Environmental Impact Assessment for proposed Future Developments within the Sun City Complex

Air Quality Impact Assessment

Report

Project Number:

SUN4642

Prepared for:

Sun International (Sun City Resort)

April 2018

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This document has been prepared by Digby Wells Environmental.

Report Type:	**Air Quality Impact Assessment Report**
Project Name:	**Environmental Impact Assessment for proposed Future Developments within the Sun City Complex**
Project Code:	**SUN4642**

Name	Responsibility	Signature	Date
Joel Maseki	Report Writer		April 2018
Matthew Ojelede	Reporter and Review		April 2018

EXECUTIVE SUMMARY

Digby Wells Environmental (hereafter Digby Wells) was appointed by Sun City Resort to undertake an Environmental Impact Assessment (EIA) in relation to the proposed future developments within the Sun City Resort Complex located near Rustenburg, North West Province. The investigation included a baseline assessment, which includes, evaluation of site specific meteorology, evaluation of background air quality scenario over a one month period, impact assessment and recommendation of mitigation measures incorporating Best Practicable Environmental Option to ensure compliance regulatory standard.

The air quality study evaluated the meteorology and the air quality status quo in the Project area prior to the commencement of the proposed development, which will serve as a baseline to which future perturbations can be compared. In addition, an impact assessment was conducted based on the measured pollutants levels, and the fact construction will occur in phases (with minimal impact on ambient air quality) and cessation of emissions during the operational phase respectively, before recommending mitigation measures to curtail potential impacts.

The construction phase will be conducted in phases and impacts on ambient air quality are presumed minimal. In addition, the operational phase will exact little or no impact on ambient air quality of the area.

The meteorological data showed that wind greater than 5.4 m/s occurred for only 4.1% of the time (~14 days in a year), which equates to once in a month. As such, impacts associated with wind erosion are not anticipated to the severe. Ambient air quality data measured on site showed that pollutants concentrations are very low and within the current South African ambient air quality standard.

The proposed construction of the Sun City Resort will occur in phases, mobile equipment employed will be limited, they will be used intermittently and anticipated emission will be low with negligible impacts on the ambient atmosphere. Associated emissions will not exacerbate or elevate background levels above the standards. This is not only true for the construction phase, but also applies to the operation phase of the Project (with emission sources limited to the vehicle fleet and generator set (which will be used intermittently).

In conclusion, if mitigation measures are implemented during the construction and operational phases, substantial reduction in emissions is anticipated. Hence, it is the recommendation of the air quality specialist that the Project be allowed to proceed as anticipated impacts on the ambient air quality will be minimal

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1 Introduction

Digby Wells Environmental (hereafter Digby Wells) has been appointed by Sun City Resort to undertake an Environmental Impact Assessment (EIA) in relation to proposed future developments within the Sun City Resort Complex located near Rustenburg, North West Province. The proposed Projects involve the following:

Table 1-1: Summary of Projects

Category	No.	Project Name	Project Summary
Resort Expansion Projects (REP)	REP1	Eco-Lodge	Development of a Bush Lodge / Eco-Lodge at Gary Player Golf Course Workshop.
	REP2	Driving Range Road	Construct a Road to connect the Driving Range at Lost City Golf Course (LCGC) to the Gary Player Golf Course (GPGC) via the Palace garden road and Valley of Waves (VOW) road.
	REP3	Kwena Gardens Expansion	Construct 20 additional Rustic Chalets at Kwena Gardens.
	REP4	Vacation Club (VC) Phase 3	Construct an additional 150 simplex units, 2- 3 bed units and associated infrastructure to expand capacity at the VC. The site identified for the expansion currently houses the Helipad and Nursery.
	REP5	Recreational Lake Beach Expansion	Expand the existing artificial beach at the Lake and construct an additional shallow swimming pool at Waterworld Beach
	REP6	Helipad relocation and expansion	Decommission the existing helipad, to make space for VC Phase 3, and construct a new helipad with increased bays closer to the Palace.
	REP7	Additional Parking Garage, Convention Centre and Hotel	Construct an additional parking garage, Convention Centre and Hotel (250 rooms) including a bridge link from Sun Central to the new Hotel.
	REP8	Soccer Fields	Develop 2 soccer fields at the Warehouse
Utilities and Services Projects (USP)	USP1	Storm water culverts at Golf Course Roads	Install Storm water pipes / culverts at Golf Course Roads to allow water to flow under the roads and maintain the road surface for fence inspections by security (prevent floods washing away the road).
	USP2	Additional Reservoirs to Supplement existing	Construct 2 x 10Ml reservoirs or alternatively 1x 20Ml Reservoir on Telkom Hill next to existing

		water storage capacity	Upper Reservoir.
	USP3	Effluent transfer line replacement	Currently there is an effluent transfer line (old asbestos line) through Sunset Drive to Hole 2. This line will be decommissioned (shut down) but remain in place. A new line will then be installed against the fence of Letsatsing.
	USP4	Sunset-Sky-train Fresh Water Line	Construct a main water line from the Welcome Centre to Sky-train (pipe will be attached to sky-train route)
	USP5	Ledig Sewer Line decommissioning, New WWTW for VC and Palace	Currently the sewer line running through Ledig (old asbestos line) is leaking. The line will be decommissioned (shut down but remain in place). A new wastewater treatment works (WWTW) will be established to manage sewage from VC and The Palace. A new pipeline will be required to the Lost City hole 3 dam to return the treated water for irrigation.
	USP6	South Village Pipeline	Construct an additional pipeline for water supply to South Village
	USP7	Generator Park	Consolidate the generators throughout the site into one area for effective monitoring and control, or establish a generator park to service the east side business units.
Maintenance Projects (MP)	MP1	Clearance of Fence Roads	Vegetation Clearance at perimeter fences to serve as maintenance roads and Fire Breaks (25 km)
	MP2	Sun Park Culverts	Clear the Culverts under the road at Sun Park from debris and siltation. Construct maintenance road to facilitate future maintenance.

Activities that are listed in terms of the Environmental Impact Assessment (EIA) Regulations[1] require environmental authorisation prior to commencing. The proposed Projects at Sun City constitute Listed Activities in terms of GN R 983 (Listing Notice 1); GN R 984 (Listing Notice 2) and GN R 985 (Listing Notice 3) as amended.

[1] As published in Government Notices R982; 983; 984 and 985 on 4 December 2014, as Amended 7 April 2017.

This specialist Air Quality Report has been compiled in terms of Appendix 6 of the NEMA EIA Regulations, 2014, (as amended) in terms of the Scoping and EIA process which is being followed in applying for Environmental Authorisation.

The requirements of Appendix 6 are presented in Table 1-2 and cross-referenced to the relevant sections of this Report.

Table 1-2: Structure of this report in accordance with the EIA Regulations

Regulatory Requirement for EIA Reports	Relevant Section of this report
1. (1) A specialist report prepared in terms of these Regulations must contain -	
(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;	Please refer to Section 2 and Appendix A of this Report
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Please refer to Section 2 of this report: Details of the Specialist
(c) an indication of the scope of, and the purpose for which, the report was prepared;	Please see Section 3: Scope and Purpose of this Report
(cA) an indication of the quality and age of base data used for the specialist report;	Please see Section 4.3: Details of the Baseline Data
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Please see Section 4.3: Details of the Baseline Data
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Please see Section 4.3: Details of the Baseline Data
(e) a description of the methodology adopted in preparing the report inclusive of equipment and modelling used;	Please see Section 4.0: Methodology
(f) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Please see Section 11.0: Conclusion
(g) any mitigation measures for inclusion in the Environmental Management Plan report (EMPr);	Please see Section 7.0: EMP
(h) any conditions for inclusion in the environmental authorisation;	

(i) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Please see Section 8.0: Monitoring Plan
(j) a reasoned opinion— (i) whether the proposed activity, activities or portions thereof should be authorised; (i) (A) regarding the acceptability of the proposed activity or activities; and (ii) if the opinion is that the proposed activity, activities 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;	Please see Section 11.0: Specialist Opinion
(k) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Please see Section. Refer to the PPP Report
(l) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	
(m) any other information requested by the competent authority.	No additional information was requested.

2 Details of the Specialist

This Specialist Air Quality Report has been compiled by the following specialists (CVs of the Project Team are included in Appendix A):

Table 2-1: Details of the Specialist(s) who prepared this Report

Responsibility	Report compilation and field work
Full Name of Specialist	Joel Maseki
Highest Qualification	MSc
Years of experience in specialist field	Two Years
Responsibility	Report compilation and reviewer
Full Name of Specialist	Matthew Ojelede
Highest Qualification	PhD
Years of experience in specialist field	Nine Years

2.1 Declaration of the Specialist

I Joel Maseki, as the appointed specialist hereby declare/affirm the correctness of the information provided or to be provided as part of the application, and that I:

- in terms of the general requirement to be independent:
  - other than fair remuneration for work performed/to be performed in terms of this application, have no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise my objectivity; or
  - am not independent, but another specialist that meets the general requirements set out in Regulation 13 have been appointed to review my work (Note: a declaration by the review specialist must be submitted);
- in terms of the remainder of the general requirements for a specialist, am fully aware of and meet all of the requirements and that failure to comply with any the requirements may result in disqualification;
- have disclosed/will disclose, to the applicant, the Department and interested and affected parties, all material information that have or may have the potential to influence the decision of the Department or the objectivity of any report, plan or document prepared or to be prepared as part of the application;

- have ensured/will ensure that information containing all relevant facts in respect of the application was/will be distributed or was/will be made available to interested and affected parties and the public and that participation by interested and affected parties was/will be facilitated in such a manner that all interested and affected parties were/will be provided with a reasonable opportunity to participate and to provide comments;
- have ensured/will ensure that the comments of all interested and affected parties were/will be considered, recorded and submitted to the Department in respect of the application;
- have ensured/will ensure the inclusion of inputs and recommendations from the specialist reports in respect of the application, where relevant;
- have kept/will keep a register of all interested and affected parties that participate/d in the public participation process; and
- am aware that a false declaration is an offence in terms of regulation 48 of the 2014 NEMA EIA Regulations.

Signature of the specialist:

Full Name and Surname of the specialist: Joel Boloko Maseki

Name of company: Digby Wells Environmental

Date: 19/04/2018

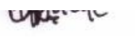
2.2 Declaration of the Specialist

I Matthew Ojelede, as the appointed specialist hereby declare/affirm the correctness of the information provided or to be provided as part of the application, and that I:

- in terms of the general requirement to be independent:
  - other than fair remuneration for work performed/to be performed in terms of this application, have no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise my objectivity; or
  - am not independent, but another specialist that meets the general requirements set out in Regulation 13 have been appointed to review my work (Note: a declaration by the review specialist must be submitted);
- in terms of the remainder of the general requirements for a specialist, am fully aware of and meet all of the requirements and that failure to comply with any the requirements may result in disqualification;
- have disclosed/will disclose, to the applicant, the Department and interested and affected parties, all material information that have or may have the potential to

influence the decision of the Department or the objectivity of any report, plan or document prepared or to be prepared as part of the application;

- have ensured/will ensure that information containing all relevant facts in respect of the application was/will be distributed or was/will be made available to interested and affected parties and the public and that participation by interested and affected parties was/will be facilitated in such a manner that all interested and affected parties were/will be provided with a reasonable opportunity to participate and to provide comments;
- have ensured/will ensure that the comments of all interested and affected parties were/will be considered, recorded and submitted to the Department in respect of the application;
- have ensured/will ensure the inclusion of inputs and recommendations from the specialist reports in respect of the application, where relevant;
- have kept/will keep a register of all interested and affected parties that participate/d in the public participation process; and
- am aware that a false declaration is an offence in terms of regulation 48 of the 2014 NEMA EIA Regulations.



Signature of the specialist:

Matthew Ehigiator Ojelede

Full Name and Surname of the specialist:

Digby Wells Environmental

Name of company:

19 April 2018

Date:

3 Scope and Purpose of this Report

The Terms of Reference (ToR) for the Air Quality Scope of Work (SoW) are outlined below:

- Baseline assessment;
  - Evaluation of site specific meteorology;
  - Evaluation of background air quality scenario (monitoring of particulates and gases over a one month period);
- Impact assessment; and
- Recommendation of mitigation measures incorporating Best Practicable Environmental Option.

The purpose of this study was to provide a detailed description of the meteorology and establish the background air quality status quo in the Project area prior to the commencement of the proposed development. Ambient levels of pollutants measured will serve as reference point to which future perturbations can be compared. In addition, an impact assessment was conducted based on measured ambient air quality data and anticipated construction phase impacts, coupled with mitigation measures to curtail such impacts.

4 Methodology

The approach adopted in this study encompasses a reconnaissance site visit to validate ambient air quality monitoring location and setup the real-time monitoring equipment (AQ-Mesh® to collect background data), a discussion of the legal requirements (i.e. a review of the South African standards) and possible health implications associated with exposure to anticipated pollutants from the construction and operational phases. The aforementioned was followed by an impact assessment of the different phases of the Project.

4.1 Site Visit and Installation of Ambient Air Quality Monitor

A one-day site visit was conducted by Digby Wells Environmental Air quality specialist at mid-January 2018 to set up the real-time particulate monitor (AQ-Mesh® pod from Air Monitors) at an optimum site in the vicinity of the proposed Project area.

4.2 Review of the Legal Context and Health Implications of Pollutants

4.2.1 South African Standards

Guidelines provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to minimum ambient levels of pollutants that are known or likely to be hazardous to human health and wellbeing - World Health Organization (WHO, 2000). Once the guidelines are adopted as standards, they become legally enforceable. These standards prescribe the allowable ambient concentrations of pollutants which are not to be exceeded during a specified time period in a defined area. If the air quality guidelines/standards are exceeded, the ambient air quality is poor and the potential for health effects is greatest.

