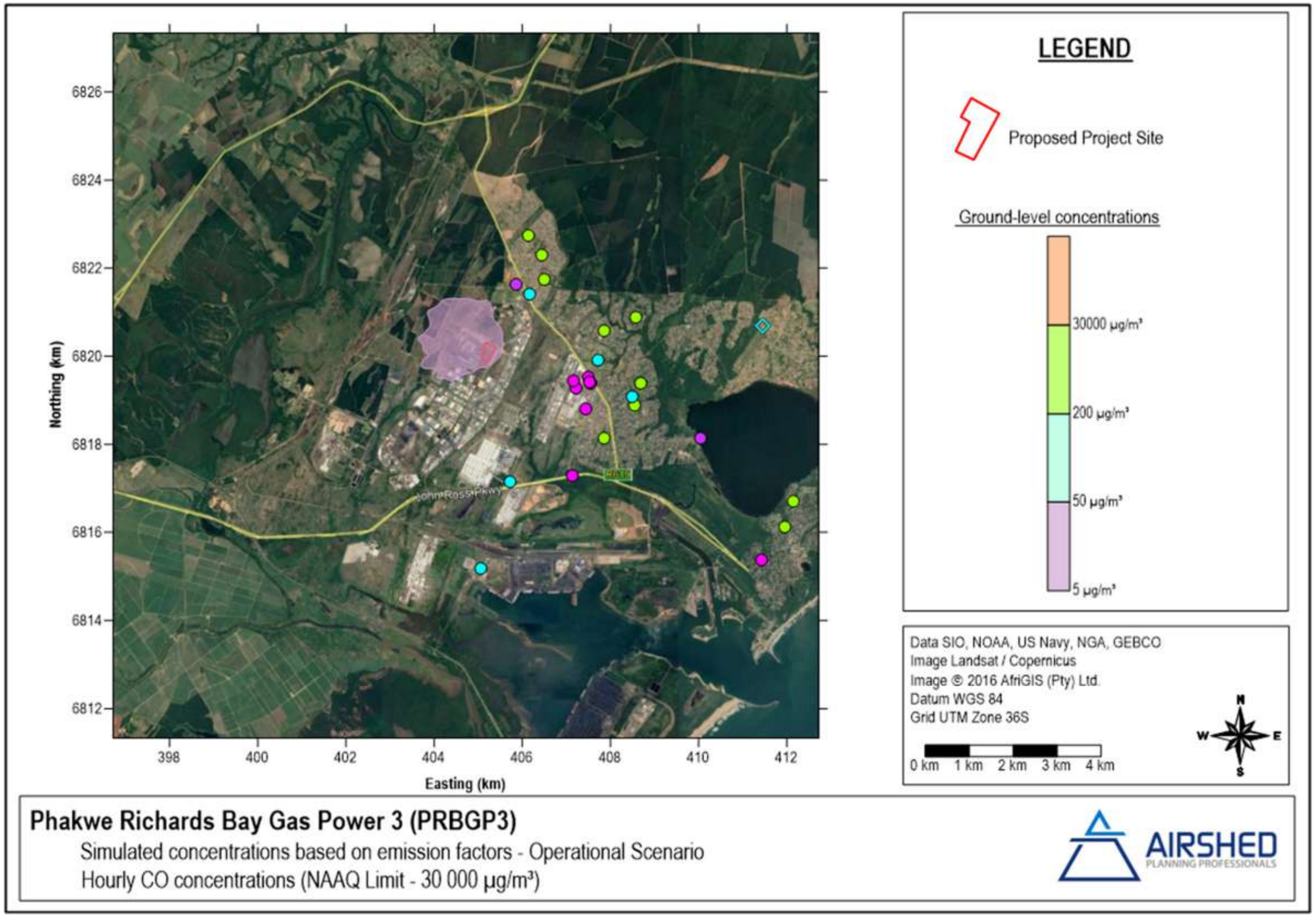

Figure 7-18: Simulated hourly average CO concentrations due to emissions based on emission factors

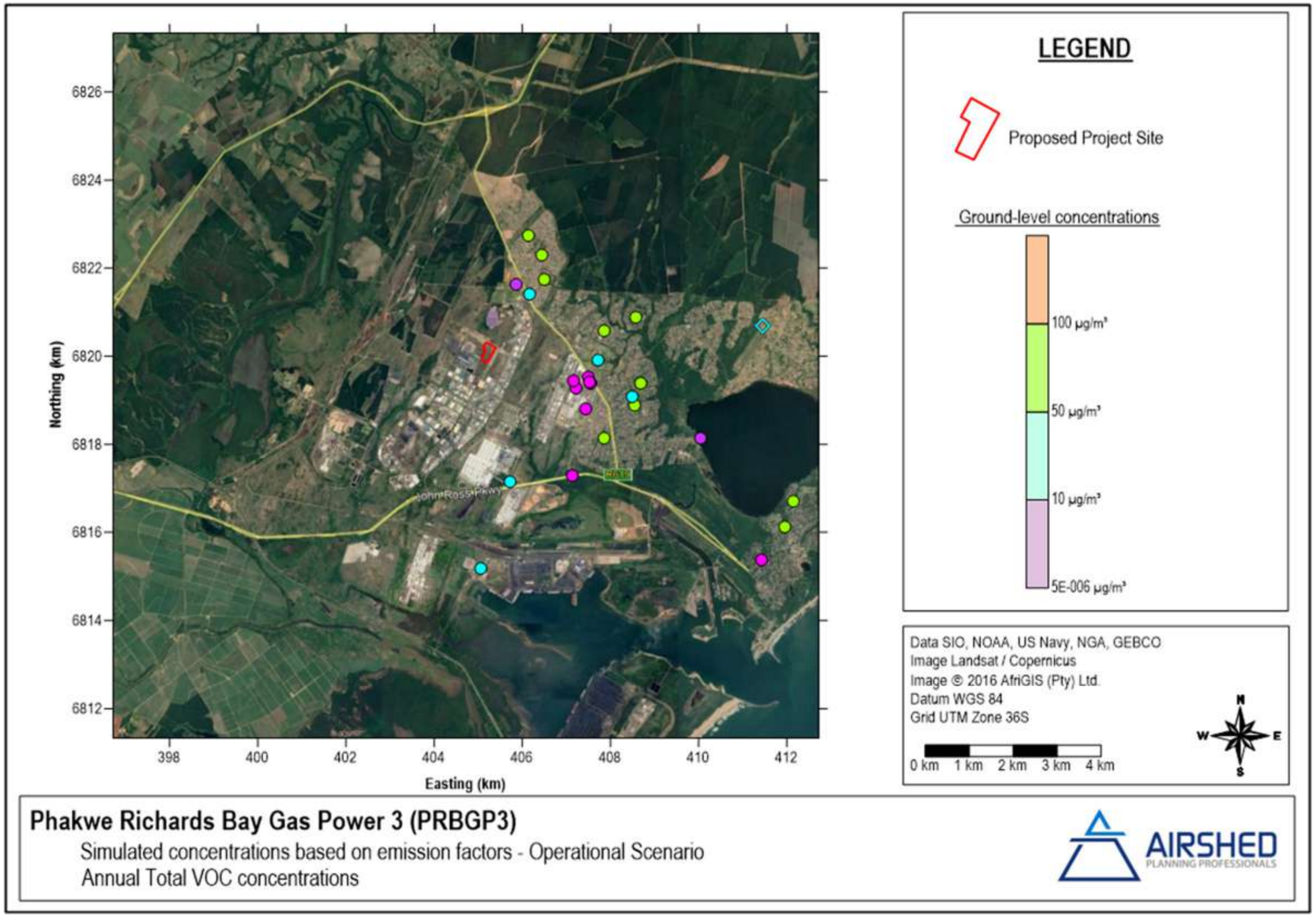

Figure 7-19: Simulated annual average total VOC concentrations due to emissions based on emission factors

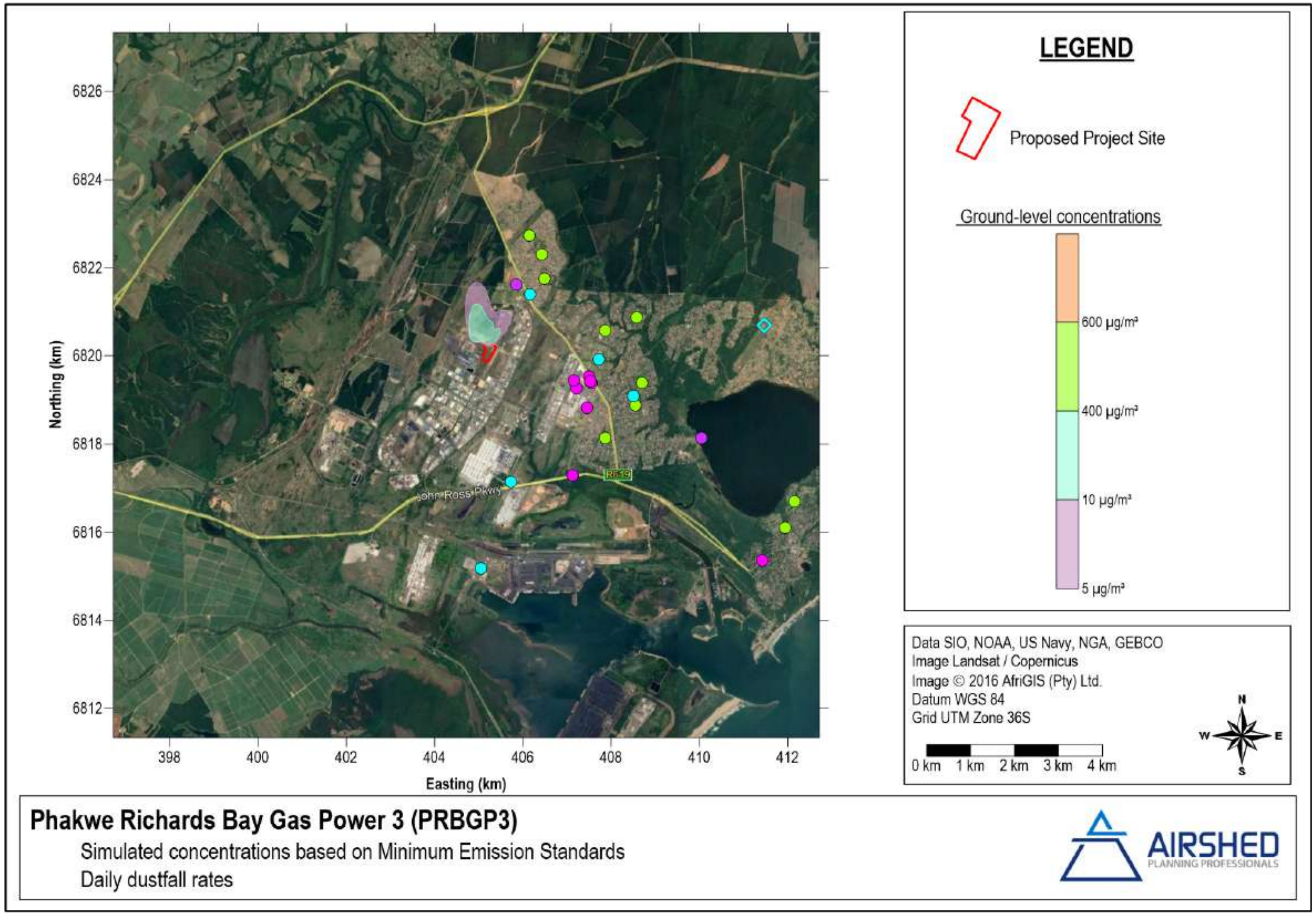

Figure 7-20: Simulated daily dustfall rates based on emission factors for normal operations

7.1.8 Simulated Incremental Impacts on Flora and Fauna

The thresholds for assessment of impact to flora and fauna were described in Section 4.9.

