ATMOSPHERIC IMPACT REPORT:
Proposed Glass Bottle Manufacturing Facility
Vereeniging, Gauteng

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

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Report Details

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Revision Record

Revision Number	Date	Reason for Revision
Draft	June 2018	First draft for client review
Revision 1	July 2018	Updated with client comments
Revision 1.1	August 2018	Minor process description updates
Revision 1.2	September 2018	Replacement of type of particulate control system (from electrostatic precipitator to Ceramic Catalytic Filter)

Abbreviations

AEL	Atmospheric Emissions Licence
AERMOD	A dispersion modelling suite; see p17
AIR	Atmospheric Impact Report
Airshed	Airshed Planning Professionals (Pty) Ltd
AMS	American Meteorological Society
AQMS	Air Quality Monitoring Station
AQO	Air Quality Officer
AQMS	Air Quality Monitoring Station
ASTM	American Society Testing and Materials (now ASTM International)
CCF	Ceramic Catalytic Filter
DEA	Department of Environmental Affairs
EIA	Environmental Impact Assessment
FOE	Frequency of Exceedance
IRIS	Integrated Risk Information System
ISO	International Organization for Standardization
MES	Minimum Emission Standard (as defined in Section 21 of the National Environmental Management: Air Quality Act)
NAEIS	National Atmospheric Emission Inventory System
NAAQS	National Ambient Air Quality Standards
NDCR	National Dust Control Regulations
NEM-AQA	National Environmental management: Air Quality Act
NMES	National Minimum Emission Standards
SAAQIS	South African Air Quality Information System
SABS	South African Bureau of Standards
SLR	SLR Consulting (South Africa) (Pty) Ltd
US EPA	United States Environmental protection Agency
VTAPA	Vaal Triangle Airshed Priority Area

Glossary

Air pollution[(a)]	The presence of substances in the atmosphere, particularly those that do not occur naturally
Dispersion[(a)]	The spreading of atmospheric constituents, such as air pollutants
Dust[(a)]	Solid materials suspended in the atmosphere in the form of small irregular particles, many of which are microscopic in size
Frequency of exceedance	Permissible margin of tolerance of the Limit Concentration
Instability[(a)]	A property of the steady state of a system such that certain disturbances or perturbations introduced into the steady state will increase in magnitude, the maximum perturbation amplitude always remaining larger than the initial amplitude
Limit Concentration	Maximum allowable concentration of a pollutant applicable for an applicable averaging period
Mechanical mixing[(a)]	Any mixing process that utilizes the kinetic energy of relative fluid motion
Oxides of nitrogen (NO_x)	The sum of nitrogen oxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide (NO_2)
Particulate matter (PM)	Total particulate matter, that is solid matter contained in the gas stream in the solid state as well as insoluble and soluble solid matter contained in entrained droplets in the gas stream
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of less than 2.5 µm
PM_{10}	Particulate Matter with an aerodynamic diameter of less than 10 µm
Stability[(a)]	The characteristic of a system if sufficiently small disturbances have only small effects, either decreasing in amplitude or oscillating periodically; it is asymptotically stable if the effect of small disturbances vanishes for long time periods
Standard	A combination of the Limit Concentration and the allowable frequency of exceedance

Notes:

(a) Definition from American Meteorological Society's glossary of meteorology (AMS, 2014)

Symbols and Units

°C	Degree Celsius
CO	Carbon monoxide
g	Gram(s)
g/s	Grams per second
kg	Kilograms
km	Kilometre
K	Temperature in Kelvin
1 kilogram	1 000 grams
m	Metre
m/s	Metres per second
mamsl	Metres above mean sea level
µg	Microgram(s)
µg/m³	Micrograms per cubic metre
m²	Square metre
m³/hr	Cubic metre per hour
mg/m².day	Milligram per square metre per day
mg/Am³	Milligram per actual cubic metre
mg/Nm³	Milligram per normal cubic metre (normalised at 273 K; 101.3 kpa)
mm	Millimetres
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
PM	Particulate matter
$PM_{2.5}$	Inhalable particulate matter (aerodynamic diameter less than 2.5 µm)
PM_{10}	Thoracic particulate matter (aerodynamic diameter less than 10 µm)
SO_2	Sulfur dioxide
t/a	Tonnes per annum
t/d	Tonnes per day
TSP	Total Suspended Particulates

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)"

Executive Summary

SLR Consulting (South Africa) (Pty) Ltd (SLR) appointed Airshed to compile this Atmospheric Impact Report (AIR) to assess the impact of the proposed facility which intends to manufacture 920 tonnes per day of glass containers using two production lines for the two glass colour variants: amber and green. The proposed location is near Lager Street, Vereeniging, on Portion 238 of the farm Leeuwkuil 596 IQ, Gauteng.

The assessment of the impact of the project assumed that emissions from the main glass manufacturing buildings would be extracted and passed through a scrubber system to vent to the atmosphere with the main furnace emissions, such that the emissions would meet the national minimum emission standards (NMES) for Subcategory 5.8 – Glass and glass wool manufacturing. Natural ventilation of the batch plant building was also quantified for handling of raw materials prior to delivery to the glass furnaces. The estimation of total emissions was based on information provided by the facility design engineers.

Meteorological and monitoring data from the Sharpeville Air Quality Monitoring Station (AQMS) (managed by the national Department of Environmental Affairs) was acquired for the period 2014 to 2016. The wind field showed generally north-easterly and north-westerly codominance.

Baseline air quality at the Sharpeville AQMS, for the period 1 January 2014 to 31 December 2017, showed compliance with short-term and annual concentrations of sulfur dioxide (SO_2) and oxides of nitrogen (NO_x). Daily and annual average concentrations of $PM_{2.5}$ and PM_{10} were in non-compliance with the NAAQS for all three years used for the assessment. A short-term on-site monitoring campaign was conducted to assess the representativeness of the Sharpeville AQMS data for the proposed site.

The impact of the proposed project on ambient air quality was simulated using the US EPA AERMOD model. Simulated pollutant concentrations were compared against the National Ambient Air Quality Standards (NAAQS). Simulated nuisance dustfall rates were compared against the National Dust Control Regulations (NDCR) for residential areas due to the proximity of residential areas to the proposed site location.

The main findings of the assessment were:

1. Gaseous pollutants (SO_2, and NO_2) were predicted to comply with the NAAQS across the domain for all applicable time periods.
2. Particulate emissions, particularly those associated with the batch plant, may result in off-site exceedances of the $PM_{2.5}$ and PM_{10} standards. The exceedances could affect nearby industrial activities and residential areas.
    a. Particulate emission control systems, such as baghouses or fabric filters, are recommended for the batch plant.
    b. Regular sweeping and/or watering of the facility access road (assumed to be paved or tarred) would reduce the silt content of particulates on the road surface, controlling the scale of impact to on-site.
3. Dustfall rates are likely to comply with the NDCR.
    a. Dustfall monitoring is recommended at the facility boundary. Dustfall rates should comply with the residential standard, due to the proximity of residences to the proposed site boundary.
4. The impact of the proposed project on the ambient air quality was assessed to have a “low” to “medium” impact significance, especially if particulate emissions from materials handling can be controlled.

Conclusion

From an air quality perspective, it is recommended that the project go ahead, on condition that:

- Control systems commissioned on the batch plant to minimise particulate emissions have a control efficiency of 98%;
- The access road be paved, and regularly maintained, swept and/or watered to minimise particulate along the access road; and,
- Dustfall and fine particulate monitoring is conducted during operations.

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Specialist report requirements

	A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	Section in report
a	details of- (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Report details (page i) Appendix D
b	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Report details (page i)
c	an indication of the scope of, and the purpose for which, the report was prepared;	Purpose and Scope (Page 1)
d	the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	No site investigation for air
e	a description of the methodology adopted in preparing the report or carrying out the specialised process;	Section 5.1.1 – Study Methodology (Page 18)
f	the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;	Section 1.3 (Page 4)
g	an identification of any areas to be avoided, including buffers;	Not Applicable
h	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 1.3 (Page 4)
i	a description of any assumptions made and any uncertainties or gaps in knowledge;	Assumptions and limitations (Page 1)
j	a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;	Section 5.3 – Main Findings and Conclusions (Page 39)
k	any mitigation measures for inclusion in the EMPr;	
l	any conditions for inclusion in the environmental authorisation;	
m	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	• Emissions testing as per conditions in AEL (to be confirmed by Authority) • On-site monitoring of gaseous and dustfall (Section 5.3 – Main Findings and Conclusions (Page 40))
n	a reasoned opinion- (i) as to whether the proposed activity or portions thereof should be authorised; and (ii) if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 5.3 – Main Findings and Conclusions (Page 39)

	A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	Section in report
o	a description of any consultation process that was undertaken during the course of preparing the specialist report;	Appendix C of this report and Appendix C of the Final Scoping Report
p	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Not Applicable
q	any other information requested by the competent authority.	Not Applicable

PREFACE

Background and Context

SLR Consulting (South Africa) (Pty) Ltd (SLR) appointed Airshed to compile this Atmospheric Impact Report (AIR) to assess the impact of the proposed facility. The format of the assessment meets the prescribed format of an AIR set out in the Regulations gazetted on 11th of October 2013 (Gazette No. 36904; and its amendment: Gazette No.38633, 2nd April 2015). In this case, the AIR will accompany the application for, an Atmospheric Emissions License (AEL). An Impact Assessment Rating is included in this report as required by the Environmental Impact Assessment (EIA) process. The project intends to manufacture 920 tonnes per day of glass containers using two production lines for the two glass colour variants: amber and green. The proposed location is near Lager street, Vereeniging, on Portion 238 of the farm Leeuwkuil 596 IQ, Gauteng.

Purpose and Scope

The main purpose of the appointment is to develop an AIR in support of the eventual application for an AEL for the proposed facility. To successfully develop an AIR, the following tasks are included in the scope of work:

1. Air Quality Study:
    a. A review of project information;
    b. A review of legal requirements pertaining to air quality and specifically referring to;
        i. The National Environmental Management Air Quality Act (NEM:AQA) Act No. 39 of 2004:
            1. National Ambient Air Quality Standards (NAAQS)
            2. National Minimum Emission Standards (NMES)
            3. National Guidelines for Dispersion Modelling
            4. National Dust Control Regulations (NDCR)
    c. A study of the receiving environment including:
        i. An analysis of regional climate and site-specific atmospheric dispersion potential;
        ii. Analysis and assessment of existing (baseline) ambient air quality based on existing data collected at the Sharpeville Air Quality Monitoring Station (AQMS);
        iii. Short-term on-site baseline monitoring; and,
        iv. The identification of air quality sensitive receptors.
    d. The establishment of an emissions inventory by referring to NMES, engineering design parameters, and emission factors for fugitive dust (raw material batch processes, and vehicle particulate entrainment);
    e. Atmospheric dispersion simulations using the US EPA Aermod suite;
    f. A human health risk and nuisance impact screening assessment based on dispersion simulation results by comparing simulated ambient pollutant concentrations against the NAAQS, and NDCR;
    g. A comprehensive air quality impact assessment report in the format prescribed by the Department of Environmental Affairs (DEA) in support of the Atmospheric Emission License (AEL) application;
    h. Completion of the technical sections the AEL application form.

Assumptions and Limitations

1. The AIR is limited to the operational phase of the proposed glass manufacturing facility only.
    a. It is understood that a maize wet mill is proposed for development in close proximity to the glass bottle manufacturing facility. The cumulative impact on annual average ambient air quality has been contemplated (Section 5.1.7).
2. The plant was assumed to be operational 24 hours per day, 7 days per week. Vehicle access to site via a paved road, and therefore entrainment of particulates, was assumed to occur 24 hours per day.

3. Engineering designs include an extraction and ceramic catalytic filter to minimise fugitive emissions from the Furnace and Hot End areas of the main manufacturing building. Furnace stack emission parameters were provided.
4. Emissions from material handling within the batch plant would be naturally ventilated from the building where the enclosure in the building would control emissions by 75%. The required control efficiency of these systems was estimated to be 98%.
5. It is understood that particulate emissions control systems are planned; however, the design specifics are not yet finalised.
6. The glass furnace emissions were assumed to be at the upper limit of engineering design emission concentrations, which are compliant with the minimum emissions standards applicable to Listed Activities in the Subcategory 5.8.
7. Raw materials and product haulage would be via paved access roads, where the silt content would be similar to the default US EPA value for low vehicle volume facilities. US EPA emission factors were used to calculate vehicle entrainment emission rates. Road usage was based on the most conservative values of the range of values provided.

1 ENTERPRISE DETAILS

1.1 Enterprise Details

The details of the proposed project operations are summarised in Table 1-1. The contact details of the responsible person are provided in Table 1-2.

Table 1-1: Enterprise details

Enterprise Name	The South African Breweries (Pty) Limited
Trading as	SAB
Type of Enterprise	Company
Company Registration Number	
Registered Address	
Telephone Number (General)	
Industry Type/Nature of Trade	
Land Use Zoning as per Town Planning Scheme	Currently agriculture. A town planning application has been made for rezoning to Industrial
Land Use Rights if Outside Town Planning Scheme	Not applicable

Table 1-2: Contact details of responsible person

Responsible Person	
Telephone Number	
Cell Number	
Fax Number	
Email Address	
After Hours Contact Details	

1.2 Location and Extent of the Plant

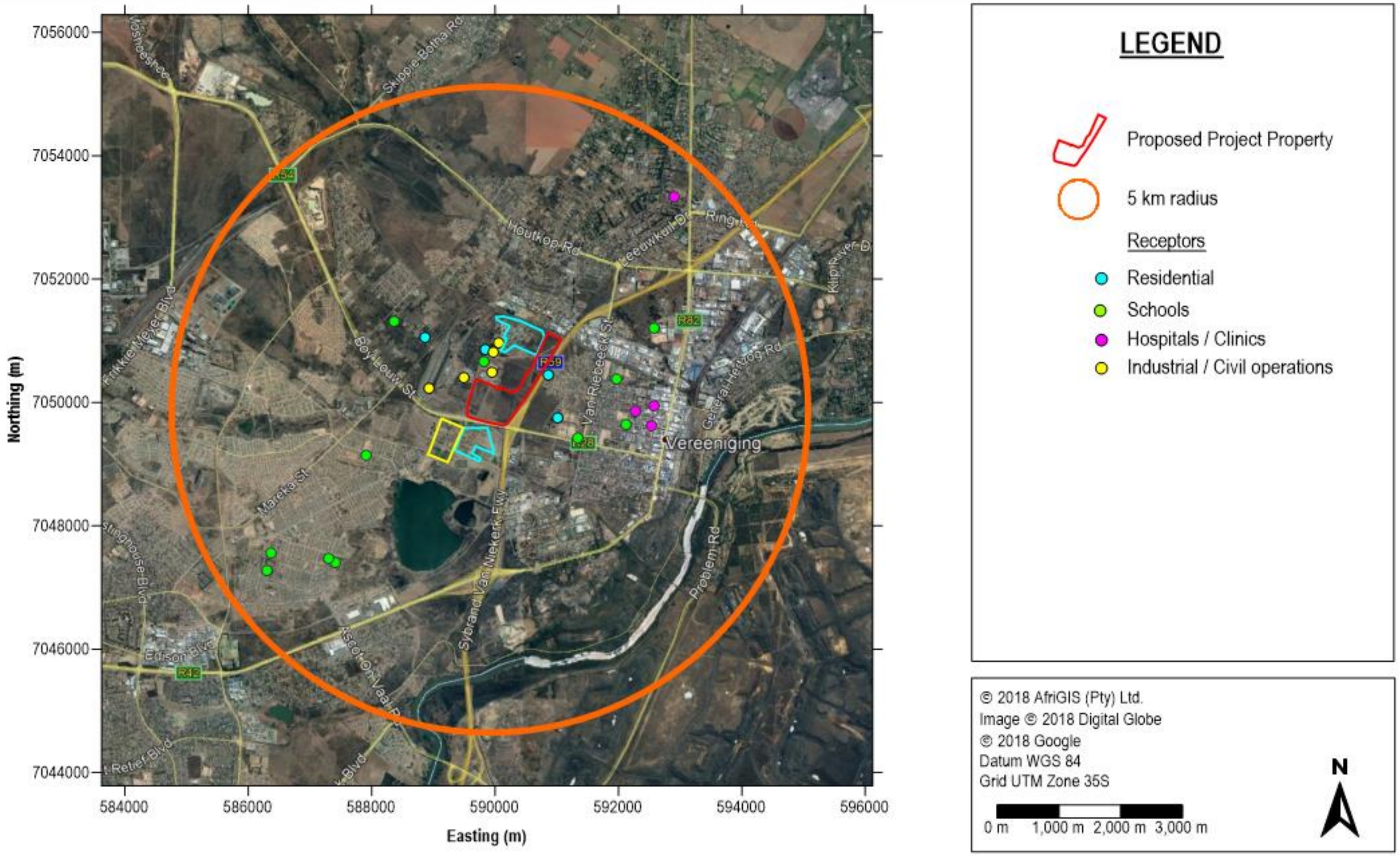
Table 1-3: Location and extent of the plant

