Air Quality Specialist Scoping Report for the Proposed Zero-Waste Recovery Plant near Emalahleni, Mpumalanga

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

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1 COMPANY INTRODUCTION

Airshed Planning Professionals (Pty) Ltd, a South African company, was established in 2003, specialising in all aspects of air quality, ranging from nearby neighbourhood concerns to regional air pollution impacts. The company originated in 1990 as Environmental Management Services, which amalgamated with its sister company, Matrix Environmental Consultants, in 2003. Airshed comprises a team of professional air quality scientists drawn from a range of disciplines including chemical and mechanical engineering, meteorology, geography and environmental management. Our team holds extensive expertise and experience in all aspects of air pollution impact assessments and air quality management. Airshed is at the forefront of air quality science encouraging and facilitating further study and skills development among our staff and through our association with universities and research organisations. The team is motivated, capable and well equipped to meet the challenge of managing air quality within the sustainable development concept.

Airshed Planning Professionals (Pty) Ltd was appointed by Savannah Environmental (Pty) Ltd to undertake an Air Quality Impact Assessment AQIA presented in the form of an Atmospheric Impact Report (AIR) and to assist with the compilation of the Atmospheric Emissions Licence application for the proposed Zero-Waste Recovery Plant at Highveld Steel near Emalahleni in the Mpumalanga province of South Africa.

2 SPECIALIST TEAM INTRODUCTION

Report author: NB Grobler, BEng (Chemical Engineering), BEng (Hons) (Environmental Engineering) (Pretoria)
Nick Grobler joined Airshed Planning Professionals after finishing his BEng degree in Chemical Engineering and BEng (Hons) in Environmental Engineering, both from the University of Pretoria. For the past nine and a half years, Nick has been actively involved in all facets off air quality management, including ambient air quality monitoring, dispersion modelling, air quality impact assessments, and the compilation of air quality management plans since 2011. Nick also expanded into conducting environmental noise baseline and impact assessments in 2017. Nick is an associate member of the Institution of Chemical Engineers (IChemE) and a member of Golden Key international.

Nick has been actively involved with projects for the opencast and underground mining of: copper, platinum, chrome, gold, iron, coal, limestone, potash, graphite, lead, mineral sands, aggregate stone, clay and zinc. Furthermore, he's also conducted air quality or noise studies for the production of: copper, platinum, PGM metals, gold, base metals, iron, steel, coal, coke, heavy mineral sands, vanadium, solder, lime, urea, chrome, gypsum, asphalt, acetylene, LNG liquefaction, vegetable oil, fertilizer, explosives, wood pulp, cement, grease, oil recycling, tyre and general waste pyrolysis, power generation, fuel storage as well as crematoriums, general waste landfills, meat processing and rendering at abattoirs and animal waste incineration. Nick has experience in working with projects in South Africa, Zimbabwe, Namibia, Mozambique, Republic of Congo, Democratic Republic of Congo, Ghana, Liberia, Guinea, Mali, Suriname and Saudi Arabia.

Report reviewer: Dr Theresa (Terri) Bird, Pr. Sci. Nat., PhD (University of the Witwatersrand)
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 mining operations (including coal, mineral sand,

diamond and platinum mines); coal-fired power station ash disposal facilities; waste incineration and landfilling; and power generation facilities using fuels such as coal, diesel, LPG, natural gas, and biogas from anaerobic digestion. 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 Suspension of Emission Standards for various Listed Activities.

3 SCOPE OF WORK

- Determine and document the baseline, ambient air quality conditions of the study area based on available data. This will include description of the pre-project pollutant levels where possible and a qualitative description of existing sources of emissions to ambient air quality (if any) associated with the project area;
- Review legal requirements pertaining to air quality and specifically referring to IFC Standards and The National Environmental Management Air Quality Act (NEMAQA) Act No. 39 of 2004.
- Model the concentrations of pollutants of concern and emissions from the operations, and determine the zones of influence around emission sources accordingly;
- Describe any sensitive receptors (e.g. local communities) within the zones of influence identified above;
- Assess the significance of impacts to the receiving air quality environment and sensitive receptors within the zone of influence according to criteria to be provided by the client (based on the nature, extent, duration, extent, magnitude and probability of the impacts)
- Identify and assess any potential cumulative impacts in terms of the above criteria;
- Provide practical and implementable mitigation measures by which to manage the identified impacts. Any changes to the significance of impacts resulting from implementation of mitigation or management measures must be illustrated;
- Report on all legislation, provincial legislation and any ordinances at a local or municipal level that will impact this project and what permits this project will require going forward;
- Describe a monitoring protocol to be implemented;
- Compile an AIR report;
- Provide shapefiles illustration sensitive receptors, zones of impact, etc; and
- Assist with completion of an AEL application.

4 DESCRIPTION OF PROPOSED PROJECT

Fodere Titanium Zero Waste Recovery Solution (Fodere Titanium) has developed a disruptive technology for the economic extraction of valuable minerals from mining ore and waste materials. The process offers solutions for simultaneously extracting both vanadium and titanium oxides from slag materials. The technology developed by the Fodere Group is also demonstrated to extract aluminium as aluminium oxide (Al_2O_3), magnesium as magnesium oxide (MgO) and calcium as calcium sulphate/gypsum ($CaSO_4$).

Anglo African Metals (Pty) Ltd (the South African registered company of Fodere Titanium) has identified a suitable tailings/slag resource at Highveld Steel in Mpumalanga between Balmoral and Emalahleni. A site for a small-scale industrial plant has been defined within the Highveld Steel property. It is understood that the following is relevant to the proposed facility:

» The plant would be developed to process 2000 tonnes of tailings/slag per month, approximately 3 tons per day. This plant would be developed within the Highveld industrial plant owned property. The purpose of this plant would be to confirm the process inputs and outputs and refine the extraction processes as necessary.

» The plant would be primarily fuelled by LPG and Sasol gas brought into site by dedicated transport truck deliveries.

The plant will comprise the following infrastructure:

- » Acid plant area, where process chemicals are produced, stored and handled as required by the waste recovery process;
- » Substation and plant utility unit as interface and controlling unit for the electricity utilised by the plant during operation;
- » Slag stockpile
- » Crushing plant;
- » Mill;
- » Product area for storage of the various products produced through the recovery process;
- » Reagent area, for the storage and handling of reactants utilised in the waste recovery process;
- » A security area;
- » Parking lot;
- » Admin and control room including offices and ablutions for staff.

Operation of the plant is anticipated for 24 hours per day, 365 per year (i.e. non-stop operation) and will utilise the slag produced by the Highveld Steel operations. The process offers solutions for simultaneously extracting both vanadium and titanium oxide from slag materials. The technology developed by the Fodere Group is also demonstrated to extract aluminium as aluminium oxide (Al_2O_3), magnesium as magnesium oxide (MgO) and calcium as calcium sulphate/gypsum ($CaSO_4$), and involves the following approximate process (due to intellectual property and commercial sensitivity of this process, various technical details have been omitted):

- » Crushing and milling of titanium dioxide (TiO_2) slag to the appropriate size for further treatment;
- » Magnetic separation of entrained metallic iron from the crushed slag, which is used in a separate ferroalloy production processes;
- » Alkali roasting of the remaining feedstock using a gas fired kiln. Off-gases from the kiln is a combination of carbon monoxide (CO) and sulfur[1] dioxide (SO_2). By comparison, sulfur dioxide (SO_2) is only 3-5% of the carbon monoxide gas. These off gases are passed through the off-gas scrubber to remove SO_2 and the remaining CO_2 is reused in the kiln to supply part of the required heat.
- » The material produced during alkali roasting from the kiln is then leached in water to dissolve vanadium and alumina.
- » A further process produces vanadium pentoxide and recovers aluminium oxide from the leached products in the steps above.
- » The remaining solid or residue after extracting vanadium is treated via leaching and roasting with sulfuric acid. The SO_2 gases or fumes given out during leaching or roasting are scrubbed off.
- » Iron, magnesium and TiO_2 are recovered from solution via precipitation steps.
- » Precipitated TiO_2 is heated in order to remove water of hydration.

[1] 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)"

- The leach solution is neutralised with lime form calcium sulphate and respective sulphates. The mixture of sulphates is heated in the furnace to produce sulfuric acid which is then used in the leaching step. The solid material after heating in the furnace is mainly calcium silicate which is used for cement production and construction.
- The remaining material after leaching of titanium, magnesium, aluminium oxide etc. is mainly silica sand which is also used for construction.

