Rayten
ENGINEERING SOLUTIONS
Environmental and Engineering Consultants

AIR QUALITY BASELINE ASSESSMENT

Proposed Residential Development

Kutalo Robert-Strachan Site

Prepared By:

Rayten Engineering Solutions
PO Box 1369, Bromhof, 2154
Contact: Amy Atherstone
Office: 011 792 0880
Email: info@rayten.co.za

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	Name	Signature	Date
Author	**Amy Atherstone** **Junior Environmental Scientist** M.Sc. Geography and Environmental Sciences BA Hons Geography and Environmental Sciences BA Geography		07 April 2017
Document Reviewer	**Sophia Valsamakis** M.Sc. Geography and Environmental Sciences (Air Quality) BSc Hons Geography and Environmental Sciences BSc Environmental Sciences		07 April 2017
Document Authorisation	**Claire Wray** **Atmospheric Scientist** (Pri. Sci. Nat) M.Sc. Atmospheric Sciences BSc Hons Geography and Environmental Management BSc Geography and Informatics		07 April 2017

DECLARATION

I declare that –

General declaration:

I act as the independent specialist in this application;
I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
I declare that there are no circumstances that may compromise my objectivity in performing such work;
I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
I will comply with the Act, regulations and all other applicable legislation;
I have no, and will not engage in, conflicting interests in the undertaking of the activity;
I undertake to disclose to the applicant and the competent authority 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 competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
All the particulars furnished by me in this form are true and correct; and
I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.

Claire Wray

Member

_____
Signature of the specialist:

Rayten Engineering Solutions

07 April 2017

SUMMARY

Rayten Engineering Solutions were appointed to conduct an Air Quality Baseline Assessment for a proposed residential development at the Kutalo Robert Strachan site, located in Ekurhuleni, Gauteng. The main objectives of the Air Quality Baseline Assessment are to:

a) Present the baseline ambient concentrations of the criteria air pollutants (air pollutants that are known to have a negative impact on human health and environmental well-being) using available data from a nearby monitoring station;
b) Determine the frequency of exceedance of the air pollutants in line with the South African National Ambient Air Quality Standards;
c) Present the baseline dust fallout rates surrounding the proposed development site using available monitoring data; and
d) Identify existing sources of emissions surrounding the proposed development site through a desktop exercise.

The main conclusions based on the information obtained during the Baseline Assessment can be summarised as follows: The proposed Kutalo Station residential development is located within the Ekurhuleni Metropolitan Municipality (EMM) which falls within the Highveld Priority Area (HPA). Land use immediately surrounding the proposed residential development site is predominantly used for mining, industry and residential settlements. Mining activities are predominantly located in the north-east, south-east and north-west quadrants from the project site while industrial activities surround the proposed site within a 10-km buffer. Kutalo Train Station, Rand Airport and OR Tambo International Airport are located in close proximity to the project site.

Existing key sources of air pollution surrounding the project site have been identified to be:

- Potential domestic fuel burning;
- Industrial Activity;
- Manufacturing Faculties;
- Waste Treatment Plants;
- Vehicle exhaust emissions and vehicle dust entrainment;
- Wind erosion from exposed areas (e.g. tailings, open veld, open degraded/eroded areas, etc.); and
- Mining activity.

Meteorological data were obtained from the OR Tambo International Airport weather station for the period January 2013 to December 2016. Based on the prevailing wind fields for the period, emissions from surrounding sources are likely transported towards the southern, south-eastern and south-south-eastern regions. The Kutalo Station site is downwind from mining, industrial and business/commercial activities. Moderate to fast wind speeds observed may result in effective dispersion and dilution of emissions. However, moderate to fast wind speeds may also facilitate dust emissions from open storage piles and

exposed areas surrounding the site. Removal of pollutants via wet depositional processes would be evident during the spring and summer seasons, thus lower ambient concentrations of pollutants (particularly dust) are expected during these seasons. Elevated levels of pollutants would be expected during the autumn and winter seasons due to reduced wet depositional process. Higher ambient concentrations of pollutants would also be evident during the autumn and winter seasons due to reduced vertical dispersion of pollutants as a result of the winter inversion layers.

Ambient air quality standards have been developed for eight criteria air pollutants in South Africa. These pollutants are considered to be harmful to human health. People who are exposed to pollutant concentrations that frequently exceed the acceptable ambient air quality standards, are considered to be vulnerable to potential health risks. South Africa has also developed Dust Control Regulations which provide acceptable dust fallout limits for residential and non-residential areas. High dust fallout rates can act as a nuisance and damage property or crops and can also create irritation of the skin, eyes, nose and throat in people. In order to assess the existing air quality situation and establish whether the criteria air pollutants and dust fallout rates fall within the acceptable limits, air quality monitoring data is required. These data are usually obtained from permanent ambient air quality monitoring stations and dust fallout networks operated within close proximity to the project site.

The Germiston Ambient Air Quality Monitoring Station (hereafter Germiston Station) is the closest station to the project site where data is available on the SAAQIS. The Germiston Station is situated approximately <2 km west-south-west of the Kutalo Station proposed residential development site. Baseline concentrations for CO, NO_2, PM_{10} and SO_2 were assessed for the period January 2011 to December 2016. Dust fallout rates for seven sites located <5 km from the proposed residential site were also provided by Ekurhuleni Metropolitan Municipality for the period July 2015 – October 2016.

The baseline air quality data can be summarised as follows:

- There was only 12% data availability for C_6H_6 (Benzene) concentrations and 2% data availability for O_3 (Ozone) concentrations. Therefore, no analysis was conducted with these parameters.
- Annual average NO_2 and SO_2 concentrations were below the acceptable standards of 21 and 19 ppb for the period, respectively.
- There was no exceedance of the daily limit of 48 ppb for SO_2 concentrations.
- No exceedances of the NO_2 and SO_2, hourly standards of 106 and 134 ppb, respectively, were observed for the monitoring period.
- Exceedances of the hourly limit of 26 ppm were recorded for CO concentrations.
- Exceedances of both the daily (75 ppb) and annual (40 ppb) limits were recorded for PM_{10} concentrations.
- Diurnal variation is observed for CO, NO_2 and SO_2 concentrations. Concentrations typically increase during the morning and evening periods. Higher concentrations of gaseous pollutants are also

observed over the autumn and winter seasons compared to the summer and spring seasons. People in the area will likely be exposed to higher concentrations of pollutants during these periods.

- Exceedances of the short term (hourly) CO standards were recorded; suggesting that people in the area could potentially be exposed to future high concentrations, and may represent a concern for human health and environmental impacts. However, the NO_2 and SO_2 concentrations in the area are expected to be in compliance for most of the time based on the data provided.
- Exceedances of daily and annual PM_{10} concentrations are a result of the surrounding mining activities (quarries, tailings, etc.), industrial activities and informal settlements (immediately east of the project site). Mining and industrial activity, wind erosion from exposed surfaces and domestic fuel burning are all key sources of particulate matter, thus, accounting for the high concentrations of PM_{10} recorded over the monitoring period.
- Exceedances of the short term (daily) and long term (annual) PM_{10} standards; suggest that people in the area will likely be exposed to future high concentrations, and may represent a concern for human health and environmental impacts.
- There was no data available for $PM_{2.5}$ concentrations for the Germiston Station.
- The site is also located in the HPA; which is associated with relatively poor air quality where PM_{10} and $PM_{2.5}$ concentrations frequently exceed ambient air quality standards (DEA 2011).
- Dust fallout rates, one exceedance of the residential limit of 600 mg/m^2/day was recorded at site 1 during 2015 (July 2015 to December 2015). There were no exceedances of the non-residential limit of 1200 mg/m^2/day during the 2015 monitoring period for the seven buckets located in close proximity to the project site. During the 2016 monitoring period (January 2016 – October 2016) dust fallout rates fell below the residential limit (600 mg/m^2/day) and non-residential limit (1200 mg/m^2/day) for the seven buckets located in close proximity to the project site.
- Based on the data provided for the 2016 monitoring period, the dust fallout rates for the seven sites which are in close proximity to the Kutalo Station do not exceed the acceptable applicable limits.

General recommendations: Air pollution is controlled at the emission source by standard practice, however, some general measures can be considered to try reduce exposure to air pollutants in terms of the building design. These can include:

- Automated entrance and exit doors
    - This would ensure that doors will remain closed at all times to reduce the amount of airborne dust entering the buildings.
- Climate control with filtration system
    - Climate control with a filtration ventilation system would ensure that windows do not need to be left open, while ensuring air circulation. This will reduce the amount of dust from entering the building as well as dilution of potential radon gas and dust particles.
- Exterior wind breaks
    - These would be in the form of indigenous hedges and/or trees to act as a dust trap as well as a wind break to minimize dust onto the site.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AQA	Air Quality Act
AQMP	Air Quality Management Plan
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DEA	Department of Environmental Affairs
EMM	Ekurhuleni Metropolitan Municipality
ESE	East-South-East
GHG	Greenhouse gas
LPG	Liquified Petroleum Gas
HPA	Highveld Priority Area
NAEIS	National Atmospheric Emissions Inventory System
NPI	National Pollutant Inventory
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
N_2O	Nitrous Oxide
Mtpa	Million tonnes per annum
O_3	Ozone
PM_{10}	Particulate Matter, aerodynamic diameter equal to or size less than 10µm
$PM_{2.5}$	Particulate Matter, aerodynamic diameter size equal to or less than 2.5µm
RDF	Refuse Derived Fuel Plant
SAAQIS	South African Air Quality Information System
SE	South East
SSE	South-South-East
SO_2	Sulphur Dioxide
TSP	Total Suspended Particles
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
WHO	World Health Organisation

1 INTRODUCTION

Rayten Engineering Solutions were appointed to conduct an Air Quality Baseline Assessment for the proposed construction of a residential development at the Kutalo Robert Strachan site, located in Ekurhuleni, Gauteng. The main objectives of the study are to:

a) Present the baseline ambient concentrations of the criteria air pollutants (air pollutants that are known to have a negative impact on human health and environmental well-being) using available data from a nearby monitoring station;
b) Determine the frequency of exceedance of the air pollutants with the South African National Ambient Air Quality Standards;
c) Present the baseline dust fallout rates surrounding the proposed development site using available monitoring data; and
d) Identify existing sources of emissions surrounding the proposed development site through a desktop exercise.