The prevailing legislation in the Republic of South Africa with regards to the Air Quality field is the National Environment Management: Air Quality Act [NEM:AQA] (Act No. 39 of 2004). NEM: AQA repealed the Atmospheric Pollution Prevention Act [APPA] (Act No. 45 of 1965) and various other laws dealing with air pollution.

According to NEM: AQA the Department of Environmental Affairs (DEA), the provincial environmental departments and local authorities (district and local municipalities) are separately and jointly responsible for the implementation and enforcement of various aspects of the Act. Each of these spheres of government is obliged to appoint an air quality officer and to co-operate with each other and co-ordinate their activities through mechanisms provided for in the National Environment Management Act [NEMA], 1998 (Act No. 107 of 1998).

The purpose of NEM: AQA is to set norms and standards that relate to:

- Institutional frameworks, roles and responsibilities;
- Air quality management planning;
- Air quality monitoring and information management;
- Air quality management measures; and
- General compliance and enforcement.

Amongst other things, it is intended that the setting of norms and standards will achieve the following:

- The protection, restoration and enhancement of air quality in South Africa;
- Increased public participation in the protection of air quality and improved public access to relevant and meaningful information about air quality; and
- The reduction of risks to human health and the prevention of the degradation of air quality.

The Minister of Water and Environmental Affairs, released on the 01 November 2013 the National Dust Control Regulation, in terms of Section 53, read with Section 32 of the NEMAQA - National Dust Control Regulation (NDCR), the National DEA published the acceptable dust fallout limits for residential and non-residential areas. The NDCR fallout standard is given in the Table 4-1 below.

Table 4-1: Acceptable dust fall standards (NEMAQA - NDCR, 2013)

Restriction Areas	Dust fall rate (mg/m²/day, 30-days average)	Permitted Frequency of exceeding dust fall rate
Residential Area	< 600	Two within a year, not sequential months
Non-Residential Area	< 1200	Two within a year, not sequential months

Any person who conducts any activity in such a way as to give rise to dust in quantities and concentrations that may exceed the dustfall standard (Table 4-1) set out in regulation 3 must, upon receipt of a notice from an air quality officer, implement a dustfall monitoring programme (NEMAQA-NDCR, 2013).

In the NDCR, terms like target, action and alert thresholds were omitted. Another notable observation was the reduction of the *margin of tolerance* from the usual three to two incidences within a year (NEMAQA-NDCR, 2013). The NDCR actually adopted a more stringent approach than the previous standard, and would require dedicated mitigation plans now that it is in force.

Also, the DEA has established National Ambient Air Quality Standards for PM_{10} (Table 4-2) and particulate matter of aerodynamic diameter less than 2.5 µm since June 2012 (GN 486: 2012) as depicted in Table 4-3.

Table 4-2: National Ambient Air Quality Standards (2009)

National Ambient Air Quality Standards for Sulfur Dioxide (SO_2)				
AVERAGING PERIOD	LIMIT VALUE (µg/m³)	LIMIT VALUE (ppb)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE
10 Minutes	500	191	526	Immediate
1 hour	350	134	88	Immediate
24 hours	125	48	4	Immediate
1 year	50	19	0	Immediate
The reference method for the analysis of SO_2 shall be ISO 6767.				
National Ambient Air Quality Standards for Nitrogen Dioxide (NO_2)				
AVERAGING PERIOD	LIMIT VALUE (µg/m³)	LIMIT VALUE (ppb)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE
1 hour	200	106	88	Immediate
1 year	40	21	0	Immediate
The reference method for the analysis of NO_2 shall be ISO 7996.				
National Ambient Air Quality Standards for Particulate Matter (PM_{10})				

AVERAGING PERIOD	LIMIT VALUE ($\mu g/m^3$)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE
24 hour	75	4	1 January 2015
1 year	40	0	1 January 2015
The reference method for the determination of the PM_{10} fraction of suspended particulate matter shall be EN 12341.			

National Ambient Air Quality Standards for Ozone (O_3)				
AVERAGING PERIOD	**LIMIT VALUE ($\mu g/m^3$)**	**LIMIT VALUE (ppb)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
8 hours (running)	120	61	11	Immediate
The reference method for the analysis of ozone shall be the UV photometric method as described in SANS 13964.				
National Ambient Air Quality Standards for Benzene (C_6H_6)				
AVERAGING PERIOD	**LIMIT VALUE ($\mu g/m^3$)**	**LIMIT VALUE (ppb)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
1 year	5	1.6	0	1 January 2015
The reference methods for the sampling and analysis of benzene shall either be EPA Compendium method TO-14 A or method TO-17.				
National Ambient Air Quality Standard for Lead (Pb)				
AVERAGING PERIOD	**LIMIT VALUE ($\mu g/m^3$)**	**LIMIT VALUE (ppb)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
1 year	0.5		0	Immediate
The reference method for the analysis of lead shall be ISO 9855.				

National Ambient Air Quality Standards for Carbon Monoxide (CO)				
AVERAGING PERIOD	**LIMIT VALUE (mg/m^3)**	**LIMIT VALUE (ppm)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
1 hour	30	26	88	Immediate
8 hour (calculated on 1 hourly averages)	10	8.7	11	Immediate
The reference method for analysis of CO shall be ISO 4224.				

Table 4-3: National Ambient Air Quality Standards for Particulate Matter ($PM_{2.5}$) (2012)

National Ambient Air Quality Standards for Particulate Matter ($PM_{2.5}$)			
AVERAGING PERIOD	**LIMIT VALUE (µg/m^3)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
24 hours	40	0	1 January 2016 – 31 December 2029
24 hours	25	0	01 January 2030
1 year	20	0	1 January 2016 – 31 December 2029
1 year	15	0	01 January 2030
The reference method for the determination of PM2.5 fraction of suspended particulate matter shall be EN 14907.			

4.2.2 Health Implications of Anticipated Pollutants

During the construction phase, the off-road vehicle fleet may include mobile cranes, jackhammers, trucks, concrete cutters, bulldozers, graders, asphalt pavers, rollers and pile drivers. Operation of the vehicle fleet will result in the release of particulates and gaseous emissions.

Exhaust emissions from gasoline and diesel-fuelled construction equipment would include carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$). PM_{10} - represents particulate matter with an aerodynamic diameter of less than 10 µm and fine particles $PM_{2.5}$ (particulate matter with an aerodynamic diameter of less than 2.5 µm). Construction vehicles and equipment operated on-site will vary on a daily basis. Construction traffic will be spatially dispersed across the Project site, limited in number and employed intermittently, thus are not expected to have significant impacts on background air quality. Impact will be further minimised by the fact that construction will take place in phases and associated emissions will cease once construction is complete (Fenger, 2002, Harrison and van Grieken, 1998).

4.2.2.1 Particulate Matter

In terms of health effects, particulate air pollution is associated with complaints of the respiratory system (WHO, 2000). PM size is relevant in terms of health because it controls where in the respiratory system a given particle is deposited. Fine particles are thought to be more damaging to human health than coarse particles as larger particles are less respirable in that they do not penetrate deep into the lungs compared to smaller particles (Manahan, 1991). Larger particles are deposited into the extra-thoracic part of the respiratory tract while smaller particles are deposited into the smaller airways leading to the respiratory bronchioles (WHO, 2000).

The range of adverse health effects of particulate matter is broad, involving respiratory and cardiovascular systems in children and adults. Both short- and long-term exposures lead to adverse health effects. Very young children, probably including unborn babies, are particularly sensitive to the adverse effects of particulates. The evidence is sufficient to infer a causal relationship between exposure and deaths from respiratory diseases in the post-neonatal period. Adverse effects on lung development include reversible deficits of lung function as well as chronically reduced lung growth rate and long-term lung function deficit. The available evidence is also sufficient to assume a causal relationship between exposure and aggravation of asthma, as well as cough and bronchitis symptoms. Daily mortality and hospital admissions have been linked with short term variation of ambient levels. Increased mortality from cardiovascular and respiratory diseases and from lung cancer has been observed in residents of more polluted areas.

Based on existing evidence of adverse health effects at lower concentrations, the World WHO established the Air Quality Guidelines (AQG) for particulate matter (WHO, 2005). For $PM_{2.5}$, the new AQG values are 10 µg/m^3 (annual average) and 25 µg/m^3 (24-hour average), not to be exceeded for more than 3 days/year. The corresponding annual and daily guidelines for PM_{10} were set as 20 µg/m^3 and 50 µg/m^3. The South African standard was applied in this assessment.

Ambient PM_{10} concentrations are a good approximation of population exposure from outdoor sources. Numerous epidemiological studies conducted in Europe and in other parts of the world have shown adverse health effects of exposure to PM_{10} and $PM_{2.5}$ at concentrations that are currently observed in Europe and the rest of the world. WHO estimated that approximately 700 annual deaths from acute respiratory infections in children aged 0–4 years could be attributed to PM_{10} exposure in the WHO European Region in the late 1990s alone. Population health effects of exposure to PM in adults are dominated by mortality associated with long-time exposure to fine PM ($PM_{2.5}$). Short-term and long-term health effects associated with exposure to particulate matter are presented in Table 4-4.

4.2.2.1.1 Short-Term Exposure

Recent studies suggest that short-term exposure to particulate matter is associated with health effects, even at low concentrations of exposure. Various studies undertaken during the 1980s and early 1990s have looked at the relationship between daily fluctuations in particulate matter and mortality at low levels of exposure. Pope *et al* (1992) studied daily mortality in relation to PM_{10} concentrations in Utah Valley during the period 1985 - 1989. A maximum daily average concentration of 365 µg/m^3 was recorded with effects on mortality observed at concentrations of < 100 µg/m^3. The increase in total daily mortality was 13% per 100 µg/m^3 increase in the 24 hour average. Studies by Schwartz (1993) in Birmingham recorded daily concentrations of 163 µg/m^3 and noted that an increase in daily mortality was experienced with an increase in PM_{10} concentrations. Relative risks for chronic lung disease and cardiovascular deaths were higher than deaths from other causes.

However, in the past, daily particulate concentrations were in the range 100 – 1000 µg/m^3 whereas in more recent times, daily concentrations are between 10 – 100 µg/m^3. Overall, exposure-response can be described as curvilinear, with small absolute changes in exposure at the low end of the curve having similar effects on mortality to large absolute changes at the high end (WHO, 2000; 2002).

Morbidity effects associated with short-term exposure to fine PM include increases in lower respiratory symptoms, medication use and small reductions in lung function. Pope and Dockery (1992) studied panels of children in Utah Valley in winter during the period 1990 – 1991. Daily PM_{10} concentrations ranged between 7 – 251 µg/m^3. Peak Expiratory flow was decreased and respiratory symptoms increased when PM_{10} concentrations increased. Pope and Kanner (1993) utilised lung function data obtained from smokers with mild to moderate chronic obstructive pulmonary disease in Salt Lake City. The estimated effect was a 2% decline in Forced Expiratory Volume over one second for each 100 µg/m^3 increase in the daily PM_{10} average.

4.2.2.1.2 Long-Term Exposure

Long-term exposure to low concentrations (~10 µg/m^3) of PM is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function (WHO, 2000; 2002).

Studies have indicated an association between lung function and chronic respiratory disease and airborne particles. Older studies by Chestnut *et al* (1991) found that Forced Vital Capacity decreases with increasing annual average particulate levels with an apparent threshold at 60 µg/m^3. Using chronic respiratory disease data, Schwartz (1993) determined that the risk of chronic bronchitis increased with increasing particulate concentrations, with no apparent threshold.

Few studies have been undertaken documenting the morbidity effects of long-term exposure to PM (Table 4-4). Recently, the Harvard Six Cities Study showed increased respiratory illness rates among children exposed to increasing PM, sulphate and hydrogen ion concentrations. Relative risk estimates suggest an 11% increase in cough and bronchitis rates for each 10 µg/m^3 increase in annual average particulate concentrations.

Table 4-4: Short-term and long-term health effects associated with exposure to PM (WHO 2004)

Pollutant	Short-term exposure	Long-term exposure
Particulate matter	▪ Lung inflammatory reactions ▪ Respiratory symptoms ▪ Adverse effects on the cardiovascular system ▪ Increase in medication usage ▪ Increase in hospital admissions ▪ Increase in mortality	▪ Increase in lower respiratory symptoms ▪ Reduction in lung function in children ▪ Increase in chronic obstructive pulmonary disease ▪ Reduction in lung function in adults ▪ Reduction in life expectancy ▪ Reduction in lung function development

4.2.2.2 Gases

4.2.2.2.1 Sulfur dioxide (SO_2)

Sulfur dioxide (SO_2) forms part of the entire group of sulfur oxides (SO_x), and constitutes the component of greatest concern. Emissions that lead to high concentrations of SO_2 generally also lead to the formation of other SO_x. In the context of this project, SO_2 will result from tailpipe emissions from the use of heavy construction equipment burning fuel with sulfur content. SO_2 can have adverse effect public health and the environment (Alberta Health & Wellness, 2006).

Short-term exposures to SO_2 can result in difficulties for the human respiratory system, making breathing difficult. Children, the elderly, and those who suffer from asthma are particularly sensitive to effects of SO_2.