This process therefore recovers vanadium and titanium oxide from slag materials, with water, carbon dioxide, gypsum and synthetic rutile produced at the various stages. These materials are all useful in other processes and are collected and sold to third parties, and thus the process itself results in no further waste production, while simultaneously utilising a common waste type – slag.

5 DESCRIPTION OF STUDY AREA

The waste recovery plant is located on Portion 4 of the farm 309 JS: TOJS00000000030900048, and comprises an area of approximately 4.10 ha footprint within the Highveld Steel property, located in the eMalahleni Local Municipality (LM) within the Nkangala District Municipality (DM) in Mpumalanga, approximately 17 km west of eMalahleni town. The site may be reached directly off the R104, from the N4 turnoff near Kwa-Guqa informal settlement (Figure 1).

Sensitive receptors within a 10 km radius (Figure 2) of the proposed operations include the residential areas of Kwa-Guqa, eMumelelweni and Hlalanikahle to the north, the residential areas of Ackerville, Thushanang, Schoongezicht and Lynnville to the east and Clewer to the south. KwaGuqa is a township west of the industrial town of eMalahleni and is the largest populated area within close proximity to the proposed development site (approximately 1 500 m north of the proposed development site at its closest point). There are also numerous schools, clinics and hospitals in the nearby residential areas, as shown in Figure 2. There are a large number of operations within a 50km radius that are sources of major emissions, including seven power stations and numerous mines (Figure 3).

The proposed project site lies at an altitude between 1,480 and 1,560 metres above sea level (masl) (Figure 4). In general, the topography of the site slopes downwards from north to south at a gradient of approximately 1 m per 70 m and from west to east at a gradient of approximately 1 m per 30 m.

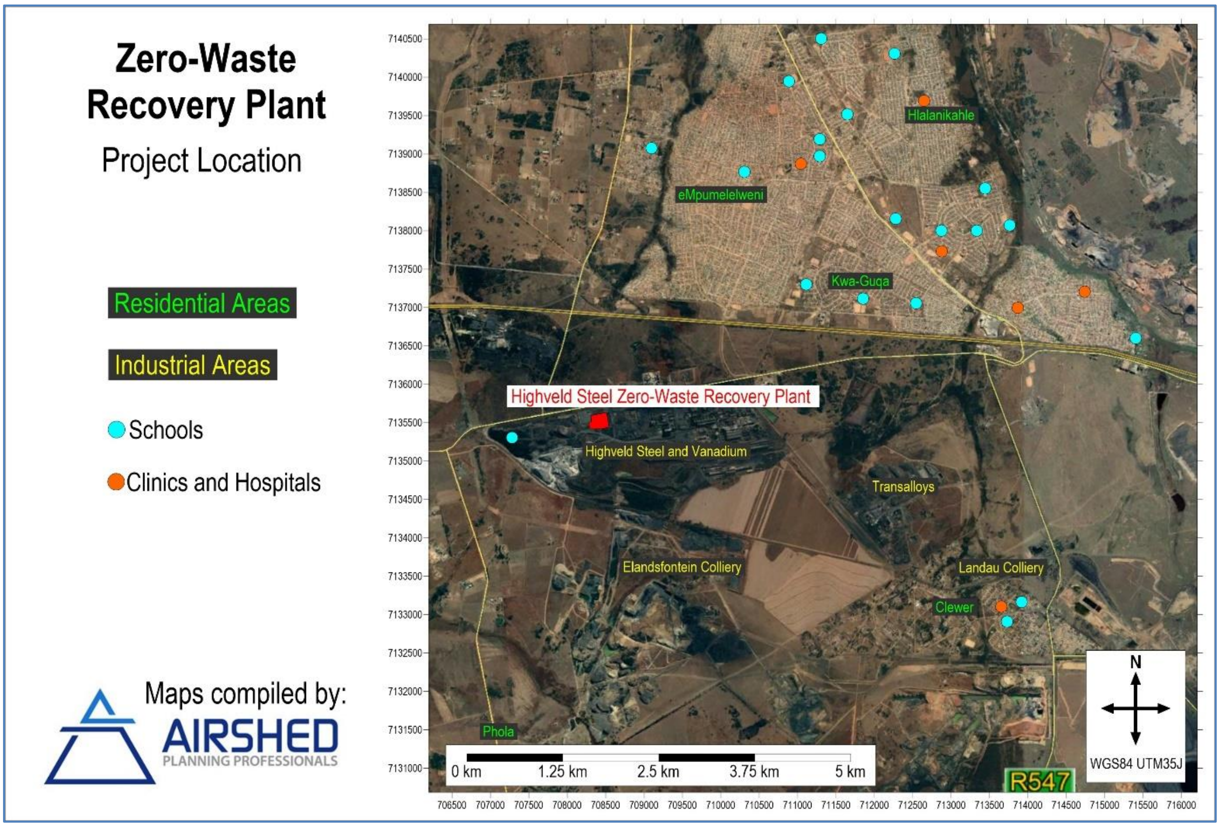

Figure 1: Project location with surrounding land use and sensitive receptor locations shown - 5 km radius.

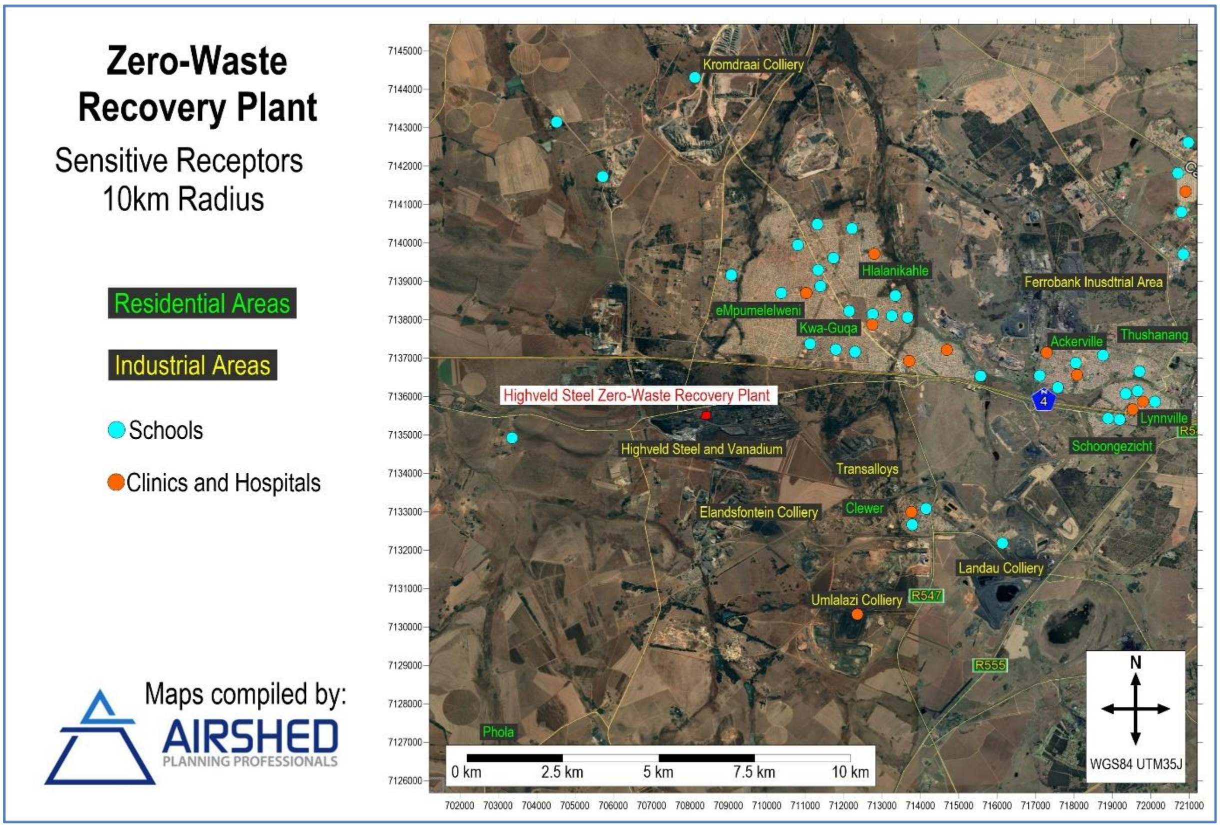

Figure 2: Project location with nearby industries, residential areas, schools and hospitals shown – 10 km radius.