1.1 Terms of Reference

The scope of work for the Air Quality Baseline Assessment for the proposed Kutalo Station residential development is as follows:

i. Overview of the prevailing meteorological conditions;
ii. Review of air quality monitoring data;
iii. Review of air quality legislation; and
iv. Identification of nearby existing sources of emissions surrounding the project site.

1.2 Outline of Report

An overview of the site location is given in **Section 2**. National ambient air quality standards and dust fallout regulations are provided in **Section 3.** Air pollutants identified to have a negative impact on human health and the associated health effects are described in **Section 3.** The baseline air quality situation, including ambient concentrations of identified air pollutants and the frequency of exceedance of the standards, and the surrounding sources of emissions are given in **Section 4.** The local meteorological conditions are provided in **Section 4**. A summary report and conclusion, listing mitigation measures and recommendations associated with the impacts from the proposed development, are given in **Section 4.**

2 SITE CHARACTERISTICS

2.1 Site Locality

The proposed residential development is located adjacent to the Kutalo Train Station in Germiston, under the jurisdiction of the Ekurhuleni Metropolitan Municipality (EMM), South Africa (26.217898^{o} S; 28.190748^{o} E) (Figure 2-1). Germiston is situated in the East Rand region of Gauteng and covers a total area of 143.24 km^{2}. Germiston falls in the core economic triangle within the EMM, which also includes Kempton Park, Boksburg and Benoni (Government Gazette, No.35072, 2012) and is predominantly industrial, consisting of both light and heavy industrial activities. Other cities in close proximity to the project site include Boksburg (east-south-east of the project site), Alberton (south-south-west of the project site), Bedfordview (north-west) and Edenvale (north-north-west of the project site). The largest convergence and divergence of railway routes is stationed in Germiston. The Germiston Stadium (1.96 km) and Victoria Lake (3.42 km) are situated west-south-west of the project site.

2.2 Land Use

The land use surrounding the proposed project site is given in Figure 2-2. Land use immediately surrounding the proposed residential development site is predominantly used for mining, industry and residential settlements. Open space, residential areas and mining activities are located north and east of the site. Industry, open space and business and commercial activities are located south and west of the site. Mining activities are predominant in the north-east, south-east and north-west quadrants. The Kutalo Train Station is located to the west of the site. Rand Airport is located 5 km west-south-west of the site whilst OR Tambo International Airport is located ~10 km north-north-east of the site.

2.3 Topography

The topography surrounding the proposed Kutalo Station residential development is shown in Figure 2-3. Surrounding elevations range from approximately 1450 – 1770m above sea level. The proposed project site is situated approximately 1640m above sea level.

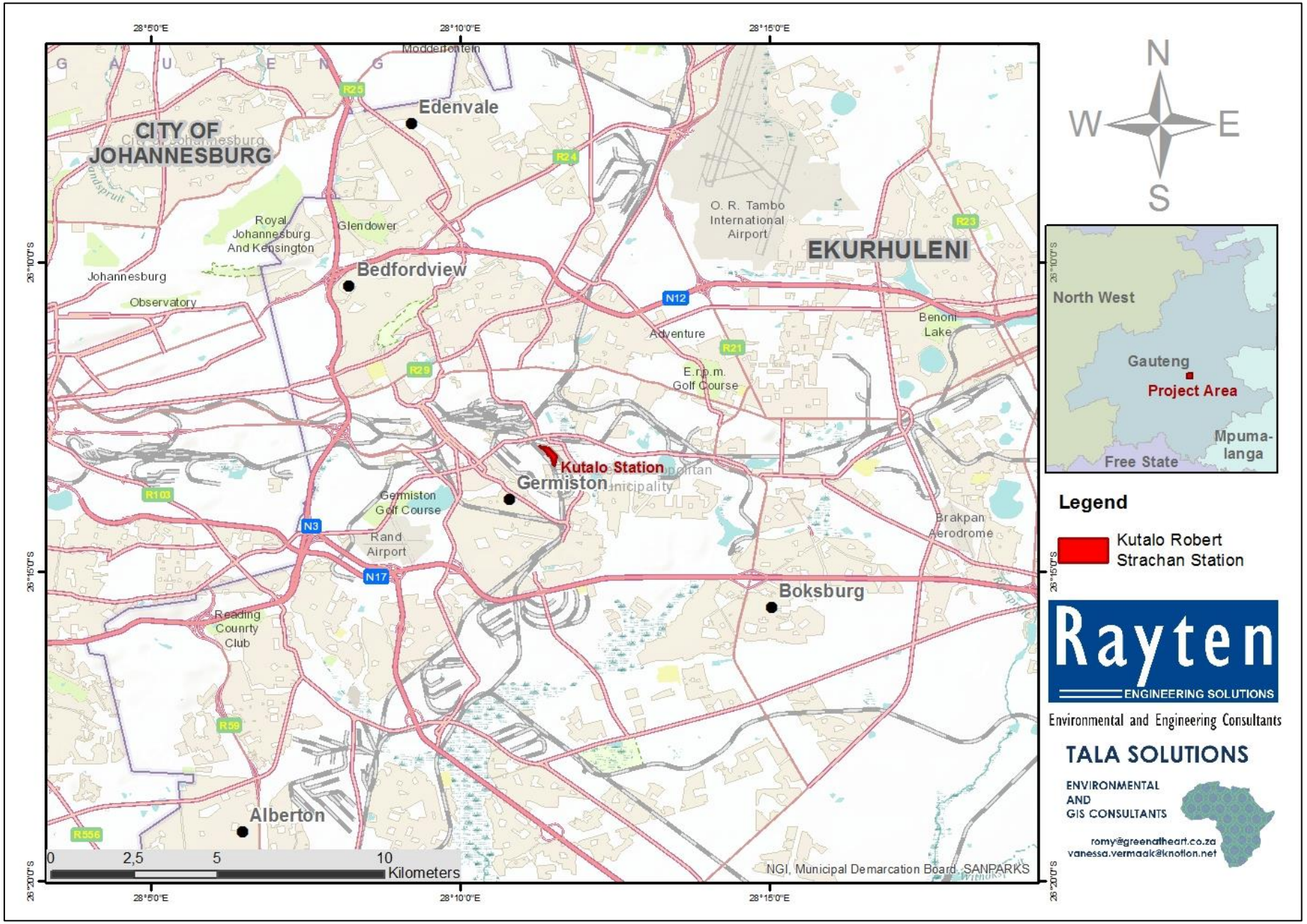


Figure 2-1: Site Locality for the Proposed Residential Development.