Physical Address of the Plant	Lager Street, Vereeniging
Description of Site (Where no Street Address)	Portion 238 of the farm Leeuwkuil 596 IQ. A town planning application is underway to subdivide this property and rename the site as Portion 295 of the farm Leeuwkuil 596 IQ.
Coordinates of Approximate Centre of Operations	Latitude: 26.668523°S Longitude: 27.903563°E
Extent	~66.9 ha
Elevation Above Sea Level	1 448 m
Province	Gauteng
Metropolitan/District Municipality	Sedibeng
Local Municipality	Emfuleni
Designated Priority Area	Vaal Triangle Airshed Priority Area

1.3 Description of Surrounding Land Use (within 5 km radius)

The glass manufacturing facility is proposed for development near the Leeuwkuil area of Vereeniging, in the Emfuleni Local and Sedibeng District Municipalities. The proposed site is close to existing residential areas (both formal and informal) and industrial actives. Formal residential areas occur to the north (Correctional Services Facility – the closest being the staff accommodation) and to the east of the R59 (Leeuhof). Informal residences include the occupation of an abandoned building to the west of the proposed site, and informal housing for cattle herders to the south of the proposed site. Industrial actives near to the proposed site include: workshops and warehousing to the north and west; a fresh produce market to the west; wheat mill plant to the north; engineering and fabrication facilities to the north; and waste water treatment works to the south. The proposed site is located centrally within the Vaal Triangle Airshed Priority Area (VTAPA)l, an area with an already compromised air quality.

The National Ambient Air Quality Standards (NAAQS) (detailed in Section 5.1.2.2) are based on human exposure to specific criteria pollutants and as such, sensitive receptors were identified where the public is likely to be unwittingly exposed. NAAQS are enforceable outside of property of the licensed facility. Therefore the sensitive receptors identified (Figure 1-1) included the nearby residential areas, hospitals and schools (Table 1-4).



SAB's Glass Bottle Manufacturing Plant

Dispersion modelling domain and Air Quality Sensitive Receptors

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Figure 1-1: Location of the proposed Project in relation to surroundings

Table 1-4: Distance to nearby air quality sensitive receptors

Receptor details	Distance from centre of proposed site (m)	Direction from proposed site
SAB Vereeniging depot	458	N
Fresh Produce Market	526	W
Wise Owl Preschool	630	W
Roads Agency Depot	778	NW
Leeuwkuil Waste water treatment works	797	SSW
Residence (appears to be occupied)	816	NW
Telkom office / stores / workshop	962	NW
Informal cattle post housing	965	S
Transnet	968	NNW
Leeuhof residential area	986	NE
Dept of Correctional Services	1 047	NNE
School hostel	1 186	SSE
Rood Gardens A.H.	1 441	NW
General Smuts High School	1 591	ESE
Isizwe-Setjhaba Secondary School	1 981	NW
Vereeniging Gimnasium	2 130	ENE
Emmanuel Primary School	2 154	SW
Selborne Primary School	2 280	E
Medi-Clinic Vereeniging	2 403	E
Medi Zone Three Rivers	2 699	E
Care Cure	2 718	E
Phoenix High School	2 949	NNE
Mohloli Secondary School	3 594	SW
Titima Primary School	3 632	SW
Sharpeville AQMS	4 279	SW
Thuto Lore Secondary School	4 296	SW
Kopanong Hospital	4 470	NE
Lekoa Shandu Secondary School	4 513	SW

1.4 Atmospheric Emission Licence and other Authorisations

The proposed project is a new facility and does not yet have an Atmospheric Emissions License (AEL). As a glass manufacturing plant, the project will require an AEL to operate (Subcategory 5.8; Section 21 of the National Environmental Management: Air Quality Act (NEM:AQA)).

2 Nature of the Process

2.1 Listed Activities

All potential listed activities, as per Section 21 of NEM:AQA, proposed for the project are given in Table 2-1.

Table 2-1: Listed activities at the proposed Project

Section 21 Subcategory	Listed Process Description:
5.8	Glass and Mineral Wool Production

2.2 Process Description

Glass is a non-crystalline amorphous solid made of the fusion of diverse non-organic oxides found in sand, soda ash, limestone and other raw materials. These materials are stored in independent silos within the Batch Plant building. This building is typically separate from the main manufacturing building to reduce dust contamination within the main plant due to materials handling. Design provisions to minimize particulate emissions include: enclosure of materials handling and storage in a building, enclosure of conveyors transferring material to the main plant and particulate collection systems. Typical control systems would include the use of baghouses; or by pre-sintering, briquetting, pelletizing, or liquid alkali treatments. The control efficiencies of the typical control systems can be 99% or better. The storage capacity is sufficient to meet seven (7) days sand requirements and 15 days for other raw materials. The materials are weighed and mixed to a predetermined recipe and transferred to the batch mixer. The mixed batch is elevated by a bucket elevator and conveyers across to the main manufacturing building.

The main manufacturing building is separated into three general areas: the Furnace area, the Hot End area, and the Cold End area. In the Furnace area, raw materials are melted in the glass furnaces, where temperatures reach 1 530°C. The gas furnaces will use natural gas as the fuel source. Two furnaces are planned for the proposed facility: one furnace for green glass, with a daily capacity of 390 tonnes per day (t/d); and, a second furnace for amber glass, with a daily capacity of 530 t/d. After the glass is melted and degassed, it is cooled to a viscosity suitable for glass container forming. Cooling is achieved while the glass is channelled to the glass forming machines by the refiner and forehearth systems.

At the end of the forehearths, located in the Hot End area, glass is formed into drops or gobs at a temperature of 1 185°C. These gobs are moved to the forming machine where mechanical and pneumatic manipulation form the glass container. Glass containers exit the forming machine with a viscosity that ensures the container is self-supporting (glass temperature approximately 630°C). The glass containers are coated to enhance surface resistance to scratches and thereafter are moved into an annealing lehr where the temperature of the containers is reduced in a controlled way to avoid internal stresses. Containers exit the lehrs with temperatures of approximately 120°C, where a final coating is applied.

In the Cold End area, the containers are inspected for defects and categorized. Beyond the Cold End area, containers processed to packaging, storage and shipment. Containers that do not meet specifications are conveyed to the furnace area where hammer mills will crush the containers and add fragments to the batch mix fed to the furnaces.

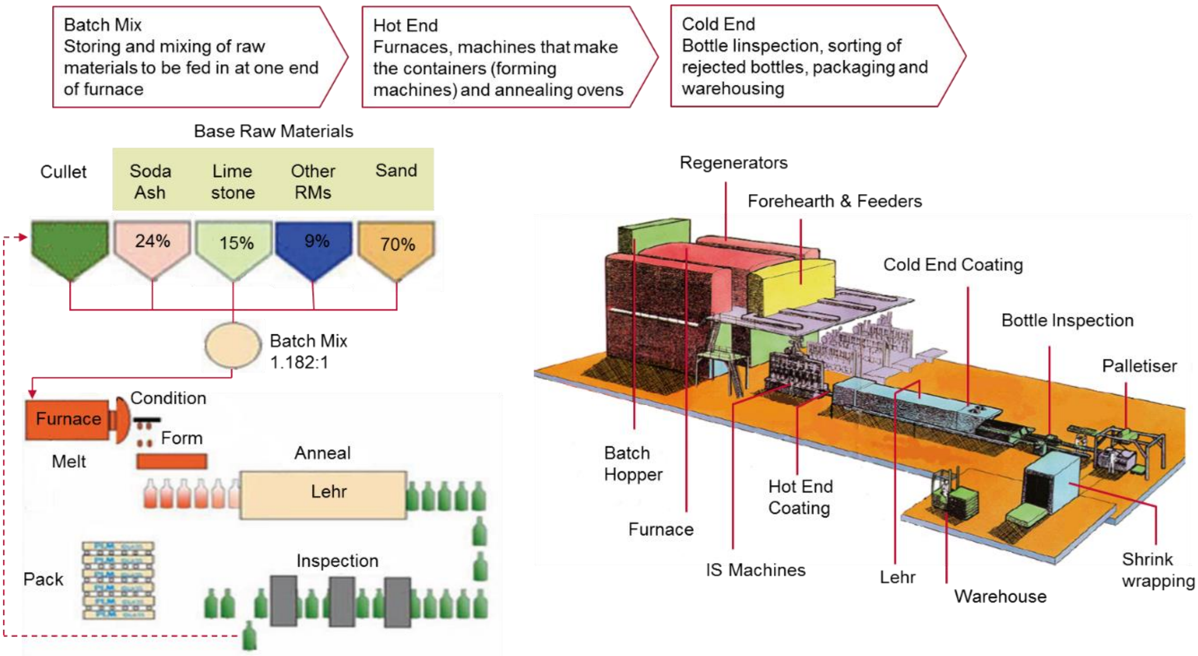


Figure 2-1: Glass container forming process flow diagram

2.3 Unit Processes

The unit processes associated with the listed activities (as per Section 21 of NEM:AQA) and proposed for the project are listed in Table 2-2.

Table 2-2: The unit processes for the proposed Project

Unit Process	Function of Unit Process	Batch or Continuous Process
Batch mix	Storage and mixing of raw materials	Continuous
Hot End Furnaces	Heat treatment of raw material and residual glass fragments in gas-fired glass furnaces	Continuous
Hot End Forming	Glob forming and cooling in refiners and forehearths	Continuous
	Container forming using mechanical and pneumatic manipulation	Continuous
Hot End Annealing lehrs	Controlled cooling of glass containers and surface coating	Continuous
Cold End	Inspection, packaging, warehousing, and shipment	Continuous

3 TECHNICAL INFORMATION

Raw material consumption rates are tabulated in Table 3-1. The proposed facility will produce 920 tonnes per day of glass containers in amber and green colour variants.

3.1 Raw Material Consumption Rates

Table 3-1: Raw materials used

Raw Material Type Alternatives	Design Consumption Rate (Volume)	Units (quantity/period)
sand	9 717.78	tonnes per day
soda ash	2 908.35	tonnes per day
limestone	2 079.73	tonnes per day
dolomite	1 130.09	tonnes per day
feldspar	264.84	tonnes per day
sodium sulfur	12.03	tonnes per day
iron oxide	11.49	tonnes per day
chrome oxide	31.60	tonnes per day
carbon	3.59	tonnes per day

3.2 Production Rates

Table 3-2: Future production rates (current rates shown in brackets)

Production Name	Maximum Production Capacity Permitted (Quantity)	Design Production Capacity (Quantity)	Actual Production Capacity (Quantity)	Units (Quantity/Period)
Green glass containers	390	390	390	tonnes per day
Amber glass containers	530	530	530	tonnes per day

Table 3-3: By-products

By-Product Name	Maximum Production Capacity Permitted (Quantity)	Design Production Capacity (Quantity)	Actual Production Capacity (Quantity)	Units (Quantity/Period)	Notes
Cullet	Variable production rates and recycled back into process.				

3.3 Appliances and Abatement Equipment Control Technology

Table 3-4: Appliances and abatement equipment control technology for furnaces and batch plant

Appliances					Abatement Equipment Control Technology							
ID	Source Name	Appliance / Process Equipment Number	Appliance Type / Description	Appliance Serial Number	Abatement Equipment Manufacture Date	Abatement Equipment Name and Model	Abatement Equipment Technology Type	Commission Date	Date of Significant Modification / Upgrade	Design Capacity	Control Efficiency (%)	Minimum Utilization (%)
GF1	Furnace Chimney 1	Not yet procured	Glass furnace	Not yet procured	Not yet procured	Not yet procured	Ceramic Catalytic Filter	During construction	New equipment	Not yet procured	~ 99%	To be confirmed
GF2	Furnace Chimney 2	Not yet procured	Glass furnace	Not yet procured	Not yet procured	Not yet procured	Ceramic Catalytic Filter	During construction	New equipment	Not yet procured	~ 99%	To be confirmed
MH	Batch plant	Not yet procured	Storage silos; batch mixer; bucket elevators	Not yet procured	Not yet procured	Not yet procured	To be confirmed[(a)]	During construction	New equipment	Not yet procured	75 to 99%	To be confirmed

Notes:

(a) Design specifics not yet confirmed. Typical batch plant control systems would include the use of baghouses; or by pre-sintering, briquetting, pelletizing, or liquid alkali treatments. The control efficiencies of the typical control systems can be 99% or better.

4 ATMOSPHERIC EMISSIONS

The establishment of a comprehensive emissions inventory formed the basis for the assessment of the air quality impacts from the proposed operations on the receiving environment. Operations (excluding transport of raw materials and products) occur within the main manufacturing building and the batch plant. Engineering designs of the main manufacturing building include extraction systems to evacuate fugitive emissions from the glass manufacturing processes, including the glass furnaces. Emissions from the furnaces were conservatively calculated using the upper emission concentration provided by the design engineers. The maximum design release rates represent 67%, 33%, and 64% of the Minimum Emission Standards for PM, SO_2, and NO_x respectively. Published emission factors were used to estimate emissions from the materials handling activities within the batch plant, where particulate emission control systems are planned. The location and exit parameters of particulate control systems was not available at this stage and the emissions were considered to be building fugitives . Emissions due to vehicle entrainment of particulates along the paved access road were also quantified.

The following sections describe the location and parameters of the individual sources associated with the proposed project (as per the prescribed format of an AIR – Government Gazette No. 36904, 2013).

4.1 Point Sources

Two point sources are proposed:

- green-line glass furnace chimney; and,
- amber-line glass furnace chimney.

Table 4-1: Parameters for point sources of atmospheric pollutant emissions at the proposed plant

Point Source code	Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m) (a)	Height Above Nearby Building (m)	Diameter at Stack Tip / Vent Exit (m) (a)	Actual Gas Exit Temperature (°C) (a)	Actual Gas Volumetric Flow (m^3/hr) (a)	Actual Gas Exit Velocity (m/s) (a)
GF1	Furnace Chimney 1	-26.6675	27.901332	35	Minimum 10	2.0	260	34 000	10
GF2	Furnace Chimney 2	-26.668084	27.901087	35	Minimum 10	2.0	260	34 000	10

Notes:
(a) Parameters assumed based on design specifications

4.2 Point Source Maximum Emission Rates during Normal Operating Conditions

Table 4-2: Atmospheric pollutant emission rates for the proposed facility

Point Source code	Pollutant Name	Maximum release rate(a)	Design Release Rate					Emissions Hours	Type of Emissions
		(mg/Nm³)	(mg/Nm³)	(mg/Am³)(b)	(g/s)	(t/a)	Averaging period		
GF1	Particulates	30	<20	4.27	0.134	4.23	Hourly	8 760	Continuous
	Sulfur dioxide (SO_2)	1 500	<500	213.50	6.707	211.52	Hourly	8 760	Continuous
	Oxides of Nitrogen (NO_X)	800	<500	213.50	6.707	211.52	Hourly	8 760	Continuous
GF2	Particulates	30	<20	4.27	0.134	4.23	Hourly	8 760	Continuous
	Sulfur dioxide (SO_2)	1 500	<500	213.50	6.707	211.52	Hourly	8 760	Continuous
	Oxides of Nitrogen (NO_X)	800	<500	213.50	6.707	211.52	Hourly	8 760	Continuous

Notes:
(a) Minimum Emission Standards for Subcategory 5.8 – Glass and Glass Wool Manufacturing
(b) Actual emission concentrations (mg/Am³) were estimated based on the proposed stack design (stack diameter) and emission parameters (exit temperature, velocity, and pressure). This may vary under actual operational conditions.