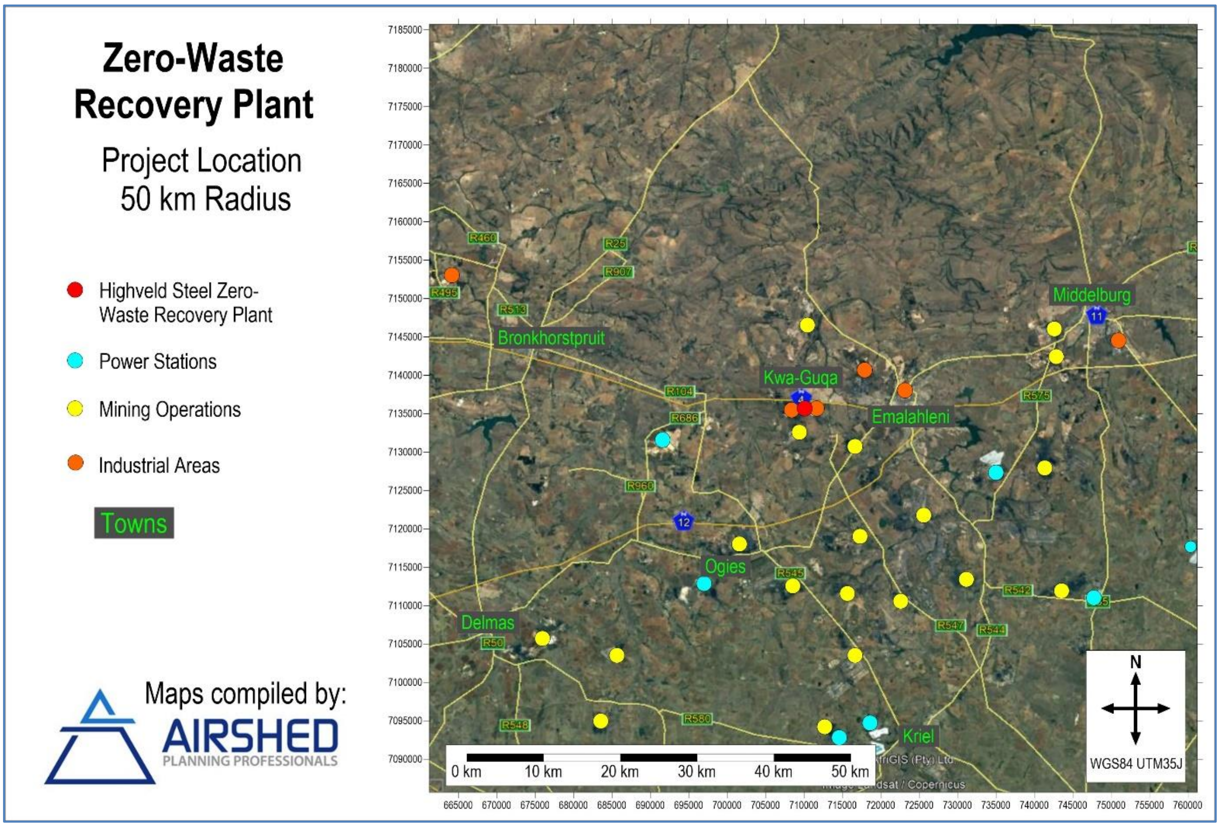

Figure 3: Project location with major emission sources and major towns shown – 50 km radius

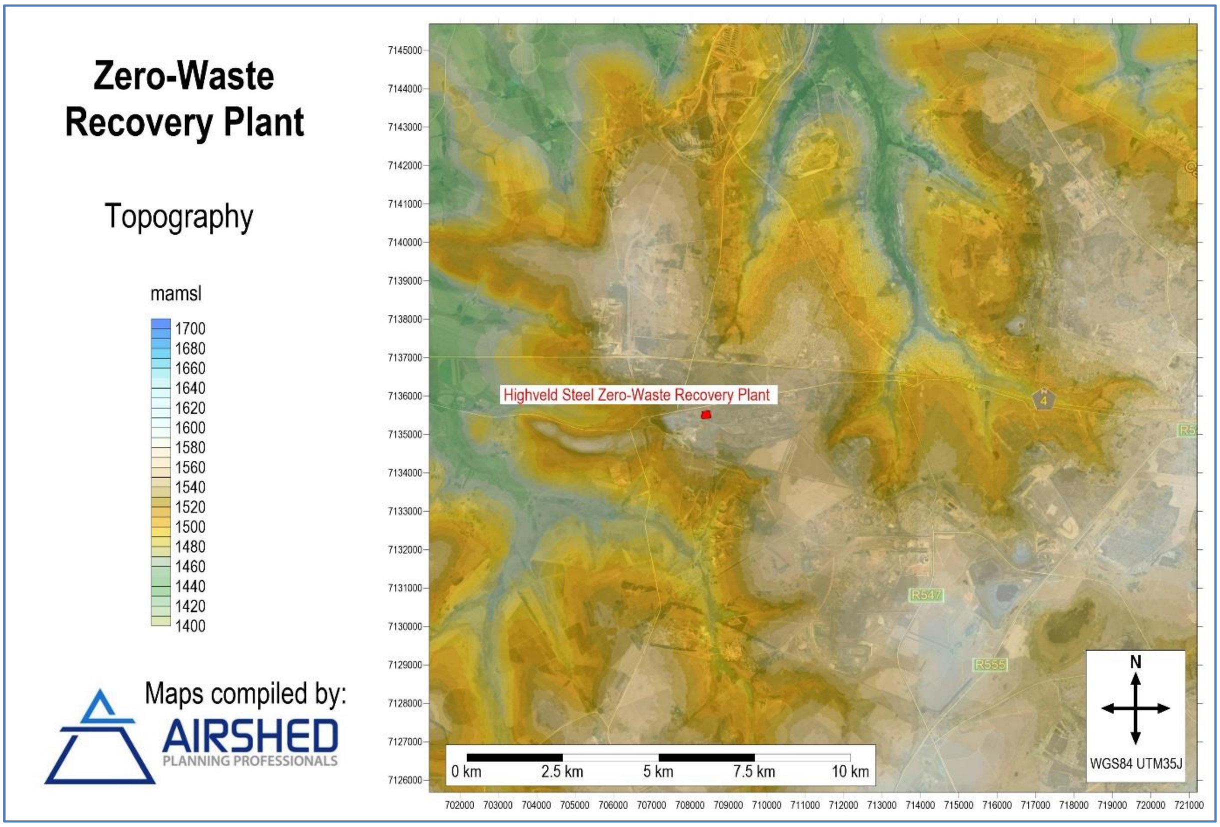

Figure 4: Project location with topography

5.1 Study Methodology

5.1.1 Study Plan

The study methodology may conveniently be divided into a "preparatory phase" and an "execution phase".

The preparatory phase included the flowing basic steps prior to performing the actual dispersion modelling and analyses:

1. Understand Scope of Work
2. Assign Appropriate Specialists
3. Review of Legal Requirements (e.g. dispersion modelling guideline)
4. Prepare a Plan of Study for Peer Review
5. Decide on Dispersion Model

The Regulations Regarding Air Dispersion Modelling (Gazette No 37804 published 11 July 2014) was referenced for the dispersion model selection.

Three Levels of Assessment are defined in the Regulations Regarding Air Dispersion Modelling:

- Level 1: where worst-case air quality impacts are assessed using simpler screening models
- Level 2: for assessment of air quality impacts as part of license application or amendment processes, where impacts are the greatest within a few kilometres downwind (less than 50km)
- Level 3: require more sophisticated dispersion models (and corresponding input data, resources and model operator expertise) in situations:
  - 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 processes 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 airshed; or,
  - when assessing contaminants resulting from non-linear processes (e.g. deposition, ground-level O_3, particulate formation, visibility)

Due to the relatively short distance to sensitive receptors (especially to the north of the operations) the assessment of impact as a result of emissions from the proposed Zero-Waste Recovery Plant is considered to fall within the scope of a Level 2 assessment.

The execution phase (i.e. dispersion modelling and analyses) will firstly involve gathering specific information in relation to the emission source(s) and site(s) to be assessed. This includes:

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

The model uses this specific input data to run various algorithms to estimate the dispersion of pollutants between the source and receptor. The model output is in the form of a predicted time-averaged concentration at the receptor. These predicted concentrations are compared with the relevant ambient air quality standard or guideline. Post-processing can be carried out to produce contour plots that can be prepared for reporting purposes.

The following steps will be followed for the execution phase of the assessment:

- Decide on meteorological data input;
- Prepare all meteorological model input files;
- Select control options in meteorological model;
- Review emissions inventory and ambient measurements;
- Decide on modelling domain and receptor locations;
- Prepare all dispersion model input files:
    - Control options;
    - Meteorology;
    - Source data;
    - Receptor grid and discrete receptors;
- Review all modelling input data files and fix where necessary;
- Simulate source groups per pollutant and calculate air concentration levels for regular and discrete grid locations for the operational phase of the project;
- Compare against National Ambient Air Quality Standards (NAAQS) and international guidelines;
- Preparation of draft AIR; and,
- Preparation of final AIR.