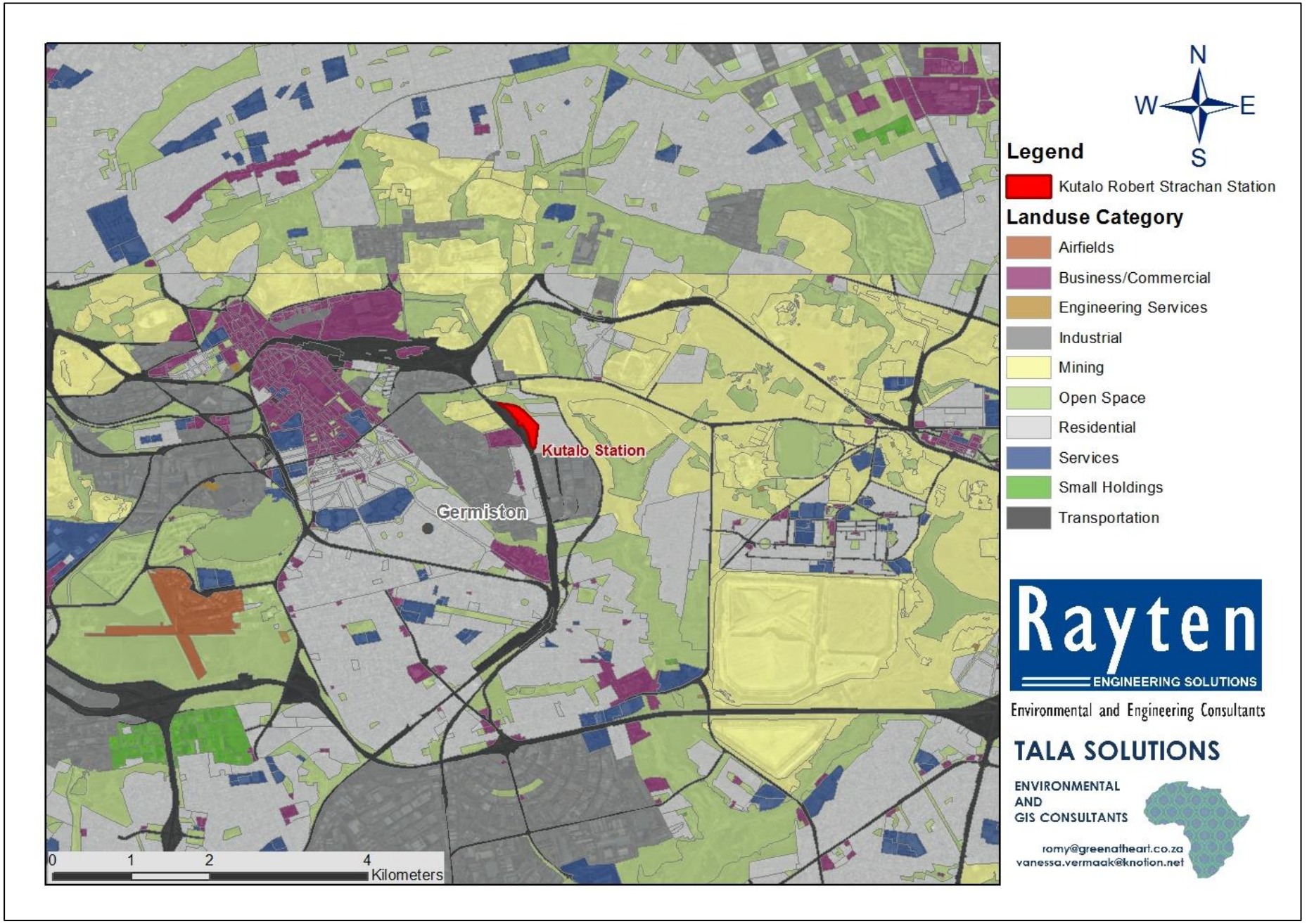


Figure 2-2: Land Use Surrounding the Proposed Residential Development.

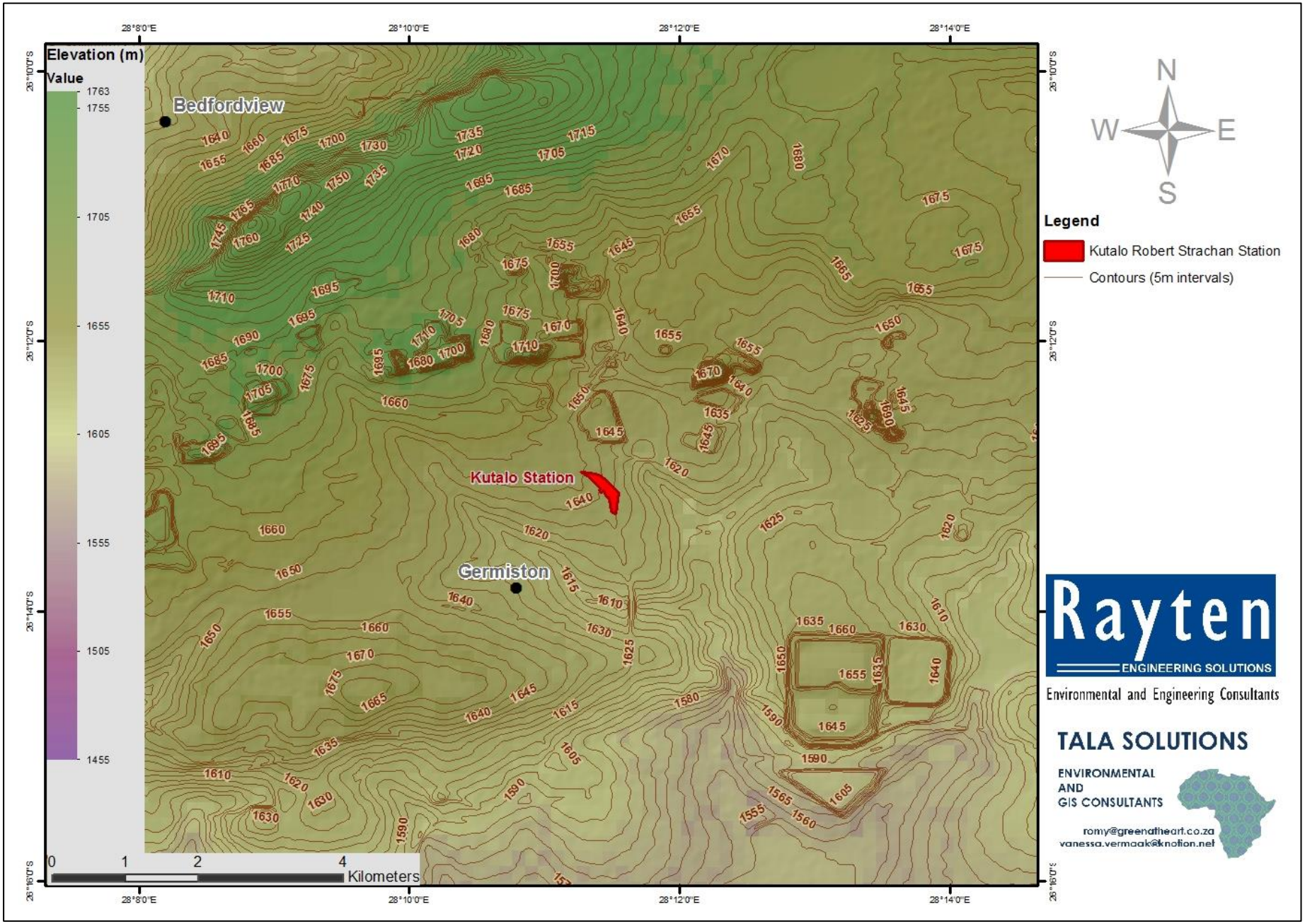


Figure 2-3: Topography Surrounding the Proposed Residential Development.

3 LEGISLATION, POLICIES AND GUIDELINES

3.1 National Environmental Management: Air Quality Act

The National Environmental Management: Air Quality Act (AQA) No. 39 of 2004 and as amended Act No. 20 of 2014 has shifted the approach of air quality management from source-based control to receptor-based control. The main objectives of the Act are to:

- Give effect to everyone's right 'to an environment that is not harmful to their health and well-being'
- Protect the environment by providing reasonable legislative and other measures that (i) prevent pollution and ecological degradation, (ii) promote conservation and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

The Act makes provision for the setting and formulation of National ambient air quality standards for 'substances or mixtures of substances which present a threat to health, well-being or the environment'. More stringent standards can be established at the provincial and local levels.

The control and management of emissions in the AQA relates to the listing of activities that are sources of emissions and the issuing of emission licences. Listed activities are defined as activities which 'result in atmospheric emissions and are regarded as having a significant detrimental effect on the environment, including human health'. Listed activities have been identified by the Minister of the Department of Environmental Affairs and atmospheric emission standards have been established for each of these activities. These listed activities now require an atmospheric emission licence to operate. The issuing of emission licences for Listed Activities will be the responsibility of the Metropolitan and District Municipalities.

In addition, the Minister may declare any substance contributing to air pollution as a priority pollutant. Any industries or industrial sectors that emit these priority pollutants will be required to implement a Pollution Prevention Plan. Municipalities are required to 'designate an air quality officer to be responsible for co-ordinating matters pertaining to air quality management in the Municipality. The appointed Air Quality Officer is responsible for the issuing of atmospheric emission licences.

3.2 Listed Activities and Minimum Emission Standards

The Air Quality Act requires all persons undertaking listed activities in terms of Section 21 of the Act to obtain an Atmospheric Emission Licence. The Listed Activities and Associated Minimum Emission Standards were issued by the Department of Environmental Affairs on 31 March 2010 (Government Gazette No 33064). Amended List of Activiities were published on the 22 November 2013 (Government Gazette No 37054) and 21 June 2015 (Government Gazette No 38863). The emission standards provide maximum

emission rates for various air pollutants that are permissable for a particular acitivity. The purpose of these standards is to control the release of emissions from key emitting activities and sources.

3.3 Ambient Air Quality Standards

Ambient air quality standards have been developed for eight criteria air pollutants in South Africa. These are pollutants that are known to have a negative impact on human health and environmental quality. National ambient air quality standards, including allowable frequencies of exceedance and compliance timeframes, were issued by the Minister of Water and Environmental Affairs on 24 December 2009 (Table 3-1). National standards for PM2.5 were established by the Minister of Water and Environmental Affairs on 29 June 2012.

Table 3-1: National Ambient Air Quality Standards for Criteria Pollutants. The Values Indicated in Blue are Expressed in ppb.

POLLUTANT	AVERAGING PERIOD	CONCENTRATION ($\mu g/m^3$)	FREQUENCY OF EXCEEDANCE
Sulphur dioxide (SO_2)	10 minutes	500 (191)	526
	1 hour	350 (134)	88
	24 hours	125 (48)	4
	1 year	50 (19)	0
Nitrogen dioxide (NO_2)	1 hour	200 (106)	88
	1 year	40 (21)	0
Particulate Matter (PM10)	24 hours	75	4
	1 year	40	0
Particulate Matter (PM2.5)	24 hours	40[(1)] 25[(2)]	0
	1 year	20[(1)] 15[(2)]	0
Ozone (O_3)	8 hours (running)	120 (61)	11
Benzene (C_6H_6)	1 year	5 (1.6)	0
Lead (Pb)	1 year	0.5	0
Carbon monoxide (CO)	1 hour	30 000 (26 000)	88
	8 hour (calculated on 1 hourly averages)	10 000 (8 700)	11

Notes:
[(1)] Compliance required by 1 January 2016 – 31 December 2029.
[(2)] Compliance required by 1 January 2030.