The annual concentrations of SO_2 – based on MES – could affect vegetation off-site, including: forest and (semi-)natural vegetation by up to 800 m; and cyanobacterial lichen by up to 2.8 km from the project boundary (Figure 7-21). Annual average SO_2 concentrations due to emissions factors – the more realistic impact for natural gas as a low sulfur fuel – are lower than all critical levels for vegetation (see Figure 7-8). Domain maximum annual NO_2 concentrations are less than 3 µg/m³ and are therefore not likely to affect vegetation within the domain (Figure 7-22).

The simulated short-term concentrations of SO_2 associated with the project using MES were elevated near site but still below the range shown to result in health impacts in animals (see Figure 7-3, Figure 7-5 and Figure 7-7). The simulated concentrations of SO_2 (for all averaging periods) associated with the project using emission factors were very low (<0.01 µg/m³ off-site) and are expected to have a negligible impact on animal health (see Figure 7-8).

The calculated[2] (data not shown) maximum daily SO_2 average concentration (8.52 µg/m³ at the RBCAA Brackenham AQMS) was lower than 265 µg/m³, while the average simulated daily NO_2 concentration was less than 2 µg/m³ the project is likely to have a low impact on animal health.

The simulated annual concentrations of PM_{10} and $PM_{2.5}$ associated with the project were very low (<0.2 µg/m³ off-site) and are expected to have a negligible incremental impact on animal health.

[2] Using the hourly to daily conversion factor (0.4) recommended in Table 8 of the Regulations Regarding Air Dispersion Modelling (Gazette No 37804 published 11 July 2014)

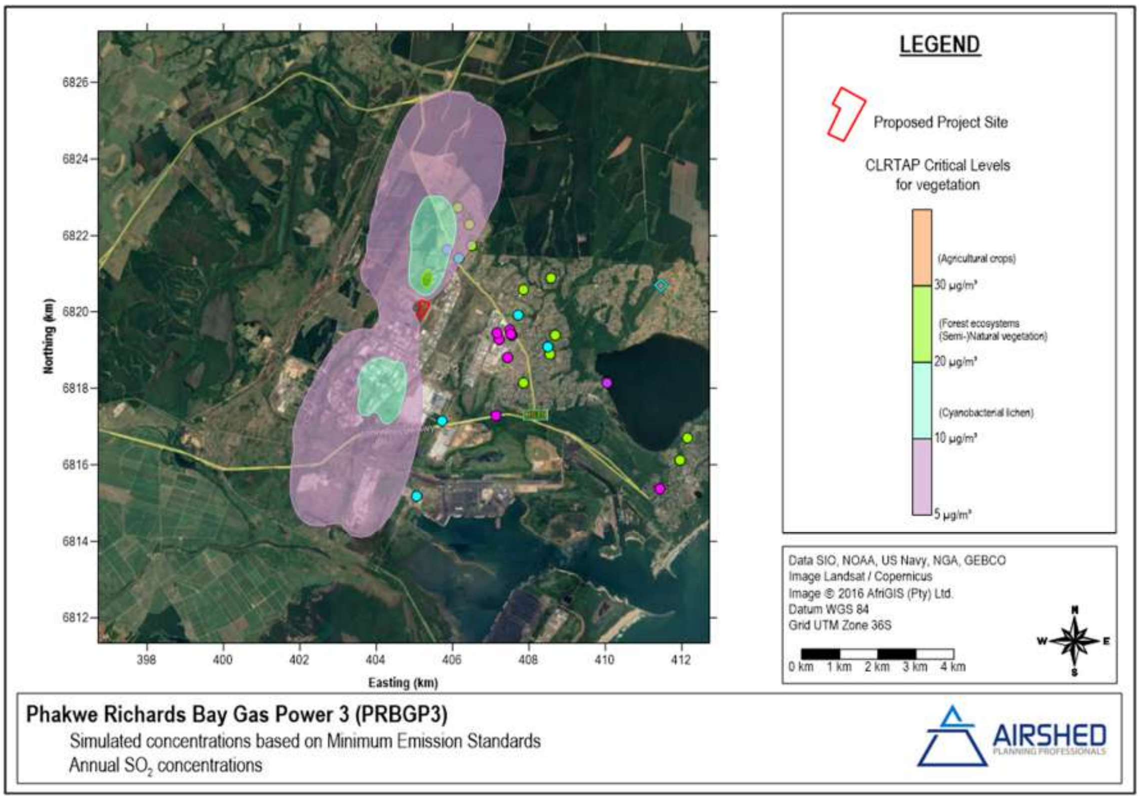

Figure 7-21: Simulated annual average SO_2 concentrations based on Minimum Emission Standards – vegetation impact

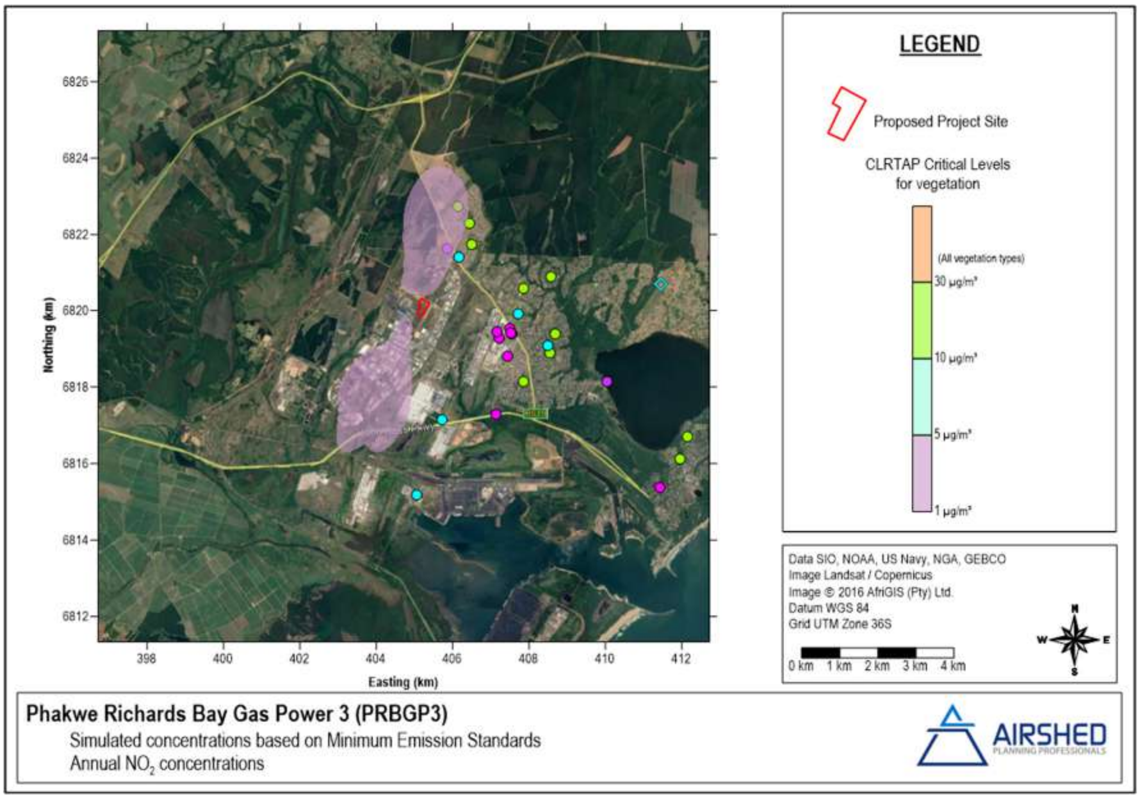

Figure 7-22: Simulated annual average NO_2 concentrations based on Minimum Emission Standards – vegetation impact

8 Impact Assessment: Cumulative

The project is proposed for development in an already industrialised area and therefore the project will add to the existing operational sources. Due to the proclamation of the RB IDZ, there is a growth of industries that have environmental authorisation but have not yet been commissioned that will make further contributions to the airshed.

The Integrated Resource Plan (IRP) provides for 3 000 MW from gas-to-power projects as part of the energy mix up to 2030, for which the Ministry of Mineral Resources and Energy has issued a Ministerial Determination to commence the procurement process for this allocation from Independent Power Producers. In addition to this, the Department of Mineral Resources and Energy, under the Risk Mitigation Independent Power Producer Procurement Programme in accordance with the IRP 2019, released a request for proposal to meet a stated electricity supply shortfall of 2 000 MW of generation capacity. As a result, there has been a substantial increase in interest in gas to power facility developments in South Africa - largely in Richards Bay and other port cities. It is, therefore, important to follow a precautionary approach to ensure that the potential for cumulative impacts is considered where appropriate and not considered where projects are mutually exclusive of each other.

This section assesses the potential that impacts associated with the proposed project could become more significant when considered in combination with the known or proposed gas to power projects, and existing industrial activities within the Richards Bay area. All known and viable large-scale industrial developments located within a radius of 10 km from the project site – as identified during stakeholder consultations and using information available in the public domain at the time of this assessment - are presented in Table 8-1. Fourteen (14) large-scale industrial developments (at various stages of development) were identified within the 10 km radius of the project site. At the time of writing this EIA Report, 10 facilities are operational and 4 have been authorised.

Table 8-1: Large-scale industrial developments within a 10 km radius of the PRBGP3 project site

Development Name	Approximate distance from the project	Project Status
Bayside Aluminium Richards Bay	5.4 km southeast	Existing
Hulamin (previously Isizinda)	5.4 km southeast	Existing
Foskor Richards Bay	3.5 km southeast	Existing
Mondi Richards Bay	4.3 km southwest	Existing
Port Richards Bay	5.2 km southeast	Existing
Richards Bay Coal Terminal	8.9 km southeast	Existing
South32 Aluminium	2.5 km southeast	Existing
Tata Steel	2.5 km southeast	Existing (non-operational)
Bidvest Tank Terminals	9 km south	Existing
Fermentech Fertilizer Supplier	Adjacent to the southwest	Existing
Phinda Power 320 MW RMPP	3.3 km southwest	Authorised
Richards Bay Gas to Power 400 MW	Adjacent to the west	Authorised
Eskom 3 000 MW CCPP	5.5 km southwest	Authorised
Elegant Afro Chemicals Chlor-Alkali Plant	650 m northwest	Authorised

The following cumulative impact scenarios were considered:

1. Scenario 1: PRBGP3 and existing baseline sources (Section 5.1.5)
2. Scenario 2: PRBGP3, authorised gas to power projects, and existing baseline sources.