SO_x can react with other compounds in the atmosphere to form small particles. These particles contribute to air health effects (i.e. can penetrate deeply into sensitive parts of the lungs and cause additional health problems). At high concentrations, gaseous SO_2 can harm trees and plants by damaging foliage and decreasing growth. SO_2 and other sulfur oxides can contribute to acid rain which can harm sensitive ecosystems.

4.2.2.2.2 Nitrogen Dioxide (NO_2)

Nitrogen dioxide (NO_2) is a nasty-smelling gas. Some nitrogen dioxide is formed naturally in the atmosphere by lightning and some is produced by plants, soil and water. However, only about 1% of the total amount of nitrogen dioxide found in our cities' air is formed this way.

In terms of this Project, nitrogen dioxide will arise mainly from tailpipe emissions to the ambient environment. Exposure to elevated levels of nitrogen dioxide present the likelihood of respiratory problems. This pollutant inflames the lining of the lungs, reducing immunity to lung infections – exacerbating the occurrence of wheezing, coughing, colds, flu and bronchitis (Kraft et al, 2005).

Increased levels of nitrogen dioxide can have significant impacts on people with asthma because it can cause more frequent and more intense attacks. Children with asthma and older people with heart disease are most at risk.

4.2.2.2.3 Carbon Dioxide (CO)

Carbon monoxide (CO), a poisonous, colourless, odourless and tasteless gas is known to be widely associated with incomplete combustion of material containing carbon such as gasoline, kerosene, oil, propane, coal, or wood.

Carbon monoxide is harmful when breathed because it displaces oxygen in the blood and deprives the heart, brain, and other vital organs of oxygen. Exposure to high concentrations of CO can result in loss of consciousness and suffocation. Prior to the aforementioned, tightness across the chest, headache, fatigue, dizziness, drowsiness, or nausea is common symptoms. Symptoms vary widely from person to person. CO poisoning may occur sooner in those most susceptible: young children, elderly people, people with lung or heart disease, people at high altitudes, or those who already have elevated CO blood levels, such as smokers.

The Occupational Safety and Health Administration (OSHA) standards prohibit worker exposure to more than 50 parts of the gas per million parts of air averaged during an 8-hour time period (OSHA's Safety and Health Program Management Guidelines, 2006).

4.3 Baseline Environment

A baseline assessment was undertaken by assessing the meteorology of the Project site through the interpretation of three years' worth of hourly data (2014-2016) from Lakes Environmental Software. The meteorological parameters encompass several weather parameters, such as wind direction, wind speed, temperature, precipitation and relative humidity were generated.

The current ambient air quality in the Project area was monitored with the real-time air quality monitor - AQ-Mesh®, which captured particulates and gases simultaneously. For this investigation, the real-time monitor was installed at the Project site, the Environmental Services Department Offices at Sun City to be precise for a one month period. The measured data can be exported in CSV (comma-separated) format to Excel® for subsequent interpretation.

4.3.1 Meteorology

Ambient air quality in this region of South Africa is strongly influenced by regional atmospheric movements, together with local climatic and meteorological conditions.

There are distinct summer and winter weather patterns that affect the dispersal of pollutants in the atmosphere. In summer, unstable atmospheric conditions result in mixing of the atmosphere and rapid dispersion of pollutants. Summer rainfall also aids in removing pollutants through wet deposition. Precipitation reduces wind erosion potential by increasing the moisture content of exposed surface materials–this represents an effective mechanism for suppressing wind-blown dust. Rain-days are defined as days experiencing 0.1 mm or more rainfall.

In contrast, winter is characterised by atmospheric stability caused by a persistent high-pressure system over South Africa. This dominant high-pressure system results in subsidence, causing clear skies and a pronounced temperature inversion over interior of South Africa. This inversion layer traps pollutants from near surface sources in the lower atmosphere, which results in reduced dispersion and poorer air quality. Preston-Whyte and Tyson (1988) described the atmospheric conditions in the winter months as highly unfavourable for the dispersion of atmospheric pollutants. Emissions from elevated sources, such as from tall stacks, remain stratified in the mid-troposphere and have a reduced probability of reaching the surface with high concentrations near the source.

In the absence of site specific meteorological records, three years' worth of hourly weather MM5 modelled meteorological data (2014-2016) from Lakes Environmental Software was analysed and used to generate wind rose plots and determine the local prevailing weather conditions. This dataset, from the Pennsylvania State University / National Center for Atmospheric Research (PSU/NCAR) meso-scale model is a limited-area, non-hydrostatic, terrain-following sigma-coordinate model designed to simulate or predict meso-scale atmospheric circulation. This data, obtained for a point (25.347778 S, 27.099722 E) in the proposed project area, has been tested extensively and has been found to be accurate. Generally, a data set of greater than 90% completeness is required for that month/year to be considered representative of the assessed area.

Dispersion of atmospheric pollutants is a function of the prevailing wind characteristics at any site. 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 (Cowherd *et al*, 1998; Cowherd *et al*, 2010).

The amount of particulate matter generated by wind is highly dependent upon the wind speed. Below the wind speed threshold for a specific particle type, no particulate matter is liberated, while above the threshold, particulate matter liberation tends to increase with wind speed. The amount of particulate matter generated by wind is dependent also on the surface properties, for example, whether the material is crusted, the fraction of erodible particles, and the particle size distribution (Fryrear et al., 1991).

Wind roses generally comprises of 16 spokes which represent the frequencies and the directions from which winds blew during the period. The colours reflect the different categories of wind speeds. The dotted circles provide information regarding the frequency of occurrence of wind speed and different categories. The figures at the bottom of the legend represent the frequency at which calms occurred (periods with wind speed <0.5 m/s).

The spatial and annual variability in the wind field for the proposed Project area is evident in Figure 4-1. The dominant winds are blowing from east (17.3%) and east northeast (12.1%) respectively. Secondary winds were coming from east south east (9.7%), north east (6.7%), north (6.3%) and north northeast (6.2%). Calm conditions (wind speeds <0.5 m/s) occurred 4.60% of the time.

There is some diurnal variation in the meteorological data shown in Figure 4-2. The predominant wind direction is east and east southeast with 20.24% and 13.30% respectively in the night, east (24.96%) and east southeast (13.29%) in the morning, east and east northeast in the afternoon (12.63% and 10.75%); and east (11.38%) and east northeast (11%) in the evening.

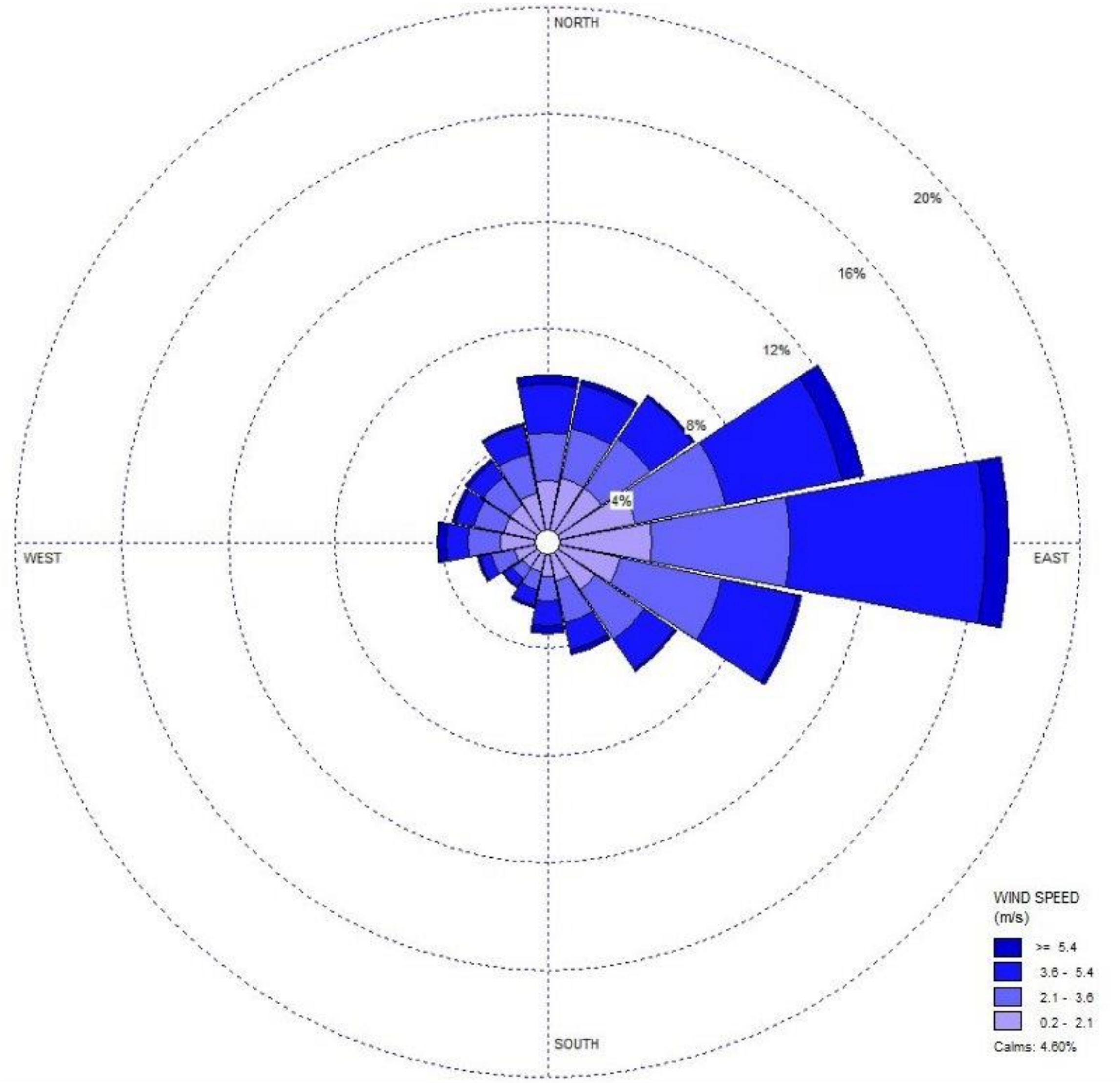


Figure 4-1: Surface Wind Rose at the Project Site

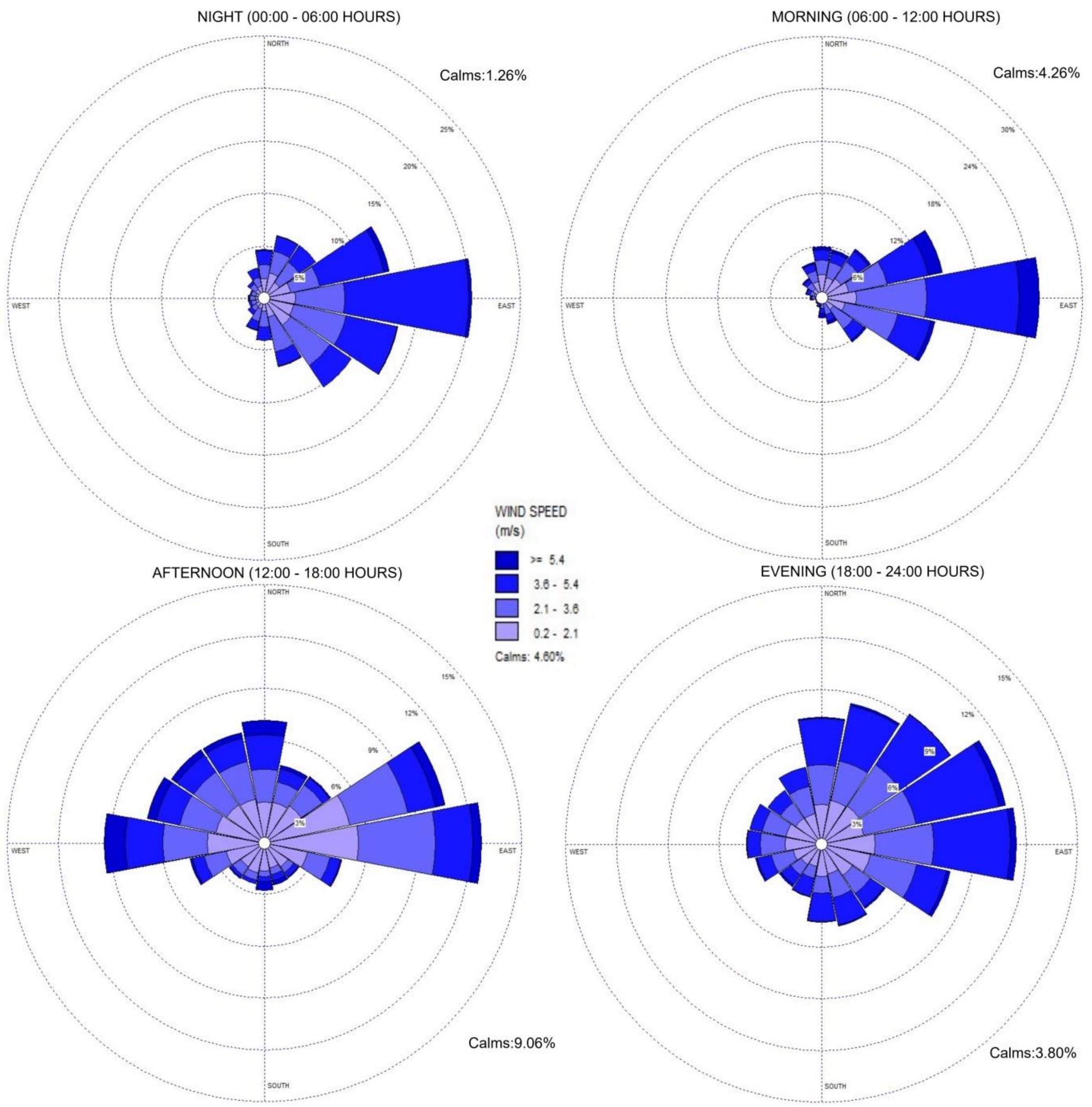


Figure 4-2: Diurnal variations of wind at night-time: 00:00 – 06:00 (top left), morning 06:00 – 12:00 (top right), afternoon 12:00 – 18:00 (bottom left) and evening 18:00 – 00:00 (bottom right)

The seasonal variability in wind direction is depicted in Figure 4-3. The seasonal signature show winds from the north- northeast and north-north dominating in autumn, winter, summer and spring. The wind class frequency distribution per sector is given in Figure 4-4 and Table 4-5.