3.4 Dust Deposition Standards

The Department of Environmental Affairs has issued National dust control regulations on 1 November 2013 (Table 3-2). The purpose of the regulations is to prescribe general measures for the control of dust in all areas. The regulations prohibit activities which give rise to dust in such quantities and concentrations that the dust fall at the boundary or beyond the boundary of the premises where it originates exceeds -

a) 600 mg/m^2/day averaged over 30 days in residential areas measured using reference method ASTM D1739.
b) 1200 mg/m^2/day averaged over 30 days in non-residential areas measured using reference method ASTM D1739.

Table 3-2: South African Dust Fallout Regulations.

RESTRICTION AREAS	DUST FALLOUT RATE (D) [1]	FREQUENCY OF EXCEEDANCE
Residential Areas	D < 600	Two within a year, no two sequential months [2]
Non-residential areas	600 < D < 1200	Two within a year, no two sequential months [2]

Notes:
[1] Averaged over 1 month (30±2-day average) (mg/m^2/day)
[2] Per dust fallout monitoring site.

Any person who has exceeded the dust fallout standard must, within three months after submission of a dust fallout monitoring report, develop and submit a dust management plan to the air quality officer for approval. The dust management plan must:

a) Identify all possible sources of dust within the affected site;
b) Detail the best practicable measures to be undertaken to mitigate dust emissions;
c) Develop an implementation schedule;
d) Identify the line management responsible for implementation;
e) Incorporate the dust fallout monitoring plan;
f) Establish a register for recording all complaints received by the person regarding dust fall, and for recording follow up actions and responses to the complainants.

The dust management plan must be implemented within a month of the date of approval. An implementation progress report must be submitted to the air quality officer at agreed time intervals.

3.5 Human Health Effects

People residing in the proposed development site will be exposed to various air pollutants, some of which include dust fallout, PM_{10}, $PM_{2.5}$, SO_2, CO, NO_2, O_3, benzene and lead. These are pollutants that are known to have a negative impact on human health and environmental quality. Ambient air quality standards and dust fallout control regulations have been developed for these pollutants. People who are frequently exposed to above standard criteria air pollutant concentrations and dust fallout rates are potentially vulnerable to health risks and environmental nuisance impacts, which are briefly discussed below.

3.5.1 Dust Fallout (TSP)

Dust fallout are particles with an aerodynamic diameter greater than 20µm that have been entrained into the air by a physical process such as wind, movement of vehicles, stack emissions and from fugitive dust. These particles are generally too heavy to remain in suspension in the air for any period of time and fall out of the air over a relatively short distance depending on a combination of various factors such as particle size, density, temperature (of the air and particle), emission velocity or method, ambient wind speed and humidity. These particles are therefore commonly known as “dust fallout”. Particulates in this range are generally classified as a nuisance dust and can cause physical damage to property and physical irritation to plants, animals and humans.

3.5.2 Particulates (PM_{10} & $PM_{2.5}$)

Particles can be classified by their aerodynamic properties into coarse particles, PM_{10} (particulate matter with an aerodynamic diameter equal to or less than 10 µm) and fine particles, $PM_{2.5}$ (particulate matter with an aerodynamic diameter equal to or less than 2.5 µm). The fine particles mostly contain secondary formed aerosols such as sulphates and nitrates, combustion particles and re-condensed organic and metal vapours. The coarse particles mostly contain earth crust materials and fugitive dust from roads and industries (Harrison *et al.,* 2014).

In terms of health impacts, particulate air pollution is associated with effects on the respiratory system (WHO, 2000). Particle size is important for health because it controls where in the respiratory system a given particle deposits. Fine particles are thought to be more damaging to human health than coarse particles as larger particles do not penetrate deep into the lungs compared to smaller particles. 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).

Recent studies suggest that short-term exposure to particulate matter leads to adverse health effects, even at low concentrations of exposure (below 100 µg/m^3). Morbidity effects associated with short-term exposure to particulates include increases in lower respiratory symptoms, medication use and small reductions in lung function. Long-term exposure to low concentrations (~10 µg/m^3) of particulates is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function (WHO, 2000). Those most at risk include the elderly, individuals with pre-existing heart or lung disease, asthmatics, and children.

3.5.3 Sulphur Dioxide (SO_2)

SO_2 originates from the combustion of sulphur-containing fuels and is a major air pollutant in many parts of the world. Health effects associated with exposure to SO_2 are also associated with the respiratory system. Being soluble, SO_2 is readily absorbed in the mucous membranes of the nose and upper respiratory tract.

Most information on the acute (short-term) effects of SO_2 is derived from short-term exposure in controlled chamber experiments. These experiments have demonstrated a wide range of sensitivity amongst individuals. Acute exposure of SO_2 concentrations can lead to severe bronchoconstriction in some individuals, while others remain completely unaffected. Response to SO_2 inhalation is rapid with the maximum effect experienced within a few minutes. Continued exposure does not increase the response. Effects of SO_2 exposure are short-lived with lung function returning back to normal within a few minutes to hours (WHO, 2000). Exposure to SO_2 over a 24-hour period has shown that when SO_2 concentrations exceed 250 µg/m^3 in the presence of PM (such as sulphates), an exacerbation of symptoms is observed in selected sensitive patients. More recent studies of health impacts in ambient air polluted by industrial and vehicular activities have demonstrated at low levels effects on mortality (total, cardiovascular and respiratory) and increases in hospital admissions. Long-term exposure to SO_2 has been found to be associated with an exacerbation of respiratory symptoms and a small reduction in lung function in children in some cases. In adults, respiratory symptoms such as wheezing and coughing are increased (WHO, 2000).

3.5.4 Oxides of Nitrogen (NO_x)

Nitric oxide (NO) is a primary pollutant emitted from the combustion of stationary sources (heating, power generation) and from motor vehicles. Nitrogen dioxide (NO_2) is formed through the oxidation of NO. Oxides of nitrogen (NO_x) are made up of NO, NO_2 and NO_x of which NO_2 is the most important from a human health point of view. NO_2 is an irritating gas that is absorbed into the mucous membrane of the respiratory tract. The most adverse health effect occurs at the junction of the conducting airway and the gas exchange region of the lungs. The upper airways are less affected because NO_2 is not very soluble in aqueous surfaces. Exposure to NO_2 is linked with increased susceptibility to respiratory infection, increased airway resistance in asthmatics and decreased pulmonary function.

Short term exposure of NO_2, at concentrations greater than 1880 µg/m^3, results in changes in the pulmonary function of adults. Normal healthy people exposed at rest or with light exercise for less than 2 hours to concentrations above 4700 µg/m^3, experience pronounced decreases in pulmonary function (WHO, 2000). Long-term epidemiological studies have been undertaken on the indoor use of gas cooking appliances and health effects. Studies on adults and children under 2 years of age found no association between the use of gas cooking appliances and respiratory effects. Children aged 5 – 12 years have a 20% increased risk for respiratory symptoms and disease for each increase of 28 µg/m^3 NO_2 concentration, where the weekly average concentrations are in the range of 15 – 128 µg/m^3. Outdoor studies consistently indicate that children with long-term ambient NO_2 exposures exhibit increased respiratory symptoms that are of a longer duration. However, no evidence is provided for the association of long-term exposures with health effects in adults (WHO, 2000).

3.5.5 Carbon Monoxide (CO)

Carbon monoxide (CO) is a tasteless, odourless and colourless gas which has a low solubility in water. In the human body, after reaching the lungs it diffuses rapidly across the alveolar and capillary membranes and binds reversibly with the haem proteins. Approximately 80 - 90% of CO binds to haemoglobin to form carboxyhaemoglobin. This causes a reduction in the oxygen-carrying capacity of the blood which leads to hypoxia as the body is starved of oxygen. Severe hypoxia due to acute poisoning results in headaches, nausea and vomiting, muscular weakness, loss of consciousness, shortness of breath and finally death, depending on the concentration and time of exposure. Poisoning may cause both reversible, short-lasting neurological deficits and severe, often delayed, neurological damage. Neurobehavioral effects include impaired co-ordination, tracking, driving ability, vigilance, and cognitive ability (WHO, 2000).

3.5.6 Benzene (C_6H_6)

Benzene is the only VOC that is legislated in South African and is a well-known carcinogen. Studies have shown that exposure to high concentrations of Benzene can cause leukaemia (Vrijheid, 2000; Duarte-Davidson *et al.,* 2001; Cointreau, 2006; www.WHO.org, 2012). Bridges *et al.,* (2000) and Vrijheid (2000) argue that there should be no standard threshold limit for gases with carcinogenic properties. This suggests that people who are exposed to carcinogenic agents irrespective of the concentration are said to be at some level of risk to adverse health effects.

Exposure to VOCs via inhalation can cause a variety of health effects depending on the concentration and type of VOC a person is exposed to and the duration of exposure. In general exposure to elevated levels of VOCs over a short duration can potentially cause skin, eyes, nose and throat irritations, headaches, drowsiness, nausea and vomiting. Exposure to low levels of VOCs over a longer duration period may potentially cause cancer, kidney and liver damage, chromosomal aberrations, and blood disease (Duarte-Davidson *et al.,* 2001).