Table 4-3: Point Source Emission Estimation Information

Point Source code	Basis for Emission Rates
GF1 & GF2	Based on emission concentrations provided by design engineers (PM: <20 mg/Nm³; SO_2: <500 mg/Nm³; and, NO_X: <500 mg/Nm³)

4.3 Fugitive Sources

Fugitive sources include: the batch plant building and the paved access road along which vehicle entrainment of particulates is likely to occur.

Table 4-4: Area, volume and/or line source parameters

Source code	Source name	Source Description	Latitude (decimal degrees) of SW corner	Longitude (decimal degrees) of SW corner	Height of Release Above Ground (m)	Length of Area (m)	Width of Area (m)	Angle of Rotation from True North (°)
MH	Batch Plant	Materials handling in the batch plant	27.90051	-26.66772	19	18	44	19
PRDR1	Road – Products	Access route used by trucks carrying product glass	27.89995	-26.66905	0.5	195.7	4.5	-70.9
PRDR2			27.90058	-26.66738	0.5	10.8	4.5	-35.3
PRDR3			27.90067	-26.66732	0.5	11.2	4.5	-4.5
PRDR4			27.90078	-26.66731	0.5	8.5	4.5	-23.1
PRDR5			27.90086	-26.66728	0.5	20.7	4.5	-49.9
PRDR6			27.90099	-26.66714	0.5	23.0	4.5	-100.2
PRDR7			27.90095	-26.66694	0.5	6.3	4.5	-22.1
PRDR8			27.90101	-26.66691	0.5	28.1	4.5	2.3
PRDR9			27.90129	-26.66692	0.5	91.4	4.5	17.6
PRDR10			27.90217	-26.66717	0.5	151.4	4.5	20.1
PRDR11			27.90360	-26.66763	0.5	10.2	4.5	-5.0
PRDR12			27.90370	-26.66762	0.5	16.9	4.5	-52.7
PRDR13			27.90380	-26.66750	0.5	33.7	4.5	-65.9
PRDR14			27.90394	-26.66722	0.5	13.9	4.5	-24.2
PRDR15			27.90407	-26.66717	0.5	156.1	4.5	18.0
PRDR16			27.90556	-26.66759	0.5	24.6	4.5	55.8
PRDR17			27.90570	-26.66778	0.5	46.0	4.5	107.7
PRDR18			27.90556	-26.66817	0.5	16.0	4.5	151.6
PRDR19			27.90542	-26.66824	0.5	38.5	4.5	-155.1
PRDR20			27.90507	-26.66810	0.5	31.9	4.5	-84.2

Source code	Source name	Source Description	Latitude (decimal degrees) of SW corner	Longitude (decimal degrees) of SW corner	Height of Release Above Ground (m)	Length of Area (m)	Width of Area (m)	Angle of Rotation from True North (°)
PRDR21			27.90510	-26.66781	0.5	65.3	4.5	-159.3
PRDR22			27.90449	-26.66761	0.5	44.5	4.5	-118.2
PRDR23			27.90427	-26.66725	0.5	19.1	4.5	-165.0
PRDR24			27.90409	-26.66721	0.5	13.3	4.5	156.8
PRDR25			27.90396	-26.66726	0.5	38.9	4.5	113.9
PRDR26			27.90381	-26.66757	0.5	14.3	4.5	148.0
PRDR27			27.90369	-26.66765	0.5	20.0	4.5	-171.3
PRDR28			27.90349	-26.66762	0.5	230.0	4.5	-160.8
PRDR29			27.90130	-26.66695	0.5	16.6	4.5	173.7
PRDR30			27.90114	-26.66697	0.5	26.6	4.5	115.5
PRDR31			27.90102	-26.66719	0.5	17.2	4.5	131.1
PRDR32			27.90091	-26.66731	0.5	21.8	4.5	168.9
PRDR33			27.90069	-26.66735	0.5	206.6	4.5	110.9
RAWR1	Road – Raw	Access route used by trucks carrying raw materials	27.89995	-26.66905	0.5	130.1	4.5	-70.6
RAWR2			27.90038	-26.66794	0.5	43.5	4.5	20.5
RAWR3			27.90079	-26.66808	0.5	26.1	4.5	-73.5
RAWR4			27.90086	-26.66785	0.5	32.4	4.5	-163.1
RAWR5			27.90055	-26.66777	0.5	22.8	4.5	107.7
RAWR6			27.90048	-26.66796	0.5	5.4	4.5	170.2
RAWR7			27.90043	-26.66797	0.5	132.1	4.5	110.6

Table 4-5: Fugitive source emissions

Area Source code	Pollutant Name	Maximum Hourly Release Rate	Average Annual Release Rate (t/a)	Emission Hours	Type of Emission	Wind Dependent (yes/no)
MH	Particulates (PM_{10})	6.22 g/s	196.21	8760 per year	Continuous	No
PRDR1-33	Particulates (total suspended particulates)	$1.77x10^{-5}$ g/s.m^2	2.76	12 Hours; Monday to Friday	Intermittent	No
	Particulates (PM_{10})	$3.40x10^{-6}$ g/s.m^2	0.53	12 Hours; Monday to Friday	Intermittent	No
	Particulates ($PM_{2.5}$)	$8.23x10^{-7}$ g/s.m^2	0.13	12 Hours; Monday to Friday	Intermittent	No
RAWR1-7	Particulates (total suspended particulates)	$2.11x10^{-5}$ g/s.m^2	0.77	12 Hours; Monday to Friday	Intermittent	No
	Particulates (PM_{10})	$4.04x10^{-6}$ g/s.m^2	0.15	12 Hours; Monday to Friday	Intermittent	No
	Particulates ($PM_{2.5}$)	$9.78x10^{-7}$ g/s.m^2	0.04	12 Hours; Monday to Friday	Intermittent	No

Table 4-6: Area Source Emission Estimation Information

Area Source code	Basis for Emission Rates
MH	Australian National Pollutant Inventory Emissions Estimation Techniques Manual for glass and glass fibre Manufacturing (NPI, 2004) using batch plant capacity of 1 131.7 t/d. • 75% control efficiency accounts for enclosure of materials handling activities in a building • The emission factors for PM_{10} for: unloading and conveying; storage bins; and, mixing and weighing were used. • Neither emission factors nor particulate size distributions are provided for in the NPI emissions estimation manual for particulate size fractions other than PM_{10}. PM_{10} emission rates were therefore conservatively assumed to apply to total suspended particulates or $PM_{2.5}$.
PRDR1-33 RAWR1-7	US EPA AP 42, 5th Edition, Volume I, Chapter 13: Miscellaneous Sources, 13.2.1 Paved Roads (2011) using the default silt content of 0.6 g/m^2 for low vehicle volume (<500) facilities. Assuming: • 30 tonne trucks carrying moving 1 314 tonnes of product per day; 9 trips per hour (product and raw materials). • 24 hours per day, 240 days per year

4.4 Emergency Incidents

Emission upset conditions would occur during start-up, shut-down, and unplanned downtime events.

Emergency incidents will need to be documented in detail. The summary of each emergency incident must include:

(a) Nature and cause of incident;

(b) Actions taken immediately following the incident to minimise impact; and

(c) Subsequent actions taken to reduce the likelihood of reoccurrence.

When emergency events persist for longer than 48 hours Section 30 of the National Environmental Management, 1998 (Act No. 107 of 1998), shall apply unless otherwise specified by the Licensing Authority.

5 IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT

5.1 Analysis of Emissions' Impact on Human Health

5.1.1 Study Methodology

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

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

1. Understand Scope of Work
2. Review of legal requirements (e.g. dispersion modelling guideline) (see Section 5.1.2)
3. Decide on Dispersion Model (see Section 5.1.1.1)

The Regulations Regarding Air Dispersion Modelling (Gazette No 37801 published 11 July 2014) was referenced for the dispersion model selection.

Three levels of assessment are defined in the Draft Regulations regarding Air Dispersion Modelling, depending on the study complexity. This study was considered to meet the requirements of a Level 2 assessment, and AERMOD was selected on the basis that this Gaussian plume model is well suited to simulate dispersion where transport distances are likely to be less than 50 km.

The execution phase (i.e. dispersion modelling and analyses) firstly involved 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 added to suitable background concentrations and compared with the relevant ambient air quality standard or guideline. In some cases, post-processing can be carried out to produce percentile concentrations or contour plots that can be prepared for reporting purposes.

5.1.1.1 Dispersion Model Selection

Gaussian plume models are best used for near-field applications where the steady-state meteorology assumption is most likely to apply. One of the most widely used Gaussian plume model is the US EPA AERMOD model that was used in this study. AERMOD is a model developed with the support of 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.*, 2001). AERMOD is a dispersion modelling system with three components, namely: AERMOD (AERMIC Dispersion Model), AERMAP (AERMOD terrain pre-processor), and AERMET (AERMOD meteorological pre-processor).

AERMOD is an advanced new-generation model. It is designed to predict pollution concentrations from continuous point, flare, area, line, and volume sources. AERMOD offers new and potentially improved algorithms for plume rise and buoyancy, and the computation of vertical profiles of wind, turbulence and temperature however retains the single straight-line trajectory limitation. AERMET is a meteorological pre-processor for AERMOD. Input data can come from hourly cloud cover observations, surface meteorological observations and twice-a-day upper air soundings. Output includes surface meteorological observations and parameters and vertical profiles of several atmospheric parameters. AERMAP is a terrain pre-processor designed to simplify and standardise the input of terrain data for AERMOD. Input data includes receptor terrain elevation data. The terrain data may be in the form of digital terrain data. The output includes, for each receptor, location and height scale, which are elevations used for the computation of air flow around hills. A disadvantage of the model is that spatial varying wind fields, due to topography or other factors cannot be included.

Input data required for the AERMOD model include: source data, meteorological data (pre-processed by the AERMET model), terrain data and information on the nature of the receptor grid.

AERMOD version 7.12.1.0 (and executable version 16216r) was used in the study, along with its pre-processors. The terrain in the vicinity of the proposed facility is flat or gently sloping (less than 10%), and therefore does not meet the recommendation to include terrain. The parameters used in the AERMET meteorological pre-processor setup are detailed in Table 5-1.

Table 5-1: Land use parameters used in AERMET meteorological pre-processor

Scale / radius	Land use	Parameter estimated by AERMET based on land use
1 km	25% cultivated land 75% urban	Surface Roughness
10 km	10% water 35% cultivated land 4% grassland 15% urban	Albedo / Bowen Ratio

5.1.2 Legal Requirements

5.1.2.1 Atmospheric Impact Report

According to the NEM: 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; or,
- 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).

5.1.2.2 National Ambient Air Quality Standards and Health Effect Screening Levels

National Ambient Air Quality Standards (NAAQS) were determined based on international best practice for inhalable particulate matter ($PM_{2.5}$), thoracic particulate matter (PM_{10}), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone, lead and benzene. The NAAQS permit a frequency of exceedance (FOE) of 1% per year (88 hours or 4 days per year for 1-hour and 24-hour average concentrations) for some pollutants. Simulated ambient air pollutant concentrations were assessed against NAAQS (Table 5-2), where $PM_{2.5}$; PM_{10}; SO_2; and, NO_2 were the criteria pollutants of concern in this assessment.

Table 5-2: National Ambient Air Quality Standards for pollutants of concern in this assessment

Pollutant	Averaging Period	Concentration (µg/m³)	Concentration (ppb)	Permitted Frequency of Exceedance (FOE)	Compliance Date
$PM_{2.5}$	24 hours	40	-	4	Enforceable between 1 January 2016 to 31 December 2029
	1 year	20	-	-	
	24 hours	25	-	4	Enforceable from 1 January 2030
	1 year	15	-	-	
PM_{10}	24 hours	75	-	4	Currently enforceable
	1 year	40	-	-	
SO_2	1 hour	350	134	88	Currently enforceable
	24 hours	125	48	4	
	1 year	50	19	-	
NO_2	1 hour	200	106	88	Currently enforceable
	1 year	40	21	-	

5.1.2.3 National Dust Control Regulations

The National Dust Control Regulations (NDCR) was gazetted on 1 November 2013 (No. 36974). The purpose of the regulations is to prescribe general measures for the control of dust in all areas including residential and light commercial areas. The standard for acceptable dustfall rate is set out in Table 5-3. The method to be used for measuring dustfall rate and the guideline for locating sampling points shall be ASTM D1739: 1970, or equivalent method approved by any internationally recognized body. The measurement of dustfall and the submission of a dust mitigation plant is only applicable to those installation identified, and notified by written notice, by the local air quality officer.

Table 5-3: Acceptable dustfall rates

Restriction Area	Dustfall Rate (mg/m².day, 30-day average)	Permitted Frequency of Exceeding Dustfall Rate
Residential area [(a)]	D<600	Two in a year, not sequential months
Non-residential area [(b)]	600<D<1200	Two in a year, not sequential months
Notes: (a) Applicable at the sensitive receptors and residential areas near Coega IDZ (b) Applicable within the Coega IDZ property boundary		

5.1.2.4 Listed Activities and Minimum Emission Standards

The production of more than 100 tonnes of glass per annum is a Listed Activity under Section 21 of the National Environmental Management: Air Quality Act (NEM:AQA) and will require an Atmospheric Emissions License (AEL) to operate. The proposed glass furnaces will be required to comply with the new plant Minimum Emission Standards (MES). The applicable listed activities categories will include: Sub-category 5.8 (Glass and Mineral Wool Production) (Table 5-4).

Table 5-4: Listed Activity Subcategory 5.8

Sub-category 5.8 – Glass and Mineral Wool Production			
Description:	The production of glass containers, flat glass, glass fibre and mineral wool.		
Application:	All installations producing 100 tonnes per annum or more.		
Substance or Mixture of Substances		**Plant Status**	**Emission concentration limit (mg/Nm³ under normal conditions of 273 Kelvin; 101.3 kPa; and 11% O_2)**
Common Name	**Chemical Symbol**		
Particulate matter	N/A	New	30
Sulfur dioxide	Gas fired furnace - SO_2		800
Oxides of nitrogen	NO_X, expressed as NO_2		1 500

5.1.2.5 Reporting of Atmospheric Emissions

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 proposed Project would be classified under Group A ("Listed activity published in terms of section 21(1) of the Act"). Emission reports from Group A must be made in the format required for NAEIS and should be in accordance with the AEL or provisional AEL.

As per the regulation, the operator and/or their data provider must register on the NAEIS within 30 days after commencing with proposed activities. 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.

5.1.2.6 The Vaal Triangle Airshed Priority Area

The proposed location of the glass bottle manufacturing facility is within the Vaal Triangle Airshed Priority Area: an area of already compromised air quality. The spatial extent of the priority area includes: Regions D and G of the City of Johannesburg; the Emfuleni Local Municipality; the Midvaal Local Municipality; and, the Metsimaholo Local Municipality.

The proposed site is located centrally within the Priority Area and has several important implications for this operation. New developments which are associated with atmospheric emissions, and hence the potential for contributing to air pollutant concentrations, are subject to intense scrutiny by national air pollution control officers. Emphasis is being placed on ensuring that best practice control measures are being proposed for implementation and that the development will not substantially add to the existing air pollution burden in the region. Existing industries with significant emissions are likely to be expected to implement emission reduction programmes and air quality management measures for other significant sources (e.g. household fuel burning) will be sought and implemented.