Although a chlor-alkali plant has been authorised for development within Zone 1F of the RB IDZ (DC28/0003/2018: KZN/EIA/0000823/2018), the air quality specialist report with the required quantitative detail was not available for inclusion as part of the cumulative assessment.

8.1.1 Cumulative Impact – PRBGP3 and Existing Sources

The simulated and measured Richards Bay baseline annual average pollutant concentrations (Section 5.3) were added to the simulated concentrations because of the PRBGP3 project (Section 7). Cumulative SO_2 (Table 8-2) and NO_2 (Table 8-3) concentrations are likely to be lower than the applicable NAAQS across the domain and the contribution from PRBGP3 is low for SO_2 and moderate for NO_2 (less than 0.3% for hourly, daily and annual SO_2; less than 30% for hourly and annual NO_2).

Cumulative PM_{10} concentrations may exceed the daily NAAQS at Brackenham (RBCAA), Arboretum (uMthlathuze), Harbour West, and Scorpio monitoring stations due to the elevated baseline concentrations in those areas. However, the contribution from PRBGP3 will be minor at less than 4% on both daily and annual averaging periods (Table 8-4).

Table 8-2: Cumulative SO_2 concentrations at the monitoring stations

AQMS	Simulated PRBGP3	Measured[(a)]	Simulated 2016 baseline[(b)]	Cumulative[(c)]	Project contribution to Cumulative	Cumulative contribution to NAAQS
1-hour						
Brackenham (uMhlathuze)	0.0076	28.80	125.85	125.85	0.006%	36%
Brackenham (RBCAA)	0.0049	18.30	137.50	137.51	0.004%	39%
CBD (RBCAA)	0.0007	97.10	114.27	114.27	0.001%	33%
Arboretum (uMhlathuze)	0.0005	31.40	38.56	38.56	0.001%	11%
Arboretum (RBCAA)	0.0006	50.00	71.94	71.94	0.001%	21%
Scorpio (RBCAA)	0.0029	232.30	54.80	232.30	0.001%	66%
Harbour West (RBCAA)	0.0047	246.20	125.87	246.20	0.002%	70%
eNseleni (RBCAA)	0.0018	19.10	[(d)]	19.10	0.010%	5%
Felixton (RBCAA)	0.0008	34.50	[(d)]	34.50	0.002%	10%
eSikhaleni (uMhlathuze)	0.0009	21.00	[(d)]	21.00	0.004%	6%
eSikhaleni (RBCAA)	0.0009	107.60	[(d)]	107.60	0.001%	31%
24-hour						
Brackenham (uMhlathuze)	0.0029	13.80	24.69	24.69	0.012%	20%
Brackenham (RBCAA)	0.0016	14.10	27.59	27.59	0.006%	22%
CBD (RBCAA)	0.0006	57.90	23.16	57.90	0.001%	46%
Arboretum (uMhlathuze)	0.0003	16.60	7.81	16.60	0.002%	13%
Arboretum (RBCAA)	0.0004	20.70	14.46	20.70	0.002%	17%
Scorpio (RBCAA)	0.0011	115.60	10.56	115.60	0.001%	92%
Harbour West (RBCAA)	0.0011	102.80	25.10	102.80	0.001%	82%
eNseleni (RBCAA)	0.0006	14.40	[(d)]	14.40	0.004%	12%
Felixton (RBCAA)	0.0003	19.50	[(d)]	19.50	0.001%	16%
eSikhaleni (uMhlathuze)	0.0003	17.00	[(d)]	17.00	0.002%	14%
eSikhaleni (RBCAA)	0.0003	20.20	[(d)]	20.20	0.001%	16%
Annual						
Brackenham (uMhlathuze)	4.19E-04	4.10	9.91	9.91	0.0042%	20%
Brackenham (RBCAA)	1.96E-04	3.40	10.82	10.82	0.0018%	22%
CBD (RBCAA)	3.01E-05	10.70	9.26	10.70	0.0003%	21%
Arboretum (uMhlathuze)	1.82E-05	8.20	3.12	8.20	0.0002%	16%
Arboretum (RBCAA)	2.70E-05	9.3	5.80	9.30	0.0003%	19%
Scorpio (RBCAA)	8.72E-05	22.9	4.11	22.90	0.0004%	46%
Harbour West (RBCAA)	1.47E-04	23.60	10.10	23.60	0.0006%	47%
eNseleni (RBCAA)	8.97E-05	3.40	[(d)]	3.40	0.0026%	7%

AQMS	Simulated PRBGP3	Measured[(a)]	Simulated 2016 baseline[(b)]	Cumulative[(c)]	Project contribution to Cumulative	Cumulative contribution to NAAQS
Felixton (RBCAA)	2.98E-05	7.40	(d)	7.40	0.0004%	15%
eSikhaleni (uMhlathuze)	4.32E-05	10.00	(d)	10.00	0.0004%	20%
eSikhaleni (RBCAA)	4.32E-05	9.30	(d)	9.30	0.0005%	19%

Notes:
(a) Maximum measured at each station irrespective of year of measurement or variability between years
(b) Hourly and daily average concentrations extrapolated from annual averages from the simulated baseline (Section 5.4) using the averaging time conversion factors defined in Table 8 of the Regulations regarding Air Dispersion Modelling (Gazette No. 37804, vol. 589; 11 July 2014)
(c) Sum of the PRBGP3 and the maximum of measured or simulated concentrations
(d) Not included in the baseline simulation domain

Table 8-3: Cumulative NO_2 concentrations at the monitoring stations

AQMS	Simulated PRBGP3	Measured[(a)]	Simulated 2016 baseline[(b)]	Cumulative[(c)]	Project contribution to Cumulative	Cumulative contribution to NAAQS
1-hour						
Brackenham (uMhlathuze)	21.29	32.00	84.08	105.37	20.2%	53%
Brackenham (RBCAA)	13.69		76.09	89.79	15.3%	45%
CBD (RBCAA)	1.49		27.08	28.57	5.2%	14%
Arboretum (uMhlathuze)	0.99	32.00	16.13	32.99	3.0%	16%
Arboretum (RBCAA)	1.43		19.31	20.74	6.9%	10%
Scorpio (RBCAA)	7.50		30.70	38.20	19.6%	19%
Harbour West (RBCAA)	12.83		28.05	40.88	31.4%	20%
eNseleni (RBCAA)	4.98		(d)	4.98		2%
Felixton (RBCAA)	1.89		(d)	1.89		0.9%
eSikhaleni (uMhlathuze)	2.23	43.20	(d)	45.43	4.9%	23%
eSikhaleni (RBCAA)	2.26		(d)	2.26		1.1%
Annual						
Brackenham (uMhlathuze)	1.16	9.80	6.61	10.96	10.6%	27%
Brackenham (RBCAA)	0.53		6.30	6.83	7.8%	17%
CBD (RBCAA)	0.07		2.17	2.24	3.3%	6%
Arboretum (uMhlathuze)	0.04	7.50	1.31	7.54	0.6%	19%
Arboretum (RBCAA)	0.07		1.54	1.61	4.1%	4%
Scorpio (RBCAA)	0.23		2.38	2.61	8.8%	7%
Harbour West (RBCAA)	0.39		2.25	2.64	14.9%	7%
eNseleni (RBCAA)	0.24		(d)	0.24		1%
Felixton (RBCAA)	0.07		(d)	0.07		0%
eSikhaleni (uMhlathuze)	0.11	9.80	(d)	9.91	1.1%	25%
eSikhaleni (RBCAA)	0.10		(d)	0.11		0%

Notes:
(a) Maximum measured at each station irrespective of year of measurement or variability between years
(b) Hourly and daily average concentrations extrapolated from annual averages from the simulated baseline (Section 5.4) using the averaging time conversion factors defined in Table 8 of the Regulations regarding Air Dispersion Modelling (Gazette No. 37804, vol. 589; 11 July 2014)
(c) Sum of the PRBGP3 and the maximum of measured or simulated concentrations
(d) Not included in the baseline simulation domain

Table 8-4: Cumulative PM_{10} concentrations at the monitoring stations

AQMS	Simulated PRBGP3	Measured[(a)]	Simulated 2016 baseline[(b)]	Cumulative[(c)]	Project contribution to Cumulative	Cumulative contribution to NAAQS
24-hour						
Brackenham (uMhlathuze)	1.68	33.50	26.23	35.18	4.8%	47%
Brackenham (RBCAA)	1.13	92.50	28.21	93.63	1.2%	125%
CBD (RBCAA)	0.62	57.10	49.53	57.72	1.1%	77%
Arboretum (uMhlathuze)	0.45	31.40	97.31	97.76	0.5%	130%
Arboretum (RBCAA)	0.62		71.81	72.43	0.9%	97%
Scorpio (RBCAA)	0.90		123.83	124.73	0.7%	166%
Harbour West (RBCAA)	0.84		647.42	648.26	0.1%	864%
eNseleni (RBCAA)	0.53	58.10	(d)	58.63	0.9%	78%
Felixton (RBCAA)	0.44	61.10	(d)	61.54	0.7%	82%
eSikhaleni (uMhlathuze)	0.41	119.00	(d)	119.41	0.3%	159%
eSikhaleni (RBCAA)	0.42	67.00	(d)	67.42	0.6%	90%
Annual						
Brackenham (uMhlathuze)	0.27	9.30	10.63	10.89	2.4%	27%
Brackenham (RBCAA)	0.14	32.50	11.42	32.64	0.4%	82%
CBD (RBCAA)	0.04	26.00	19.86	26.04	0.1%	65%
Arboretum (uMhlathuze)	0.03	8.10	39.09	39.12	0.1%	98%
Arboretum (RBCAA)	0.04		29.41	29.44	0.1%	74%
Scorpio (RBCAA)	0.08		48.61	48.69	0.2%	122%
Harbour West (RBCAA)	0.11		242.79	242.90	0.0%	607%
eNseleni (RBCAA)	0.08	29.10	(d)	29.18	0.3%	73%
Felixton (RBCAA)	0.04	26.20	(d)	26.24	0.2%	66%
eSikhaleni (uMhlathuze)	0.05	30.10	(d)	30.15	0.2%	75%
eSikhaleni (RBCAA)	0.05	24.00	(d)	24.05	0.2%	60%

Notes:
(a) Maximum measured at each station irrespective of year of measurement or variability between years
(b) Hourly and daily average concentrations extrapolated from annual averages from the simulated baseline (Section 5.4) using the averaging time conversion factors defined in Table 8 of the Regulations regarding Air Dispersion Modelling (Gazette No. 37804, vol. 589; 11 July 2014)
(c) Sum of the PRBGP3 and the maximum of measured or simulated concentrations
(d) Not included in the baseline simulation domain

8.1.2 Cumulative Impact - Proposed Gas-to-Power Developments, and Existing Sources

There are a number of gas-to-power projects proposed within the Richards Bay area. In considering the cumulative impact, it is important to consider the policy framework for gas to power generation and the likelihood of proposed projects proceeding to implementation. As stated previously, the IRP provides for a maximum of 3 000 MW of power to be generated by gas to power technologies up to 2030. There are three (3) gas to power facilities that have the required environmental authorisation to proceed with development, located within a 10 km radius of the project site (Table 8-5).