3.5.7 Lead (Pb)

Lead occurs naturally in the environment and has many industrial uses. Everyone is exposed to low levels of lead through food, drinking water, air, household dust, soil, and some consumer products. However, ongoing exposure to even small amounts of lead may be harmful to a person's health. Once taken into the body, lead distributes throughout the body in the blood and is accumulated in the bones. Depending on the level of exposure, lead can adversely affect the nervous system, kidney function, immune system, reproductive and developmental systems and the cardiovascular system. Lead exposure also affects the oxygen carrying capacity of the blood. The lead effects most commonly encountered in current populations are neurological effects in children and cardiovascular effects (e.g., high blood pressure and heart disease) in adults. Infants and young children are especially sensitive to even low levels of lead, which may contribute to behavioural problems, learning deficits and lowered IQ.

Lead is persistent in the environment and accumulates in soils and sediments through deposition from air sources, direct discharge of waste streams to water bodies, mining, and erosion. Ecosystems near point sources of lead demonstrate a wide range of adverse effects including losses in biodiversity, changes in community composition, decreased growth and reproductive rates in plants and animals, and neurological effects in vertebrates (USEPA, 2011).

4 BASELINE ASSESSMENT

4.1 Meteorological Overview

Meteorological processes determine the dispersion and dilution potential of pollutants emitted into the atmosphere. The vertical dispersion of pollution is governed by the stability of the atmosphere and the depth of the surface mixing layer. Dominant wind fields define influence the horizontal dispersion of pollution. Therefore, meteorological parameters including temperature, precipitation, wind speed and wind direction are of significance as they will influence the degree to which pollution will accumulate or disperse in the atmosphere.

The OR Tambo International Airport Weather Station (hereafter OR Tambo Station) (26.143000° S; 28.234600° E) is the nearest weather station to the project site that data were available for all of the required parameters. The OR Tambo Station is located approximately 8.45 km north-north-east of the proposed residential development. Meteorological data, including wind speed, wind direction, rainfall, cloud cover, temperature, and relative humidity, were obtained from SAWS for the OR Tambo International Airport Weather Station for the period January 2013 to December 2016.

4.1.1 Local Wind Field

Figure 4-1 provides the period wind rose plot for the period January 2013 to December 2016. The predominant wind directions for the period are observed from the north, north-west and north-north-westerly directions. Wind speeds for the period are generally fast with calm conditions, defined as wind speeds less than 1 m/s, observed for 2.14% of the time (Figure 4-1).

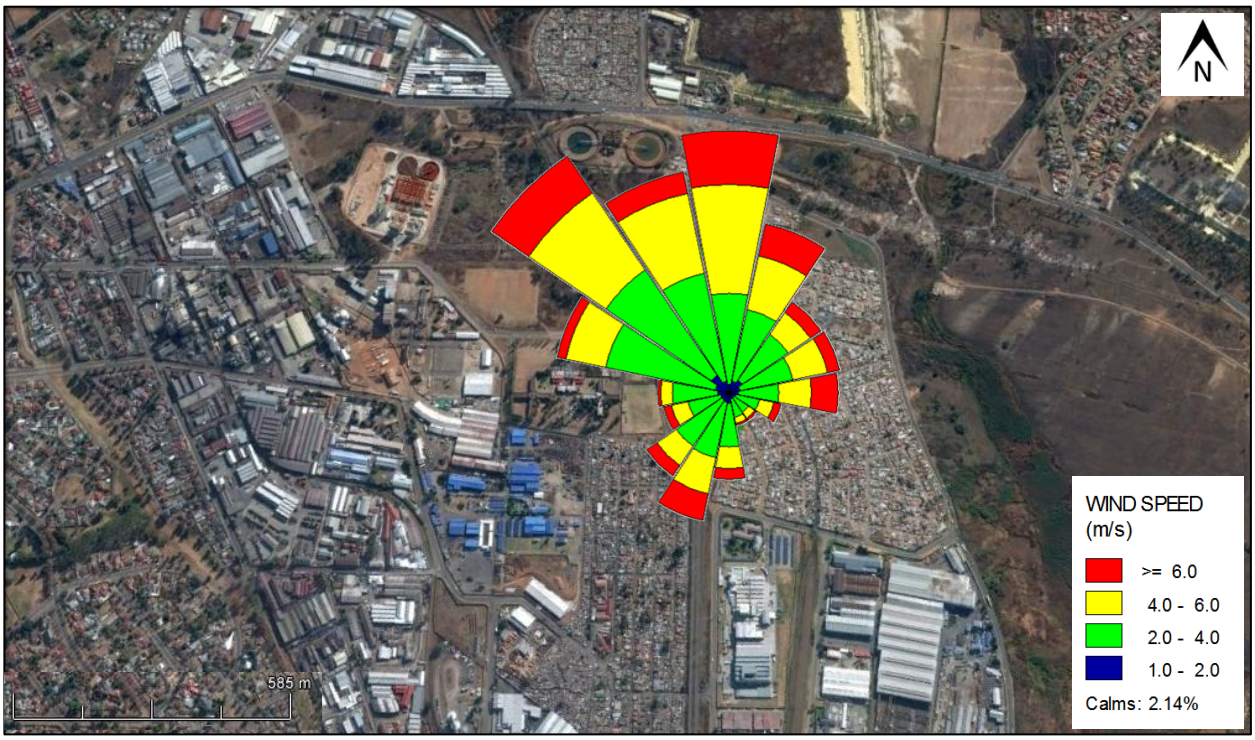


Figure 4-1: Period Wind Rose Plot for the Period January 2013 to December 2016.

The morning/day and afternoon/night time period wind rose plots for the period January 2013 to December 2016 show slight diurnal variation in the wind field data. During the morning/day, a higher frequency of winds is observed from the north compared to the afternoon/night time period (Figure 4-2). During the afternoon/night time, prevailing winds are observed from the north-west (Figure 4-3). A slightly higher percentage of calmer winds occur during the morning/day compared to the afternoon/night period.

Based on the prevailing wind fields for the period, emissions from surrounding sources are likely transported towards the southern, south-eastern and south-south-eastern regions. The Kutalo Station site is downwind from mining, industrial and business/commercial activities. Moderate to fast wind speeds observed may result in effective dispersion and dilution of emissions. However, moderate to fast wind speeds may also facilitate dust emissions from open storage piles and exposed areas surrounding the site. Removal of pollutants via wet depositional processes would be evident during the spring and summer seasons, thus lower ambient concentrations of pollutants (particularly dust) are expected during these seasons. Elevated levels of pollutants would be expected during the autumn and winter seasons due to reduced wet depositional process. Higher ambient concentrations of pollutants would also be evident during the autumn and winter seasons due to reduced vertical dispersion of pollutants as a result of the winter inversion layers.