5.1.2 AERMOD Modelling Suite

It was decided that the most recently US Environmental Protection Agency's (US EPA) approved regulatory model will be employed. The most widely used US EPA model has been the Industrial Source Complex Short Term model (ISCST3). This model is based on a Gaussian plume model. However, this model has been replaced by the new generation AERMET/AERMOD suite of models. AERMOD is a dispersion model, which was developed under the support of the AMS/EPA Regulatory Model Improvement Committee (AERMIC), whose objective has been to include state-of the-art science in regulatory models (Hanna et al., 1999). The AERMOD is a dispersion modelling system with three components, namely: AERMOD (AERMIC Dispersion Model), AERMAP (AERMOD terrain pre-processor), and AERMET (AERMOD meteorological pre-processor).

- AERMOD is an advanced new-generation model. It is designed to predict pollution concentrations from continuous point, flare, area, line, and volume sources (Trinity Consultants, 2004). AERMOD offers new and potentially improved algorithms for plume rise and buoyancy, and the computation of vertical profiles of wind, turbulence and temperature. However, it does retain the single straight-line trajectory limitation of ISCST3 (Hanna et al., 1999). The Breeze AERMOD executable 19191 was used for dispersion modelling.
- AERMET is a meteorological pre-processor for the AERMOD model. Input data can come from hourly cloud cover observations, surface meteorological observations and twice-a-day upper air soundings. Output includes surface meteorological observations and parameters and vertical profiles of several atmospheric parameters. AERMET version 7.9.0.3 will be used to process the meteorological data.

- AERMAP is a terrain pre-processor designed to simplify and standardize the input of terrain data for the AERMOD model. Input data includes receptor terrain elevation data. The terrain data may be in the form of digital terrain data. Output includes, for each receptor, location and height scale, which are elevations used for the computation of air flow around hills.

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

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 the above factors contribute to the inaccuracies not even associated with the mathematical models themselves.

Similar to the ISC model, a disadvantage of the model is that spatial varying wind fields, due to topography or other factors cannot be included. Although the model has been shown to be an improvement on the ISC model, especially short-term predictions, the range of uncertainty of the model predictions is -50% to 200%. The accuracy improves with fairly strong wind speeds and during neutral atmospheric conditions.

Input data types required for the AERMOD model include: meteorological data, source data, and information on the nature of the receptor grid. Each of these data types will be described below.

5.1.3 Meteorological Requirements

AERMOD requires two specific input files generated by the AERMET pre-processor. Meteorological data for the closest South African Weather Service Station (Emalahleni) for the period January 2016 to December 2018 was selected for use in the simulations. This station is located at the Witbank Aerodrome to the north of Ackerville in eMalahleni, approximately 12.3km east-northeast of the project location. The coordinates of the station are 25°49'56.28"S and 29°11'31.56"E.

5.1.4 Topographical Data

The topography of the modelling domain around the operations is generally flat with an average slope of less than 10% (Figure 4). The AERMOD Implementation Guide recommends that slopes less than 10% terrain be excluded from the dispersion model (US-EPA, 2005). On this basis, the flat terrain option will be used in the AERMOD model during the model runs.

5.1.5 Receptor Grid

The dispersion of pollutants will be modelled for an area covering 10 km (north-south) by 10 km (east-west) with the proposed Zero-Waste Recovery Plant at the centre. This area will be divided into a grid with a resolution of 250 m (north-south) by 250 m (east-west). In order to assess impacts at nearby receptor points, a nested 5 km by 5 km grid with a resolution of 100 m by 100 m will also be included. AERMOD simulates ground-level concentrations for each of the receptor grid points.

5.1.6 Emission Quantification

The AERMOD model is able to model point, line, area and volume sources. Typical emission information required for dispersion modelling include pollutant emission rates as well as source location and geometry (such as coordinates and height) as well as other source parameters such as flow rate, exit velocity, temperature etc.

During the impact assessment for the Zero-Waste Recovery plant a comprehensive emissions inventory for the operations will be established and will include points sources as well as fugitive emission sources from the operations.

The pollutants of concern from the plant that will be quantified, modelled and impacts assessed will be the three pollutants for which there are Subcategory 4.20 Minimum Emission Standards (Table 3) namely particulates (PM_{10} and $PM_{2.5}$), oxides of nitrogen (NO_2) and sulfur dioxide (SO_2). Fugitive emissions will be estimated from material throughput rates using internationally published emission factor from sources such as the US EPA AP42 or the Australian NPI.

5.1.7 Cumulative Assessment

Cumulative impacts from the Zero-Waste Recovery Plant will be assessed by adding modelled impacts from the operations to baseline pollutant concentrations (Table 5) and simulated impacts from the Highveld Steel and Vanadium operations as quantified during the postponement application undertake during 2019 (G Petzer & R von Gruenewaldt, 2019, Atmospheric Impact Report: EVRAZ Highveld Steel and Vanadium, Airshed Planning Professionals Report No 18EHS01)

5.2 Legal Requirements

5.2.1 Atmospheric Impact Report

According to the National Environmental Management (NEM) Air Quality Act (AQA), an Air Quality Officer (AQO) may require the submission of an Atmospheric Impact Report (AIR) in terms of section 30, 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 the AQA.

The format of the Atmospheric Impact Report 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).

5.2.2 National Ambient Air Quality Standards

The National Framework provided a stepped approach in setting ambient air quality standards. Based on this the standard for a specific pollutant must include limit values for specific exposures, the number of allowed exceedances and a timetable for compliance. The limit values (concentrations) are based on scientific evidence. National Ambient Air Quality Standards (NAAQS) were determined based on international best practice for particulate matter less than 10 and 2.5 µm in aerodynamic diameter (PM_{10} and $PM_{2.5}$), dust fall, sulfur dioxide, nitrogen dioxide, ozone, carbon monoxide, lead and benzene. These standards were published for comment in the Government Gazette on 9 June 2007 with the new standards, which include frequency of exceedance and implementation timeframes, published on the 24th of December 2009 (Government Gazette 32816). $PM_{2.5}$ standards were gazetted and passed in June 2012 (*Government Gazette 35463*).

Based on the minimum emission standards for slag processing (Section 5.2.4), the main criteria pollutants of concern for this study are NO_2, SO_2, PM_{10} and $PM_{2.5}$, all of which have South African standards, which are listed in Table 1. The 2016 to 2029 standards will be used to evaluate the impact of $PM_{2.5}$.

Table 1: National ambient air quality standards for PM_{10}, $PM_{2.5}$, NO_2, CO and SO_2

Pollutant	Averaging Period	Limit Value (µg/m^3)	Frequency of Exceedance
PM_{10}	24 hours	75	4
	1 year	40	0
$PM_{2.5}$	24 hours	40	4
	1 year	20	0
NO_2	1 hour	200	88
	1 year	40	0
CO	1 hour	30 000	88
	8 hours (calculated on 1hourly averages)	10 000	11
SO_2	1 hour	350	88
	24 hours	125	4
	1 year	50	0

5.2.3 National Dust Control Regulations

South Africa's National Dust Control Regulations (NDCR) were published on 1 November 2013 (Government Gazette No 36974). The purpose of the regulations is to prescribe general measures for the control of dust in all areas, including residential and light commercial areas. Acceptable dust fallout rates according to the regulations are summarised in Table 2.

Table 2: Acceptable dust fallout rates

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

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

Revised Draft National Dust Control Regulations were published on 25 March 2018 (Government Gazette No. 41650) which references the same acceptable dust fallout rates but refers to the latest version of the ASTM D1739 method to be used for sampling.

5.2.4 Listed Activities and Minimum Emission Standards

In 2010 the Department of Environmental Affairs (now the Department of Environment, Forestry and Fisheries - DEFF) published, under Section 21 of the National Environmental Management: Air Quality Act (NEM:AQA), a List of Activities which result in Atmospheric Emissions which have, or may have, a significant detrimental effect on the environment, including health, social conditions, economic conditions, ecological conditions or cultural heritage (Government Gazette No 33064). Amendments to Section 21 of the Act were published in 2013 (Government Gazette No 37054), 2015 (Government Gazette No 38863), 2018 (Government Gazette No 42013) and 2020 (Government Gazette No 43174).

Under Section 21 of NEM:AQA any permanent or experimental plant with a design capacity equal to or greater than the threshold for the listed activity needs to comply with the Minimum Emission Standards for that activity.