Operating in the Priority Area will require stringent compliance with NEM:AQA from construction phase; including, but not limited to: a facility-specific air quality management plan (AQMP) using best available technology emissions controls (engineering design) and best practice on-site control of fugitive emissions. A complaints register should be available from on-set of the construction phase.

5.1.3 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.

Hourly sequential near-site meteorological and ambient air quality monitoring data was accessed for the 2014 to 2016 period from the Sharpeville air quality monitoring station (AQMS) which is located approximately 4.5 km south-west of the proposed project site. The station records concentrations as a result of surrounding emissions including: domestic fuel burning, as well as industrial emissions. This data was used in dispersion modelling and is discussed below.

5.1.3.1 Local Wind Field

The vertical dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness.

The wind roses for Sharpeville (Figure 5-1 and Figure 5-2) comprise 16 spokes, which represent the directions from which winds blew during the period. The colours reflected the different categories of wind speeds with the dotted circles indicating the frequency of occurrence, and each circle representing a 3% frequency of occurrence.

The period wind field for Sharpeville (Figure 5-1) shows that the wind flow is dominated by north-westerly winds, followed by winds from the north-east. Calm conditions occurred 8.5% of the period summarised. Day-time winds are more frequently higher than 5 m/s, and predominantly from the west and north-west. Night-time (18:00 to 05:00) shows more calm conditions (12.7%) with winds equally dominant from the north-east and north-west.

The seasonal wind field for Sharpeville shows the winds usually from the north-east and north-west during autumn and winter with winds from the north-east more dominant during summer. Spring-time winds show a predominance of north-westerly winds with the winds more frequently above 5 m/s. Winter has the highest frequency of calms at 14%, while spring shows the most infrequent calm conditions (3.9%).

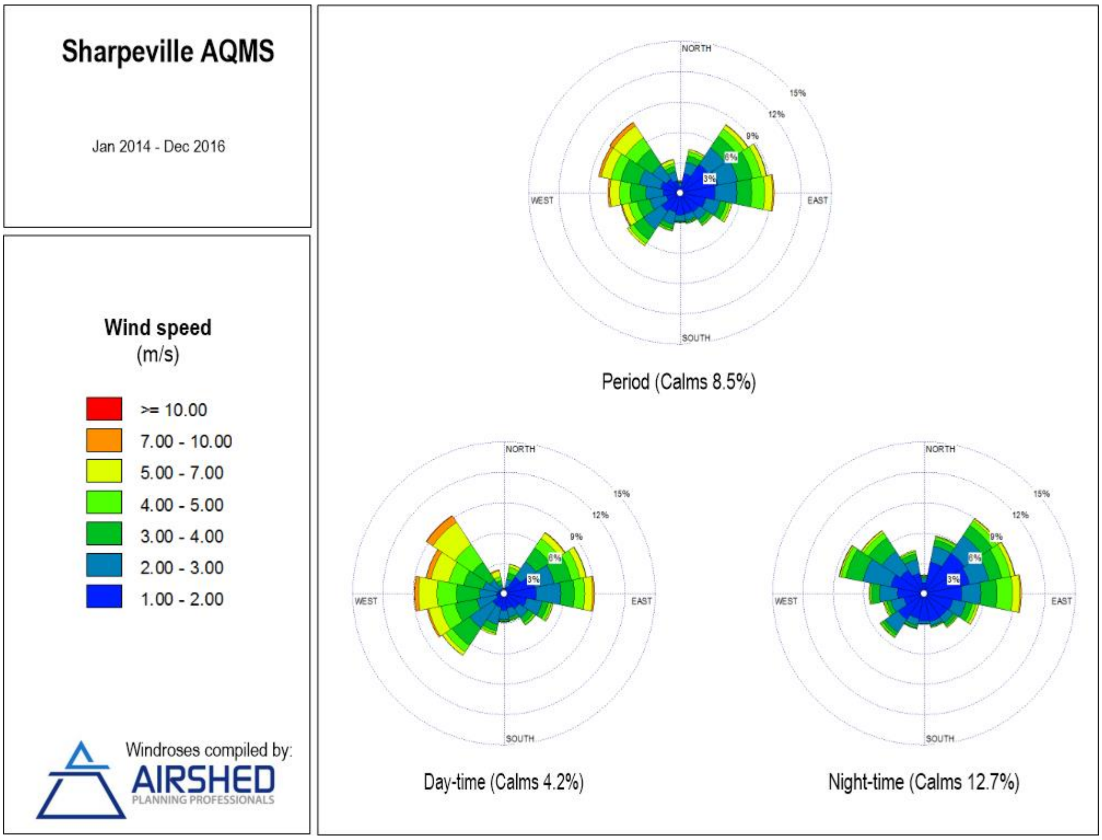


Figure 5-1: Period, day-time and night-time wind roses for Sharpeville AQMS, 2014-2017

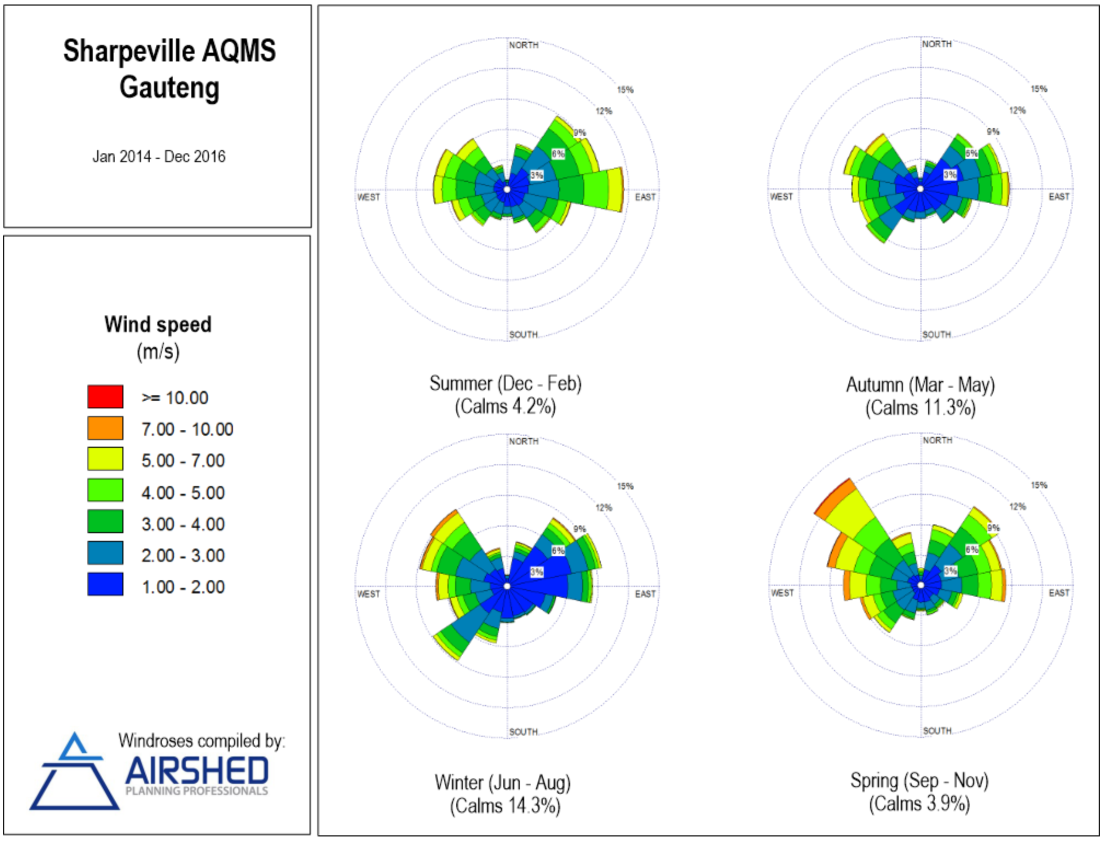


Figure 5-2: Seasonal wind roses for Sharpeville AQMS, 2014-2017

5.1.3.2 Ambient Temperature

The air temperature is important for determining the development of the mixing and inversion layers. Monthly temperatures statistics for hourly data recorded at the Sharpeville AQMS (2013 to 2015) show that minimum temperatures can drop below 0°C between June and September, while maximum temperatures exceed 30°C between August and April (Table 5-5). The period reported for the Sharpeville AQMS is within the range of the long-term average for the area; however, the maximum for Sharpeville (39.1°C) is higher than the long-term average for the period 1950 to 2000. While elevated air temperatures can assist with pollutant dispersion, heat waves (area average is 4 heat waves per year) can be associated with periods of poor dispersion. Similarly, cold temperatures in winter are generally associated with near-surface inversion layers and poor dispersion conditions.

Table 5-5: Minimum, average and maximum temperature per month from the Sharpeville AQMS (2014 - 2016), and long-term (1950 to 2000) statistics at the same location

Temperature	Month of Year												Long-term (1950 – 2000)[(a)]
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Minimum	8.2	3.0	7.0	1.1	-1.7	-5.7	-5.0	-3.8	-1.2	2.9	5.9	9.1	-6.4
Average	21.8	21.7	20.0	17.1	13.9	10.8	10.4	13.8	18.5	20.2	20.9	21.7	16.8
Maximum	39.1	34.6	33.2	31.7	29.1	26.4	24.6	30.4	32.7	35.3	36.4	36.7	35.9

Notes:
(a) Schulze *et al*. (2008)

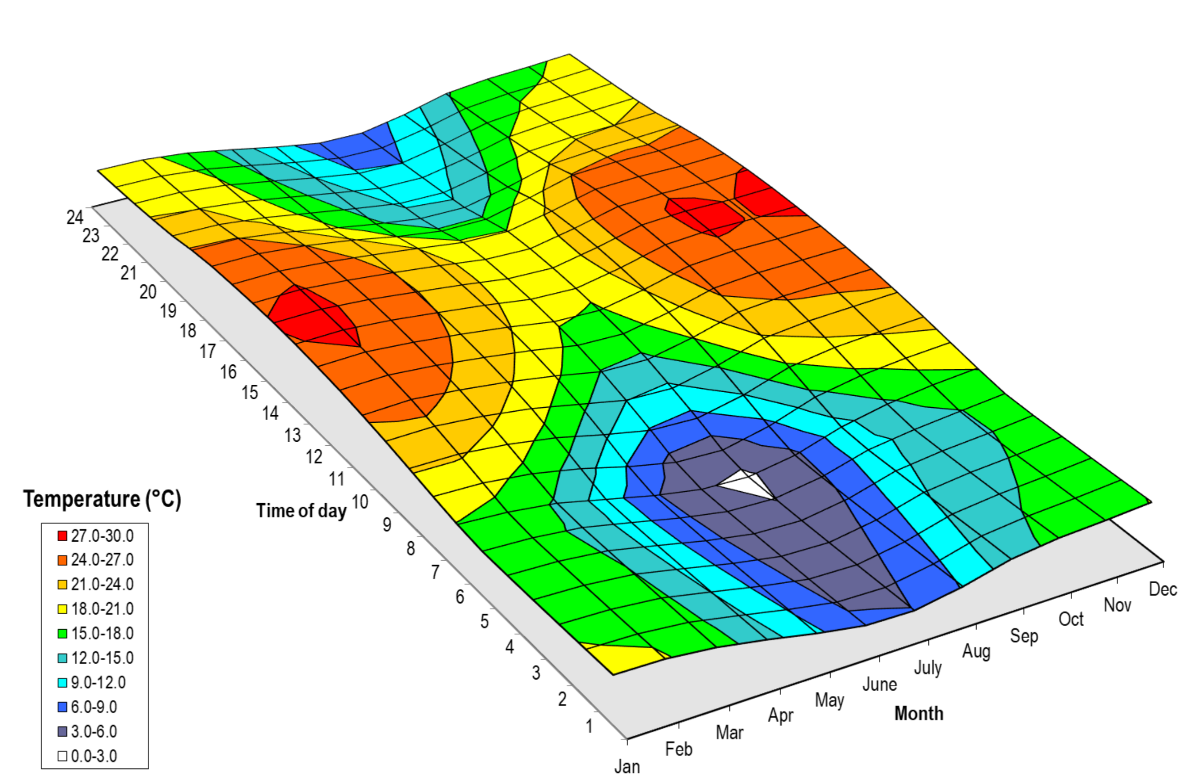


Figure 5-3: Diurnal temperature profile for Sharpeville AQMS, 2014-2017

5.1.4 Baseline Ambient Air Quality – Sharpeville AQMS

Several AQMS are located across the VTAPA and are owned and managed by both National and District government departments, as well as industry partners. The closest station to the proposed facility considered to be representative of the ambient air quality at the site is the Sharpeville station. Verified data for the period 1 January 2014 to 31 December 2016 were made available for this study and a summary of measured parameters is provided in Table 5-6. Non-compliance with the applicable NAAQS was recorded for: annual average NO_2 concentration in 2015; and PM_{10} and $PM_{2.5}$ daily and annual concentrations for all years summarised. The pollutants of concern for the facility ($PM_{2.5}$, PM_{10}, SO_2, and NO_2) are discussed below.

Table 5-6: Summary of the ambient measurements at Sharpeville for the period 2014 - 2016

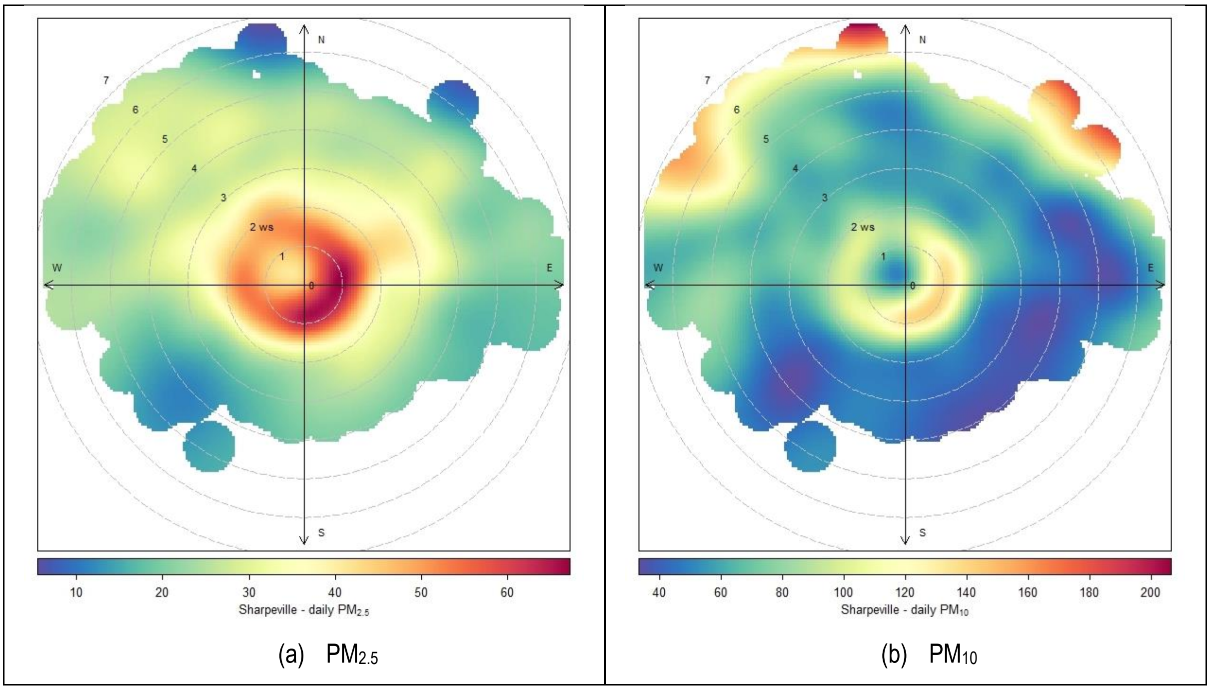
Period	Data Availability	Hourly 99th Percentile	Annual Average	No of recorded hourly exceedances
		SO_2 (units: ppb)		
2014	96%	73.5	8.8	8
2015	87%	51.8	7.3	15
2016	80%	48.5	5.8	3
Average		*57.9*	*7.3*	
		NO_2 (units: ppb)		
2014	97%	50.6	15.1	1
2015	86%	83.3	**23.3**	15
2016	86%	55.7	15.8	-

Average		63.2	18.1	
Period	**Data Availability**	**Daily**	**Annual Average**	**No of recorded daily exceedances**
		99th Percentile		
$PM_{2.5}$ (units: µg/m³)				
2014	99%	112.5	**38.3**	**34**
2015	88%	97.9	**36.5**	**27**
2016	**53%**	77.2	**31.6**	**43**
Average		*95.9*	*35.5*	
PM_{10} (units: µg/m³)				
2014	99%	173.8	**64.8**	**25**
2015	89%	153.6	**62.8**	**83**
2016	86%	234.8	**95.9**	**185**
Average		*187.4*	*74.5*	
SO_2 (units: ppb)				
2014	96%	35.7	8.8	-
2015	87%	35.9	7.3	2
2016	80%	28.4	5.8	-
Average		*33.3*	*7.3*	

5.1.4.1 Particulate Matter ($PM_{2.5}$ and PM_{10})

Exceedances of the NAAQ daily limit concentration for $PM_{2.5}$ numbered between 27 (2015) and 43 (2016) days during the assessment period (Table 5-6). Annual average concentrations also exceeded the NAAQS for all three years, despite low data availability in 2016. Between 2014 and 2016, daily PM_{10} concentrations exceeded the NAAQ limit concentration a maximum of 185 days (in 2016) and a minimum of 25 days (2014). Annual average concentrations exceeded NAAQS during all three years with a maximum of 95.9 µg/m³ during 2016 (Table 5-6).