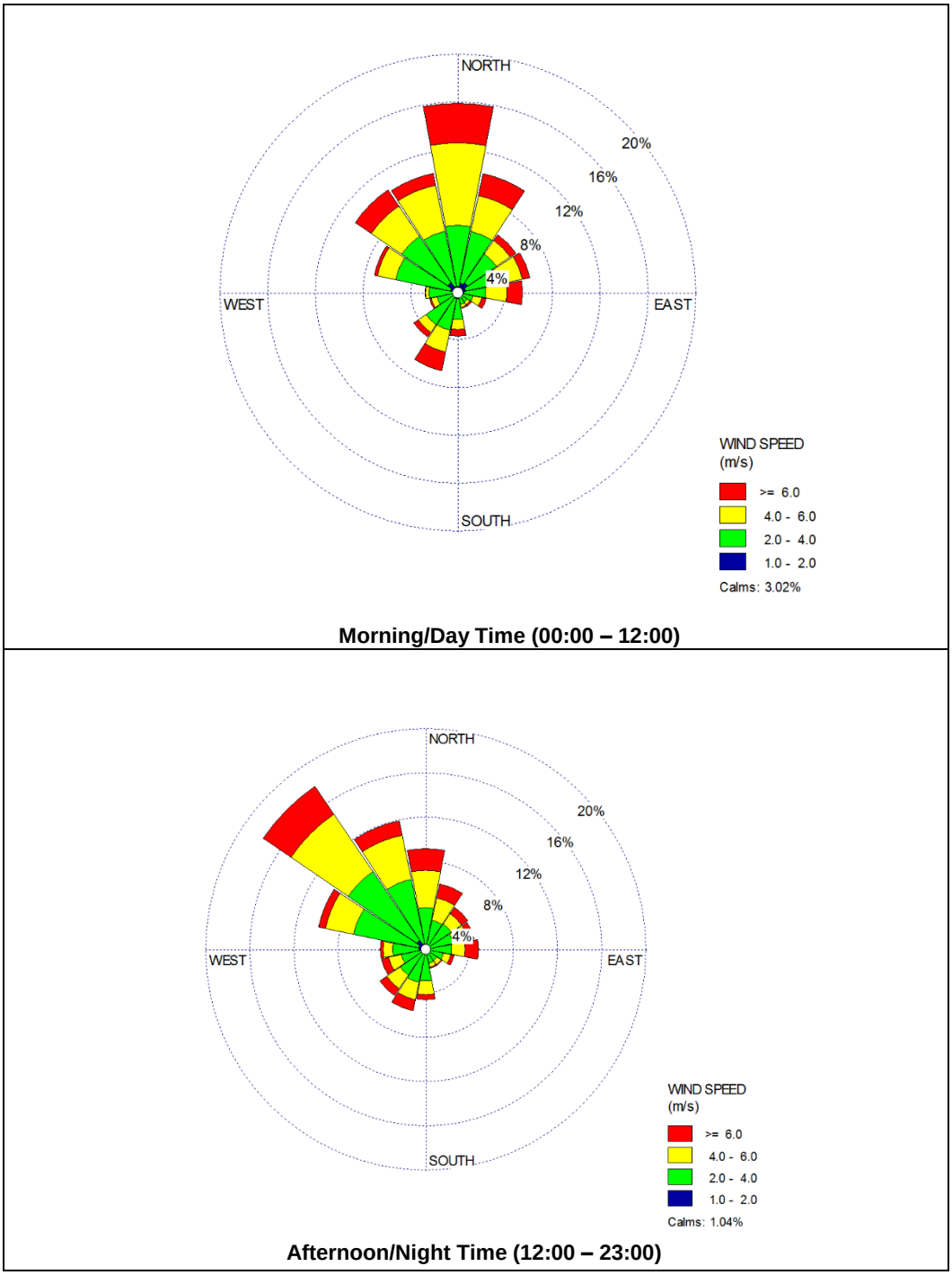


Figure 4-2: Morning/Day Time (00:00 – 12:00) and Afternoon/Night Time (12:00 – 23:00) Period Wind Rose Plots for the Period January 2013 to December 2016.

Seasonal variation in winds for the period January 2013 to December 2016 is shown in Figure 4-3. Winds occur predominantly from the north, north-west and north-north-west sectors throughout the year. However, during the summer season, a higher frequency of winds is observed from the north-eastern quadrant. In the autumn and winter seasons, south-westerly and south-south-westerly winds strengthen.

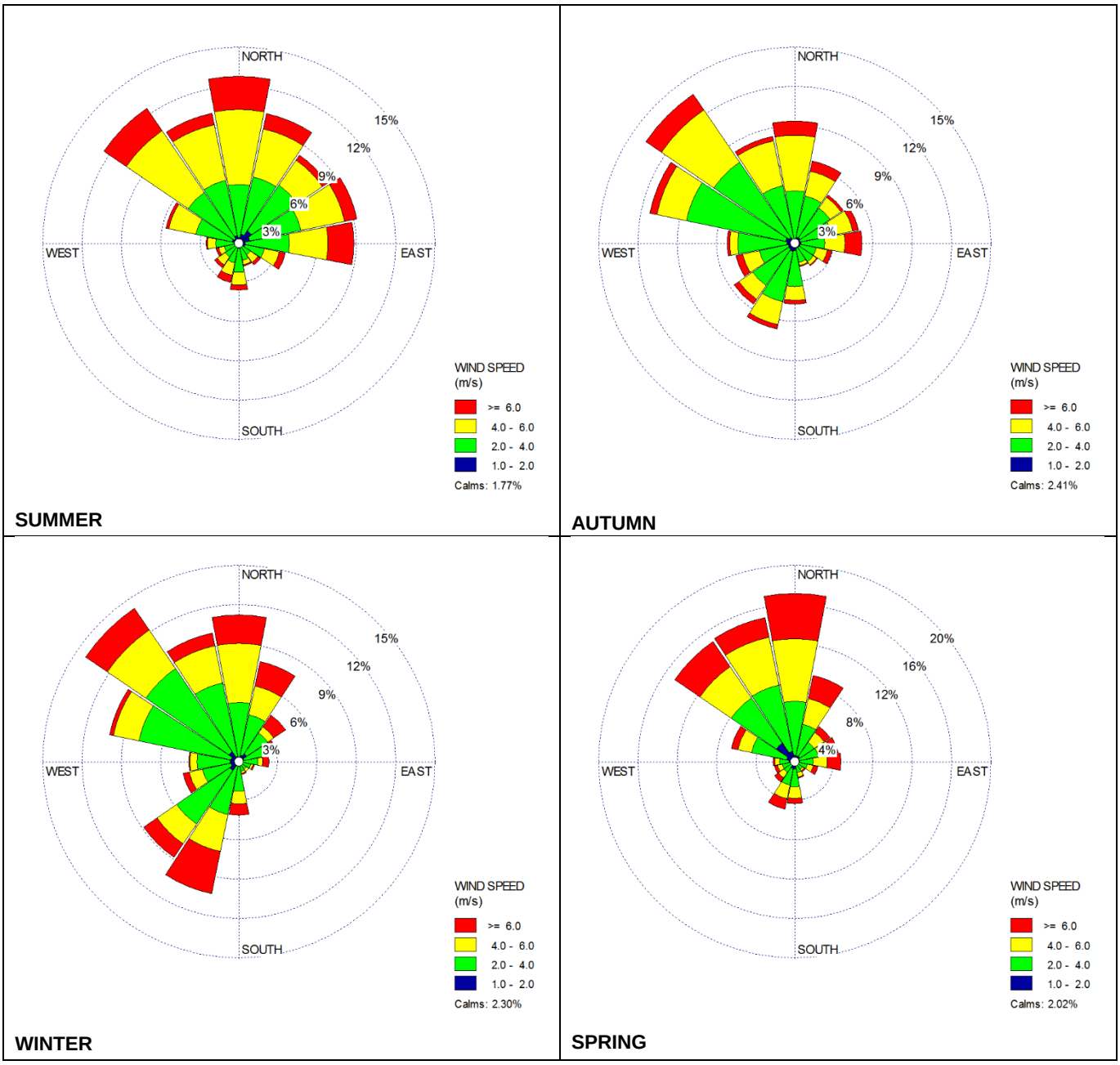


Figure 4-3: Seasonal Variation of Winds for the Period January 2013 to December 2016.

4.1.2 Temperature and Relative Humidity

Temperature affects the formation, action and interactions of pollutants in various ways. Temperature provides an indication of the rate of development and dissipation of the mixing layer, which is largely controlled by surface inversions. Surface temperature inversions play a major role in air quality, especially during the winter months when these inversions are the strongest. Higher ambient temperatures will facilitate the dispersion of air pollutants which can result in lower ambient concentrations.

Chemical reaction rates also tend to increase with temperature and the warmer the air, the more water it can hold and therefore the higher the humidity. Relative humidity can be expressed as the amount (percentage) of water vapour in the air compared to the maximum amount of water vapour that the air can hold at a certain temperature. When relative humidity exceeds 70%, light scattering by suspended particles

begins to increase, as a function of increased water uptake by the particles. This results in decreased visibility due to the resultant haze. Many pollutants may also dissolve in water to form acids.

Figure 4-4 shows monthly average temperatures and relative humidity profiles for OR Tambo weather station for the period January 2013 to December 2016. Average monthly temperatures range from approximately 17.7 – 20.8°C in spring/summer to 11.0 – 19.0°C in autumn/winter (Table 4-1). Highest temperatures are observed during the summer months (December – February) and minimum temperatures are observed during the winter months (June – August). Relative humidity is lowest during the winter season and highest during the summer period.

Table 4-1: Hourly Minimum, Maximum and Monthly Average Temperatures for the Period January 2013 to December 2016.

Daily Minimum, Maximum and Monthly Average Temperatures (°C)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	20.7	20.7	19.0	16.9	15.1	11.4	11.0	14.5	17.7	19.6	19.0	20.8
Minimum	12.8	11.2	10.6	3.8	3.9	-1.3	-3.3	-1.9	3.3	2.8	4.4	10.5
Maximum	34.8	31	29.4	27.6	25.5	22.6	21.7	27.5	30.3	32.9	33	32.2