Under Section 22 of NEM:AQA no person may without a Provisional Atmospheric Emissions Licence (PAEL) or Atmospheric Emissions Licence (AEL) conduct a listed activity.

The processing or recovery of metallurgical slag is a listed activity as per Subcategory 4.20 of Section 21 of the National Environmental Management: Air Quality Act (NEM:AQA) (Act no 39 of 2004) and will require an Atmospheric Emissions Licence (AEL) to operate. The plant will be required to comply with the New Plant Minimum Emission Standards (MES) for Subcategory 4.20 as described in Table 3.

Table 3: Listed Activity Subcategory 4.20: Slag Processes

Category 4.20	**Slag Processes**	
Description:	The processing or recovery of metallurgical slag by the application of heat	
Application:	All installations	
Substance or Mixture of Substances		**New Plant emission limits: mg/Nm³ under normal conditions of 273 Kelvin and 101.3 kPa**
Common Name	**Chemical Symbol**	
Particulate Matter	PM	50
Oxides of nitrogen	NO_x expressed as NO_2	350
Sulfur dioxide	SO_2	1500

5.2.5 Highveld Priority Area

The Highveld Airshed was the second priority area declared by the minister. This required that an Air Quality Management Plan for the area be developed. The plan includes the establishment of emissions reduction strategies and intervention programmes based on the findings of a baseline characterisation of the area. The implication of this is that all contributing sources in the area will be assessed to determine the emission reduction targets to be achieved over the following few years.

The project area is located within the footprint demarcated as the Highveld Priority Area (HPA). The Department of Environmental Affairs (DEA – now DEFF) published the management plan for the Highveld Priority Area in September 2011. Included in this management plan are seven goals, each of which has a further list of objectives that have to be met. The goals for the Highveld Priority area are as follows:

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

Goal 2 applies directly to the project, the objectives associated with this goal (as well as the activities applicable to industries for each objective) include:

- Emissions are quantified from all sources;
    - Establish and maintain a site emissions inventory that includes all point and diffuse sources for all significant pollutants.
    - Submit emissions inventory report as per emission reporting regulations.
- Gaseous and particulate emissions are reduced;
    - Submit AIR report using a regulated modelling approach.
    - Develop and implement a maintenance plan for each plant.
    - Schedule and conduct repairs to coincide with plant offline times.
    - Incorporate equipment changes into the maintenance schedule.
    - Operate plants with minimum disruption e.g. back-up plan for energy consumption/generation.
- Fugitive emissions are minimised;
    - Develop fugitive emission management plan.
    - Implement appropriate interventions, e.g. a leak detection and repair program.
- Emissions from dust generating activities are reduced;
    - Develop and implement dust reduction programmes in line with industry best practice, considering technology and management interventions.
    - Investigate feasibility of using alternative means for haulage, e.g. conveyors, rail.
    - Plan and carry out regular fleet maintenance.
    - Investigate opportunities to market waste as raw material inputs to other industries.
- Greenhouse gas emissions are reduced;
    - Include greenhouse gas emissions in site emissions inventory.
    - Develop and implement a site energy efficiency plan.
    - Consider climate change implications in air quality management (AQM) decision making.
    - Investigate opportunities for co-generation.
    - Investigate feasibility of renewable energy.

- Incidences of spontaneous combustion are reduced;
- Abatement technology is appropriate and operational;
    - Install and/or maintain appropriate air pollution abatement technology compliant with requirements of AEL and achieving Section 21 emission standards.
    - Train operators to ensure optimal operation of abatement equipment.
- Industrial Air Quality Management (AQM) decision making is robust and well-informed, with necessary information available;
    - Establish sector information sharing fora.
    - Conduct international benchmarking within the sectors.
    - Make sector emission performance information available for company benchmarking.
- Clean technologies and processes are implemented;
    - Investigate feasibility of introducing clean technologies on plant-specific basis.
    - Implement feasible technology options on plant-specific basis.
    - Investigate possibility of switching to clean fuels at times of poor dispersion.
    - Investigate alternative design and process options to improve plume dispersion.
    - Implement feasible alternative design and process options.
- Adequate resources are available for AQM in industry;
    - Revise organograms to create air quality structure and designation, where needed.
    - Optimise environmental management resource availability to accommodate air quality function.
    - Fill AQM posts with appropriately skilled staff, where needed.
    - Input into financial planning to implement emission abatement and measurement requirements of AEL and Section 21 emission standards.
    - Investigate the possible use of offset programs to reduce financial investments.
- Ambient air quality standard and dust fallout limit value exceedances as a result of industrial emissions are assessed; and,
    - Conduct ambient air quality monitoring in accordance with AEL requirements.
    - Conduct dust fallout monitoring in accordance with legislative requirements, and consider advances in monitoring technology.
    - Report ambient monitoring results to relevant AQO and publish on SAAQIS.
    - Update AIR submissions.
- A line of communication exists between industry and communities.
    - Conduct quarterly consultative community meetings.

Each of these objectives and activities has a timeframe, responsibility and indicator. Further details are available in the DEA (2012) Highveld Priority Management Plan.

5.2.6 Regulations Regarding Air Dispersion Modelling

Air dispersion modelling provides a cost-effective means for assessing the impact of air emission sources, the major focus of which is to determine compliance with the relevant ambient air quality standards. Regulations regarding Air Dispersion Modelling were promulgated in Government Gazette No. 37804 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 AQA;
(b) in the development of a priority area air quality management plan, as contemplated in Section 19 of the AQA;
(c) in the development of an atmospheric impact report, as contemplated in Section 30 of the AQA; and,
(d) in the development of a specialist air quality impact assessment study, as contemplated in Chapter 5 of the AQA.

The Regulations have been applied to the development of this report. The first step in the dispersion modelling exercise requires a clear objective of the modelling exercise, and thereby gives clear direction to the choice of the dispersion model most suited for the purpose. Chapter 2 of the Regulations present the typical levels of assessments, technical summaries of the prescribed models (SCREEN3, AERSCREEN, AERMOD, SCIPUFF, and CALPUFF) and good practice steps to be taken for modelling applications.

Dispersion modelling provides a versatile means of assessing various emission options for the management of emissions from existing or proposed installations. Chapter 3 of the Regulations prescribe the source data input to be used in the models.

Dispersion modelling can typically be used in the:

- Apportionment of individual sources for installations with multiple sources. In this way, the individual contribution of each source to the maximum ambient predicted concentration can be determined. This may be extended to the study of cumulative impact assessments where modelling can be used to model numerous installations and to investigate the impact of individual installations and sources on the maximum ambient pollutant concentrations.
- Analysis of ground level concentration changes as a result of different release conditions (e.g. by changing stack heights, diameters and operating conditions such as exit gas velocity and temperatures).
- Assessment of variable emissions as a result of process variations, start-up, shut-down or abnormal operations.
- Specification and planning of ambient air monitoring programmes which, in addition to the location of sensitive receptors, are often based on the prediction of air quality hotspots.

The above options can be used to determine the most cost-effective strategy for compliance with the NAAQS. Dispersion models are particularly useful under circumstances where the maximum ambient concentration approaches the ambient air quality limit value. They also provide a means for establishing the preferred combination of mitigation measures that may be required, including:

- Stack height increases;
- Reduction in pollutant emissions through the use of air pollution control systems (APCS) or process variations;
- Switching from continuous to non-continuous process operations or from full to partial load.

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

New generation dispersion models, including models such as AERMOD and CALPUFF simulate the dispersion process using planetary boundary layer (PBL) scaling theory. PBL depth and the dispersion of pollutants within this layer are influenced by specific surface characteristics such as surface roughness, albedo and the availability of surface moisture:

- Roughness length (z_o) is a measure of the aerodynamic roughness of a surface and is related to the height, shape and density of the surface as well as the wind speed.
- Albedo is a measure of the reflectivity of the Earth's surface. This parameter provides a measure of the amount of incident solar radiation that is absorbed by the Earth/atmosphere system. It is an important parameter since absorbed solar radiation is one of the driving forces for local, regional, and global atmospheric dynamics.
- The Bowen ratio provides measures of the availability of surface moisture injected into the atmosphere and is defined as the ratio of the vertical flux of sensible heat to latent heat, where sensible heat is the transfer of heat from the surface to the atmosphere via convection, and latent heat is the transfer of heat required to evaporate liquid water from the surface to the atmosphere.