To quantitatively assess the cumulative impact of the proposed PRBGP3, other authorised (but not yet commissioned) facilities (Table 8-5) and the existing sources of air pollution in the Richards Bay area, the following approach was adopted. Maximum 1 hour, 24 hour, and annual average SO_2, NO_2, and PM concentrations due to the projects were gathered from simulations or from the respective Environmental Impact Assessment reports or specialist Air Quality specialist assessment reports as available to Interested and Affected Parties. These maximum values were either for the domain or receptors, depending on what level of detail was available for the respective projects. The additive effect of the identified projects to the current baseline was calculated using extrapolated, simulated and/or measured concentrations to estimate the range of cumulative impact (Table 8-6).

Table 8-5: Gas to power facilities located within a 10 km radius of the proposed PRBGP3

Project Name	Brief Project Description	Approximate distance from PRBGP3	Project Status / Likelihood
Richards Bay Gas to Power 2	Gas to power facility with 400 MW generation capacity.	Adjacent property to the west of PRBGP3	EIA has been authorised.
Richards Bay CCPP	Eskom Gas-power facility with 3 000 MW generation capacity.	5.7 km southwest	This project is being developed outside of the current 3 000 MW gas to power allocation as the Minister has determined that this allocation will be procured from independent power producers and not from Eskom. EIA has been approved.
Phinda Power 320 MW RMPP	Gas to power facility with 320 MW generation capacity.	3.2 km south-southwest	EIA has been authorised.
Karpowership SA R/Bay	Floating power plant berthed in the Port of Richards Bay with a generating capacity of 554 MW from liquified natural gas.	6.2 km south-east	RMIPPPP preferred bidder; not yet authorised.

The findings of the cumulative impact estimation (Table 8-6) indicate that:

- the range of cumulative hourly, daily, and annual SO_2 concentrations are lower than the applicable NAAQS;
- the lower end of the range of cumulative hourly NO_2 concentrations is lower than the NAAQ limit concentration but the upper end of the range suggests that exceedances of the NAAQ limit could occur in some areas of the domain and are associated with existing developments, the 3 000 MW Eskom facility, followed by the proposed PRBGP3;
- the range of cumulative annual NO_2 concentrations is close to the NAAQS where the largest contributions are associated with the existing sources and the Eskom facility;
- cumulative daily and annual PM_{10} - based on an atypically high measured concentration - exceeds the NAAQS, however, the contribution from the gas-to-power projects is low (less than 15%).

Based on the existing sources in the airshed, SO_2, particulate matter, and total reduced sulfides are the pollutants of current concern based on measured (Section 5.3) and simulated (Section 5.4) impacts and the gas-to-power projects are unlikely to result in substantial contributions to the ambient concentrations of these pollutants. The additive effect of the projects equate to less than 15% of the applicable NAAQ limit concentrations and standards for SO_2 and PM_{10} (Table 8-6) and is therefore in line with the general guideline suggested by the International Finance Corporation that individual projects contribute less than 25% of air quality guidelines and standards to allow for future sustainable development in the airshed (IFC, 2007). The combined impact of PRBGP3 and the authorised gas-to power facilities equates to 53% and 60% of the respective hourly and annual NO_2 NAAQS. Potential exceedances of the NAAQS for PM_{10} are associated with the existing baseline sources.

Table 8-6: Cumulative impact on ambient air pollutant concentrations due to the proposed gas-to-power projects and the baseline sources (bold values indicate exceedance of NAAQ limits or standards)

Generating capacity	Generating technology	Fuel type	Location	SO_2			NO_2		PM_{10}		Maximum value at Receptor or within Domain
				1 hour	24 hour	annual	1 hour	annual	24 hour	annual	
400 MW	gas turbines	LPG	IDZ Zone 1F(a)	1.00	0.42	0.036	4.72	0.2	0.6	0.06	receptor
3000 MW	gas & steam turbines (combined cycle)	LNG	IDZ Zone 1D(a)	0.70	0.21	0.07	80.00	23.00	6.50	3.00	domain
320 MW	gas turbines	LPG	Alton(a)	1.51	0.38	0.070	3.33	0.15	0.35	0.05	receptor
2 000 MW	gas & steam turbines (combined cycle) [PRBGP3]	LNG	IDZ Zone 1F(a)	0.008	0.0029	4.19E-04	21.29	1.16	1.7	0.27	receptor
Cumulative Gas-to-power projects (b)				*3.22*	*1.01*	*0.18*	*109.3*	*24.51*	*9.15*	*3.38*	n/a
Contribution by Gas to Power projects (c)				0.9%	0.8%	0.4%	55%	61%	12%	8.5%	
Baseline (short-term extrapolated from simulated)				193.00	38.00	(d)	180.00	(d)	**3015.00**	(d)	domain
Baseline (simulated annual average)				(d)	(d)	15.80	(d)	15.50	(d)	**1026**	domain
Baseline (measured) (e)				246.20	115.60	23.60	43.20	9.80	**119.00**	32.50	receptor
Cumulative (low end)				*196.22*	*39.01*	*15.98*	*152.54*	*34.31*	***128.15*** (f)	*35.88*	n/a
Cumulative (high end)				*249.42*	*116.61*	*23.78*	***289.3***	***40.01***	(g)	(g)	n/a
Cumulative proportion of NAAQS (min)				56%	31%	32%	76%	86%	171%	90%	
Cumulative proportion of NAAQS (max)				71%	93%	48%	145%	100%	(g)	(g)	

Notes:

(a) SO_2 emissions based on S content of fuel

(b) Additive effect assumes all three RMIPPPP projects will be developed and operational

(c) As a general rule the International Finance Corporation suggests that projects with significant air emissions contribute less than 25% to the applicable air quality stands to allow for future sustainable development (IFC, 2007)

(d) Not necessary - simulated data available elsewhere in table

(e) Maximum for any measured year at any of the AQMS where data was analysed

(f) Exceedances dominated by elevated *measured* baseline concentrations

(g) Exceedances dominated by elevated *simulated* baseline concentrations near the sources of concern and are not representative of the entire domain.

9 Assessment of Impact

9.1 Assessment of Impact of Construction (and Decommissioning) Phase

For the purposes of assessment of impact, it is assumed that the decommissioning phase would have similar impacts to the construction phase, since activities are similar.

The construction and decommissioning phases of the project are expected to have a significance rating of "low" with and without mitigation (Table 9-1) by impacting ambient particulate concentrations and thereby affecting human health and nuisance dustfall.

Table 9-1: Impact rating for the Construction and Decommissioning Phases

<table>
<tr><td colspan="5">Nature:</td></tr>
<tr><td colspan="5">Construction (and decommissioning) activities are likely to result in emissions of particulate and gaseous pollutants due to civil and building work and from vehicle traffic. The nature of emissions from construction activities is highly variable in terms of temporal and spatial distribution and is also transient. Increased ambient concentrations of fine particulates and gaseous pollutants may result in negative human health impacts. Increased nuisance dustfall is likely as a result of wind-blown dust emissions from the working areas. Increased nuisance dustfall rates will likely result in negative impact on dustfall at nearby residences and on potentially on plants.

Unmitigated particulate emissions were conservatively found to results in slightly elevated concentrations but not resulting in exceedances of the NAAQS or NDCR off-site. The impact of gaseous pollutants is likely to minor.</td></tr>
<tr><td></td><td colspan="2">Rating before mitigation</td><td>Motivation</td><td>Significance</td></tr>
<tr><td>Duration</td><td>Short-term</td><td>2</td><td>Construction duration provided as 36 months</td><td>24</td></tr>
<tr><td>Extent</td><td>Low</td><td>2</td><td>No off-site exceedances of NAAQS or NDCR</td><td rowspan="3">Low</td></tr>
<tr><td>Magnitude</td><td>Low</td><td>4</td><td>No off-site exceedances of NAAQS or NDCR</td></tr>
<tr><td>Probability</td><td>Probable</td><td>3</td><td>Emissions estimation is conservative and assumes major earthworks for the full duration over the full area. This is unlikely in practice.</td></tr>
<tr><td colspan="5">Proposed mitigation measures:</td></tr>
<tr><td colspan="5">• Wet suppression at key handling points or cleared areas, and on unpaved roads.
• Haul trucks to be restricted to specified haul roads and using the most direct route.
• Reduce unnecessary traffic.
• Strict on-site speed control (i.e. 40km/hr for haul trucks).
• Reduction of extent of open areas to minimised the time between clearing and infrastructure construction, and/or use of wind breaks and water suppression to reduce emissions from open areas.
• Restriction of disturbance to periods of low wind speeds (less than 5 m/s).
• Stabilisation of disturbed soil (for example, chemical, rock cladding, or vegetation).
• Re-vegetation of cleared areas as soon as practically feasible.</td></tr>
<tr><td colspan="5">Post Mitigation / Enhancement Measures</td></tr>
<tr><td></td><td colspan="2">Rating after mitigation</td><td>Motivation</td><td>Significance</td></tr>
<tr><td>Duration</td><td>Short-term</td><td>2</td><td>Construction duration provided as 36 months</td><td>15</td></tr>
<tr><td>Extent</td><td>On-site</td><td>1</td><td>No off-site exceedances of NAAQS or NDCR</td><td rowspan="3">Low</td></tr>
<tr><td>Magnitude</td><td>Low</td><td>2</td><td>No off-site exceedances of NAAQS or NDCR. Lower PM_{10} and Dustfall rates associated with the construction / demolition phase of the project</td></tr>
<tr><td>Probability</td><td>Probable</td><td>3</td><td>Emissions estimation is conservative and assumes major earthworks for the full duration over the full area. This is unlikely in practice.</td></tr>
<tr><td colspan="5">Cumulative Impacts</td></tr>
<tr><td colspan="5">Construction (and decommissioning) activities are likely to result in a small increased particulate and gaseous pollutant concentrations, however, they are not likely to make a substantive contribution at the receptors and AQMS.</td></tr>
<tr><td colspan="5">Residual Impacts</td></tr>
<tr><td colspan="5">Expected to be low if mitigation measures are properly implemented.</td></tr>
</table>

9.2 Assessment of Impact of Incremental Operations

The operational phase is likely to have a "low" impact on SO_2, CO, PM, and VOCs before and after mitigation (Table 9-2). The operational phase is likely to have a "medium" impact on NO_2; however, if additional mitigation measures are implemented, the significance could be reduced to "low" (Table 9-3).