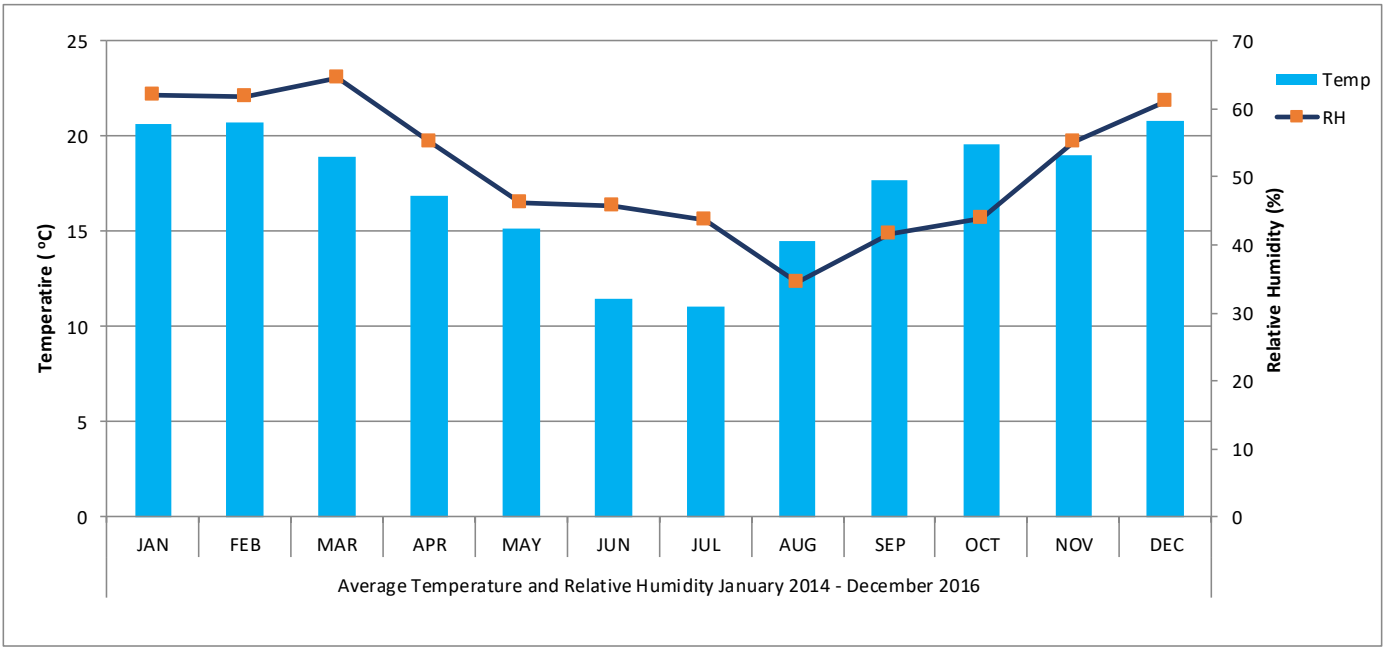
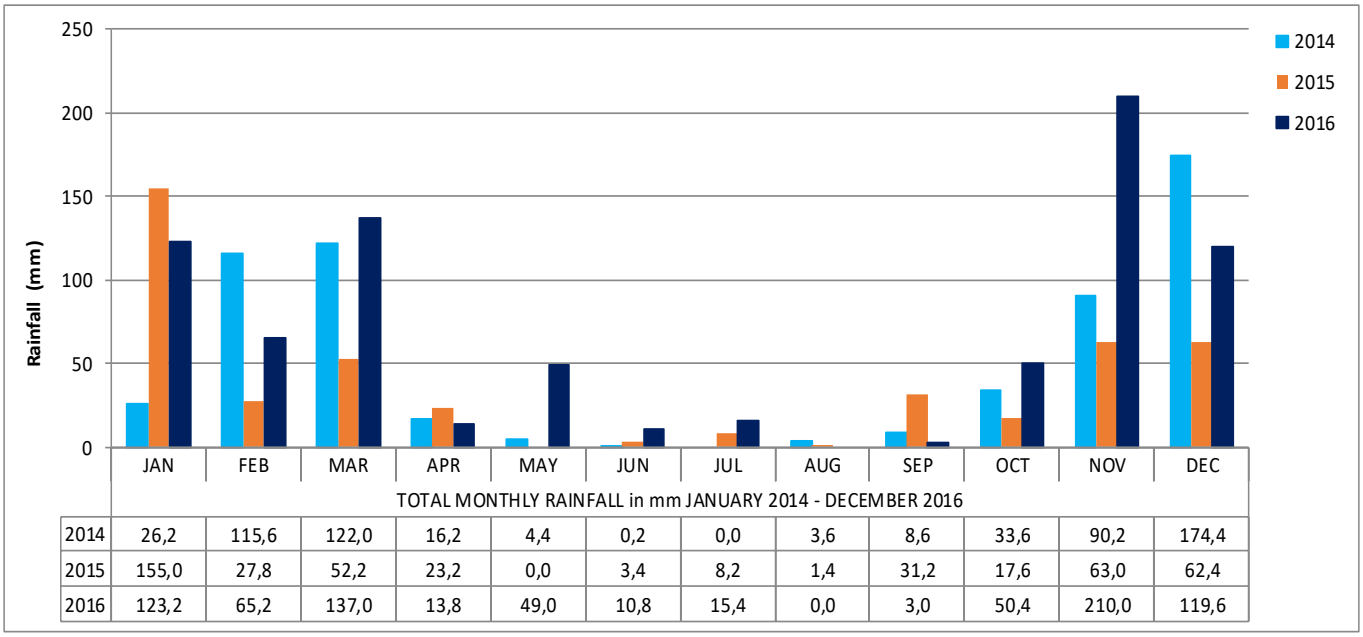


Figure 4-4: Monthly Average Temperature (°C) and Relative Humidity (%) Profile for the Period January 2013 to December 2016.

4.1.3 Precipitation

Precipitation has an overall dilution effect and cleanses the air by washing out particles and gases suspended in the atmosphere. Figure 4-5 shows monthly total rainfall for OR Tambo weather station for the period January 2013 to December 2016. The area receives most of its rainfall during the late spring and summer seasons during months October - March. Little to no rainfall is observed during the late autumn and winter seasons from April to September (Figure 4-5). Removal of pollutants via wet depositional processes would be evident during the spring and summer seasons thus lower ambient concentrations of particulates could be expected during these seasons. Over the remainder of the year higher ambient concentrations of air pollutants would be expected.



TOTAL MONTHLY RAINFALL in mm JANUARY 2014 - DECEMBER 2016

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2014	26,2	115,6	122,0	16,2	4,4	0,2	0,0	3,6	8,6	33,6	90,2	174,4
2015	155,0	27,8	52,2	23,2	0,0	3,4	8,2	1,4	31,2	17,6	63,0	62,4
2016	123,2	65,2	137,0	13,8	49,0	10,8	15,4	0,0	3,0	50,4	210,0	119,6

Figure 4-5: Total Monthly Rainfall (mm) for the Period January 2013 to December 2016.

4.2 Baseline Air Quality Concentrations

Existing sources of emissions (please refer to section 4.4 below) are all contributing to air pollution and air pollutant concentrations within the area. Air quality monitoring data is needed to assess the quality of the air that people residing in the proposed housing development site will potentially be exposed to. Air quality data is usually obtained from permanent ambient air quality monitoring stations and dust fallout networks operated within close proximity to the project site. The data provides an indication of the baseline air quality situation (i.e. quality of air). Ambient air quality standards have been developed for eight criteria air pollutants in South Africa (Table 3-1). These pollutants are considered to be harmful to human health (please refer to section 3.6). People who are exposed to pollutant concentrations that frequently exceed the acceptable ambient air quality standards, are considered to be vulnerable to potential health risks. South Africa has also developed Dust Control Regulations which provide acceptable dust fallout limits for residential and non-residential areas (Table 3-2). High dust fallout rates can act as a nuisance and damage property or crops and can also create irritation of the skin, eyes, nose and throat of people.

Air pollutant concentrations will vary for different areas due to the changes in the emission sources (i.e. type, characteristics and quantity), meteorology (i.e. wind speed, wind direction, temperature, etc.) and topography (i.e. terrain). Therefore, the air quality monitoring data, that is used to represent the air quality situation at a particular site, needs to be obtained from a sampling site that is operated in close proximity or even at the study site itself. This is often a significant limitation in baseline air quality studies; as in many cases, not all of the pollutants of concern are measured and for the pollutants that are measured, there is often a high percentage of missing or inaccurate data. Furthermore, the instruments and equipment used to monitor air pollutants is very expensive and sophisticated, thus making it difficult for monitoring to be undertaken.

In this study air quality data were obtained from a nearby station and dust fallout network operated in close proximity to the study site. Data were analysed to show the maximum, minimum, average and percentile concentrations for dust fallout, CO, NO_2, PM_{10} and SO_2, as these were the only pollutants that accurate data were available for. The frequency of exceedance of the pollutants with the applicable South African ambient standards and dust control regulations were also assessed. The data presented below, provides an indication of the ambient concentrations that people residing in the proposed housing development site will be exposed to. However, the limitations of the data, as discussed above, should be noted.

4.2.1 Criteria Air Pollutants

The Germiston Ambient Air Quality Monitoring Station (hereafter Germiston Station) is situated approximately <2 km west-south-west of the Kutalo Station proposed residential development site (26.227313° S; 28.177344 ° E) and is identified to be the nearest station to the project site where data is available for both meteorological and pollutant parameters on the SAAQIS (Figure 4-6, Table 4-2).

Figure 4-6: Locality of the Germiston Ambient Air Quality Monitoring Station (Red Pin). The Green Polygon Represents the Proposed Residential Development Site.

Table 4-2: Hourly Minimum, Maximum and Monthly Average Temperatures for the Period January 2013 to December 2016.

Germiston Station	Station Information	Abbreviation	Unit
Station ID	194		
Site Code	3		
Provider	Ekurhuleni Metropolitan Municipality	EMM	
Network	Ekurhuleni Metro	EM	
Description	Residential Ambient Monitoring Station		
Location	30 Delville Road, Delville Bowling Station		
Longitude	28.177344		Degrees
Latitude	-26,227313		Degrees
Site Classification	Urban Residential		
Data Interval	10		
Height Above Sea Level	1632		m
Site Topography	Flat Terrain		
Province	Gauteng	GP	
Municipality	Ekurhuleni Metropolitan Municipality	EMM	
Equipment Housing	Shelter		
Monitoring Objectives	Traffic and Industrial pollution from north-east to east of the monitoring station		
Parameters	Benzene	C6H6	ppb
	Carbon monoxide	CO	ppm
	Nitrogen dioxide	NO2	ppb
	Nitrogen oxide	NO	ppb
	Oxides of Nitrogen	NOX	ppb
	Ozone	O3	ppb
	Particulate Matter 10	PM10	µg/m3
	Sulphur dioxide	SO2	ppb
	Toluene	C6H5-CH3	ppb
	Xylene	C8H10	ppb
	Humidity	RH	%
	Rainfall		mm
	Temperature Ambient	TA	°C
	Wind Direction	WD	Degrees
	Wind Speed	WS	m/s
	Line Voltage	LV	V

Baseline concentrations for CO, NO_2 PM_{10} and SO_2 for the Germiston Station are shown below for the period January 2011 to December 2016. The data were provided by the South African Weather Services (SAWS). Data quality checks were performed; however, it is assumed that the data provided is accurate.