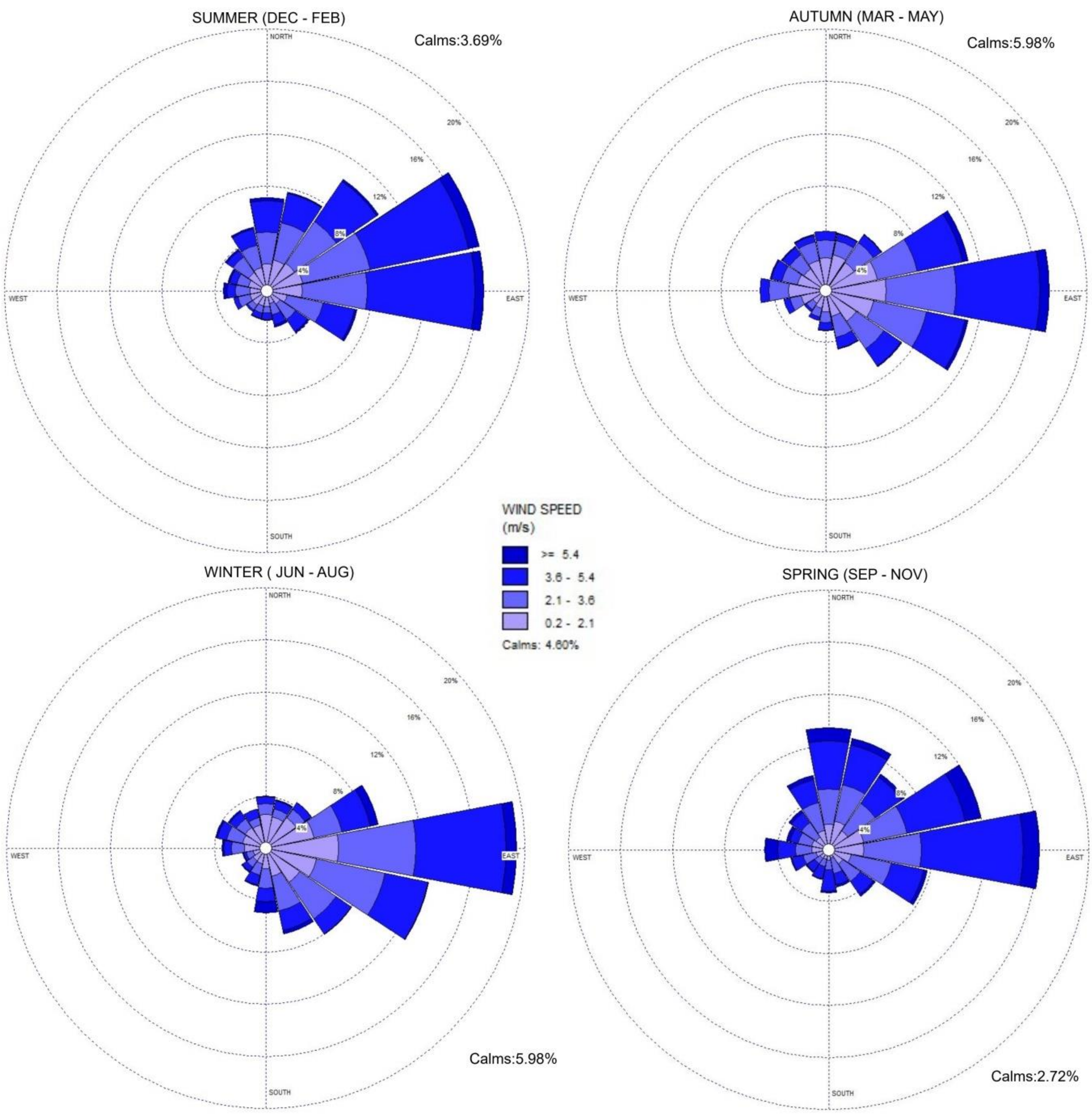


Figure 4-3: Seasonal variability of winds in summer (December – February); autumn (March – May); winter (June – August) and spring (September – November)

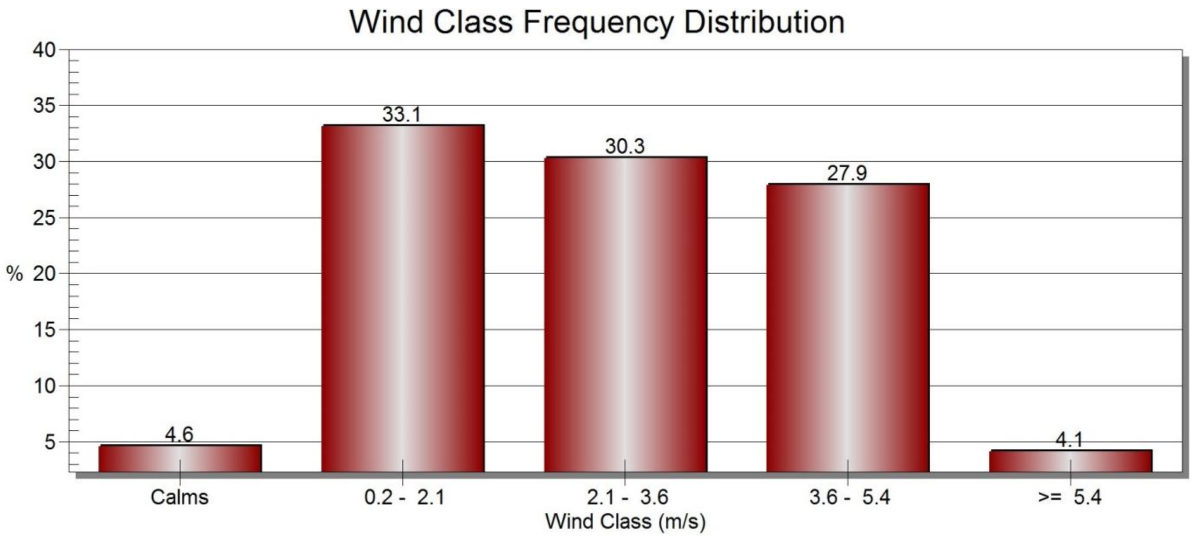


Figure 4-4: Wind Class Frequency Distribution

Table 4-5: Wind Class Frequency Distribution

	Directions (m/s)	0.20 - 2.10	2.10 - 3.60	3.60 - 5.40	>= 5.40	Total (%)
1	N	2.3	1.8	1.8	0.3	6.3
2	NNE	2.5	1.9	1.6	0.2	6.2
3	NE	2.5	2.3	1.9	0.1	6.7
4	ENE	3.4	3.5	4.5	0.8	12.1
5	E	3.9	5.2	7.3	0.9	17.3
6	ESE	2.8	3.9	2.8	0.2	9.7
7	SE	2.2	2.2	1.3	0.1	5.9
8	SSE	1.5	1.6	1.0	0.2	4.3
9	S	1.3	0.9	0.9	0.3	3.4
10	SSW	1.2	0.7	0.6	0.1	2.5
11	SW	1.2	0.5	0.4	0.1	2.1
12	WSW	1.3	0.8	0.5	0.1	2.7
13	W	1.8	1.2	0.8	0.4	4.2
14	WNW	1.7	1.1	0.7	0.2	3.7
15	NW	1.7	1.2	0.7	0.1	3.8
16	NNW	1.9	1.5	1.1	0.1	4.6
	Sub-Total	33.1	30.3	27.9	4.1	95.4
	Calms					4.6
	Missing/Incomplete					0.0
	Total					100.0

4.3.1.1 Wind Speed

One of the factors that favour the suspension and resuspension of loose particulates in the atmosphere is the intensity of the wind speed regime. Wind speed greater than 5.4 m/s leads to erosion of loose dust PM and the degree of dispersion across the landscape (Table 4-6 and Figure 4-5). Figure 4-5 shows that wind speed greater than 5.4 m/s occur every month with increases observed from the months of January, August and October (10m/s).

Although average wind speed is generally below 5.4 m/s, it can be seen from Table 4-6 that the potential is there for wind erosion to occur each month. In total, 14 days in a year recorded wind speed greater than 5.4 m/s (~ 1 day in a month).

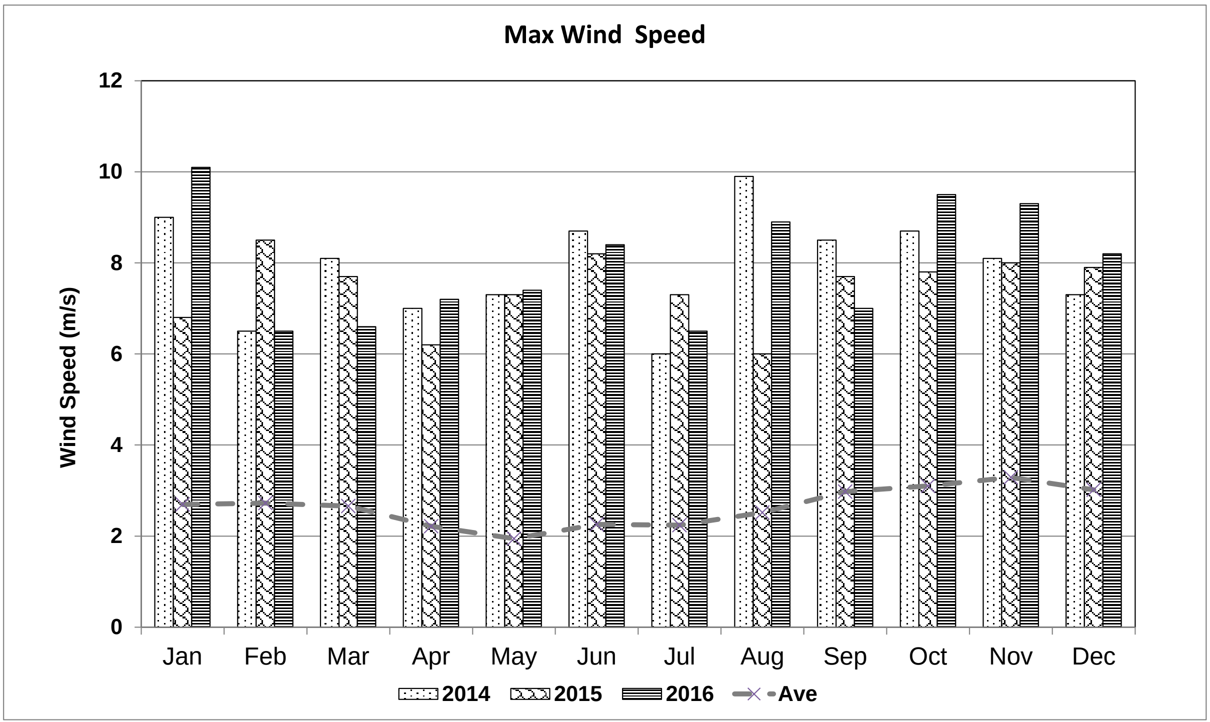


Figure 4-5: Monthly Maximum Wind Speed

Table 4-6: Monthly Wind Speed Records

Wind Speed (m/s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Monthly Max.	10	9	8	7	7	8	7	10	9	10	9	8	9
Monthly Ave	3	3	3	2	2	2	2	3	3	3	3	3	3

4.3.1.2 Temperature

The monthly maximum and average monthly temperature for the Project area is given in Table 4-7, and represented graphically in Figure 4-6. The maximum temperatures were observed from December to January recording the highest temperature 35 °C, followed by October to November and February 33°C. The monthly averages ranged from 11°C in June - July to 25°C in December/January/February. The annual average temperature for the project site is given as 19°C.