Table 9-2: Impact rating for the incremental impact of the project on ambient SO_2, CO, VOCs, and particulate matter concentrations

Nature:				
The normal operation of the proposed combined cycle power station will result in emission of gaseous and particulate pollutants including: SO_2, CO, VOCs, and to a lesser extent PM. Increased ambient concentrations of these pollutants may result in negative human health impacts, and nuisance dustfall. Unmitigated emissions of these pollutants were found to comply with the assessment criteria and off-site impacts are unlikely. Residential receptors, schools, and medical facilities are unlikely to be affected. Areas to the north and south-southwest of the project site are more likely to be affected in the long-term, due to the predominant winds.				
	Rating Without mitigation		**Motivation**	**Significance**
Duration	Long-term	4	Indicative power purchase agreement is for 20+ years	**21**
Extent	Low	1	No off-site exceedances of NAAQS, Inhalation guidelines, or NDCR	**Low**
Magnitude	Minor	2	No off-site exceedances of NAAQS, Inhalation guidelines, or NDCR	
Probability	Probable	3	Impact estimated using MES, emission factors, current design specifications and dispersion modelling. As far as possible reducible uncertainty - from (1) uncertainties in the input values of the known conditions (i.e., emission characteristics and meteorological data); (2) errors in the measured concentrations which are used to compute the concentration residuals; and (3) inadequate model physics and formulation - have been minimized through better (more accurate and more representative) measurements and better model physics. Inherent uncertainty is associated with the stochastic (turbulent) nature of the atmosphere and its representation (approximation) by numerical models. Models predict concentrations that represent an ensemble average of numerous repetitions for the same nominal event. An individual observed value can deviate significantly from the ensemble value. This uncertainty may be responsible for a ± 50% deviation from the measured value.	
Proposed mitigation measures:				
• Turbine maintenance as per manufacturers recommendations • A move to hydrogen fuel as soon as practically possible, will reduce most pollutant emissions.				
Post Mitigation / Enhancement Measures				
	Rating Without mitigation		**Motivation**	**Significance**
Duration	Long-term	4	Indicative power purchase agreement is for 20+ years	**20**
Extent	Low	1	No off-site exceedances of NAAQS, Inhalation guidelines, or NDCR	**Low**
Magnitude	Small	0	No off-site exceedances of NAAQS, Inhalation guidelines, or NDCR especially after the introduction as hydrogen in the fuel mixture	
Probability	Probable	3	The introduction of hydrogen into the fuel mix will have positive benefits, however, the technology is not yet at commercial scale implementation in South Africa. Therefore, the probability is marked as probable.	
Cumulative Impacts				
Normal operational activities are likely to result in a small increased SO_2, particulate and VOC pollutant concentrations to the airshed, however, the project is not likely to make a substantive contribution of these pollutants at the receptors and AQMS.				
Residual Impacts				
Expected to be low if mitigation measures are properly implemented.				

Table 9-3: Impact rating for the incremental impact of the project on ambient NO_2 concentrations

Nature:				
The normal operation of the proposed combined cycle power station will result in emission of gaseous and particulate pollutants including: NO_2. Increased ambient concentrations of these pollutants may result in negative human health impacts. Emissions of NO_2 at the MES were found to result in off-site exceedances with the 1-hour NAAQS, however the frequency of exceedance was within the 88 hours allowed per year. Annual average NO_2 concentrations were below the NAAQS and the critical levels for vegetation. Residential receptors, schools, and medical facilities may be affected, especially during start-up events. Areas to the north and south-southwest of the project site are more likely to be affected in the long-term, due to the predominant winds.				
	Rating Without mitigation		**Motivation**	**Significance**
Duration	Long-term	4	Indicative power purchase agreement is for 20+ years	**33**
Extent	Moderate	3	Off-site exceedances of the 1-hour NO_2 NAAQS, especially during start-up.	
Magnitude	Low	4	Off-site exceedances of the 1-hour NO_2 NAAQS, especially during start-up. Annual NO_2 concentrations were below the NAAQS and the critical levels for vegetation.	**Medium**
Probability	Probable	3	Impact estimated using MES, current design specifications, assumptions regarding start-up emissions and dispersion modelling. As far as possible reducible uncertainty - from (1) uncertainties in the input values of the known conditions (i.e., emission characteristics and meteorological data); (2) errors in the measured concentrations which are used to compute the concentration residuals; and (3) inadequate model physics and formulation - have been minimized through better (more accurate and more representative) measurements and better model physics. Inherent uncertainty is associated with the stochastic (turbulent) nature of the atmosphere and its representation (approximation) by numerical models. Models predict concentrations that represent an ensemble average of numerous repetitions for the same nominal event. An individual observed value can deviate significantly from the ensemble value. This uncertainty may be responsible for a ± 50% deviation from the measured value.	
Proposed mitigation measures:				
• Water injection for NOx emission controls to meet MES (already planned). • Minimise start-up events or the duration thereof. Restrict cold start-ups (from the backup diesel generator) as far as is practical. • Turbine maintenance as per manufacturers recommendations • A move to pure hydrogen fuel with appropriate combustion zone temperature control, as soon as practically possible, will reduce emissions of NO_X.				
Post Mitigation / Enhancement Measures				
	Rating Without mitigation		**Motivation**	**Significance**
Duration	Long-term	4	Indicative power purchase agreement is for 20+ years	**21**
Extent	Low	1	No off-site exceedances of NAAQS	
Magnitude	Low	2	No off-site exceedances of NAAQS especially after the introduction as hydrogen in the fuel mixture	
Probability	Probable	3	Compliance with emission standards during start up may not be possible. Minimisation of the number of start-ups will be dependent on the day-to-day demand of the power purchaser. Additionally, the introduction of hydrogen into the fuel mix could have positive benefits, however, the technology is not yet at commercial scale implementation in South Africa. Therefore, the probability is marked as improbable (with a larger negative impact on the significance).	**Low**
Cumulative Impacts				
Normal operational activities are likely to result in increased NO_2 concentrations across the airshed. The project could result in exceedance of the NAAQS at receptors and AQMS, especially due to start-up.				
Residual Impacts				
Since observed NO_2 concentrations (where measured in the domain) are low, residual impacts are likely to be limited to locations near site.				

9.3 Assessment of Impact of Cumulative Operations

Cumulative impacts have been discussed (Section 8) and the impact is rated as having a "medium" significance for gaseous (SO_2 and NO_2 - Table 9-4) and particulate pollutants (PM_{10} - Table 9-5), although the rating score is higher for PM_{10} due to the already elevated and, in some cases, non-compliance with NAAQS. The elevated ambient air pollutant concentrations could have human health effects, affect the productivity of vegetation, the health of domestic livestock and influence nuisance dustfall. Because the contribution of the facility in isolation is "low", any potential mitigation will require a co-ordinated response from all industrial (including agro-industry) contributors, local authorities and local community stakeholders to reduce domain-wide emissions.

Table 9-4: Impact rating for the cumulative impact of the project on SO_2 and NO_2 concentrations

Nature: The Cumulative Impact of the proposed facility and the existing baseline would result in elevated ambient air pollutant concentrations. The normal operation of the proposed gas-to-power plant, using natural gas, will result in emission of gaseous and particulate pollutants including: SO_2 and, NO_2. Increased ambient concentrations of these pollutants may result in negative human health impacts, and nuisance dustfall. Cumulative impacts, to short- and long-term ambient concentrations, were assessed to be minor since the pollutants of current concern in Richards Bay (SO_2 and PM) will have relatively small incremental increases from the normal operation of the project. The cumulative impact of the project and other projects in the area may result in short-term ambient NO_2 concentrations above NAAQS within the domain but these are likely to be localised near the source(s).		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Duration	4	4
Extent	1	3
Magnitude	2	6
Probability	3	3
Significance	**21**	**39**
	Low	**Medium**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	Unlikely	No
Can the impacts to mitigated?	To some extent	To some extent
Confidence in findings:	Moderate to High	
Potential mitigation measures: • Requiring co-ordinated response all stakeholders (authorities, industrial sources, and community groups); such that: - Industries optimise abatement controls to minimise emissions. - Use community and industry fora to discuss air pollution issues and progress towards minimising impacts. - Promote the use of cleaner heat sources (electricity, LPG, and/or bioethanol gel) for cooking, heating and lighting by residents.		
Residual impacts: Expected to be low if mitigation measures can be effectively implemented.		

Table 9-5: Impact rating for the cumulative impact of the project on particulate matter concentrations

Nature:

The Cumulative Impact of the proposed facility and the existing baseline will not add substantively to the existing baseline even though the normal operation of the proposed gas-to-power plant will result in emission of particulates (PM_{10} and $PM_{2.5}$). However, the baseline particulate concentrations across Richards Bay are elevated with exceedances of the NAAQS measured at monitoring stations near the harbour operations. Ambient concentrations of these pollutants may result in negative human health impacts, and nuisance dustfall. Although the over impact of the proposed project considered in isolation will have relatively small incremental increase from the normal operation of the gas-to-power station, the cumulative impact of the project and other projects in the area is likely to result in human health impacts.

	Overall impact of the proposed project considered in isolation	Cumulative impact of the project and other projects in the area
Duration	4	4
Extent	1	4
Magnitude	2	6
Probability	3	4
Significance	**21**	**56**
	Low	**Medium**
Status (positive or negative)	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	Unlikely	No
Can the impacts to mitigated?	To some extent	To some extent
Confidence in findings:	Moderate to High	

Potential mitigation measures:

- Requiring co-ordinated response all stakeholders (authorities, industrial sources, and community groups); such that:
  - Industries optimise abatement controls to minimise emissions.
  - Use community and industry fora to discuss air pollution issues and progress towards minimising impacts.
  - Promote the use of cleaner heat sources (electricity, LPG, and/or bioethanol gel) for cooking, heating and lighting by residents.

Residual impacts:

Expected to be low if mitigation measures can be effectively implemented.

9.4 Assessment of Impact of No-Go Option

Should the no go option be embarked on the current operations in the area will likely continue to operate as is with NO_2, SO_2, $PM_{2.5}$, and PM_{10}, impacts as per Section 5.3. As current industrial operations are also likely to cease at some stage, the ambient air quality will improve. There is the possibility of a gradual reduction in ambient air quality near the site should there be any additional industrial operations, agricultural operations, vehicle entrainment on roads, wind-blown dust from open areas, vehicle exhaust, household fuel burning and biomass – especially sugar cane - burning. The impact significance for the no-go option is rated as “medium” before mitigation and “low” after mitigation.

Table 9-6: Impact rating for the No-Go option

Nature:
The No-Go option (development of the proposed facility does not go ahead) would result ambient air pollutant concentrations similar to the existing baseline. The baseline assessment highlighted occasional short-term SO_2 exceedances and one annual exceedance of the PM_{10} NAAQS in the last four years. Increased ambient concentrations of fine particulates and gaseous pollutants may result in negative human health impacts. Impacts are likely across the Richards Bay airshed, with a hot spot area for PM_{10} located near the coal handling in the port.