An analysis of the observed $PM_{2.5}$ and PM_{10} concentrations at the Sharpeville AQMS involved categorising the concentration values into wind speed and direction bins for different concentrations. The information is most easily visualised as polar plots, where the centre of the polar plot refers to the location of the monitoring station (Figure 5-4). These polar plots (Carslaw and Ropkins, 2012; Carslaw, 2013) provide an indication of the directional contribution as well as the dependence of concentrations on wind speed. The directional display is fairly obvious, i.e. when higher concentrations are shown to occur in a certain sector, e.g. north-westerly for PM_{10} (Figure 5-4b), it is understood that most of the high concentrations occur when winds blow from that sector. The presence of a high concentration pattern which is more symmetrical around the centre of the plot is an indication that the contributions are near-equally distributed, and occur under calm-wind conditions, as for $PM_{2.5}$ (Figure 5-4a). Local sources contribute to $PM_{2.5}$ concentrations at low wind speeds, including domestic fuel burning, informal waste burning, and vehicle entrainment on unpaved roads. While local sources also contribute to PM_{10} concentrations, the highest PM_{10} concentrations are associated with wind speeds above 6 m/s and originate to the north and north-east.



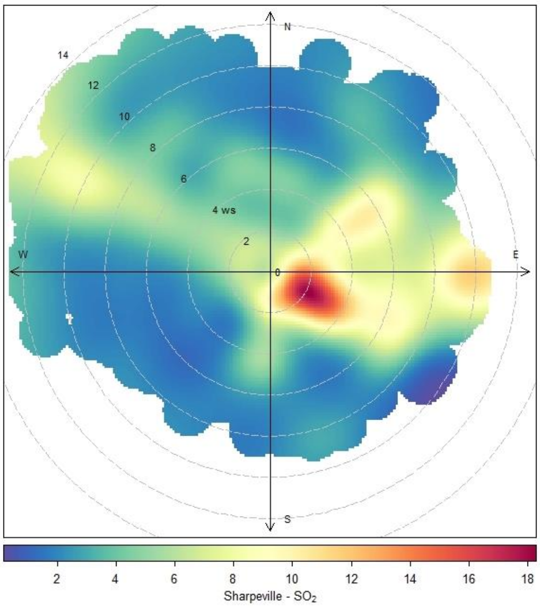
(a) $PM_{2.5}$ (b) PM_{10}

Figure 5-4: Daily $PM_{2.5}$ and PM_{10} (µg/m³) polar plots for Sharpeville

5.1.4.2 Sulfur Dioxide (SO_2)

Ambient SO_2 concentrations monitored at Sharpeville where the highest hourly concentrations were compliant with the hourly, daily and annual NAAQS between 2014 and 2016 (Table 5-6), where maximum concentrations were recorded during 2014.

Sources of SO_2 near the Sharpeville station include a source to the south east contributing the highest concentrations at wind speeds between 1 and 4 m/s; lower concentrations from the south-east and east contribute at wind speeds greater than 4 m/s (Figure 5-5). A contribution from the north-west also contributes at all wind speeds.



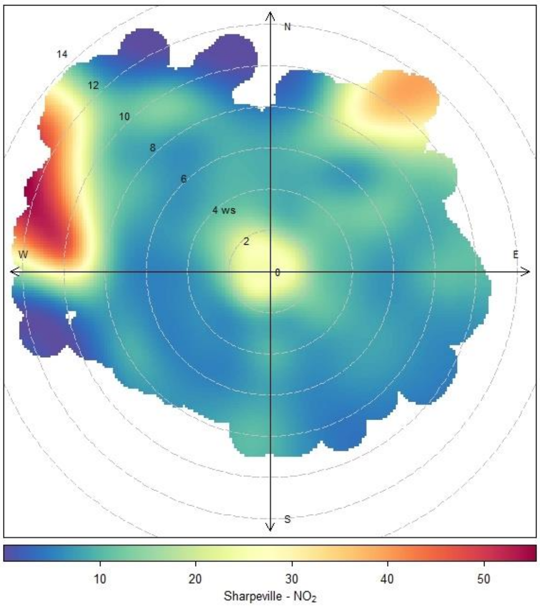
(a) SO_2

Figure 5-5: Hourly SO_2 (ppb) polar plot for Sharpeville

5.1.4.3 Nitrogen Dioxide (NO_2)

The highest NO_2 concentrations were recorded during 2015 at the Sharpeville station, where the annual average concentration was exceeded NAAQS (Table 5-6). Compliance with hourly and annual NAAQS were recorded for 2014 and 2016.

Sources contributing to NO_2 concentrations at Sharpeville originate to the north-west and north-north-east of the station at wind speeds above 8 m/s (Figure 5-6). Local sources contribute at low speeds and could be associated with vehicle activity and domestic fuel burning.



(a) NO_2

Figure 5-6: Hourly mean NO_2 (ppb) polar plot for Sharpeville

5.1.5 Baseline Ambient Air Quality – On-site Measurement Campaign

A short-term on-site air quality monitoring campaign was conducted between the 24th April and 22nd May 2018. The campaign included: PM_{10} and $PM_{2.5}$ monitoring using TAS MiniVol samplers; and passive-diffusive monitoring of SO_2, and NO_2.

5.1.5.1 Fine Particulates

Particulate matter with aerodynamic diameters less than 10 µm and 2.5 µm (or PM_{10} and $PM_{2.5}$) was sampled using a TAS MiniVol sampler - a filter-based, low volume sampler. The MiniVol samplers were set within the boundary of the SAB distribution depot – away from major on-site activities likely to result in particulate emissions - as this was the most secure location in the area and it provided easy access to the on-site employees who were trained to operate the samplers. The fine particulate fractions were sampled on weekdays, and on one weekend during the campaign. Some interruptions to the sampling frequency occurred due to public holidays and availability of staff on those days. It is therefore possible that peak or low ambient PM concentrations were not recorded. The filters removed from the samplers were placed in sealed containers and sent to Biograde Laboratory Services (Pretoria) for gravimetric analysis.

During the short-term on-site campaign, daily PM_{10} NAAQ limit concentration (75 µg/m^3) was exceeded on six days (Table 5-7). The comparison with the Sharpeville AQMS daily averages over the same period shows good correlation; where four days of exceedances co-occur at both locations. The days of exceedance are not associated with above average wind speeds and overnight temperatures were relatively low, suggesting poor dispersion conditions for accumulated particulates. Only one exceedance of the current daily $PM_{2.5}$ NAAQ limit concentration was recorded during the on-site monitoring campaign (Table 5-8). The comparison with the $PM_{2.5}$ measured at the Sharpeville station is poor, where 15 days were recorded to exceed the NAAQ limit concentration. This suggests a very localised source of $PM_{2.5}$ relative to the Sharpeville station. The day with the highest measured $PM_{2.5}$ concentration at the on-site monitoring did, however, correspond with the highest concentration measured at Sharpeville station.

Table 5-7: On-site ambient PM_{10} concentrations measured during April – May 2018 (red shading indicates exceedance of the NAAQ limit concentration)

Date	Day of week	Hours exposed	On-site daily PM_{10} concentration (µg/m³)	Sharpeville daily PM_{10} concentration (µg/m³)
25/04/2018	Wednesday	24.4	79.7	62.3
26/04/2018	Thursday	32.3	1.6	63.3
30/04/2018	Monday	35.6	44.2	66.8
02/05/2018	Wednesday	26.0	40.3	53.3
03/05/2018	Thursday	21.7	48.7	51.9
04/05/2018	Friday	23.8	No data	41.7
07/05/2018	Monday	23.6	53.8	75.7
08/05/2018	Tuesday	24.4	111.4	88.3
09/05/2018	Wednesday	23.8	123.6	136.3
10/05/2018	Thursday	23.8	78.7	89.2
11/05/2018	Friday	23.1	102.4	91.1
12/05/2018	Saturday	24.2	38.8	77.8
13/05/2018	Sunday	23.2	48.8	59.0
14/05/2018	Monday	23.6	2.1	47.0
15/05/2018	Tuesday	24.1	2.1	26.2
16/05/2018	Wednesday	23.4	2.1	26.9
17/05/2018	Thursday	31.1	82.1	60.3
18/05/2018	Friday	17.0	2.8	77.3
21/05/2018	Monday	23.8	2.1	46.1
22/05/2018	Tuesday	20.5	2.4	47.2

Table 5-8: On-site ambient $PM_{2.5}$ concentrations measured during April – May 2018 (red shading indicates exceedance of the current NAAQ limit concentration)

Date	Day of week	Hours exposed	On-site daily $PM_{2.5}$ concentration (µg/m³)	Sharpeville daily $PM_{2.5}$ concentration (µg/m³)
24/04/2018	Tuesday	24.0	27.89	49.3
25/04/2018	Wednesday	24.4	23.37	36.3
26/04/2018	Thursday	59.2	23.94	41.2
30/04/2018	Monday	39.3	12.57	43.8
02/05/2018	Wednesday	26.0	16.91	38.1
03/05/2018	Thursday	21.7	2.28	44.8
04/05/2018	Friday	23.8	2.11	35.4
07/05/2018	Monday	23.9	16.80	48.0
08/05/2018	Tuesday	24.3	23.46	54.8
09/05/2018	Wednesday	23.9	47.59	91.8
10/05/2018	Thursday	29.8	16.14	57.2
11/05/2018	Friday	23.0	30.39	56.2
12/05/2018	Saturday	24.3	2.07	50.4
13/05/2018	Sunday	24.6	25.94	42.6
14/05/2018	Monday	23.5	2.13	31.1
15/05/2018	Tuesday	24.3	2.07	19.1
16/05/2018	Wednesday	23.4	2.14	23.9
17/05/2018	Thursday	31.2	6.64	42.6
18/05/2018	Friday	16.8	2.83	45.7

5.1.5.2 Passive-Diffusive Sampling

Radiello® passive diffusive tubes were used to sample SO_2 and NO_2 concentrations. Passive diffusive sampling relies on the diffusion of analytes through a diffusive surface onto an adsorbent. After sampling, the analytes are chemically desorbed by solvent extraction or thermally desorbed and analysed. Passive sampling does not involve the use of pumping systems and does not require electricity. The concentration of analytes adsorbed during the exposure period can be calculated to time-frames comparable with the NAAQS.

Passive diffusive samplers were placed at eye level at four locations around the proposed maize wet mill site: at the SAB depot; at the Roads Agency site; at the Correctional Services Facility (near the staff accommodation); and, at a substation on the eastern side of the proposed property near the R59 (Figure 5-7). The manufacturer approved rain shelter was attached to a post to ensure protection against adverse weather conditions, while allowing adequate ventilation. Supporting plates were assembled and operated according to manufacturer instructions. Exposure time was 14 days, within the period recommended by the manufacturer (14 to 16 days). Two exposure periods were used during the on-site ambient monitoring: (1) 24th April to 8th May 2018; and, (2) 8th May to 22nd May 2018. The analytical methods and calculations depend on the pollutant according to the manufacturer specification sheets, where analysis was conducted by Biograde Laboratory Services, Pretoria.

Figure 5-7: Location of passive diffusive samplers for SO_2 and NO_2 monitoring

To compare the 1-month (two 14-day contiguous sampling campaign) average sampled concentrations to long term (annual average) NAAQS, equivalent annual average concentrations were extrapolated. For extrapolating time averaging periods of from 24 hours to 1 year, Beychock (2005), recommends the following equation:

$$\frac{C_x}{C_p} = \left(\frac{t_p}{t_x}\right)^{0.53}$$

where:

C_x *and* C_p are concentrations over any two averaging periods between 24 hours and 1 year;

t_x *and* t_p are corresponding averaging times in days.

Although mathematical extrapolations exist for averaging periods shorter than 24 hours, these extrapolations cannot be used to determine the number of exceedances of the specified NAAQS limit values for 1-hour and 24-hour averaging periods. It is therefore not appropriate for assessing compliance with short term NAAQS.

Calculated ambient SO_2 concentrations, based on the passive sampling, are likely to compliant with the annual National Ambient Air Quality Standard (NAAQS) (Table 5-9). The site with the highest campaign concentration was the Correctional Services site (during Campaign 1), and the substation (during Campaign 2). Annualised NO_2 concentration, based on the two contiguous 14-day exposure period, are likely to be compliant the annual NO_2 standard (Table 5-9). The location with the highest campaign concentrations was the substation, where concentrations could be associated with vehicle exhaust emissions along the R59.

The concentrations of SO_2 near the proposed maize wet mill are lower than concentrations measured at Sharpeville during the same 14-day campaigns periods (Table 5-9). However, there is a better correlation between on-site measurements and Sharpeville AQMS measurements of NO_2. Both SO_2 and NO_2 annual concentrations on-site are lower than the long-term average concentrations at Sharpeville. This is because the monitoring campaign was short and prior to the known winter-time peak concentrations measured at Sharpeville.

Table 5-9: Ambient SO_2 and NO_2 concentrations measured near the proposed site of the maize wet mill (all units: $\mu g/m^3$)

Location	On-site 14-day exposure period concentration		Sharpeville 14-day exposure period concentration		Calculated on-site annual concentration[(a)]	Sharpeville long-term average concentration[(b)]
	Campaign 1	Campaign 2	Campaign 1	Campaign 2		
SO_2						
SAB Depot	8.15	3.01	26.19	19.91	0.99	7.5
Roads Agency	5.22	1.40			0.59	
Correctional Services	8.55	4.27			1.14	
Substation	7.84	13.70			1.91	
NO_2						
SAB Depot	20.84	14.20	28.52	33.41	3.11	16.2
Roads Agency	18.93	9.34			2.51	
Correctional Services	21.73	20.79			3.78	
Substation	23.03	23.25			4.11	

Notes:
(a) Calculated on-site annual concentrations are based on the two 14-day passive monitoring campaigns
(b) The long-term average concentrations at Sharpeville are based on annual averages from 2007 to 2016

5.1.6 Dispersion Modelling

5.1.6.1 Emissions Estimation Methodology

Construction and Decommissioning Phases

Dispersion modelling was regarded not representative of the actual activities that will result in particulate emissions during the construction phase. It is not anticipated that the various construction activities would result in higher off-site $PM_{2.5}$, PM_{10}, NO_2, and SO_2 concentrations compared the operational activities. The temporary nature of the construction activities would likely reduce the significance of the potential impacts. Decommissioning is likely to be similar or less than the construction impacts.