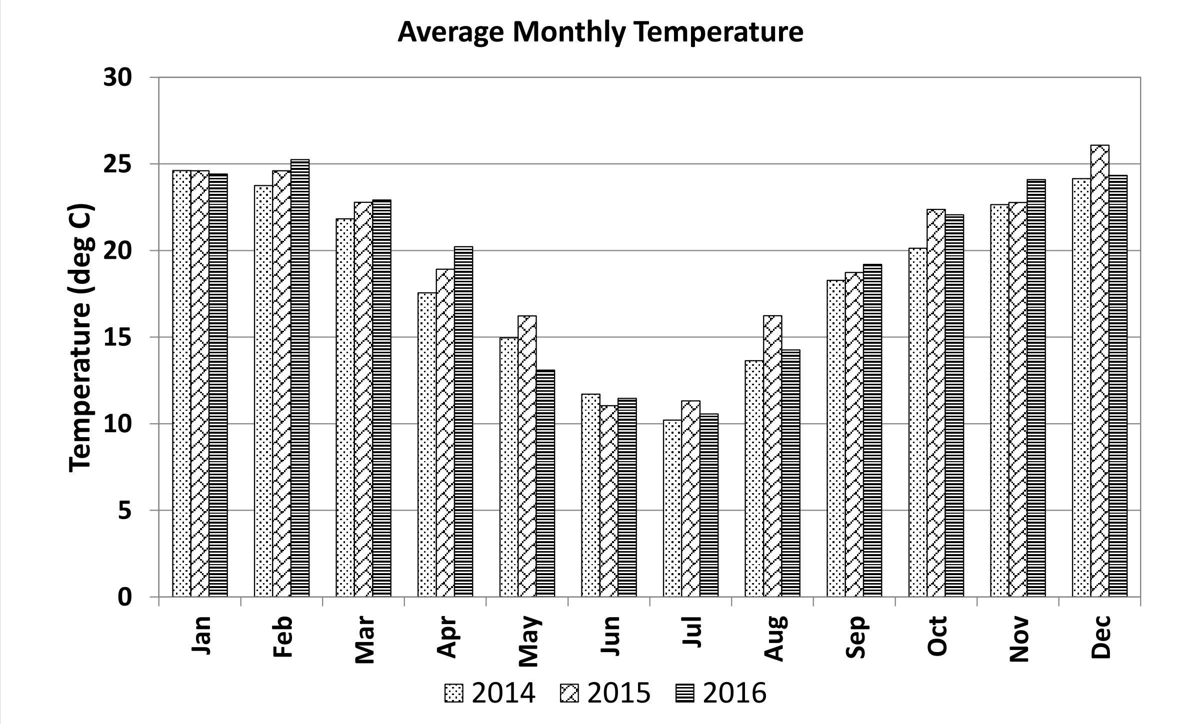


Figure 4-6: Average Monthly Temperature

Table 4-7: Monthly Temperature Records

Temp(°C)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Monthly Max.	35	33	31	30	25	22	20	27	29	33	33	35	29
Monthly Ave	25	25	23	19	15	11	11	15	19	22	23	25	19

4.3.1.3 Precipitation

The total monthly and the average monthly rainfall for the period under review is represented graphically in Figure 4-7 and reported in Table 4-8 for the three-year period (2014-2016). The highest precipitation of 281 mm was observed in March. The lowest recorded precipitation (5 mm) was observed from May and August. The annual total and average rainfall reached 1068 mm and 682 mm respectively.

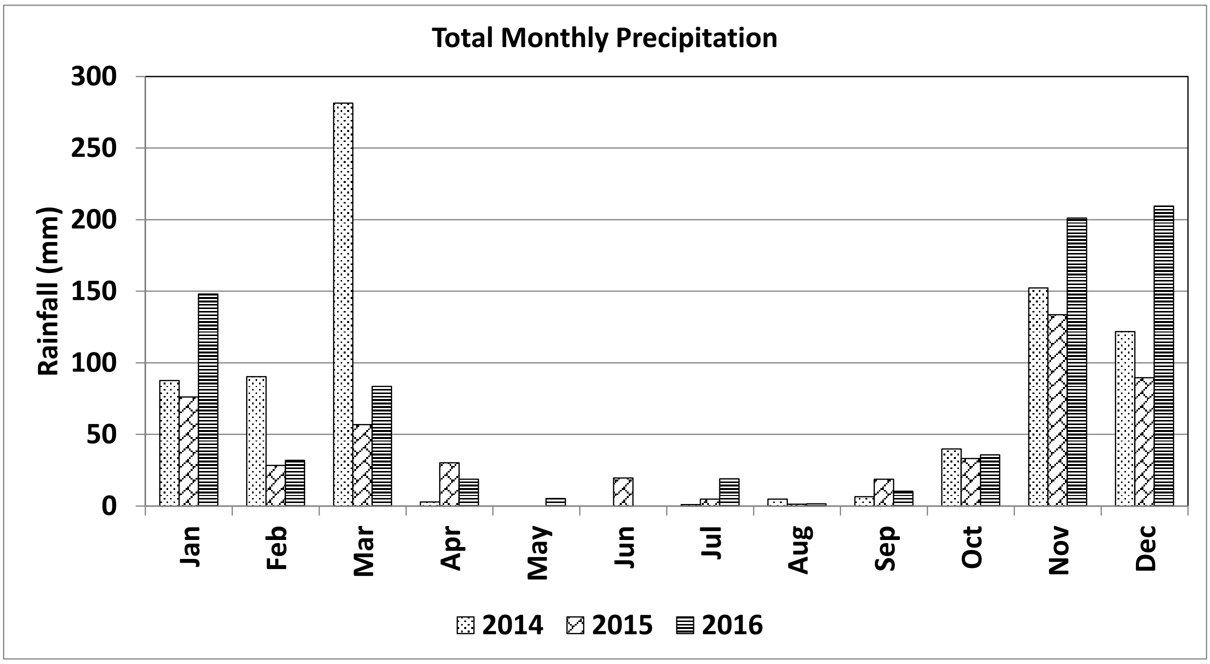


Figure 4-7: Total Monthly Precipitation

Table 4-8: Total Monthly Precipitation Records

Precipitation (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Tot. Mon Rainfall (Max)	148	90	281	30	5	20	19	5	19	40	201	210	1068
Aver. Mon Rainfall	104	50	141	17	2	7	8	3	12	36	162	140	682

4.3.1.4 Relative Humidity

The data in Table 4-9 are representative of the relative humidity for the Project area. Relative humidity reaching 100% was observed for each month, except November. The monthly average ranged between 53% and 72%.The highest relative humidity was observed in June and July respectively 72%). The annual average estimated was 62% (Table 4-9 and Figure 4-8).

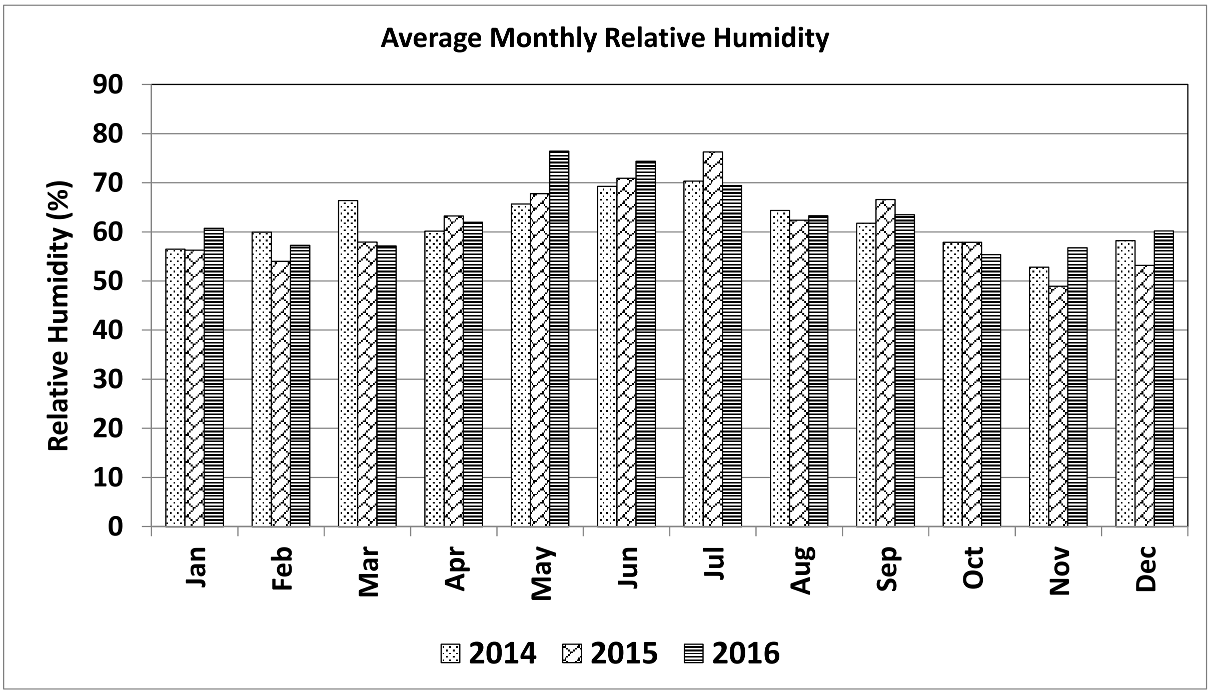


Figure 4-8: Average Monthly Relative Humidity

Table 4-9: Average Monthly Relative Humidity

Relative Humidity (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Monthly Max	100	100	100	100	100	100	100	100	100	100	98	100	100
Monthly Ave	58	57	60	62	70	72	72	63	64	57	53	57	62

4.3.2 Background Air Quality Scenario

4.3.2.1 Air Quality Monitoring of Particulates and Gases

The real-time particulate monitor was deployed on the 15th of January 2018 for a period of one month. The instrument failed to establish connectivity and after several attempt to re-establish connectivity remotely, a technician was sent to site and on the 10th of February connectivity was established and the instrument started collecting baseline data. The measured data was downloaded after one month, analysed and use to establish background scenario. Ambient concentration measured were compared with the South African standards described in Section 4.2.1 to confirm if current background levels are conducive for healthy living and within compliance of the South African regulatory standards. The air quality levels measured will serve as reference point, to which future measurements will be compared to ascertain the degree of impacts the construction and operational phases may have on the surrounding air quality of the Project site.

4.4 Particulate Matter

The graphs showing the PM_{10} and $PM_{2.5}$ concentrations at the Project area is presented in Figure 4-9 and Figure 4-10 below.

The ambient particulate matter levels measured are compared against the current South African Standard for daily averaging period. For PM_{10} levels, the ambient concentrations are below 5 µg/m^3 for the period under survey, except on the 11th of February with a concentration of ~18 µg/m^3. In general, the area can said to be in a pristine condition and daily averages were very low and within the South African Standard of 75 µg/m^3 (red dotted line).

The $PM_{2.5}$ concentrations measured at the Project area is shown in Figure 4-10. The results are similar to the PM_{10} signature. No exceedances were observed during the survey period and the daily averages were below 3 µg/m^3 for the entire sampling period. The same conclusion can be reached that in terms of $PM_{2.5}$ concentration, the area is in a pristine condition and daily averages were very low and within the South African Standard of 40 µg/m^3 (red dotted line).

During the construction phase, vehicles and moving equipment operating on-site will vary on a daily basis. In addition to the aforementioned, construction traffic will be spatially dispersed across the project site, limited in number and employed intermittently, thus are not expected to have significant impacts on the ambient air quality. Emissions will therefore be localized to each activity, impacts would be temporary, and will dissipate faster with no significant implication on the ambient air quality. Also, construction will be taking place in phases, hence, potential impacts will be further minimised, and potential impacts will cease once construction is complete.

4.5 Gases

In summary, the ambient concentrations of gases measured in the Project area are below the various South African Standards for the individual pollutants. The 1-hour NO_2 concentrations measured in the vicinity of the Project are below the South African Standard (106 ppb) (Figure 4-11). Ambient 24-hour SO_2 concentrations were below the South African Standard of 48 ppb (Figure 4-12). The same is true of ambient 1-hour CO concentrations, which were below the South African Standard of 8.7 ppm (Figure 4-13). A similar trend was observed for the 8-hour O_3 levels in the ambient environment, which was below the standard of 61 ppb (Figure 4-14).