	Rating before mitigation		Motivation	Significance
Duration	Long-term	4	Established industrialisation within the City of uMhlathuze and the growth of the RBIDZ	**33**
Extent	Moderate	3	Heavy industry localised to the City of uMhlathuze. Contributions from residential areas are away from medium and heavy industry operations.	**Medium**
Magnitude	Low	4	Non-compliance with NAAQS localised near the port (SO_2) and in residential areas reliant on dirty fuels for household cooking, heating and lighting (PM_{10}).	
Probability	Probable	3	Based on actual recorded ambient air quality	

Proposed mitigation measures:

Yes, to some extent, with large cooperative effort from local government, industry, and residents. Although the extent of impact of mitigation is unknown.

Post Mitigation / Enhancement Measures

	Rating after mitigation		Motivation	Significance
Duration	Long-term	4	Established industrialisation within the City of uMhlathuze and the growth of the RBIDZ	**24**
Extent	Moderate	2	Heavy industry localised to the City of uMhlathuze. Contributions from residential areas are away from medium and heavy industry operations.	**Low**
Magnitude	Minor	2	No exceedances of NAAQS or NDCR.	
Probability	Probable	3	Based on actual recorded ambient air quality	

Cumulative Impacts

None

Residual Impacts

None

10 AIR QUALITY MANAGEMENT MEASURES

Based on the findings of the baseline and impact assessment, the following mitigation, management and monitoring recommendations are made for inclusion in the draft Environmental Management Programme.

10.1 Management Measures for the Construction and Decommissioning Phases

Objective:	Minimise impact on ambient air quality through effective management, mitigation, and monitoring during construction phase

Project component/s	All components including associated infrastructure
Potential Impact	Heavy vehicles and construction equipment can generate dust and fine particulate matter and release air pollutants (NO_2, CO, particulates, SO_2) due to movement on-site and movement of materials on-site. Construction activities such as vegetation clearing, temporary stockpiles, foundation excavation, and road construction can result in dust and particulate release potentially affecting human health on nearby communities; or result in nuisance dustfall and reduced visibility during active construction.
Activity/risk source	The use of heavy vehicle and construction equipment Clearing of vegetation and topsoil Excavation, grading, and scraping Transport and movement of materials, equipment, and materials to site and around site (as required) Wind erosion from cleared areas, temporary stockpiles, and unsealed roads Combustion of fuel in construction equipment (e.g., generators) and heavy vehicles.
Mitigation: Target/Objective	Minimise potential particulate matter impacts associated with vehicles and construction equipment use Minimise potential health and nuisance impacts to communities and adjacent landowners from particulate emissions Minimise emissions from combustion engines (stationary or mobile) during the construction phase

Mitigation: Action/control	Responsibility	Timeframe
Establish a complaints' register and/or incident reporting system where personnel, communities and adjacent landowners can lodge complaints regarding construction activities. Ideal location would be security post at point of site access.	EO	Prior to construction
Appropriate dust suppression measures on cleared areas, temporary stockpiles, and unsealed roads such as water suppression (using non-potable water if possible), chemical stabilisation, or revegetation (as soon as practically feasible), especially during high wind speed events	EPC Contractor(s) and EO	During Construction
Use minimum safe drop heights when transferring material on-site	EPC Contractor(s) and EO	During Construction
Cover material stockpiles with tarpaulins or story in protected temporary bunkers	EPC Contractor(s) and EO	During Construction
Limit cleared area for bulk earthworks to minimum as practically feasible	EPC Contractor(s) and EO	During Construction
Heavy vehicles and construction equipment to be road worthy and regularly maintained.	EPC Contractor(s), transportation contractor(s) and EO	During Construction
All vehicles leaving site with loose material must have load-bins covered with tarpaulins.	EPC Contractor(s) and EO	During Construction
All vehicles associated with the construction phase must adhere to the designated speed limits on- and off-site.	EPC Contractor(s), transportation contractor(s) and EO	Duration of contract
Revegetation (as soon as practically feasible)	EPC Contractor(s) and EO	At completion of construction phase (or before if practically feasible)
Investigate inadequate mitigation and control measures if monitoring or complaints potential issues are indicated by non-conformance with performance indicators	EPC Contractor(s) and EO	At completion of construction phase (or before if practically feasible)

Performance Indicator	Appropriate dust suppression measures are implemented during construction phrase. No visible dust plumes from cleared areas and temporary stockpiles during high wind speed events. No visible plumes from unsealed roads when in use or during high wind speed events. Drivers are aware of potential safety issues and strict enforcement of on-site speed limits when employed and when entering site. Vehicle roadworthy certificates and maintenance records for all heavy vehicles are made available prior to construction and updated regularly. No or minimal visible exhaust fumes during normal operation.
Monitoring	The performance indicators listed above should be met during the construction phase by the responsible parties. Any potential or actual issues that could results in non-conformance with the performance indicator must be reported by on-site personnel to the Site Manager immediately. An incident reporting system must be used to record non-conformances to the EMPr A complaints register must be used to record complaints from the public

10.2 Management Measures for the Operational Phase

Objective:	Minimise impact on ambient air quality through effective management, mitigation, and monitoring during the operational phase

Project component/s	All project components including associated infrastructure
Potential Impact	The normal operation of the proposed combined cycle power station will result in emission of gaseous and particulate pollutants including: SO_2, NO_2, particulates, CO, and VOCs. Increased ambient concentrations of these pollutants may result in negative human health impacts, and nuisance dustfall.
Activity/risk source	Combustion of natural gas in turbines
Mitigation: Target/Objective	Ensure compliance with minimum emission limits as applicable to the natural gas turbines Ensure compliance with ambient air quality standards at the property boundary.

Mitigation: Action/control	Responsibility	Timeframe
Establish a complaints' register and/or incident reporting system where personnel, communities and adjacent landowners can lodge complaints regarding construction activities. Ideal location would be security post at point of site access.	EO and Plant Manager	Prior to commissioning
Regular maintenance and inspection of turbines as per original equipment manufacturer requirements	EO and Plant Manager	During operations
Annual emissions monitoring campaign (as per conditions of the AEL), by independent contractor, on all turbine stacks.	EO, Contractor and Plant Manager	During operations
Annual emissions reporting (as per conditions of the AEL)	EO, Contractor and Plant Manager	During operations
Once per year a 7-day ambient monitoring campaign at (minimum) 4 fence line locations using passive sampling techniques. Monitoring of SO_2, NO_2, CO, and VOCs	EO, Contractor and Plant Manager	During operations
Appropriate dust suppression measures on access road, including regularly sweeping and or wet suppression, to minimise particulate matter build-up.	EO and Plant Manager	During operations
Investigate inadequate mitigation and control measures if monitoring or complaints potential issues are indicated by non-conformance with performance indicators	EPC Contractor(s) and EO	During operations

Performance Indicator	Compliance with emission limits applicable to turbines during normal operation. Compliance with national ambient air quality standards based on passive sampling campaign.
Monitoring	The performance indicators listed above should be met during the operational phase by the responsible parties. Any potential or actual issues that could results in non-conformance with the performance indicator must be reported by on-site personnel to the Site Manager immediately. An incident reporting system must be used to record non-conformances to the EMPr A complaints register must be used to record complaints from the public Annual emissions monitoring campaign (as per conditions of the AEL), by independent contractor, on all turbine stacks. Annual emissions reporting (as per conditions of the AEL) Once per year a 7-day ambient monitoring campaign at (minimum) 4 fence line locations using passive sampling techniques. Monitoring of SO_2, NO_2, CO, and VOCs

11 FINDINGS AND RECOMMENDATIONS

The main findings of the simulated incremental assessment were:

1. The construction phase of the project could result in off-site exceedances of the PM_{10} daily and annual NAAQS over the 36-month construction phase.
    a. It is likely that the construction (and decommissioning) phase(s) may have a low" on the ambient air quality before and after effective mitigation measures are implemented.
2. Compliance with hourly, daily and annual NAAQS under normal operations for hourly, daily and annual average pollutant concentrations as applicable to SO_2, PM_{10} and $PM_{2.5}$, CO and TVOCs. Exceedances of the NAAQ limit concentration could result from the normal operation of the facility, but the frequency of exceedance is likely to be within the NAAQS.
    a. The operational phase of the project will have a *low* impact significance (based on design mitigation measures) on ambient SO_2, PM, CO, and VOC concentrations, with no additional mitigation required.
    b. The operational phase is likely to have a "medium" impact significance for NO_2; however, if additional mitigation measures are implemented, the significance could be reduced to "low".
3. Due to the inherently low sulfur content of natural gas, SO_2 emissions from the turbines will not reach the emission standard and therefore the facility's impact on SO_2 was also assessed using mass balance calculations for combined cycle turbines using the default sulfur content of the emission factor (4600 g/IE+06 Nm³).
    a. Compliance the NAAQS was simulated for hourly, daily, and annual average SO_2 for the operational scenario based on emission factor calculations.
4. The impact of start-up on ambient NO_2 concentrations was estimated and exceedances of the NAAQS could result at residential receptors, schools and medical facilities. The impacts can be reduced if the turbines reach Minimum Emission Standards in less than 30 minutes, and if the frequency of start-up events is reduced.
5. Annual SO_2 and NO_2 concentrations are unlikely to affect vegetation productivity or animal health off-site.
6. The impact of the facility was simulated to be below the NDCR acceptable dustfall rates for all project phases.
7. While hydrogen (or natural gas – hydrogen mixture) could significantly reduce emissions of SO_2, CO, PM and VOCs from the facility, emissions of oxides of nitrogen (NO_X) could potentially be similar to those from natural gas combustion.

The main findings of the cumulative assessment were:

1. Cumulative SO_2 concentrations (hourly, daily, and annual) are likely to be below with the applicable NAAQS across the domain, however, elevated concentrations in some areas are likely to be associated with the existing sources contributing to baseline air quality.
2. Cumulative NO_2 concentrations may be higher than the applicable NAAAQS in the long-term if large generating capacity gas-to-power projects are commissioned. The contribution of the PRBGP3 is likely to be less than 30% of the cumulative impact.
3. Cumulative PM_{10} concentrations (daily and annual) may exceed NAAQS at Harbour West, Scorpio, and Arboretum monitoring stations due to the elevated baseline concentrations. However, the contribution PRBGP3 is low and acceptable.
4. Cumulative impact of the facility and other projects in the area on the ambient air quality in the Richards Bay area is likely to be "medium" if unmitigated with the potential to reduce to low if industry and community initiatives can minimise the combined impact on air quality.

11.1 Recommendations

To ensure the lowest possible impact on AQSRs and environment it is recommended that the air quality management plan as set out in this report should be adopted. This includes:

- Implementation of design mitigation measures;
- Source and fence line monitoring; and
- Implementation of the reporting procedures.