Operational Phase

Emissions associated with the normal operation of the glass manufacturing facility were estimated as described in Section 4. Annual total emissions are summarised in Table 5-10. Planned mitigation measures were included in the emissions quantification, such as enclosure of materials handling activities in the batch plant. Neither emission factors nor particulate size distributions are provided for in the NPI emissions estimation manual for size fractions other than PM_{10}. The PM_{10} emission rates were therefore conservatively assumed to apply to total suspended particulates and $PM_{2.5}$.

Table 5-10: Annual pollutant emission rates (by source group) [units: t/a]

Source group	$PM_{2.5}$	PM_{10}	Total Suspended Particulates	SO_2	NO_X
Furnaces	8.5	8.5	8.5	423.0	423.0
Paved roads	0.2	0.7	3.5	-	-
Materials handling	196.2	196.2	196.2	-	-

5.1.6.2 Dispersion Modelling Results – Incremental Impacts

It was indicated that the glass manufacturing facility would run continuously (24 hours per day; 365 days per year). However, scheduled maintenance would result in downtime, and additional unplanned downtime, may result fewer working hours per year. Therefore, the simulated concentrations are likely to be conservative.

One operational scenario was simulated as above with applicable emissions control and management as provided by the engineering team to minimise emissions and subsequent impacts.

5.1.6.2.1 Simulated $PM_{2.5}$ Concentrations

The most stringent $PM_{2.5}$ NAAQS were used to indicate the impact of the proposed facility after 2030, although the plant is likely to be constructed before this standard is enforceable (see Table 5-2). The simulated $PM_{2.5}$ concentrations as result of the proposed facility show off-site exceedances of the daily standard associated with emissions from the batch plant, for approximately 2 900 m off-site (Figure 5-8). This is, however, based on a conservative estimation of the emissions. If additional control systems (e.g. extraction systems evacuating batch plant emissions via baghouse filters) are planned they are likely to reduce emissions and therefore the impact of the facility on ambient $PM_{2.5}$ concentrations. Simulated annual $PM_{2.5}$ concentrations could be non-compliant with NAAQS at up to 600 m off-site (Figure 5-9). If the planned batch plant particulate emission control systems have a 98% control efficiency, $PM_{2.5}$ impacts can be reduced to on-site (Figure 5-10).

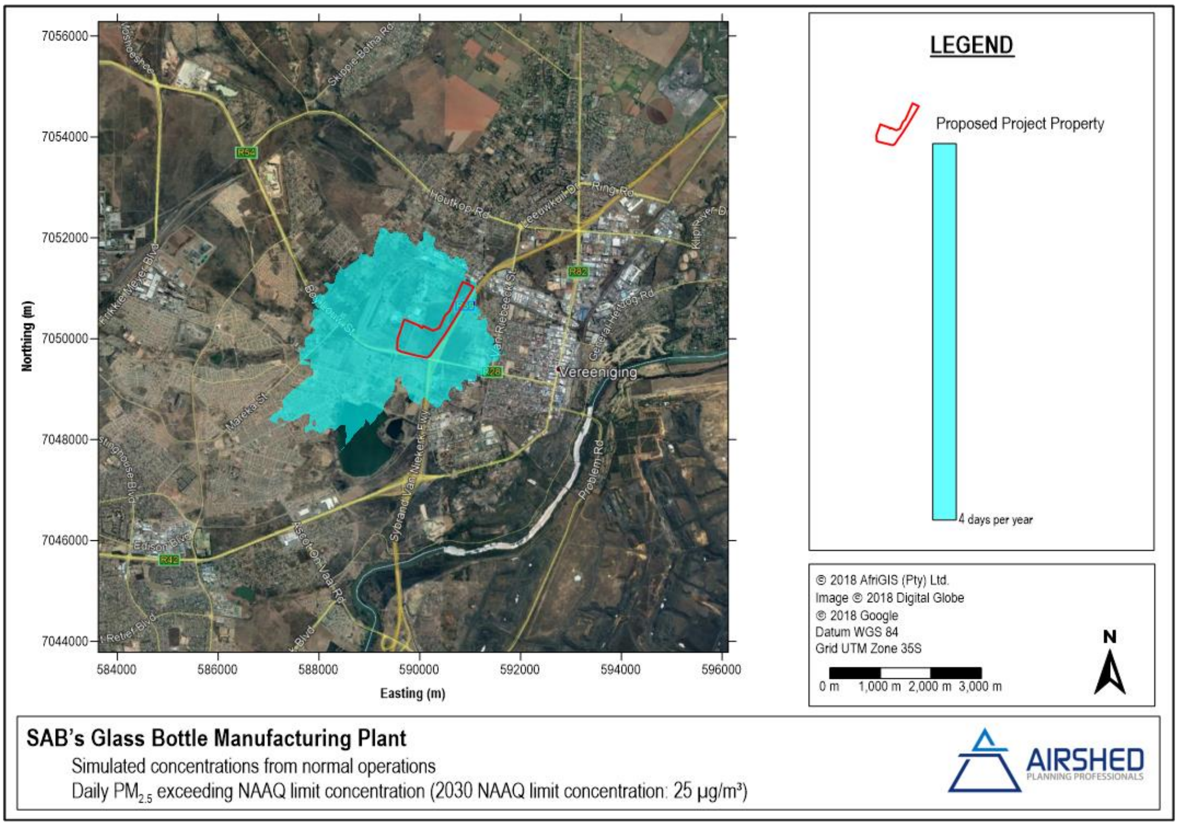


Figure 5-8: Simulated area of exceedance of the daily $PM_{2.5}$ NAAQ limit concentrations

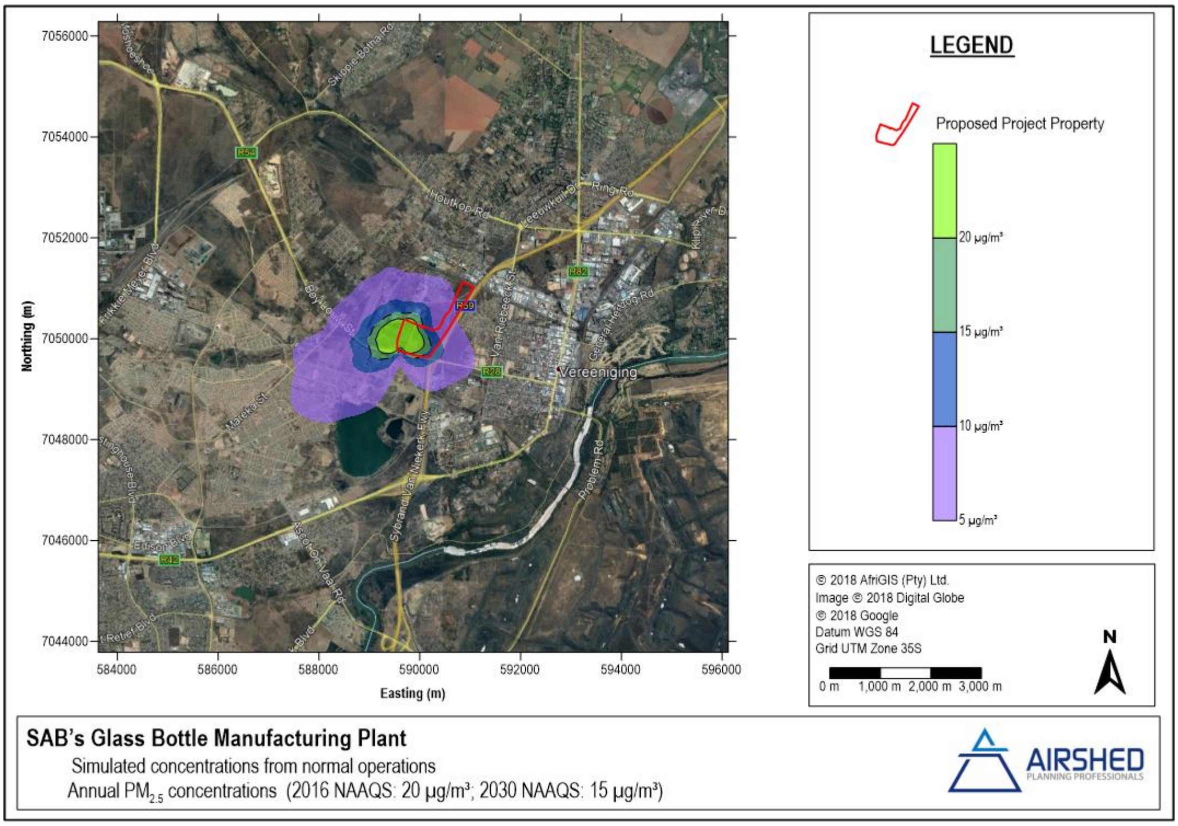


Figure 5-9: Simulated annual $PM_{2.5}$ concentrations

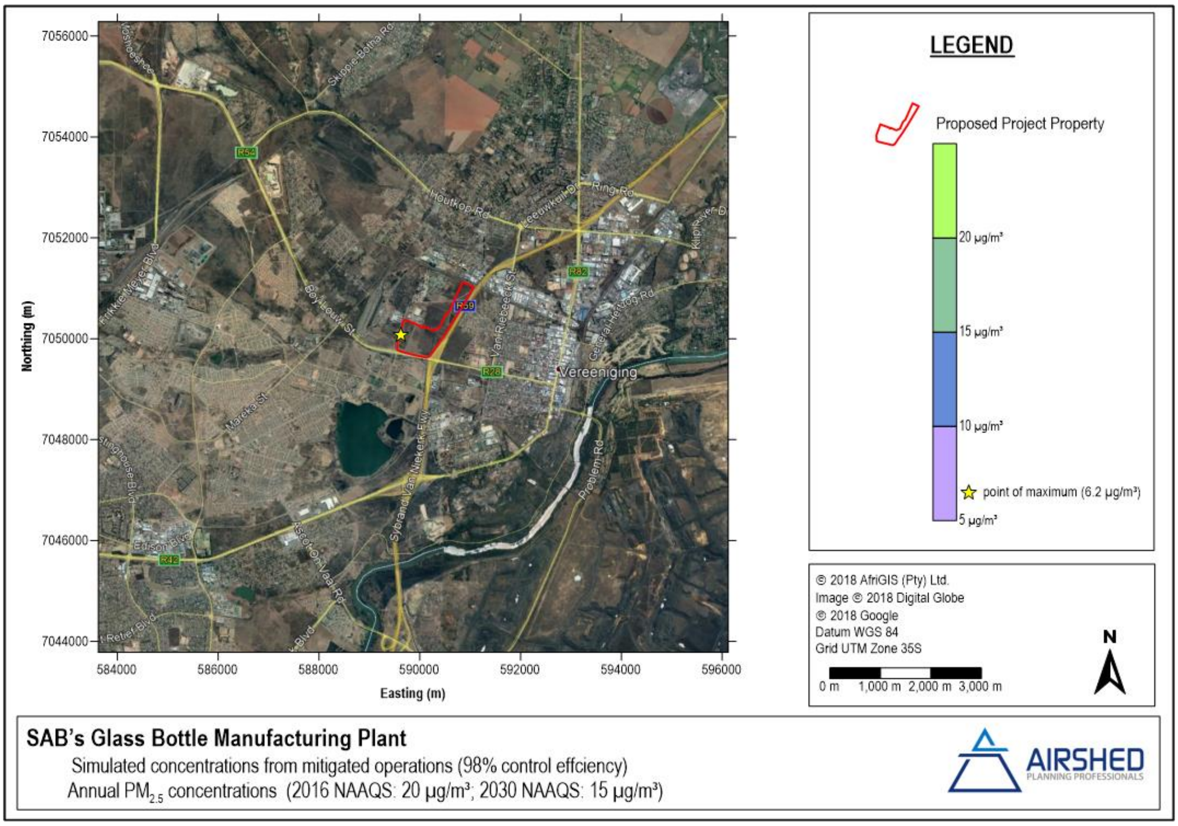


Figure 5-10: Simulated annual $PM_{2.5}$ concentrations - with 98% control efficiency on batch plant particulate emissions

5.1.6.2.2 Simulated PM_{10} Concentrations

Simulated daily PM_{10} concentrations show potential off-site exceedances of the daily NAAQS by up to 600 m (Figure 5-11). The simulated annual average PM_{10} concentrations may also exceed NAAQS off-site at up to 250 m (Figure 5-12). If additional control systems (e.g. extraction systems evacuating batch plant emissions via baghouse filters) are planned, they are likely to reduce emissions and the impact of the facility on the ambient PM_{10} concentrations. If the planned batch plant particulate emission control systems have a 98% control efficiency, PM_{10} impacts can be reduced to on-site (Figure 5-13).

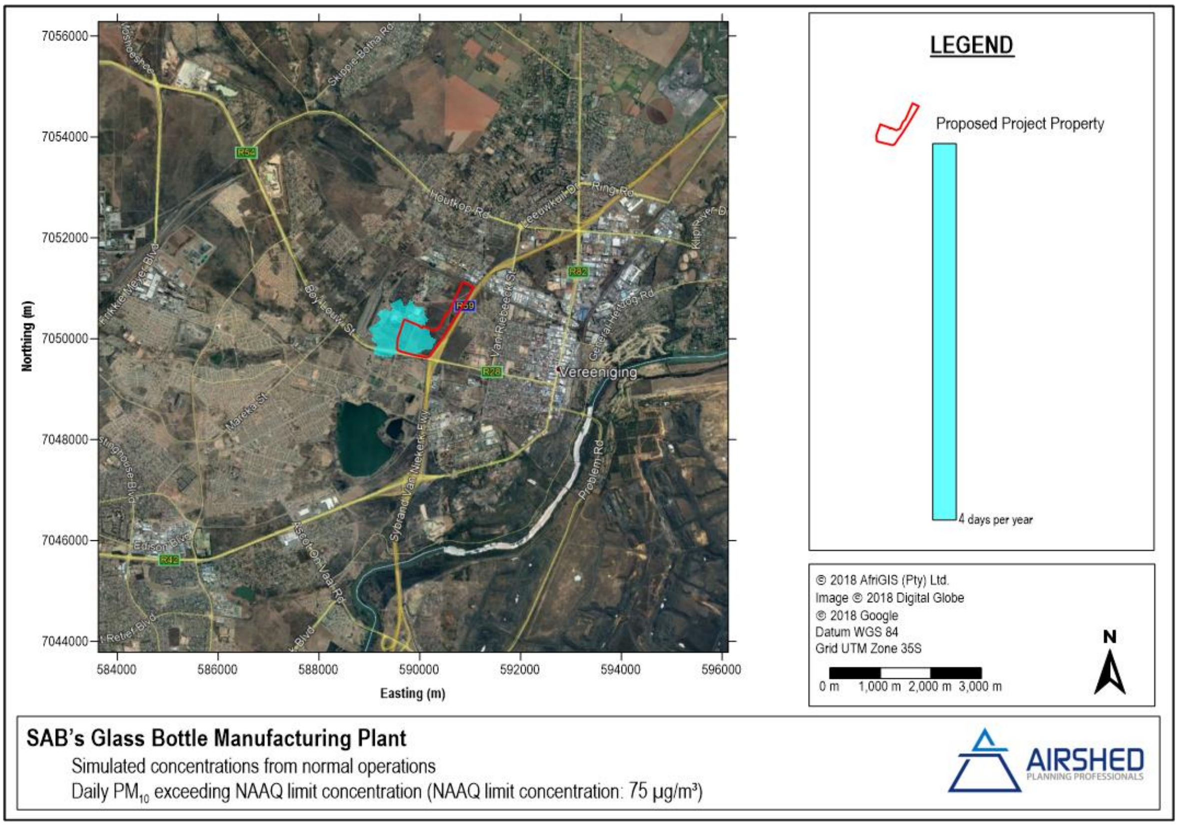


Figure 5-11: Simulated area of exceedance of the daily PM_{10} NAAQ limit concentrations