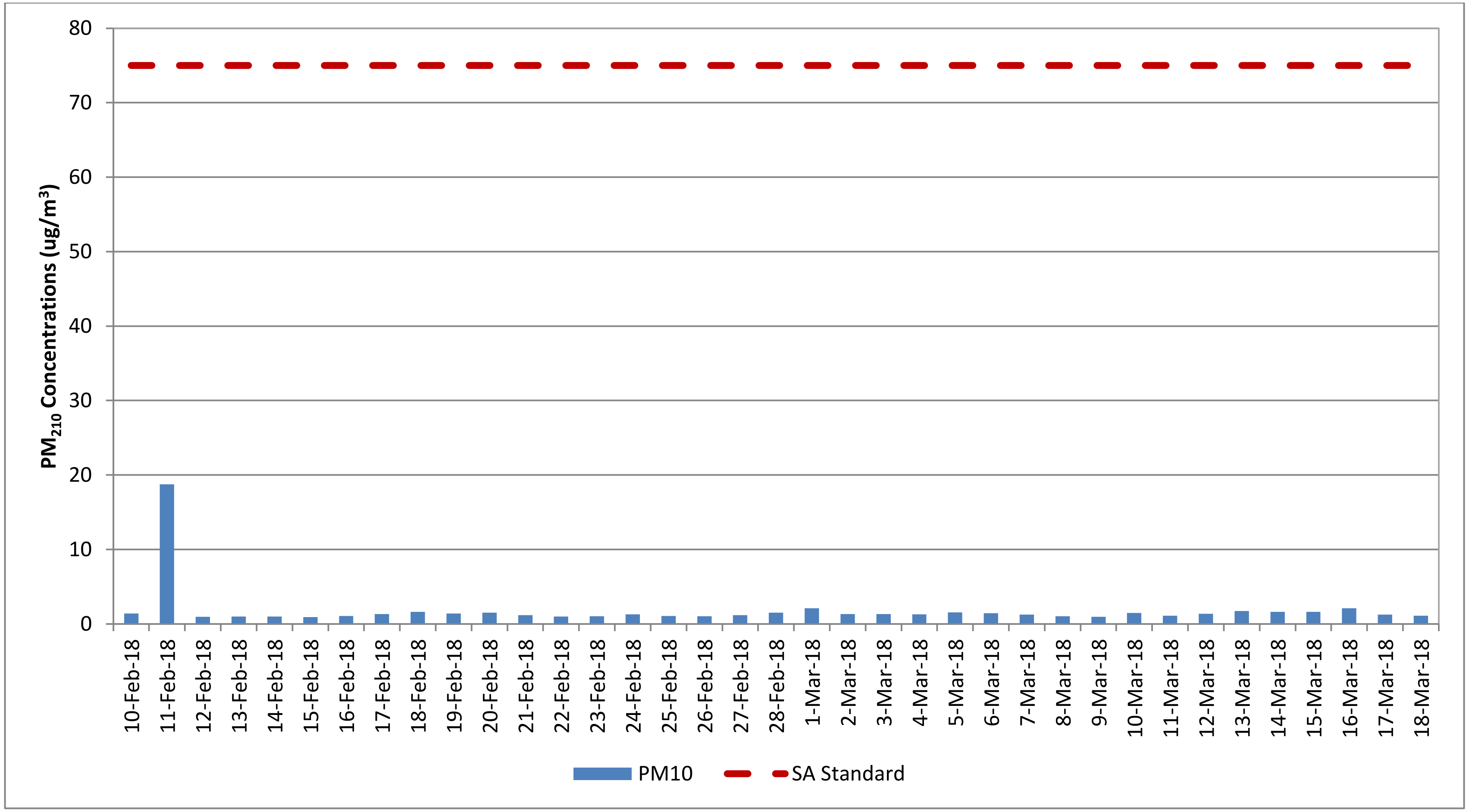


Figure 4-9: Ambient PM_{10} concentrations – February/March 2018

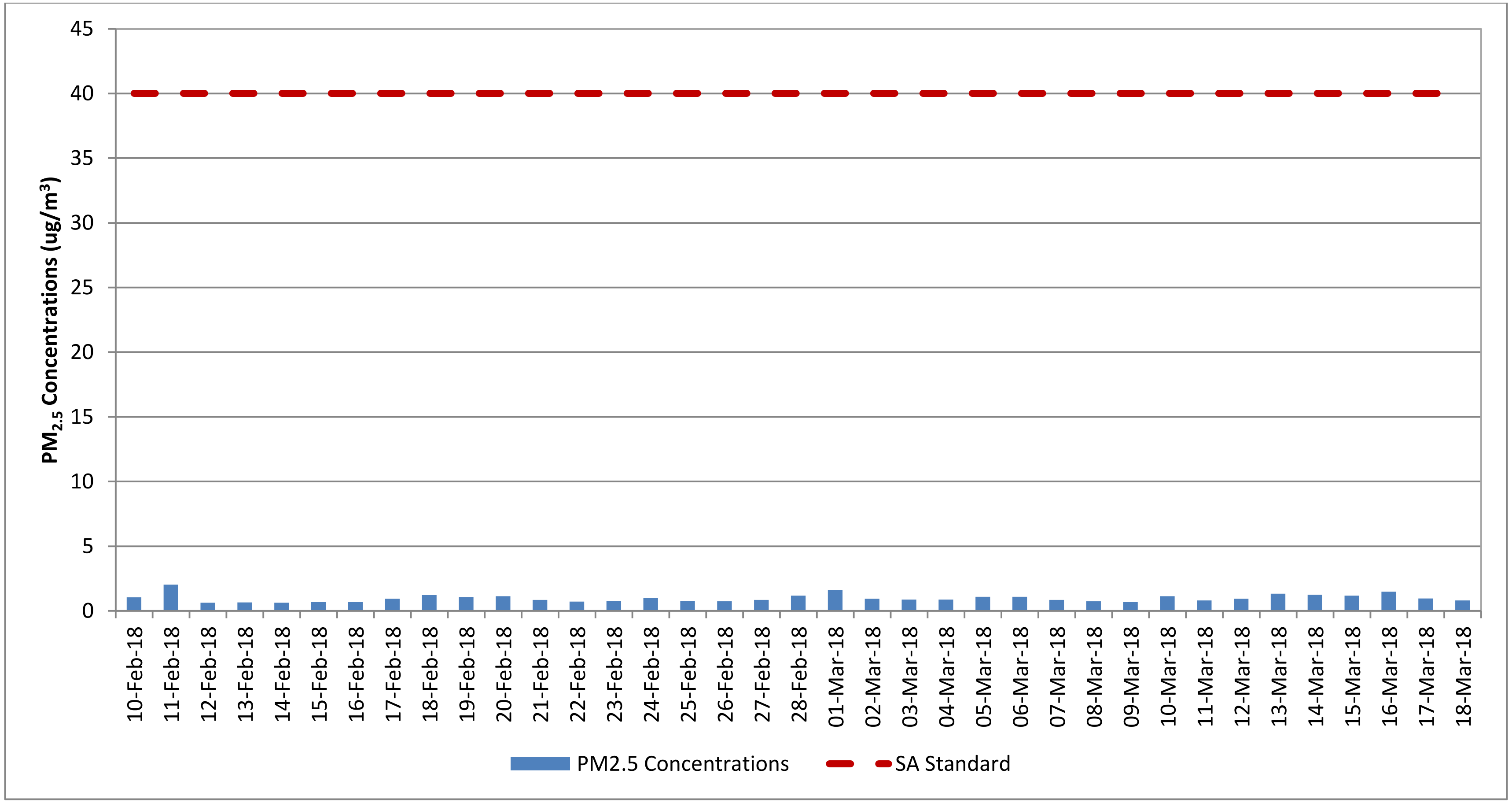


Figure 4-10: Ambient $PM_{2.5}$ concentrations – February/March 2018

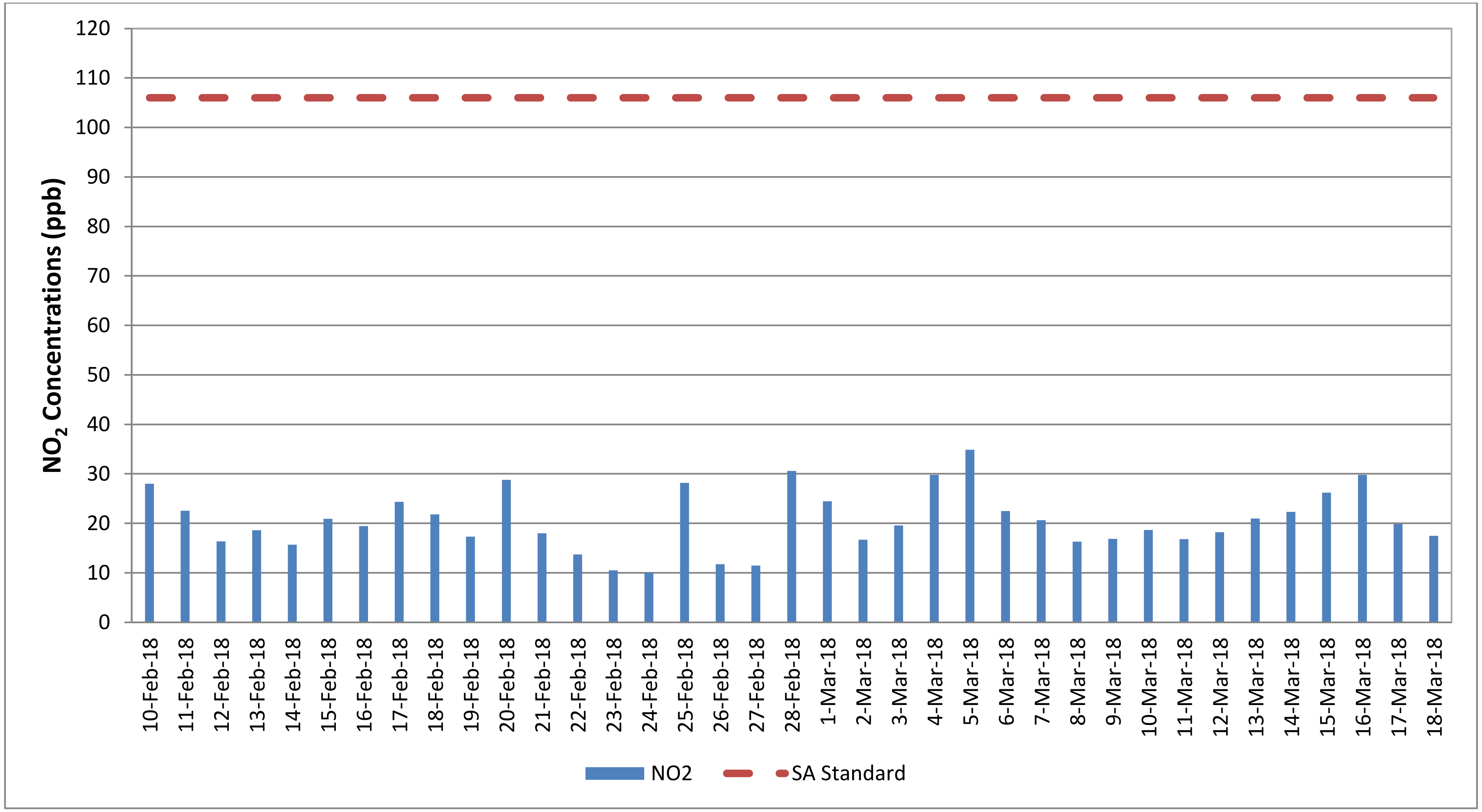


Figure 4-11: Ambient NO_2 concentrations – February/March 2018

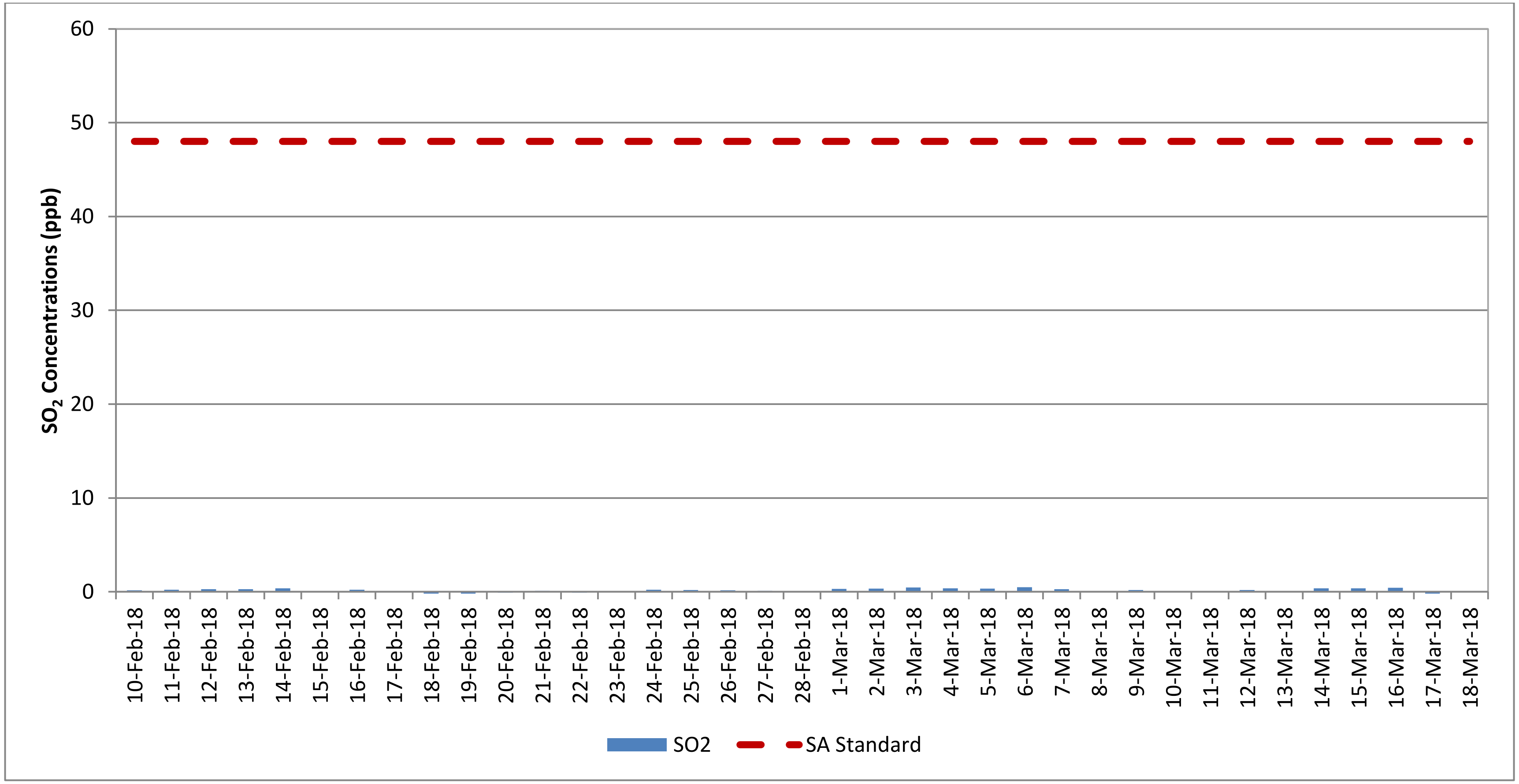


Figure 4-12: Ambient SO_2 concentrations – February/March 2018

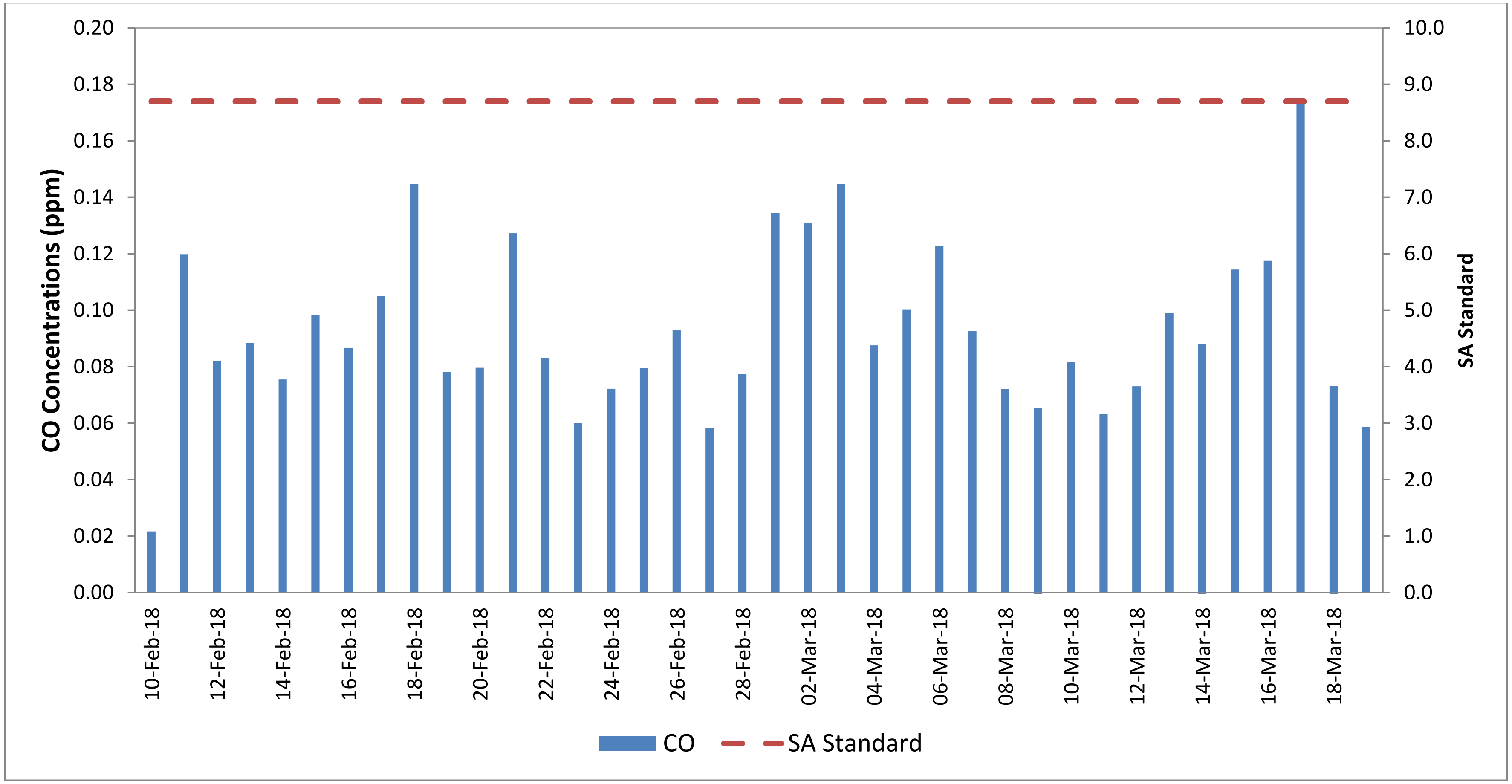


Figure 4-13: Ambient CO concentrations – February/March 2018

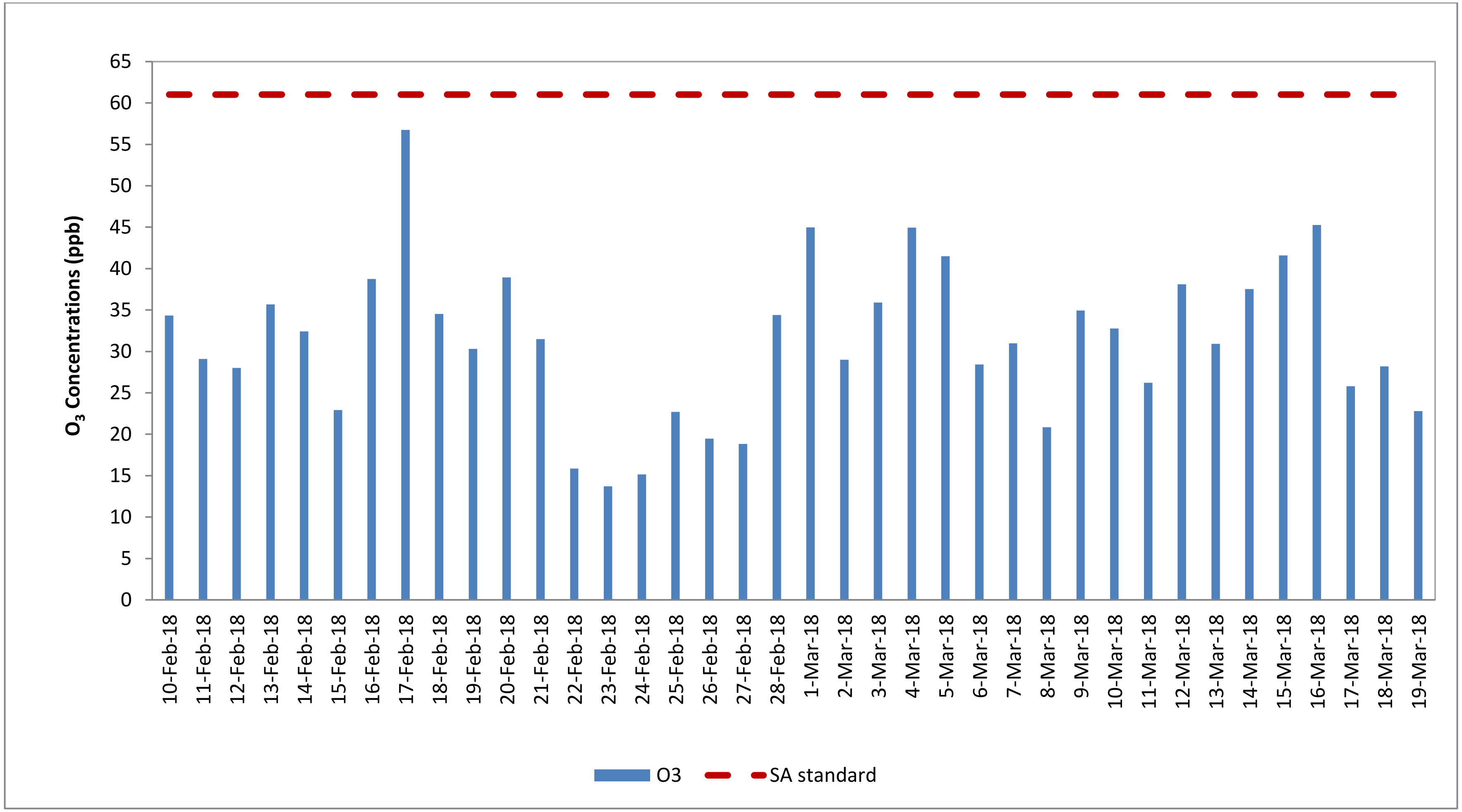


Figure 4-14: Ambient O_3 concentrations – February/March 2018

5 Conclusions

Findings from interpretation of the meteorological data have confirmed that the dominant winds are blowing from east (17.3%) and east northeast (12.1%) respectively. In total, 14 days in a year recorded wind speed greater than 5.4 m/s (~ 1 day in a month).

The ambient air quality measured in the Project area was assessed and the findings are listed below:

- Daily PM_{10} and $PM_{2.5}$ measured in the Project area were very low and within the current South African Standards;

- The NO_2, SO_2, CO and O_3 levels measured were very low and within the current South African Standards.

In conclusion, the results from the monitoring campaign confirm that the air quality in the project area is good. As mentioned previously in this report, emission will occur during the construction phase, but impacts are expected to be minimal /negligible since construction will occur phases and potential impacts will cease once construction is completed. It is anticipated that on-site emissions will be negligible, localized to the vicinity of each activity and dispersed easily across the landscape. As a result, the project will operate within compliance; anticipated impacts on air quality at on-site and off-site locations will be negligible. Once operational, pollutant release will be limited to tailpipe emissions from vehicles and generators (which will be employed intermittently) with negligible impacts on air quality.

It is the opinion of the specialist that although the construction phase of the project will be associated with release of particulate and gaseous pollutants, background levels will not be exacerbated above current standards.

6 Impact Assessment

6.1 Methodology used in Determining and Ranking the Nature, Significance, Consequence, Extent, Duration and Probability of Potential Environmental Impacts and Risks

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

The significance rating process follows the established impact/risk assessment formula:

Significance = Consequence x Probability x Nature

Where

Consequence = Intensity + Extent + Duration

And

Probability = Likelihood of an impact occurring

And

Nature = Positive (+1) or negative (-1) impact

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts

The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in Table 6-3. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in this EIA/EMP Report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 6-2, which is extracted from Table 6-1. The description of the significance ratings is discussed in Table 6-3.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

Table 6-1: Impact Assessment Parameter Ratings

Rating	Intensity/Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
7	Irreplaceable loss or damage to biological or physical resources or highly sensitive environments. Irreplaceable damage to highly sensitive cultural/social resources.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable loss or damage to biological or physical resources or moderate to highly sensitive environments. Irreplaceable damage to cultural/social resources of moderate to highly sensitivity.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur. <80% probability.

Rating	Intensity/Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
5	Serious loss and/or damage to physical or biological resources or highly sensitive environments, limiting ecosystem function. Very serious widespread social impacts. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	Province/ Region Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.
4	Serious loss and/or damage to physical or biological resources or moderately sensitive environments, limiting ecosystem function. On-going serious social issues. Significant damage to structures / items of cultural significance.	Average to intense natural and / or social benefits to some elements of the baseline.	Municipal Area Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.

Rating	Intensity/Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
3	Moderate loss and/or damage to biological or physical resources of low to moderately sensitive environments and, limiting ecosystem function. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local extending only as far as the development site area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.