From an air quality perspective, it is the opinion of the specialist that the Phakwe Richards Bay Gas Power 3 Combined Cycle Gas to Power Plant be authorised, on condition that:

•

• Emissions be monitored as per standard practice for the appropriate listed activity;

• Emissions are maintained at or lower than the Minimum Emission Standards appropriate for the listed activity;

• Conformance with the other environmental management programme requirements for air quality (Section 10) are met.

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13 APPENDIX A: AUTHOR'S CURRICULUM VITAE AND SACNASP REGISTRATION CERTIFICATE

CURRICULUM VITAE

Name	Theresa (Terri) Leigh Bird
Date of Birth	8 November 1976
Nationality	South African
Employer	Airshed Planning Professionals (Pty) Ltd
Position	Senior Consultant
Profession	Air Quality Specialist Consultant
Years with Firm	9 years

MEMBERSHIP OF PROFESSIONAL SOCIETIES

- National Association for Clean Air (NACA), 2012 to present
- South African Council for Natural Science Professions (Pr.Sci.Nat.), 2016 to present

EXPERIENCE

Projects contributing to Environmental Impact Assessments

Project type	Experience
Mining (including coal, platinum, tin, gold, and rare earth minerals)	▪ At least five proposed open-cast coal mining projects, mostly in South Africa and Botswana ▪ Air quality assessment for the expansion of an underground platinum mine to include a concentrator facility and tailings facility. ▪ Assessment of underground mining of cassiterite (the mineral ore mined for tin) in the Democratic Republic of Congo. The project included the assessment of emissions along a long-distance haul road from the mine to Mombasa for export. ▪ Assessment of open-cast and underground mining of gold-rich ore, including gold plant activities, in order to design an air quality monitoring network. ▪ Three rare earth mineral mining projects included dispersion model runs to assist the radiation specialist assessment of impact of radioactive compounds.

Projects contributing to Environmental Impact Assessments

Project type	Experience
	▪ The impact of mine tailings facilities on a proposed mixed use (residential and commercial) development, especially consideration to particulate matter and potential hazardous compounds on the residents of the development. ▪ A project assessing the impact of Namibian coal-fired power station on urban air quality, in the context of many small industrial sources. ▪ The assessment of retrofitting improved particulate emission controls on an existing coal-fired power station on the Mpumalanga Highveld. ▪ The assessment of impact of a floating power plant, fuelled by various potential liquid fuels, docked in a port servicing an industrial development zone.
Power Stations	▪ Professional opinion on the impact of solar power facilities (one concentrated solar power (CSP) and one photovoltaic (PV)) on ambient air quality. ▪ The assessment of three coal-fired power stations in Botswana, including two projects where the assessment assessed the combined impact of an open-cast coal mine and the associated coal-fired power station. ▪ Assessment of gas-to-power facilities using a mix of fuel options and abatement technologies.
Ash disposal facilities for coal-fired power stations	▪ Conducted the assessment of impact of ash disposal facilities coal-fired power stations requiring additional disposal area. Assessment included the estimation of increased life-time cancer risk as a result of exposure to carcinogenic metals in the wind-blown dust from the disposal facilities.
Tyre pyrolysis plant	▪ Assisted on an assessment of a plant that will use waste tyres as raw material to produce machine and vehicle oils.
Mineral alloy plant	▪ Project for a plant that uses multiple listed activities to recovery metals, via thermal processes, to produce ferroalloys that are pressed into briquettes for dispatch to clients.
Domestic waste landfill	▪ Assessing the health and odour impacts of a domestic waste landfill to support residential development plans for the area.
Hazardous waste landfill	▪ Assessing the health and odour impacts of a hazardous waste landfill to support the reduction of the required buffer zone.

Projects contributing to Environmental Impact Assessments

Project type	Experience
Thermal oxidation of industrial waste	▪ The project quantified the impact of an industrial thermal oxidation plant for waste disposal and considered upgrading of new technology to meet more stringent emission standards.
Marine Repair Facility	▪ The project quantified the impact on air quality of a marine vessel repair facility in the context of a busy port which includes an iron-ore transfer yard.
Industrial complexes	▪ Air quality impact of a large industrial special economic zone development (project assistant) ▪ Impact of road traffic on air quality associated with the development of an automated supplier park.

Air Quality Management Plans (AQMP)

Project type	Experience
Priority Area Level AQMP	▪ Involvement included: - baseline assessment of climatic conditions and ambient air quality across the Province; - collation of questionnaires from point-source emission; - point-source emissions inventory database management ▪ Contributor to management plan write-up. ▪ The management intervention strategies proposed in the AQMP were a collaborative effort of the technical project team, which included the client, stakeholders, and consultants.
Provincial Level AQMP	▪ Involvement included: - baseline assessment of climatic conditions and ambient air quality across the Province; - collation of questionnaires from point-source emission; - point-source emissions inventory database management ▪ Assisted with quantification of vehicle emissions and with dispersion modelling of baseline emissions. ▪ Main contributor to management plan write-up. ▪ The management intervention strategies proposed in the AQMP were a collaborative effort of the technical project team, which included the client and consultants.
Metropolitan city level AQMP	▪ Contributed to the emission inventory of industrial sources ▪ Collaborative project with the Council for Scientific Research (CSIR)

Air Quality Management Plans (AQMP)

Project type	Experience
Platinum smelter complex	▪ Fugitive dust emissions from ground-level sources and materials handling were a concern for a platinum smelter complex. The project scope included the identification of all sources; the quantification and ranking of emissions; and proposed management strategies. A risk assessment model was used to assess where the variability of emission sources would constitute a risk if improperly managed.
Diamond mine	▪ The project scope for a Botswana-based diamond mine approaching end-of-life required the assessment of current and future impacts of operations on the ambient air quality; including the development of an air quality management plan and the proposal of an ambient air quality monitoring network, based on the findings of the impact assessment.

Atmospheric Impact Reports (AIR)

Project type	Experience
Coal-to-liquid fuel refineries	▪ Postponement application included four sites with multiple point-sources and modelling iterations for all sources emitting at four different levels for multiple pollutants. ▪ A collaborative project where responsibilities included: model simulations, post-processing and extractions; management of model extractions and management of file transfer for peer review process; graphic summaries results; mapping of results; and, graphic presentation of measured ambient air quality. My contributions to the written report included: report template sections (as per Government Gazette No. 36904: 747); summary of meteorological data used in the assessment; measured ambient air quality; results analysis, interpretation and write-up; and, a literature review of potential impacts of the operations on the environment.
Crude oil refinery	▪ The assessment of impact of petroleum storage tanks storing products of the tar process on the ambient air quality, especially with respect to total volatile organic compounds (TVOCS). ▪ Postponement application included emissions from multiple point-sources, and fugitive emissions from storage tanks; modelling iterations for all sources emitting at two different levels for sulfur dioxide [from point sources] and total volatile organic compounds (TVOCS) [from tanks]. ▪ A collaborative project where I focused on the point-sources, including the model simulations; post-processing and extractions; graphic results summaries; and, graphic presentation of measured

Atmospheric Impact Reports (AIR)

Project type	Experience
	ambient air quality. Contributions to the written report included: report template sections; summary of meteorological data used in the assessment; measured ambient air quality; results analysis, interpretation and write-up.
	▪ Assessment report (prepared as AIR) included emissions from multiple point-sources; modelling iterations for all sources emitting at two different levels for particulate matter and ammonia emissions.
Fertilizer production	▪ A collaborative project where my responsibilities included: model simulation setup, post-processing and extractions; graphic summaries results; mapping of results; and, graphic presentation of measured ambient air quality. My contributions to the written report included: report template sections (as per Government Gazette No. 36904: 747); summary of meteorological data used in the assessment; measured ambient air quality; results analysis, interpretation and write-up.
Platinum smelter	▪ Postponement application included emissions from the smelter furnace and converter; modelling iterations for the sources emitting at two different levels where the pollutant of concern was sulfur dioxide.
Veterinary waste incinerator	▪ New Atmospheric Emissions License (AEL) application for a State Veterinary incinerator. The assessment included calculating emission rates from the incinerator; dispersion modelling; preparation of an AIR (as per Government Gazette No. 36904: 747); and completing the technical sections of the AEL application.
Galvanizing plant	▪ The project assessed the impact of a steel galvanising plant on air quality in a developing industrial development zone. Pollutants of concern included hydrochloric acid (HCl).
Secondary Aluminium Smelter	▪ A project involving the assessment of a secondary aluminium smelter in an already developed urban industrial area
NEMA Section 30	▪ Assessment of air quality impact due to industrial 'upset' events including simulating the off-site impacts for short-term high-emission events.

Ambient air quality monitoring projects

Project type	Comments regarding project details and involvement

Ferrochrome smelter complex	▪ Compiled reports for the dustfall monitoring campaign for a period of 12 months. Results were compared with the relevant legislation and recommendations made for source management as required.
Platinum smelter complex	▪ Project scope required monthly reports of the ambient sulfur dioxide concentrations downwind of a platinum smelter complex, for a 12-month reporting period. Report preparation included: data cleaning and filtering; data analysis, presentation; and report write-up.
Dustfall monitoring	▪ Collate, summarise and report on dustfall rates, and metal content, after laboratory analysis. Projects include: baseline monitoring prior to active coal mining; landfill dustfall monitoring; baseline dustfall monitoring for a residential development.
Ambient air quality monitoring	▪ Using radiello™ passive samplers to assess ambient pollutant concentrations. Projects include: volatile organic compounds around industrial waste water dams; pre-development levels near a medical waste incinerator; pre-development levels near a coal-fired power station; levels near a hazardous landfill; monitoring near an operational natural gas compression plant.
Asbestos monitoring	▪ Air and soil sampling and reporting for asbestos fibres
Petroleum product storage tanks	▪ Calculation of annual (volatile organic compound) emissions from petroleum storage tanks for the purposes of emissions reporting via the National Atmospheric Emission Inventory System.

SOFTWARE PROFICIENCY

- Atmospheric Dispersion Models: AERMOD, CALPUFF, ADMS (United Kingdom), CALINE, GASSIM
- Graphical Processing: Surfer, ArcGIS (basic proficiency)
- R, especially with the package "openair"
- Other: MS Word, MS Excel, MS Outlook

EDUCATION

University of the Witwatersrand

Ph.D. (School of Animal, Plant and Environmental Sciences) (2006 - 2011)	Thesis title: **Some impacts of sulfur and nitrogen deposition on the soils and surface waters of the Highveld grasslands, South Africa.**

M.Sc. (School of Animal, Plant and Environmental Sciences) (1999 – 2001).	Dissertation title: **Some effects of prescribed understory burning on tree growth and nutrient cycling, in *Pinus patula* plantations.**
B.Sc. (Hons) (Botany) (1998)	Project title: **The rate of nitrogen mineralization in plantation soils, in the presence of *Eucalyptus grandis* wood chips.** *Courses*: Wetland ecology, Ecophysiology and Environmental studies.
B.Sc. (1995 – 1997)	Botany III, Geography III, Zoology II.