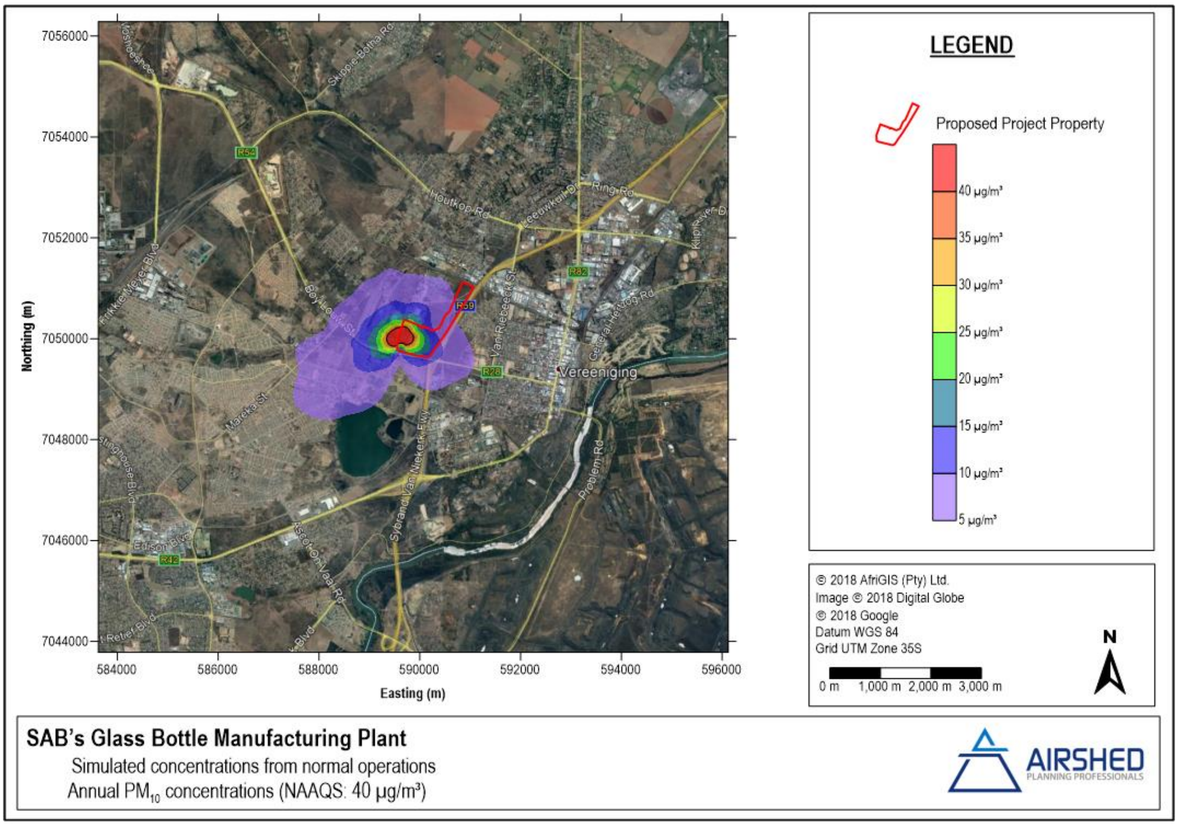


Figure 5-12: Simulated annual PM_{10} concentrations

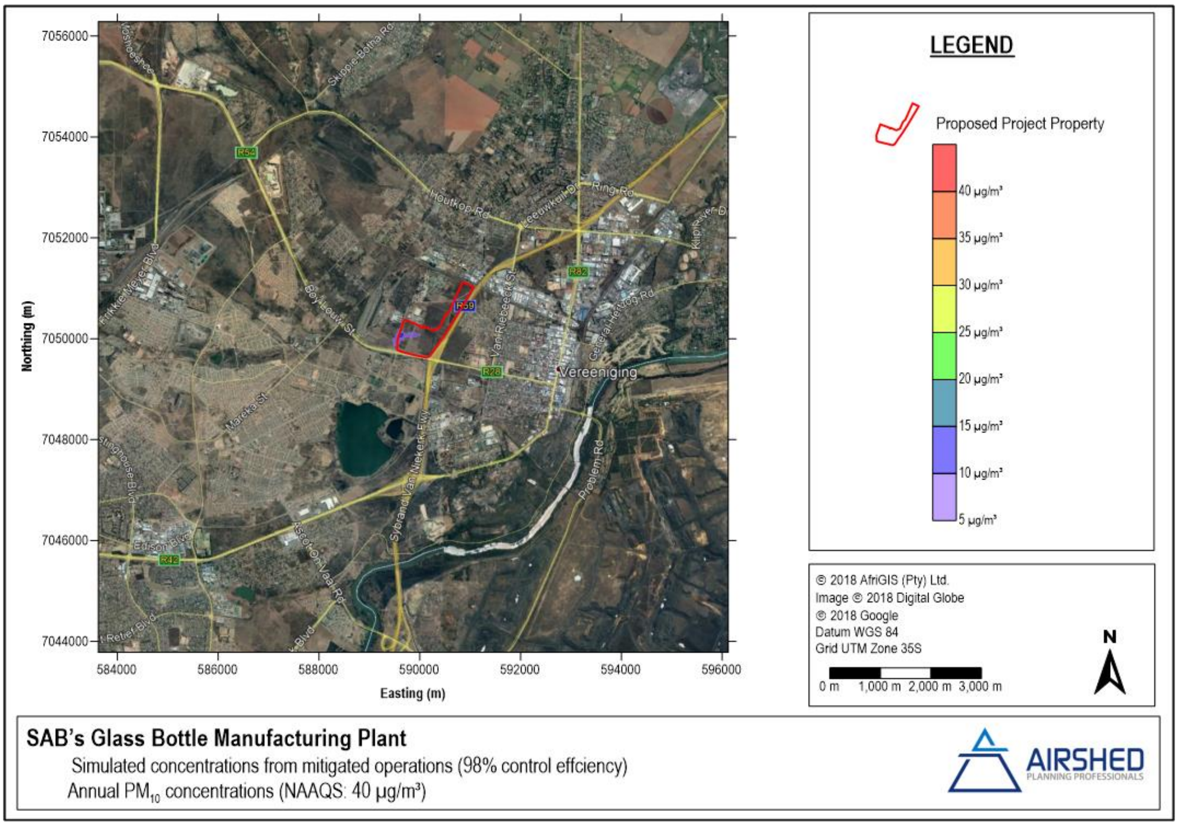


Figure 5-13: Simulated annual PM_{10} concentrations - with 98% control efficiency on batch plant particulate emissions

5.1.6.2.3 Simulated SO_2 Concentrations

No exceedances of the hourly SO_2 concentrations were simulated and the maximum simulated concentration was 71 µg/m³. The maximum simulated daily SO_2 concentrations were less than 33 µg/m³. Annual average SO_2 concentrations were simulated to represent less than 10% of the annual NAAQS across the domain (Figure 5-14).

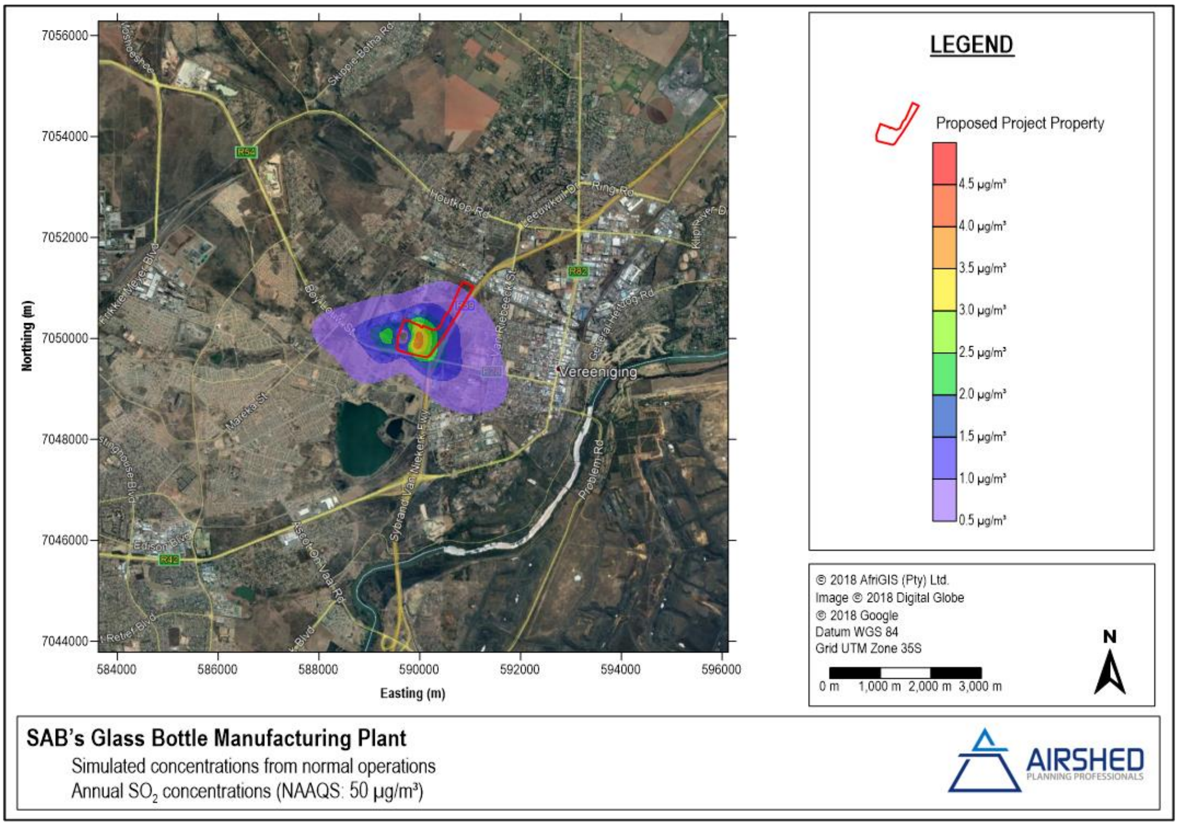


Figure 5-14: Simulated annual SO_2 concentrations

5.1.6.2.4 Simulated NO_X and NO_2 Concentrations

The simulated hourly NO_X concentrations were compliant with the hourly limit concentration, assuming all NO_X converts to NO_2, such that the maximum simulated NO_2 concentration was 70.2 µg/m³.

Annual NO_2 concentrations were converted from NO_X to NO_2 using the Ambient Ratio Method for Tier 2 assessments recommended in the Regulations Regarding Air Dispersion Modelling (Government Gazette No. 37804 vol. 589; 11 July 2014) and based on the national ratio of NO_2:NO_X=0.8. Simulated annual NO_2 concentrations complied with the annual NAAQS (maximum simulated concentration 3.2 µg/m³ - Figure 5-15).

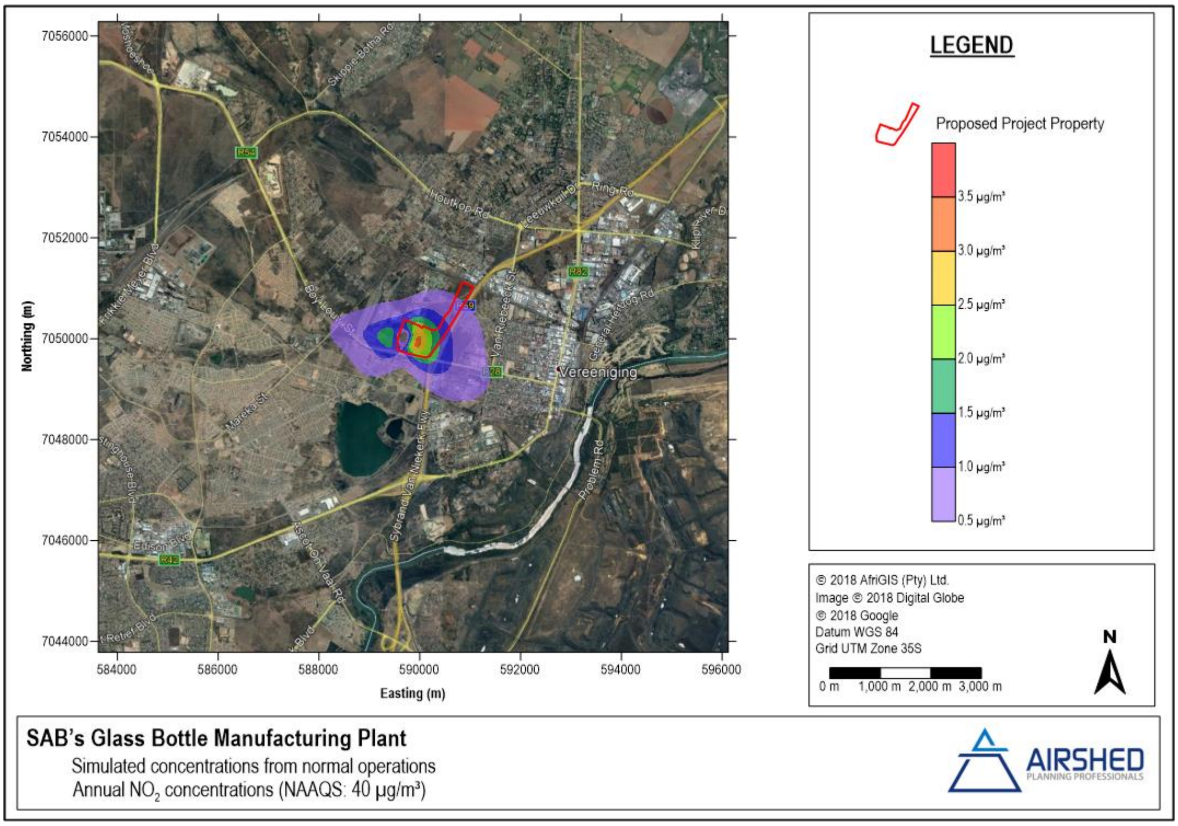


Figure 5-15: Simulated annual NO_2 concentrations

5.1.7 Dispersion Modelling Results - Cumulative

The cumulative impact of the proposed facility and the existing baseline was estimated using annual averaging period for the pollutants of concern. The cumulative annual average concentrations suggest that the proposed facility on its own will not result in exceedances of annual standards for SO_2 and NO_2 (Table 5-11). The baseline $PM_{2.5}$ and PM_{10} concentrations, assuming the Sharpeville AQMS averages are valid for the proposed site, are already in non-compliance with NAAQS. (Table 5-11). Should the planned particulate control systems achieve 98% control efficiency simulated annual incremental $PM_{2.5}$ and PM_{10} concentrations could represent less than 30% of the annual NAAQS off-site (Table 5-11).

It is understood that a maize wet mill is proposed for development near to the glass manufacturing facility. The cumulative impact of the two facilities, being in close proximity to each other, is also summarised in Table 5-11. Potential exceedances of the $PM_{2.5}$ and PM_{10} annual NAAQS are possible if both facilities are developed. There is also the potential for SO_2 exceedances

Table 5-11: Cumulative annual average pollutant concentrations (bold text indicates non-compliance with NAAQS)

Pollutant	Annual average concentration (µg/m³)							
	NAAQS	On-site estimated[a]	Sharpeville AQMS Long-term Average Measured[b]	Simulated incremental[c] at site boundary	Cumulative (proposed facility only)[d]	Cumulative (proposed facility only)[e]	Cumulative (both facilities)[f]	Cumulative (both facilities)[g]
$PM_{2.5}$	15[h]	10.6	**35.4**	5.1	15.7	**40.5**	**34.1**	**58.9**
PM_{10}	40	**45.0**	**73.9**	12.0	**57.0**	**85.9**	**72.5**	**101.4**
SO_2	50	1.2	7.5	3.0	4.1	10.5	50.1	**56.5**
NO_2	40	3.4	16.2	2.4	5.8	18.6	11.5	24.3

Notes:

(a) Based on average daily ratio between on-site measured concentrations and Sharpeville AQMS daily measured.
(b) Based on the Sharpeville AQMS long-term average for the period 1 January 2007 to 31 December 2016.
(c) From dispersion modelling reported in Section 5.1.6.2 Proposed facility only (operating with control efficiencies of 98% on batch plant particulate emissions). Simulated maximum concentration at site boundary.
(d) Estimated annual at facility (a) plus simulated incremental (c).
(e) Sharpeville long-term average (b) plus simulated incremental (c).
(f) Estimated annual at facility (a) plus simulated incremental (c) plus mitigated annual incremental at maize wet mill.
(g) Sharpeville long-term average (b) plus simulated incremental (c) mitigated annual incremental at maize wet mill.