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

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

Chapter 5 of the regulations provides general guidance on geophysical data, model domain and coordinates system required in dispersion modelling, whereas Chapter 6 elaborates more on these parameters as well as the inclusion of background air concentration data. The chapter also provides guidance on the treatment of NO_2 formation from NO_x emissions, chemical transformation of sulfur dioxide into sulfates and deposition processes.

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

5.3 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.

The South African Weather Services (SAWS) operate a meteorological station in Emalahleni. For this assessment data for the period January 2016 to December 2018 was evaluated. Parameters useful in describing the dispersion and dilution potential of the site i.e. wind speed, wind direction, temperature and atmospheric stability, are subsequently discussed.

5.3.1 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 red area, for example, representing winds >6 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s, are also indicated.

The Emalahleni period wind roses (Figure 5) depict the predominance of the northerly, easterly and east-south-easterly winds with wind speeds of greater than 5 m/s, especially during the day. Winds from the north-westerly sector winds are also predominant during the day, albeit at slightly lower overall wind speed. The night-time wind rose shows a decrease in the northerly and the north-westerly winds and an increase in the easterly and east-south-easterly winds. The night-time is also characterised by an increase in the frequency of calm wind conditions.

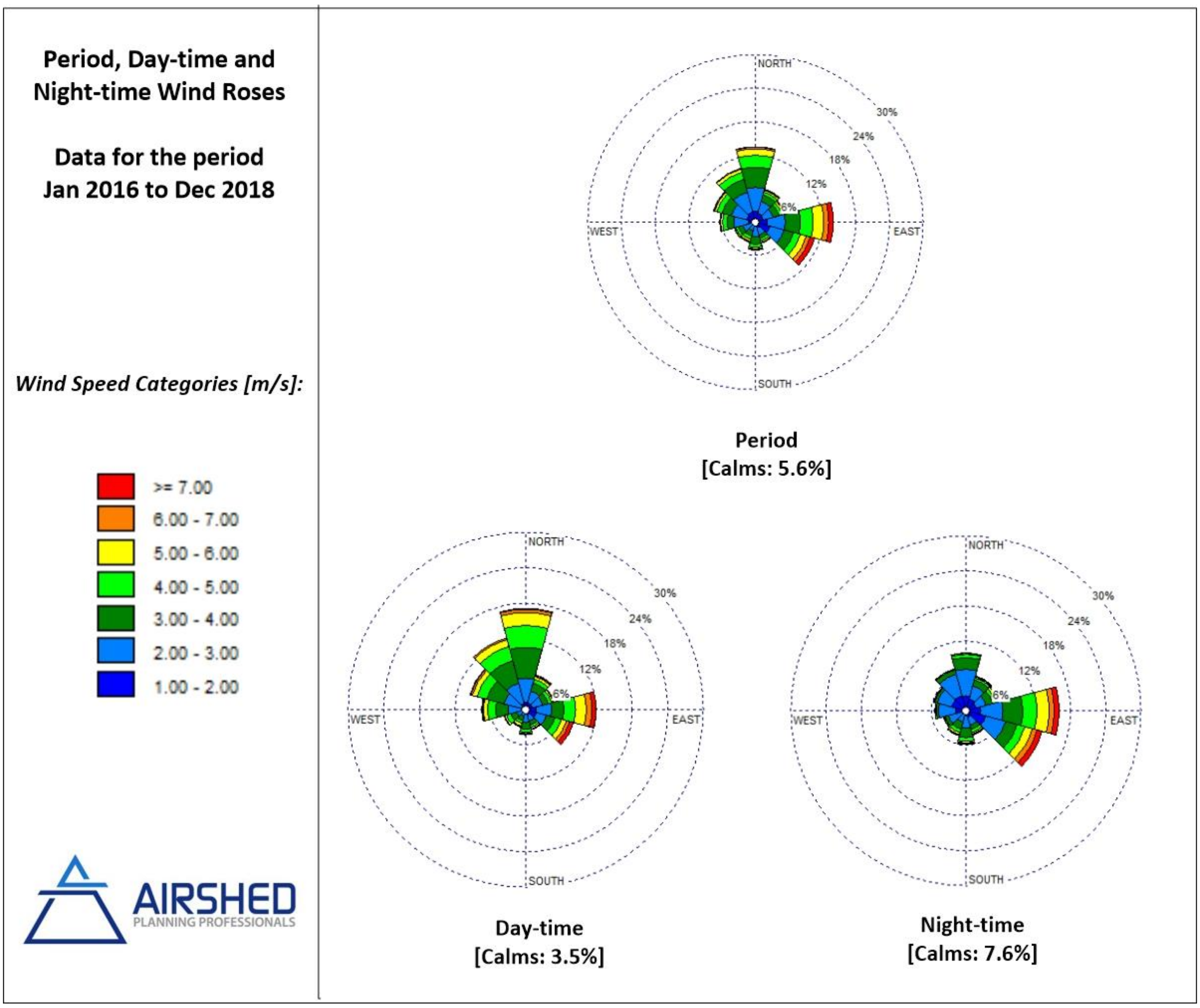

Figure 5: Period, day- and night-time wind rose for Emalahleni for the period 2016 - 2018

5.3.2 *Temperature*

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

The average monthly temperature trends are presented in Figure 6. Monthly mean and hourly maximum and minimum temperatures are given in Table 4. Average temperatures ranged between 11.3°C and 20.7°C. The highest temperatures occurred in January and the lowest in June/July. During the day, temperatures increase to reach maximum at around 15:00 in the afternoon. Ambient air temperature decreases to reach a minimum at around 05:00 i.e. just before sunrise.

Table 4: Monthly temperature summary (2016 - 2018)

Hourly Minimum, Hourly Maximum and Monthly Average Temperatures (°C)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	9.1	11.5	7.8	5.3	2.4	0.2	-2.1	0.2	0.4	4.1	5	11.1
Maximum	35.8	33.5	31.2	30.1	24.5	23.9	23.3	28	33.1	33.6	3.4	34
Average	20.5	20.4	19.3	17.2	13.6	11.8	11.3	14.2	18.2	18.4	19.2	20.7

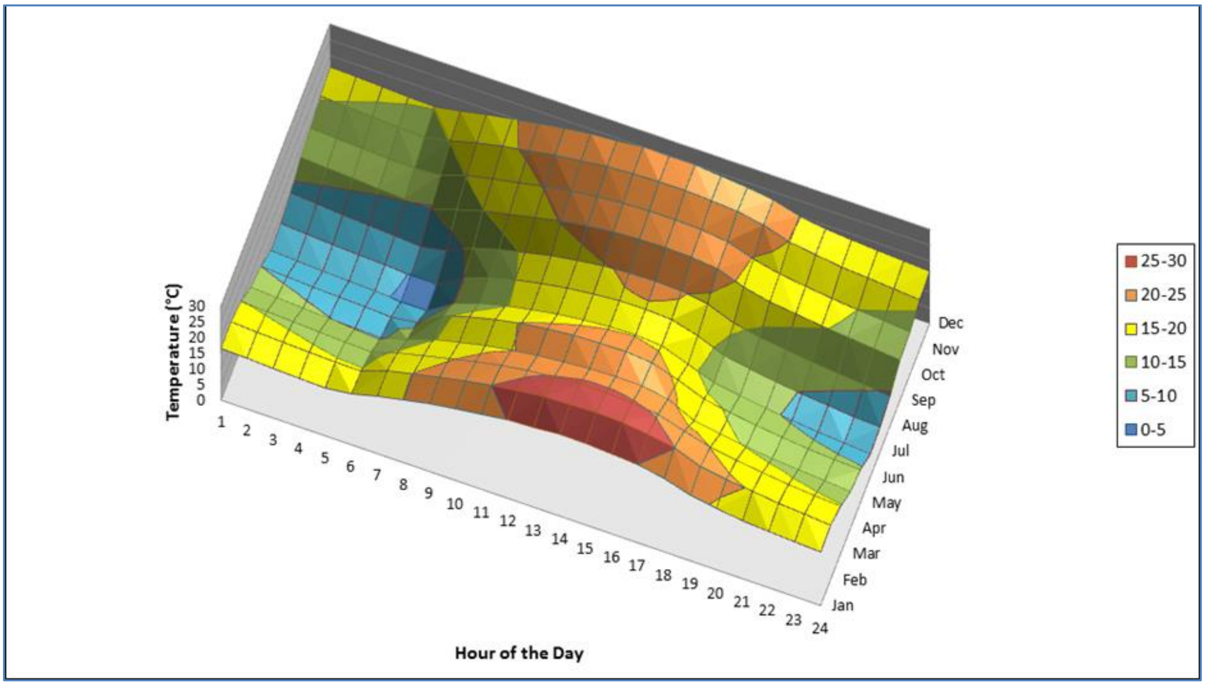

Figure 6: Monthly average temperature profile for SAWS Emalahleni

5.4 Baseline Air Quality

5.4.1 Air Quality Monitoring data

A summary of ambient data measured at the Department of Environmental Affairs, Forestry and Fisheries (DEFF)-managed Witbank station (located approximately 9 km east of the proposed project location) for the period 2018 is provided in Table 5 (with exceedances of the NAAQS shown in red). Time series of the measured ambient air quality data is provided in Figure 9.