2	Minor loss and/or effects to biological or physical resources or low sensitive environments, not affecting ecosystem functioning. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by a small percentage of the baseline.	Limited Limited to the site and its immediate surroundings.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.

Rating	Intensity/Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
1	Minimal to no loss and/or effect to biological or physical resources, not affecting ecosystem functioning. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	Very limited/Isolated Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

Table 6-2: Probability/Consequence Matrix

Significance

Probability																																						
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Consequence	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Table 6-3: Significance Rating Description[2]

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Major (positive) (+)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Moderate (positive) (+)
36 to 72	A positive impact. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive) (+)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive) (+)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative) (-)
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative) (-)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe changes.	Moderate (negative) (-)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative) (-)

[2] It is generally sufficient to only monitor impacts that are rated as negligible or minor

6.2 Project Activities

The activities and interactions associated with the construction phase at Sun City Resort Complex are summarised in Table 6-4 below.

Table 6-4: Project Activities and Infrastructure Development

Project Phase	Activity
Construction	Site preparation by clearing, including removal of vegetation and topsoil
	Construction of road works and paving within the Sun City Resort, development of Buss Lodges and Eco-Lodges, simplex units and soccer fields, expansion of the artificial beach, swimming pools, reservoir and parking garages

6.3 Impact Assessment

6.3.1 Construction Phase

As part of the Construction Phase, the activities identified in Table 6-4 will result in the release of particulates and gaseous emissions into the ambient atmosphere. As mentioned earlier, construction will occur in phases and emissions are expected to be intermittent, with minimal impacts on ambient air quality.

Each of these activities will have similar impacts on ambient air quality; hence they have been grouped together for impact rating: site preparations, earthworks and construction of infrastructure. The ratings took into cognisance the meteorology, current environmental air quality data collected in the area and the low emissions anticipated from project activities.

6.3.1.1 Project Activities Assessed

As part of the Construction Phase, the following activities are identified that may have impact on the ambient air quality of the area:

- Site clearing, roadwork and paving, earthworks, and construction of infrastructure.

Table 6-5: Interactions and Impacts

Interaction	Impact
Site clearing, earthworks and construction of infrastructure	Poor air quality
	Nuisance due to dust fallout

6.3.1.1.1 Impact Description

Site clearing and the earthworks that follows encompasses the removal of vegetation, grading, excavation, soil stripping, re-grading; unloading and handling of excavated materials, vehicle movements on dirt roads. This is followed by the development of surface infrastructure. These activities take place using a range of construction equipment, resulting in localised emissions comprising TSP, PM_{10} and $PM_{2.5}$ in the vicinity of each activity.

6.3.1.2 Management Objectives

- To ensure that emissions associated with the construction phase activities are within compliance onsite and at off-site locations to safeguard the environment, human health and wellbeing.

6.3.1.3 Mitigation Options and Recommended Actions

Impacts associated with these activities have been rated (Table 6-6). Emissions associated with the Project are not expected to exacerbate background air quality, mitigation measures and action plans should be in place (informed by the South African regulatory requirements). To achieve this, the following should apply:

- Continuous particulate monitoring at a downwind location within the project area;
- Application of dust suppressants during construction i.e. Dust-A-Side on access roads and exposed areas to minimise emissions;
- Ensure compliance with the air quality standards at the project boundary and beyond i.e. PM_{10} (75 µg/m^3) and dust fallout (600 mg/m^2/day).