COURSES COMPLETED AND CONFERENCES ATTENDED

- Paper presented at the International Union of Air Pollution Prevention and Environmental Protection Associations World Clean Air Congress, 2013 in Cape Town, South Africa,29 September - 4th October 2013
  - *Paper entitled*: Nitrogen cycling in grasslands and commercial forestry plantations: the influence of land-use change
  - *Co-authors*: T.L. Bird, M.C. Scholes, Y. Scorgie, G. Kornelius, N.-M. Snyman, J. Blight, and S. Lorentz
- Paper prepared for the National Association for Clean Air (NACA) annual conference, 2012 in Rustenburg, South Africa, 1-2 November 2012, Rustenburg. Annual Conference Proceedings ISBN 978-0-620-53886-2, Electronic Proceedings ISBN 978-0-620-53885-5
  - *Paper entitled*: Developing an Air Quality Management Plan: Lessons from Limpopo
  - *Co-authors*: T. Bird, H. Liebenberg-Enslin*, R. von Gruenewaldt, D. Modisamongwe, P. Thivhafuni, and, T. Mphahlele
- National Association for Clean Air (NACA) annual conference, 2017 in Johannesburg, South Africa, 4-6 October 2017, Rustenburg. Annual Conference Proceedings ISBN 978-0-620-77240-2, Electronic Proceedings ISBN 978-0-620-53885-5
  - *Poster entitled*: Air Pollution in sub-tropical urban and suburban areas: Do trends indicate vegetation as a pollution source?
  - *Co-authors*: T. Bird, G. Petzer, N. von Reiche

COURSES PRESENTED

Training organisation	Details of involvement
National Association for Clean Air (NACA)	▪ Presenting the module regarding the Development of Air Quality Management Plans ▪ Module forms part of a 5-day course presented annually

Centre for Environmental Management (CEM), University of the North-West (Potchefstroom)	▪ Presented two modules: 1. Development of Air Quality Management Plans 2. Air Pollution Meteorology ▪ Modules forms part of a 2-day course presented annually, or at special request

COUNTRIES OF WORK EXPERIENCE

South Africa, Botswana, Mozambique, Democratic Republic of Congo, Namibia, Tanzania

LANGUAGES

Language	Proficiency
English	Full professional proficiency
Afrikaans	Good understanding; fair spoken and written

REFERENCES

Name	Position	Contact Number
Dr. Hanlie Liebenberg Enslin	Managing Director at Airshed Planning Professionals	+27 (83) 416 1955 hanlie@airshed.co.za
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Dr. Gerrit Kornelius	Associate of Airshed Planning Professionals	+27 (82) 925 9569 gerrit@airshed.co.za

CERTIFICATION

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

08 March 2021

SACNASP

South African Council for Natural Scientific Professions

herewith certifies that

Theresa Leigh Bird

Registration Number: 114332

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following fields(s) of practice (Schedule 1 of the Act)

Biological Science (Professional Natural Scientist)
Botanical Science (Professional Natural Scientist)

Effective **25 May 2016** Expires **31 March 2022**

Chairperson

Chief Executive Officer

To verify this certificate scan this code

14 APPENDIX B: COMPETENCIES FOR PERFORMING AIR DISPERSION MODELLING

All modelling tasks were performed by competent personnel. Table 14-1 is a summary of competency requirements. Apart from the necessary technical skills required for the calculations, personnel competency also include the correct attitude, behaviour, motive and other personal characteristic that are essential to perform the assigned job on time and with the required diligence as deemed necessary for the successful completion of the project.

The project technical team included a senior scientist with 10 years relevant experience and a principal scientist with 20 years relevant experience. A senior scientist also managed and directed the project.

Verification of modelling results was conducted by the principal scientist. The latter function requires a thorough knowledge of the

- meteorological parameters that influence the atmospheric dispersion processes and
- atmospheric chemical transformations that some pollutants may undergo during the dispersion process.

In addition, the project team included one junior staff member.

Table 14-1: Competencies for Performing Air Dispersion Modelling

Competency	Task, Knowledge and Experience
Context	Communication with field workers, technicians, laboratories, engineers and scientists and project managers during the process is important to the success of the model
	Familiar with terminology, principles and interactions
	Record keeping is important to support the accountability of the model - Understanding of data collection methods and technologies
Knowledge	Meteorology: Obtain, review and interpret meteorological data Understanding of meteorological impacts on pollutants Ability to identify and describe soil, water, drainage and terrain conditions Understanding of their interaction Familiarity with surface roughness` Ability to identify good and bad data points/sets Understanding of how to deal with incomplete/missing meteorological data
	Atmospheric Dispersion models Select appropriate dispersion model Prepare and execute dispersion model Understanding of model input parameters Interpret results of model
	Chemical and physical interactions of atmospheric pollutants Familiarity with fate and transport of pollutants in air Interaction of primary pollutants with other substances (natural or industrial) to form secondary pollutants

Competency	Task, Knowledge and Experience
	Information relevant to the model Identify potential pollution (emission) sources and rates Gather physical information on sources such as location, stack height and diameter Gather operating information on sources such as mass flow rates, stack top temperature, velocity or volumetric flow rate Calculate emission rates based on collected information Identify land use (urban/rural) Identify land cover/terrain characteristics Identify the receptor grid/site
	Legislation, regulations and guidelines in regards to National Environment Management: Air Quality Act (Act No 39 of 2004), including Minimum Emissions Standards (Section 21 of Act) National Ambient Air Quality Standards Regulations regarding Air Dispersion Modelling Atmospheric Impact Report (AIR)
Abilities	Ability to read and understand map information
	Ability to prepare reports and documents as necessary
	Ability to review reports to ensure accuracy, clarity and completeness
	Communication skills
	Team skills

15 APPENDIX C: DECLARATION OF INDEPENDENCE

DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner: Theresa Bird

Name of Registration Body: South African Council for Natural Scientific Professions

Professional Registration No.: 114332

Declaration of independence and accuracy of information provided:

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

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

Signed at Alberton on this 19th day of April 2022.

SIGNATURE

Senior Air Quality Scientist

CAPACITY OF SIGNATORY

16 APPENDIX D: METHODOLOGY TO ASSESS IDENTIFIED IMPACTS

Methodology provided by Savannah Environmental (Pty) Ltd.

Direct, indirect and cumulative impacts of the issues identified through the scoping study, as well as all other issues identified in the EIA phase must be assessed in terms of the following criteria:

» The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
» The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
» The **duration**, wherein it will be 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; or
    * 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 shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 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) and 5 is definite (impact will occur regardless of any prevention measures).
» the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
» the **status**, which will be described as either positive, negative or neutral.
» the degree to which the impact can be reversed.
» the degree to which the impact may cause irreplaceable loss of resources.
» the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:
S=(E+D+M)P
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).

Assessment of impacts must be summarised in the following table format. The rating values as per the above criteria must also be included. Complete a table and associated ratings for **each** impact identified during the assessment.

<u>Example</u> of Impact table summarising the significance of impacts (with and without mitigation)

Nature: **[Outline and describe fully the impact anticipated as per the assessment undertaken]**			
Impact description: The impact will occur due to added pressure on the availability of housing located in the local community. This may contribute to increased levels of competition in the temporary housing market.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Short-term (1)	The construction period will last for less than one year	**Low Negative (18)**
Extent	Local (1)	Pressure will only be added on the local municipality to provide housing for outsourced construction workers	
Magnitude	Low (4)	The increase in demand for affordable accommodation should not be extensive as workers will primarily be sourced from the local communities.	
Probability	Probable (3)	The possibility of the impact on the provision of affordable accommodation is very low	
Mitigation/Enhancement Measures			
Mitigation: "Mitigation", means to anticipate and prevent negative impacts and risks, then to minimise them, rehabilitate or repair impacts to the extent feasible. • Provide a description of how these mitigation measures will be undertaken keeping the above definition in mind.			
Post Mitigation/Enhancement Measures			
Duration	Short-term (1)	Pressure will only be added on the local municipality to provide housing for outsourced construction workers.	**Low Positive (8)**
Extent	Local (1)	The increase in demand for affordable accommodation should be mitigated if external construction crews are provided with onsite accommodation.	
Magnitude	Minor (2)	The possibility of the impact on the provision of affordable accommodation is very low.	
Probability	Improbable (2)	A reduced amount of pressure will be added on the local municipality to provide housing for outsourced construction workers.	
Cumulative impacts:			

"Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities.
Residual Risks: "Residual Risk", means the risk that will remain after all the recommended measures have been undertaken to mitigate the impact associated with the activity (Green Leaves III, 2014).

Assessment of Cumulative Impacts

As per requirements of the EIA Regulations, specialists are required to assess the cumulative impacts. In this regard, please refer to the methodology below that will need to be used for the assessment of Cumulative Impacts.

"Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities[3].

The role of the cumulative assessment is to test if such impacts are relevant to the proposed project in the proposed location (i.e. whether the addition of the proposed project in the area will increase the impact). This section should address whether the construction of the proposed development will result in:

- Unacceptable risk
- Unacceptable loss
- Complete or whole-scale changes to the environment or sense of place
- Unacceptable increase in impact

The specialist is required to conclude if the proposed development will result in any unacceptable loss or impact considering all the projects proposed in the area.

Example of a cumulative impact table:

Nature: Complete or whole-scale changes to the environment or sense of place (example)

Nature: **[Outline and describe fully the impact anticipated as per the assessment undertaken]**		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Low (1)	Low (1)
Duration	Medium-term (3)	Long-term (4)
Magnitude	Minor (2)	Low (4)
Probability	Improbable (2)	Probable (3)
Significance	**Low (12)**	**Low (27)**
Status (positive or negative)	Negative	Negative
Reversibility	High	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	Yes

[3] Unless otherwise stated, all definitions are from the 2014 EIA Regulations, as amended, GNR 326

Confidence in findings: High.
Mitigation: "Mitigation", means to anticipate and prevent negative impacts and risks, then to minimise them, rehabilitate or repair impacts to the extent feasible. Provide a description of how these mitigation measures will be undertaken keeping the above definition in mind.

Environmental Management Plan Table format

Measures for inclusion in the draft Environmental Management Programme must be laid out as detailed below:

OBJECTIVE: Description of the objective, which is necessary in order to meet the overall goals; these take into account the findings of the environmental impact assessment specialist studies

Project component/s	List of project components affecting the objective
Potential Impact	Brief description of potential environmental impact if objective is not met
Activity/risk source	Description of activities which could impact on achieving objective
Mitigation: Target/Objective	Description of the target; include quantitative measures and/or dates of completion

Mitigation: Action/control	**Responsibility**	**Timeframe**
List specific action(s) required to meet the mitigation target/objective described above	Who is responsible for the measures	Time periods for implementation of measures

Performance Indicator	Description of key indicator(s) that track progress/indicate the effectiveness of the management plan.
Monitoring	Mechanisms for monitoring compliance; the key monitoring actions required to check whether the objectives are being achieved, taking into consideration responsibility, frequency, methods and reporting