Table 5: Summary of the ambient measurements at Witbank for 2018 (units: µg/m³)

Period	Availability	Maximum	Annual Average	No of recorded hourly exceedances
Hourly Concentrations				
NO_2				
2018	67%	139	30	-
SO_2				
2018	84%	562	39	3
Daily Concentrations				
SO_2				
2018	84%	165	39	1
PM_{10}				
2018	16%	235	83	67
$PM_{2.5}$				
2018	31%	123	40	57

Note: Exceedances of the NAAQS are provided in red.

The hourly and daily 99th percentiles for SO_2 were below the limit value of 350 µg/m³ and 125 µg/m³ respectively. The hourly 99th percentiles for NO_2 were below the limit value (200 µg/m³). The daily 99th percentiles for PM_{10} exceeded the limit value (75 µg/m³). The daily 99th percentiles for $PM_{2.5}$ exceeded the limit value (40 µg/m³).

While the SO_2 and NO_2 annual averages were below the NAAQS, the PM_{10} and $PM_{2.5}$ annual averages exceeded the limit value of 40 µg/m³ and 20 µg/m³ respectively for 2018 at the Witbank (DEFF) station, located in Emalahleni.

This is similar to the trend seen from 2015 to 2017 in the Witbank data (State of Air Reports). The main conclusion to be drawn is that ambient particulate concentrations are elevated in the Emalahleni area.

Time series plots (mean with 95% confidence interval) of ambient SO_2, NO_2 and PM_{10} concentrations measured at Witbank (DEFF) (Figure 8 and Figure 9) show the variation of these pollutants over daily, weekly and annual cycles.

Increased NO_2 concentrations during peak traffic times illustrate the contribution of vehicle emissions to the ambient NO_2 concentrations. The winter (June, July and August) elevation of SO_2 and NO_2 shows the contribution of residential fuel burning to the ambient SO_2 and NO_2 concentrations.

Monthly variation of PM_{10} and $PM_{2.5}$ shows a typical Highveld signature of elevated concentrations during winter months due to the greater contribution from domestic fuel burning, wind erosion from uncovered soil and the lack of the settling influence of rainfall.

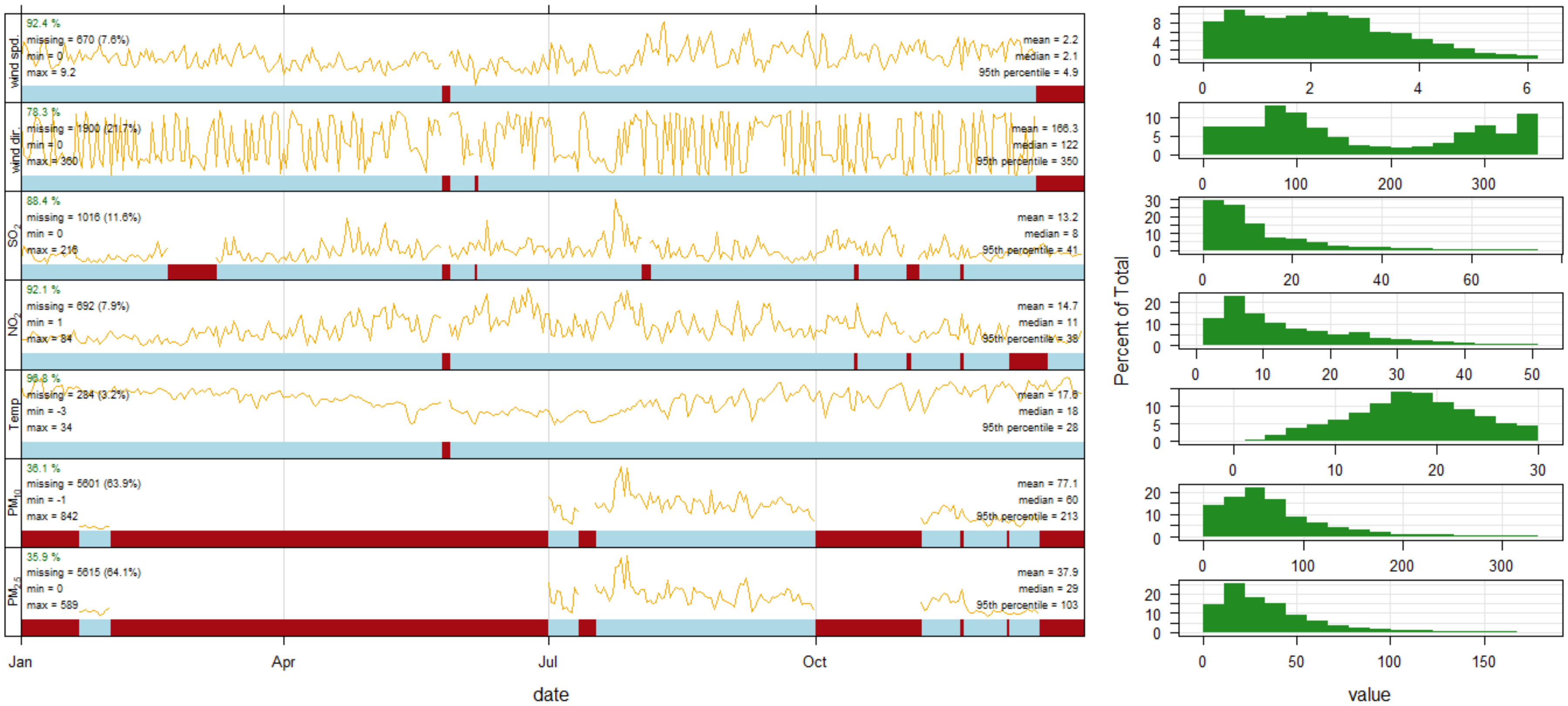

Figure 7: Data available from the DEFF Witbank ambient air quality monitoring station (2018)