6.3.1.4 Impact Ratings

Table 6-6: Site Clearing, Earthworks and Construction of Infrastructure

Activity and Interaction (Site Clearing, Earthworks and Construction of Infrastructure)			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Poor air quality and nuisance due to dust fallout			
Prior to mitigation/ management			
Duration	Medium term (3)	Dust will be generated during each activity for the duration construction.	Negligible (negative) – 28
Extent	Limited (2)	Limited to site and immediate surroundings.	
Intensity	Minor (2)	Minor effect on surrounding area is anticipated	
Probability	Probable (4)	It probable that that impact may occur.	
Nature	Negative		
Mitigation/ Management actions			

<table>
<tr><th colspan="4">Activity and Interaction (Site Clearing, Earthworks and Construction of Infrastructure)</th></tr>
<tr><th>Dimension</th><th>Rating</th><th>Motivation</th><th>Significance</th></tr>
<tr><td colspan="4">▪ Application dust suppressant on exposed areas and dirt roads;
▪ Conduct dusty activities judiciously during windy days (wind speed ≥5.4 m/s);
▪ Set maximum travel speed on dirt roads, and to have these limits enforced;
▪ The area of disturbance at all times must be kept to a minimum and no unnecessary clearing, digging or scraping must occur, especially on windy days (with wind speed ≥ 5.4 m/s); and
▪ The drop heights when loading onto trucks and at tipping points should be minimised.</td></tr>
<tr><td colspan="4">Post- mitigation</td></tr>
<tr><td>Duration</td><td>Medium term (3)</td><td>Dust will be generated in the medium term from each activity duration the construction phase</td><td rowspan="5">Negligible (negative) – 15</td></tr>
<tr><td>Extent</td><td>Very Limited (1)</td><td>After mitigation measures are implemented, it is expected that dust impacts will be limited to isolated parts of the site.</td></tr>
<tr><td>Intensity</td><td>Minimal (1)</td><td>Dust will have minimal impacts on air quality after mitigation</td></tr>
<tr><td>Probability</td><td>Unlikely (3)</td><td>It is unlikely that impact will occur after mitigation measures are applied.</td></tr>
<tr><td>Nature</td><td>Negative</td><td></td></tr>
</table>

6.3.2 Operational Phase

After construction, the use of the facility would constitute the operational phase of the project. During this phase, emissions will be mostly associated with gaseous tailpipe emissions from vehicles and generator set. Since the Sun City Complex will be relying on power from the national grid, the generator set will be used intermittently, resulting in minimal impacts on the ambient air quality.

6.3.2.1 Project Activities Assessed

As part of the Operational Phase, the following activities are identified that may have impact on the ambient air quality of the area (Table 6-7):

- Operation of vehicles and generator sets.

Table 6-7: Interactions and Impacts

Interaction	Impact
Operation of vehicles and generator sets	Poor air quality

6.3.2.1.1 Impact Description

Operation of the Sun City vehicle fleet and those belonging to clients will result in tailpipe emissions to the ambient environment. Emissions will be mainly gaseous in nature, i.e. CO, O_3, NO_2 and SO_2 in the vicinity of each activity.

6.3.2.2 Management Objectives

- To ensure that emissions associated with the operational phase activities are within compliance at onsite and off-site locations required to safeguard the environment, human health and wellbeing.

6.3.2.3 Mitigation Options and Recommended Actions

Impacts associated with these activities have been rated (Table 6-8). Emissions associated with the Project are not expected to exacerbate background air quality, mitigation measures and action plans should be in place (informed by the South African regulatory requirements). To achieve this, the following should apply:

- Occasional air quality monitoring on-site;
- Investing in Catalytic Converters may not be necessary as generator sets will be employed intermittently;
- Ensure compliance with the air quality standards at on-site and off-site locations.

6.3.2.4 Impact Ratings

Table 6-8: Operation of vehicle fleet and generator set

Activity and Interaction (Site Clearing, Earthworks and Construction of Infrastructure)			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Poor air quality and nuisance due to dust fallout			
Prior to mitigation/ management			
Duration	Short term (2)	Gaseous emissions will be generated intermittently duration the operational phase.	Negligible (negative) – 18
Extent	Limited (2)	Limited to the site of the activity and immediate surroundings.	
Intensity	Minor (2)	Minor effect on surrounding area is anticipated	
Probability	Unlikely (3)	It is definite that that impact may occur.	
Nature	Negative		
Mitigation/ Management actions			

Activity and Interaction (Site Clearing, Earthworks and Construction of Infrastructure)			
Dimension	**Rating**	**Motivation**	**Significance**
▪ Use of low sulfur fuel; and ▪ Regular maintenance to ensure the generators burn fuel efficiently.			
Post- mitigation			
Duration	Short term (2)	Gaseous emissions will be generated intermittently duration the operational phase.	Negligible (negative) – 12
Extent	Very Limited (1)	After mitigation measures are implemented, it is expected that impacts will be very limited.	
Intensity	Minimal (1)	Gaseous emissions will have minimal impacts on air quality after mitigation	
Probability	Unlikely (3)	It is unlikely that impact will occur after mitigation measures are applied.	
Nature	Negative		

6.3.3 Decommissioning Phase

During the decommissioning phase, the activities conducted and the machinery used will be similar to those used during the construction phase. Hence, the pollutants released and associated impacts will be similar. The ratings took into cognisance the meteorology, current environmental air quality data collected in the area and the low emissions anticipated from project activities.

6.3.3.1 Project Activities Assessed

As part of the decommissioning Phase, the following activities are identified that may have impact (Table 6-9) on the ambient air quality of the area:

- Earthwork and demolition of infrastructure.

Table 6-9: Interactions and Impacts

Interaction	Impact
Earthworks and demolition of infrastructure	Poor air quality
	Nuisance due to dust fallout

6.3.3.1.1 Impact Description

Earthworks and demolition of infrastructure during the decommissioning Phase will result in the emission of particulate matter and gases respectively. It occurs when the wind speed forces exerted are higher or overcome the gravitational and cohesive forces of the particulates on exposed surfaces.

6.3.3.2 Management Objectives

To ensure that emissions associated with the operational phase activities are within compliance at onsite and off-site locations required to safeguard the environment, human health and wellbeing.

6.3.3.3 Mitigation Options and Recommended Actions

Impacts associated with these activities have been rated (Table 6-10). In order to keep pollutants level below the recommended standards, mitigation measures and action plans should be implemented by the owners (informed by the South African regulatory requirements). To achieve this, the following should apply:

- Set up air quality monitoring during this phase to ensure impacts are minimal;
- Application of dust suppressants on exposed areas; and
- Vegetation and re-vegetation of open surfaces.

6.3.3.4 Impact Ratings

Table 6-10: Demolition of Infrastructure

Activity and Interaction (Demolition of Infrastructure)			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Poor air quality and nuisance due to dust fallout			
Prior to mitigation/ management			
Duration	Short term (2)	Dust generation will be short term during the decommission phase.	Negligible (negative) – 24
Extent	Limited (2)	Limited to site and immediate surroundings.	
Intensity	Minor (2)	Minor effect on surrounding area is anticipated	
Probability	Probable (4)	It probable that that impact may occur.	
Nature	Negative		
Mitigation/ Management actions			

Activity and Interaction (Demolition of Infrastructure)			
Dimension	**Rating**	**Motivation**	**Significance**
▪ Application dust suppressant on exposed areas and dirt roads; ▪ Conduct dusty activities judiciously during windy days (wind speed ≥5.4 m/s); ▪ Set maximum travel speed on dirt roads, and to have these limits enforced; ▪ The area of disturbance at all times must be kept to a minimum and no unnecessary clearing, digging or scraping must occur, especially on windy days (with wind speed ≥ 5.4 m/s); and ▪ The drop heights when loading onto trucks and at tipping points should be minimised.			
Post- mitigation			
Duration	Short term (2)	Dust generation will be short term during the decommission phase.	Negligible (negative) – 12
Extent	Very Limited (1)	After mitigation measures are implemented, it is expected that dust impacts will be limited to isolated parts of the site.	
Intensity	Minimal (1)	Dust will have minimal impacts on air quality after mitigation	
Probability	Unlikely (3)	It is unlikely that impact will occur after mitigation measures are applied.	
Nature	Negative		

7 Environmental Management Plan

7.1 Project Activities with Significant Air Quality Impacts

The ratings associated with the Sun City Project have shown that impacts will be negligible negative, because emissions generate will not exacerbate background levels of pollutants above regulatory limits. Hence, none of the activities will pose significant air quality either at the construction phase or operational phase of the Project.

7.2 Summary of Mitigation and Management

Table 7-1 to Table 7-3 provide a summary of the proposed project activities, environmental aspects and impacts on the receiving environment. Information on the frequency of mitigation, relevant legal requirements, recommended management plans, timing of implementation, and roles / responsibilities of persons implementing the EMP.

Table 7-1: Impacts

Activities	Phase	Size and scale of disturbance	Mitigation Measures	Compliance with Standards	Time period for Implementation
▪ Site preparation by clearing, including removal of vegetation	Construction	▪ Impacts will be localised, few metres from each activity.	▪ Each activity must be conducted in phases; ▪ Use of suppressants and binders on exposed areas to reduce dust generation; ▪ The area of disturbance at all times must be kept to a minimum ▪ The drop heights when loading onto trucks and at tipping points should be minimised; ▪ Activity must be carried out judiciously on windy days (with wind speed ≥ 5.4 m/s); ▪ There is need to set maximum speed limits on site and to have these limits enforced.	▪ National Environmental Management: Air Quality Act, Act.39 of 2004: GN 486 GG35463; GN1210 GG32816 ▪ National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) - National Dust Control Regulations (2013): GN827 GG36974	▪ Immediately the construction phase commences.
▪ Construction of road works and paving within the Sun City Resort, development of Buss Lodges and Eco-Lodges, simplex units and soccer fields, expansion of the artificial beach, swimming pools, reservoir and parking garages	Construction				
▪ Operation of the vehicle fleet and generators	Operation	▪ Impacts will be localised, few metres from each activity	▪ Use of low sulfur fuel; and ▪ Regular maintenance to ensure the generators burn fuel efficiently.	▪ National Environmental Management: Air Quality Act, Act.39 of 2004: GN 486 GG35463; GN1210 GG32816 ▪ National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) - National Dust Control Regulations (2013): GN827 GG36974	▪ Immediately the operational phase commences.

Table 7-2: Objectives and Outcomes of the EMP

Activities	Potential impacts	Aspects affected	Phase	Mitigation	Standard to be achieved/objective
▪ Site preparation by clearing, including removal of vegetation ▪ Construction of road works and paving within the Sun City Resort, development of Buss Lodges and Eco-Lodges, simplex units and soccer fields, expansion of the artificial beach, swimming pools, reservoir and parking garages	▪ Poor air quality due particulates and gaseous emissions ▪ Nuisance due to dust fallout	▪ Air Quality	▪ Construction	▪ The use of dust suppressants and binders on haul roads to reduce dust generation; ▪ The area of disturbance at all times must be kept to a minimum and no unnecessary clearing, digging or scraping must occur, especially on windy days (with wind speed ≥ 5.4 m/s); ▪ The drop heights when loading onto trucks and at tipping points should be minimised. ▪ There is need to set maximum speed limits on site and to have these limits enforced.	▪ South African National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004): GN 486 GG35463; GN1210 GG32816; GN827 GG36974
▪ Operation of the vehicle fleet and generators	▪ Poor air quality due particulates and gaseous emissions	▪ Air Quality	▪ Operation	▪ Use of low sulfur fuel; and ▪ Regular maintenance to ensure the generators burn fuel efficiently.	▪ South African National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004): GN 486 GG35463; GN1210 GG32816; GN827 GG36974

Table 7-3: Prescribed Environmental Management Standards, Practice, Guideline, Policy or Law

Specialist field	Applicable standard, practice, guideline, policy or law
Air quality	National Environmental Management: Air Quality Act, Act.39 of 2004, 2004 - GN 486 GG35463; GN1210 GG32816
	National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) - National Dust Control Regulations (2013) - GN827 GG36974

8 Monitoring Plan

This study has identified that construction and operational phase impacts will be minimal and as such a comprehensive air quality management plan is not necessary.

9 Mitigation and Management Measures

The mitigation and management measures discussed are recommended to maintain the quality of air on-site and at off-site locations during the construction and operational phases.

10 Recommendations

Based on the results presented in this report, additional recommendations should be applied during construction and operational phases:

- Establish codes of practice for good housekeeping with respect to air quality management and mitigation; and
- Monitor the air quality management measures and information to ensure that adopted measures are sufficient to achieve current air quality standards.

11 Conclusion

The conclusions reached in this reported are informed by the results from the meteorological data, the ambient air quality measured in the Project area, and the emissions anticipated from the project related activities. The meteorological data showed that wind greater than 5.4 m/s occurred for only 4.1% of the time (~14 days in a year), amounting to approximately once in a month. As such, impacts associated with wind erosion are not anticipated to the severe. Monitoring conducted on site showed that ambient concentrations of pollutants are very low and below the current South African ambient air quality standards for fine particulate matter and gases respectively.

The construction of the Sun City Resort will occur in phases, mobile equipment employed will be limited, they will be used intermittently and anticipated emission will be low with negligible impacts on the ambient atmosphere. Associated emissions will not exacerbate or elevate background levels (measured with the AQ-Mesh) above the current regulatory standards (i.e. cumulative impacts will be lower than the regulatory standards). This is not only true for the construction phase, but also applies to the operation phase of the Project (with emission sources limited to the vehicle fleet and generator sets).

In conclusion, if mitigation measures suggested in this report are implemented during construction phase and operational phase, substantial reduction in emissions is guaranteed. Hence, it is the recommendation of the air quality specialist that the project be allowed to proceed as expected impacts on the ambient atmosphere will be minimal.

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Appendix A: CVs of the Project Team

Appendix B: Maps and Plans