5.2 Analysis of Emissions' Impact on the Environment

5.2.1 Dustfall Rates

Dustfall deposition rates were estimated based on emissions from the operational phase of the project. The simulated TSP concentrations were converted to deposition rates by assuming a settling velocity of 3.24 x 10^{-2} m/s (based on a 30 µm particle with a density of 1.2 g/cm^3).

The impact of the proposed project on the environment was assessed with respect to nuisance dustfall. Emissions of the particle size fraction likely to result in elevated dustfall rates were from the batch plant (assumed to be equal to PM_{10} emissions), vehicle entrainment of particulates along the access road used for haul raw materials and product. From the batch plant on its own, compliance with the NDCR for residential areas was predicted across the domain, with a maximum daily dustfall rate of 75 mg/m^2.day.

5.3 Main Findings and Conclusions

The findings from the air quality impact assessment are:

1. Baseline ambient SO_2 and NO_2 concentrations near the proposed facility is compliant with NAAQS.
2. Baseline ambient $PM_{2.5}$ and PM_{10} concentrations near the proposed facility is non-compliant with NAAQS for both daily or annual average values, based on the Sharpeville AQMS data.
3. The glass manufacturing plant was assessed assuming:
    a. Emissions from material handling within the batch plant would be naturally ventilated from the building where the enclosure in the building would control emissions by 75%. It is understood that particulate emissions control systems are planned, however insufficient detail was available at this time to simulated emissions from the control systems. The required control efficiency of these systems was estimated to be 98%.
    b. The glass furnaces emissions would occur at the upper limit of engineering design emission concentrations, which are compliant with the minimum emissions standards applicable to Listed Activities in the Subcategory 5.8.
    c. The glass manufacturing process would operate 24 hours per day, 7 days per week.
    d. Raw materials and product haulage would be via paved access roads, where the silt content would be similar to the default US EPA value for low vehicle volume facilities. US EPA emission factors were used to calculate vehicle entrainment emission rates.
4. Gaseous pollutants were simulated to comply with the NAAQS across the domain for all applicable time periods included: SO_2, and NO_2.
5. Particulate emissions, particularly those associated with the batch plant, may result in off-site exceedances of the $PM_{2.5}$ and PM_{10} standards. The exceedances could affect nearby industrial activities and residential areas.
    a. Particulate emission control systems, such as baghouses or fabric filters, are required for the batch plant.
    b. Regular sweeping and/or watering of the facility access road (assumed to be paved or tarred) would reduce the silt content of particulates in and around the batch plant, as well as on the road surfaces, minimising off-site impacts.
6. Dustfall rates are likely to comply with the NDCR.
    a. Dustfall monitoring is recommended at the facility boundary. Dustfall rates should comply with the residential standard, due to the proximity of residences to the proposed site boundary.

Conclusion

From an air quality perspective, it is recommended that the project go ahead, **on condition that**:

- Control systems commissioned on the batch plant to minimise particulate emissions have a control efficiency of 98% or better;
- The access road be paved, and regularly maintained, swept and/or watered to minimise particulate along the access road; and,
- Dustfall and fine particulate monitoring is conducted during operations.

5.3.1 Impact Assessment Rating

The impact of the proposed project was assessed (Table 5-12) according to the methodology provided by SLR (Appendix B). The exceedances of the $PM_{2.5}$ and PM_{10} standards resulted in a "medium" impact beyond the site boundary. With additional particulate emission control systems on the batch plant, it may be possible to reduce the impact to "medium". Although very low concentrations were simulated for the gaseous pollutants (SO_2, and NO_X) the project duration resulted in a "medium" impact significance rating. The no-go option (baseline) was calculated to have a "very high" impact due to the regional scale elevated particulate concentrations across the VTAPA. Similarly, as a result of the baseline air quality, the significance of the project on the cumulative air quality would be "very high".

Table 5-12: Impact significance rating for the proposed project

Impact	Intensity	Duration	Spatial Extent	Consequence	Probability	Significance
Unmitigated incremental						
$PM_{2.5}$	H	H	H	High	Probable	High
PM_{10}	H	H	H	High	Probable	High
SO_2 and NO_2	VL	H	L	Low	Probable	Low
Mitigated incremental						
$PM_{2.5}$	L	H	L	Medium	Probable	Medium
PM_{10}	L	H	L	Medium	Probable	Medium
Mitigated Cumulative						
$PM_{2.5}$	H	H	VH	Very high	Probable	Very High
PM_{10}	H	H	VH	Very high	Probable	Very High
Non-go option (baseline)	H	H	VH	Very high	Probable	Very High

6 ANNEXURE A

DECLARATION OF ACCURACY OF INFORMATION – APPLICANT

Name of Enterprise: ______________________________

Declaration of accuracy of information provided:

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

I, [*duly authorised*], declare that 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 the National Environmental Management: Air Quality Act (Act No. 39 of 2004).

Signed at on this day of

SIGNATURE

CAPACITY OF SIGNATORY

7 ANNEXURE B

DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner: Theresa Bird

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

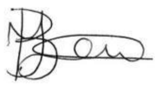
Professional Registration No.: 114332

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 Midrand on this 2nd day of August 2018.



SIGNATURE

Principal Air Quality Scientist

CAPACITY OF SIGNATORY

8 REFERENCES

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APPENDIX A: COMPARISON OF STUDY APPROACH WITH THE REGULATIONS PRESCRIBING THE FORMAT OF THE ATMOSPHERIC IMPACT REPORT AND THE REGULATIONS REGARDING AIR DISPERSION MODELLING (GAZETTE NO 37804 PUBLISHED 11 JULY 2014)

The Regulations prescribing the format of the Atmospheric Impact Report (AIR) (Government Gazette No 36094; published 11 October 2013) were referenced for the air dispersion modelling approach used in this study. Table A-1 compares the AIR Regulations with the approach used in Section 5.

The regulations regarding Air Dispersion Modelling (Gazette No 37804 published 11 July 2014) were referenced for the air dispersion modelling approach used in this study. The promulgated Regulations regarding Air Dispersion Modelling (Gazette No. 37804, vol 589; 11 July 2014) were consulted to ensure that the dispersion modelling process used in this assessment was in agreement with the updated regulations. Table A-2 compares the Regulations Regarding Air Dispersion Modelling with the approach used in Section 5.

Table A-1: Comparison of Regulations for the AIR with study approach

Chapter	Name	AIR regulations requirement	Status in AIR
1	Enterprise details	• Enterprise Details • Location and Extent of the Plant • Atmospheric Emission License and other Authorisations	Enterprise details included. Location of plant included. AEL numbers not valid for new application.
2	Nature of process	• Listed Activities • Process Description • Unit Processes	All sources included (Section 2).
3	Technical Information	• Raw Materials Used and Production Rates • Appliances and Abatement Equipment Control Technology	Section 3

4	Atmospheric Emissions	• Point Source Emissions
		  • Point Source Parameters
		  • Point Source Maximum Emission Rates during Normal Operating Conditions
		  • Point Source Maximum Emission Rates during Start-up, Maintenance and/or Shut-down
		• Fugitive Emissions
		• Emergency Incidents
			Completed as set out by the Regulations (Section 4).

5	Impact of enterprise on receiving environment		
5.1	Analysis of emissions impact on human health	Must conduct dispersion modelling, must be done in accordance with Regulations; must use NAAQS	Completed as set out by the Regulations.
5.2	Analysis of emissions impact on environment	Must be undertaken at discretion of Air Quality Officer.	Section 5.2.
6	Complaints	Details on complaints received for last two years	Proposed facility, no complaints received yet.
7	Current or planned air quality management interventions	Interventions currently being implemented and scheduled and approved for next 5 years.	Proposed facility. Proposed equipment designed to meet Minimum Emissions Standards for Section 21 Listed Activity Subcategory 5.8.

Chapter	Name	AIR regulations requirement	Status in AIR
8	Compliance and enforcement history	Must set out all air quality compliance and enforcement actions undertaken against the enterprise in the last 5 years. Includes directives, compliance notices, interdicts, prosecution, fines	Proposed facility, no compliance and enforcement notices received yet.
9	Additional information		None.

Table A-2: Comparison of Regulations regarding Air Dispersion Modelling with study approach

AIR Regulations	Compliance with Regulations	Comment
Levels of assessment • 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: requires 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, and 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 airshed; or, – when assessing contaminants resulting from non-linear processes (e.g. deposition, ground-level ozone (O_3), particulate formation, visibility)	Level 2 assessment using AERMOD	Gaussian plume models are best used for near-field applications where the steady-state meteorology assumption is most likely to apply. The impacts of the galvanizing facility were expected to be localised within a few kilometres of the facility.
Model Input Source characterisation	Yes	Section 4
Emission rates: For new or modified existing sources the maximum allowed amount, volume, emission rates and concentration of pollutants that may be discharged to the atmosphere should be used	Yes	Section 4 and Section 5.1.6.1.
Meteorological data		
Full meteorological conditions are recommended for regulatory applications.	Yes	Sharpeville AQMS station (Sections 5.1.2.6).
Data period	Yes	3+ years (January 2014 to June 2017)
Geographical Information		

AIR Regulations	Compliance with Regulations	Comment
Topography and land-use		Required for AERMET meteorological file preparation (Section 5.1.1.1)
Domain and co-ordinate system	Yes	• Dispersion modelling domain: 12.5 x 12.5 km • UTM co-ordinate system Zone 35S (WGS84) (Section 1.3)
General Modelling Considerations		
Ambient Background Concentrations, including estimating background concentrations in multi-source areas	Yes	Section 5.1.4
NAAQS analyses for new or modified sources: impact of source modification in terms of ground-level concentrations should be assessed within the context of the background concentrations and the facility.	Yes	Model simulated concentrations and measured concentrations used as an indication of how proposed facility will impact ambient concentrations (Section 5.1.5 and 5.1.7).
Land-use classification	Yes	Section 1.3
Surface roughness	Yes	Computed from Land-use categories in the AERMET pre-processing step (Section 5.1.1.1).
Albedo	Yes	Computed from Land-use categories in the AERMET pre-processing step (Section 5.1.1.1).
Temporal and spatial resolution		
Receptors and spatial resolutions	Yes	Sections 1.3 and Section 5.1.6.2
Building downwash	No	
Chemical transformations	Yes	Sections 5.1.6.2.4
General Reporting Requirements		
Model accuracy and uncertainty	No	
Plan of study	No	
Air Dispersion Modelling Study Reporting Requirements	Yes	As per the Regulations Prescribing the Format of the Atmospheric Impact Report, Government Gazette No. 36904, Notice Number 747 of 2013 (11 October 2013) and as per the Regulations Regarding Air Dispersion Modelling (Government Gazette No. 37804 published 11 July 2014).
Plotted dispersion contours	Yes	Sections 5.1.6.2 and 5.2.1

APPENDIX B: IMPACT ASSESSMENT METHODOLOGY

PART A: DEFINITIONS AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.
	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	**VL**	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	**VL**	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.

	VH	Regional/National

PART B: DETERMINING CONSEQUENCE							
			EXTENT				
			A part of the site/property	Whole site	Beyond the site, affecting neighbours	Local area, extending far beyond site.	Regional/ National
			VL	**L**	**M**	**H**	**VH**
INTENSITY = VL							
DURATION	Very long	**VH**	**Low**	**Low**	**Medium**	**Medium**	**High**
	Long term	**H**	**Low**	**Low**	**Low**	**Medium**	**Medium**
	Medium term	**M**	**Very Low**	**Low**	**Low**	**Low**	**Medium**
	Short term	**L**	**Very low**	**Very Low**	**Low**	**Low**	**Low**
	Very short	**VL**	**Very low**	**Very Low**	**Very Low**	**Low**	**Low**
INTENSITY = L							
DURATION	Very long	**VH**	**Medium**	**Medium**	**Medium**	**High**	**High**
	Long term	**H**	**Low**	**Medium**	**Medium**	**Medium**	**High**
	Medium term	**M**	**Low**	**Low**	**Medium**	**Medium**	**Medium**
	Short term	**L**	**Low**	**Low**	**Low**	**Medium**	**Medium**
	Very short	**VL**	**Very low**	**Low**	**Low**	**Low**	**Medium**
INTENSITY = M							
DURATION	Very long	**VH**	**Medium**	**High**	**High**	**High**	**Very High**
	Long term	**H**	**Medium**	**Medium**	**Medium**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**Medium**	**High**	**High**
	Short term	**L**	**Low**	**Medium**	**Medium**	**Medium**	**High**
	Very short	**VL**	**Low**	**Low**	**Low**	**Medium**	**Medium**
INTENSITY = H							
DURATION	Very long	**VH**	**High**	**High**	**High**	**Very High**	**Very High**
	Long term	**H**	**Medium**	**High**	**High**	**High**	**Very High**
	Medium term	**M**	**Medium**	**Medium**	**High**	**High**	**High**
	Short term	**L**	**Medium**	**Medium**	**Medium**	**High**	**High**
	Very short	**VL**	**Low**	**Medium**	**Medium**	**Medium**	**High**
INTENSITY = VH							
DURATION	Very long	**VH**	**High**	**High**	**Very High**	**Very High**	**Very High**
	Long term	**H**	**High**	**High**	**High**	**Very High**	**Very High**
	Medium term	**M**	**Medium**	**High**	**High**	**High**	**Very High**
	Short term	**L**	**Medium**	**Medium**	**High**	**High**	**High**
	Very short	**VL**	**Low**	**Medium**	**Medium**	**High**	**High**
			VL	**L**	**M**	**H**	**VH**

			A part of the site/property	Whole site	Beyond the site, affecting neighbours	Local area, extending far beyond site.	Regional/ National
			EXTENT				
PART C: DETERMINING SIGNIFICANCE							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**VH**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Probable	**H**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Possible/ frequent	**M**	**Very Low**	**Very Low**	**Low**	**Medium**	**High**
	Conceivabl e	**L**	**Insignificant**	**Very Low**	**Low**	**Medium**	**High**
	Unlikely/ improbable	**VL**	**Insignificant**	**Insignificant**	**Very Low**	**Low**	**Medium**
			VL	**L**	**M**	**H**	**VH**
			CONSEQUENCE				

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely to be required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.
***VH = very high, H = high, M= medium, L= low and VL= very low and + denotes a positive impact.**	

APPENDIX C: CURRICULUM VITAE OF PROJECT TEAM

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	5 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

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
Power Stations	▪ 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. ▪ 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.
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.
Domestic waste landfill	▪ Assessing the health and odour impacts of a domestic waste landfill to support residential development plans for the area.
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.

Air Quality Management Plans (AQMP)

Project type	Experience
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.

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Air Quality Management Plans (AQMP)

Project type	Experience
	▪ 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)
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. ▪ 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).

Atmospheric Impact Reports (AIR)

Project type	Experience
Crude oil refinery	▪ 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 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.
Fertilizer production	▪ 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. ▪ 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.

* all projects listed above supported the application for postponement of stricter Minimum Emissions Standards applicable to Listed Activities

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

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; and pre-development levels near a coal-fired power station.

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

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

18 August 2017

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