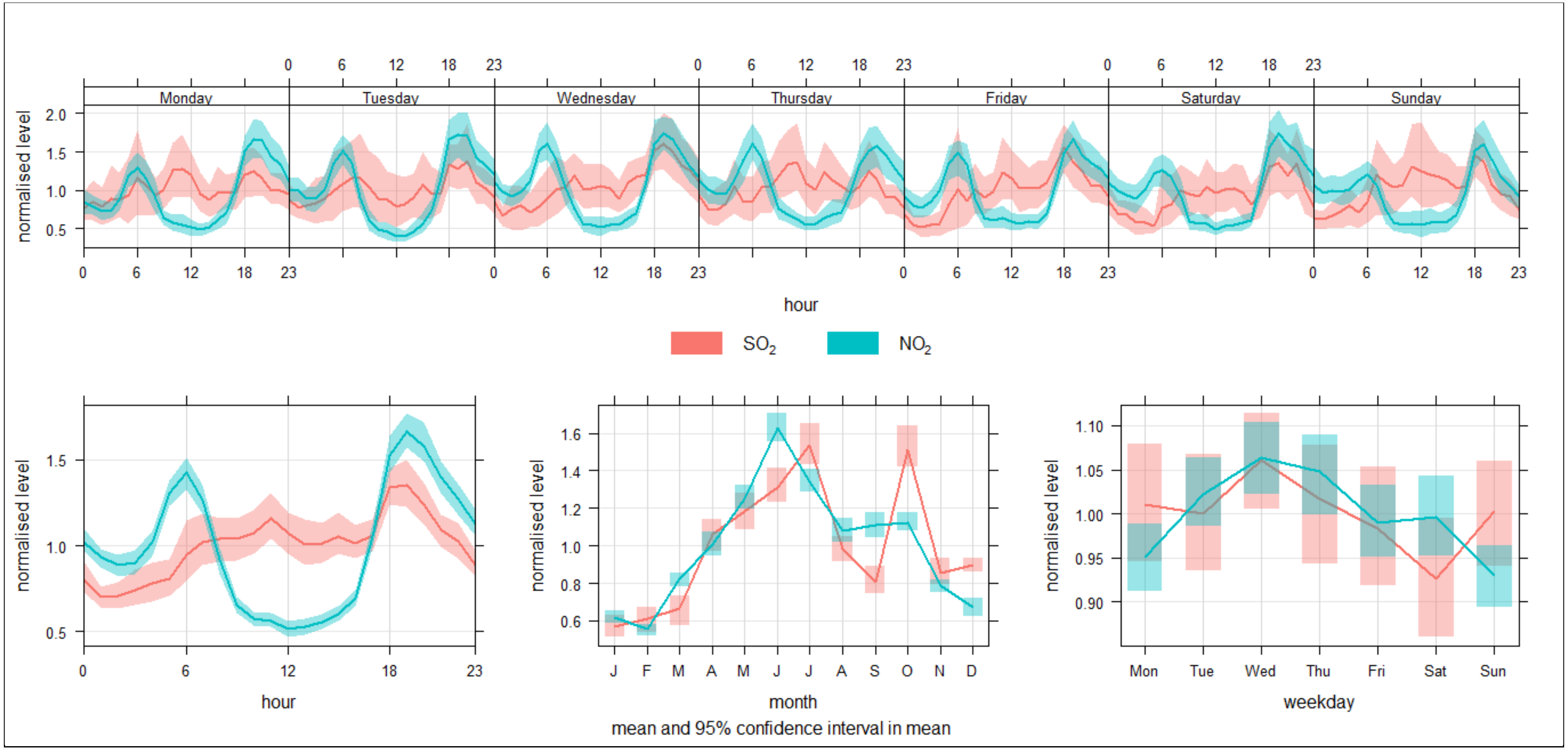

Figure 8: Weekly, diurnal and monthly trends of normalised observed SO_2 and NO_2 concentrations at Witbank (DEFF) (shaded area indicates 95th percentile confidence interval)

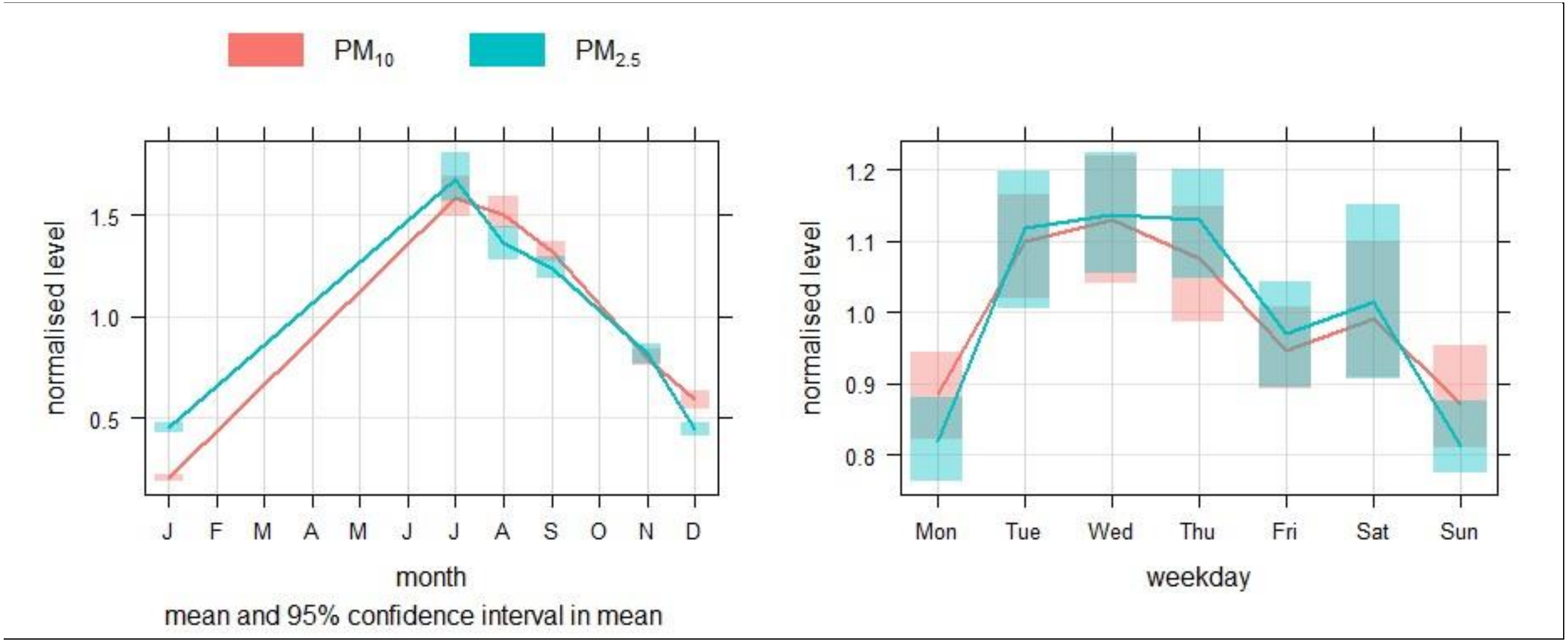

Figure 9: Time series plot of normalised observed PM_{10} and $PM_{2.5}$ concentrations at Witbank (DEFF) (shaded area indicates 95th percentile confidence interval)

6 SCOPING PHASE IMPACT ASSESSMENT

The purpose of the Scoping Report is to identify the main issues and potential impacts of the proposed project based on a desktop assessment of existing information. It should be noted that this is a preliminary assessment based on the information available during the Scoping Phase. The assessment will be updated during the Impact Assessment Phase.

It is assumed that all point sources from the operations will comply with the MES for processing or recovery of metallurgical slag as required by legislation.

The **extent** of incremental impacts due to the Zero-Waste Recovery Plant are expected to be localised to the vicinity of the operations, possibly outside the Highveld Steel and Vanadium Boundary and possibly at the closest sensitive receptor locations . The **duration** of the impacts is expected to be long-term (for the life of the project) while the **magnitude** of impacts is expected to be low to medium, depending on the height at which pollutants are released, abatement equipment design, and mitigation measures employed to minimise fugitive emissions. If all fugitive sources are properly managed, no residual impact is expected post closure.

Given that particulate concentrations in the study area are already elevated, it is possible that cumulative impacts could be high in **magnitude**. It is therefore recommended that best available technologies be employed to mitigate point source and fugitive particulate emissions.

Table 6: Expected Incremental Potential Impact Associated with the Operation phase of the Zero-Waste Recovery Plant at the Scoping Phase

Nature: Elevated ambient concentrations of particulate and gaseous atmospheric pollutants as a result of Zero-Waste Recovery Plant operational activities		
	Without mitigation	**With mitigation**
Extent	Surrounding suburbs (2)	Surrounding suburbs (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Medium (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (36)**	**Medium (30)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	Yes
Mitigation: No mitigation of point sources is expected to be needed if the Zero-Waste Recovery plant complies with the subcategory 4.20 MES (Section 5.2.4). Best available technology mitigation measures are recommended for fugitive dust sources.		
Cumulative impacts: Cumulative impacts are expected due to the high baseline particulate concentrations in the study area (Section 5.4.1)		
Residual Risks: If all fugitive dust sources are properly managed, no residual impact is expected post closure.		
Gaps in knowledge & recommendations for further study Atmospheric dispersion modelling will be used during the EIA phase to assess the extent of the impact of the proposed facility and the cumulative impact of the pollutants of concern. It was assumed that the Zero-Waste Recovery Plant will be designed to comply with the subcategory 4.20 MES		

Table 7: Expected Cumulative Potential Impact Associated with the Operation phase of the Zero-Waste Recovery Plant at the Scoping Phase

Nature: Elevated ambient concentrations of particulate and gaseous atmospheric pollutants as a result of Zero-Waste Recovery Plant operational activities		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the study area**
Extent	Surrounding suburbs (2)	Surrounding suburbs (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Medium (6)	High (10)
Probability	Probable (3)	Probable (3)
Significance	**Medium (36)**	**Medium (48)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	Yes
Mitigation: No mitigation of point sources is expected to be needed if the Zero-Waste Recovery plant complies with the subcategory 4.20 MES (Section 5.2.4). Best available technology mitigation measures are recommended for fugitive dust sources.		
Cumulative impacts: Cumulative impacts are expected due to the high baseline particulate concentrations in the study area (Section 5.4.1)		
Residual Risks: If all fugitive dust sources are properly managed, no residual impact is expected post closure.		
Gaps in knowledge & recommendations for further study Atmospheric dispersion modelling will be used during the EIA phase to assess the extent of the impact of the proposed facility and the cumulative impact of the pollutants of concern. It was assumed that the Zero-Waste Recovery Plant will be designed to comply with the subcategory 4.20 MES		

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