4.2.2.1. Carbon Monoxide (CO)

Daily average CO concentrations at Germiston Station for the period January 2011 to December 2016 are provided in Figure 4-7. Daily CO concentrations are generally recorded as < 5 ppm and range from 0.00 – 32.69 ppm for the period (there is no daily National Ambient Air Quality Standard for CO) (Table 4-3). Diurnal variation is shown for CO concentrations, indicating an increase in the early morning (6:00) and early evening periods (18:00); which is likely due to domestic fuel burning activity in the surrounding informal settlements (Figure 4-8). Higher seasonal concentrations are observed during autumn and winter (March - August) (Figure 4-8). Increased fuel burning for heating purposes and the winter inversion layer contribute to higher CO concentrations during the winter season. Weekday trends indicate an increase in CO concentrations on Monday, with a steep decline in concentrations from Friday and over the weekend period (Friday – Sunday) (Figure 4-8).

The annual average CO concentrations for the years 2011 to 2016 ranged between 0.45 and 5.07 ppm; with a total of 37% data availability for the monitoring period (January 2011 to December 2016) (Table 4-4). Hourly average CO concentrations range from 0.00 – 106.27 ppm with concentrations ≤1.85 ppm observed 99% of the time throughout the monitoring period. There were 64 exceedances of the hourly National Ambient Air Quality Standard of 26 ppm for CO for the period 2011 to 2016 (Figure 4-16, Table 4-5).

4.2.2.2. Nitrogen Dioxide (NO_2)

Daily average NO_2 concentrations at Germiston Station for the period January 2011 to December 2016 are provided in Figure 4-9. Daily NO2 concentrations ranged between 0.10 – 46.24 ppb (there is no daily National Ambient Air Quality Standard for NO2) (Table 4-3). Diurnal variation is shown for NO_2 concentrations with a gradual increase observed during the early morning (7:00) and a significant increase observed during the early evening period (17:00 – 19:00). Concentrations are specifically noted to be low during the period 20:00 – 7:00. These diurnal trends are likely due to higher vehicle emissions during peak traffic times. Higher seasonal concentrations are observed during winter (June – August). During the weekday period, concentrations increase on Monday and show a consistent trend through to Friday. A decrease in concentrations is noted over the weekend period (Friday – Sunday) (Figure 4-10).

The annual average NO_2 concentrations for the years 2011 to 2016 ranged between 11.08 and 19.53 ppb; falling below the annual average standard of 21 ppb (Table 4-4). There is a total of 54% data availability for the monitoring period (January 2011 to December 2016) (Table 4-4). Hourly average NO_2 concentrations for the period ranged between 0.00– 91.12 ppb; with no exceedances of the hourly limit of 106 ppb recorded (Figure 4-17, Table 4-5).

4.2.2.3. Particulate Matter (PM_{10})

Daily average PM_{10} concentrations at Germiston Station for the period January 2011 to December 2016 are provided in Figure 4-11. Daily average PM_{10} concentrations ranged between 0.00 – 163.14 µg/m^3, with 82 exceedances of the daily standard of 75 µg/m^3 recorded during the monitoring period (Table 4-3). Seasonal concentrations indicate higher concentrations during autumn and winter (March - August).

The annual average PM_{10} concentrations for the years 2011 to 2016 ranged between 19.47 - 50.73 µg/m^3 with annual concentrations exceeding the National Ambient Annual Air Quality Standard of 40 µg/m^3 during 2011, 2012 and 2014 (Table 4-4). There is a total of 37% data availability for the monitoring period (January 2011 to December 2016) (Table 4-4).

4.2.2.4. Sulphur Dioxide (SO_2)

Daily average SO_2 concentrations at Germiston Station for the period January 2011 to December 2016 are provided in Figure 4-17. Daily SO_2 concentrations ranged from 0.23 – 37.67 ppb with no exceedances of the daily standard of 48 ppb recorded (Table 4-13). Diurnal variation in SO_2 concentrations indicates an increase in the morning (8:00 – 9:00), with a gradual decrease in concentrations to 13:00. A consistent pattern of concentrations extends through the afternoon to early evening period (13:00 – 18:00), with an increase observed from 20:00. Seasonal concentrations of SO_2 fluctuate with no specific pattern evident. The highest average concentrations are recorded for spring. Weekday trends show a steep increase in SO_2 concentrations recorded from late Monday, with a decrease in concentrations towards the weekend period (Friday – Sunday) (Figure 4-14).

The annual average SO_2 concentration for the years 2011 to 2016 ranged from 8.97 – 11.61 ppb; falling below the annual average standard of 19 ppb (Table 4-4). There is a total of 40% data availability for the monitoring period (May 2014 to Dec 2015) (Table 4-4). Hourly average SO_2 concentrations for the period ranged between 0.00 – 120.19 ppb, there were no exceedances of the hourly standard of 134 ppb (Figure 4-18, Table 4-5).

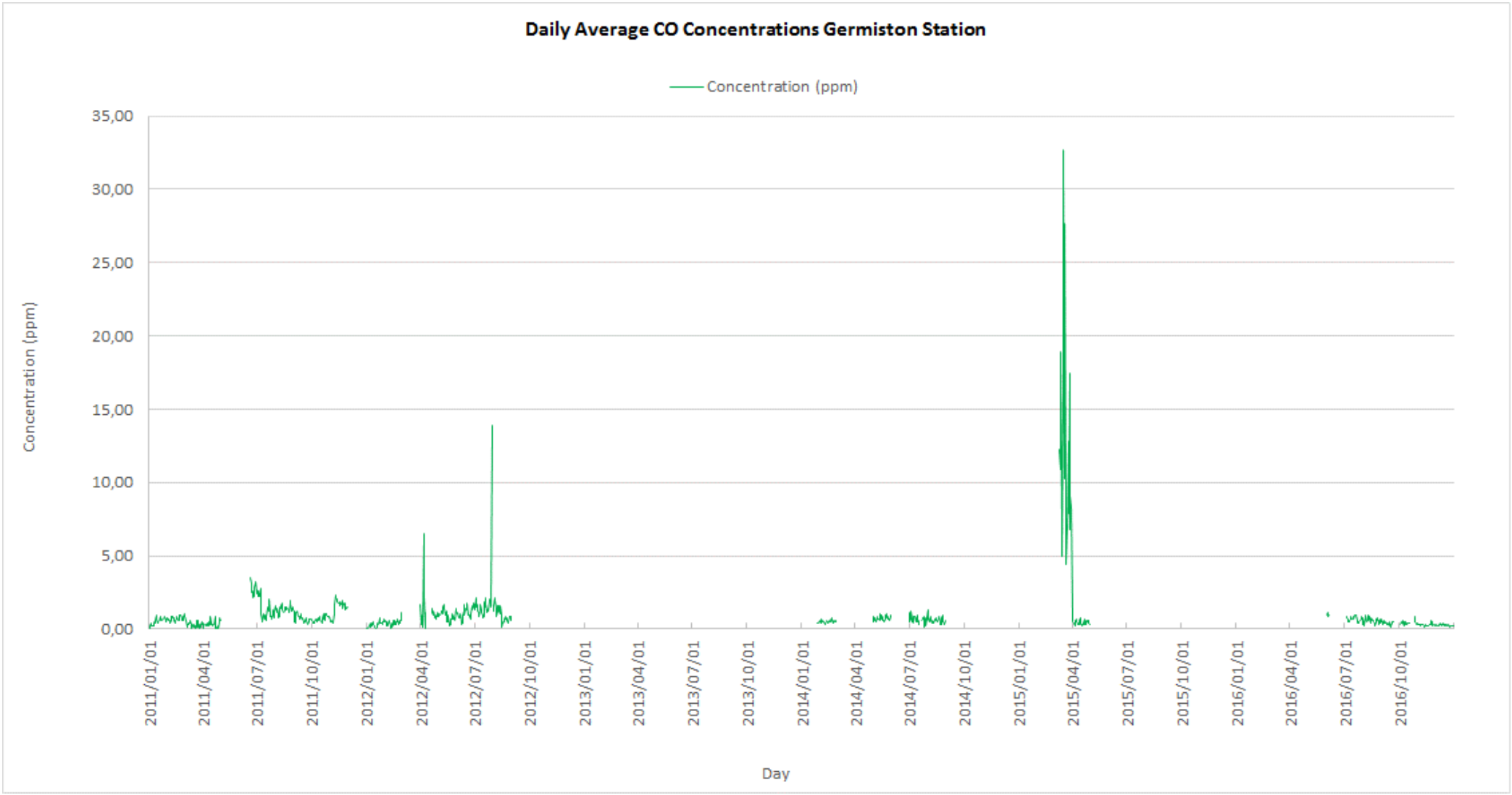


Figure 4-7: Daily Average CO Concentrations (ppm) for the period January 2011 to December 2016.

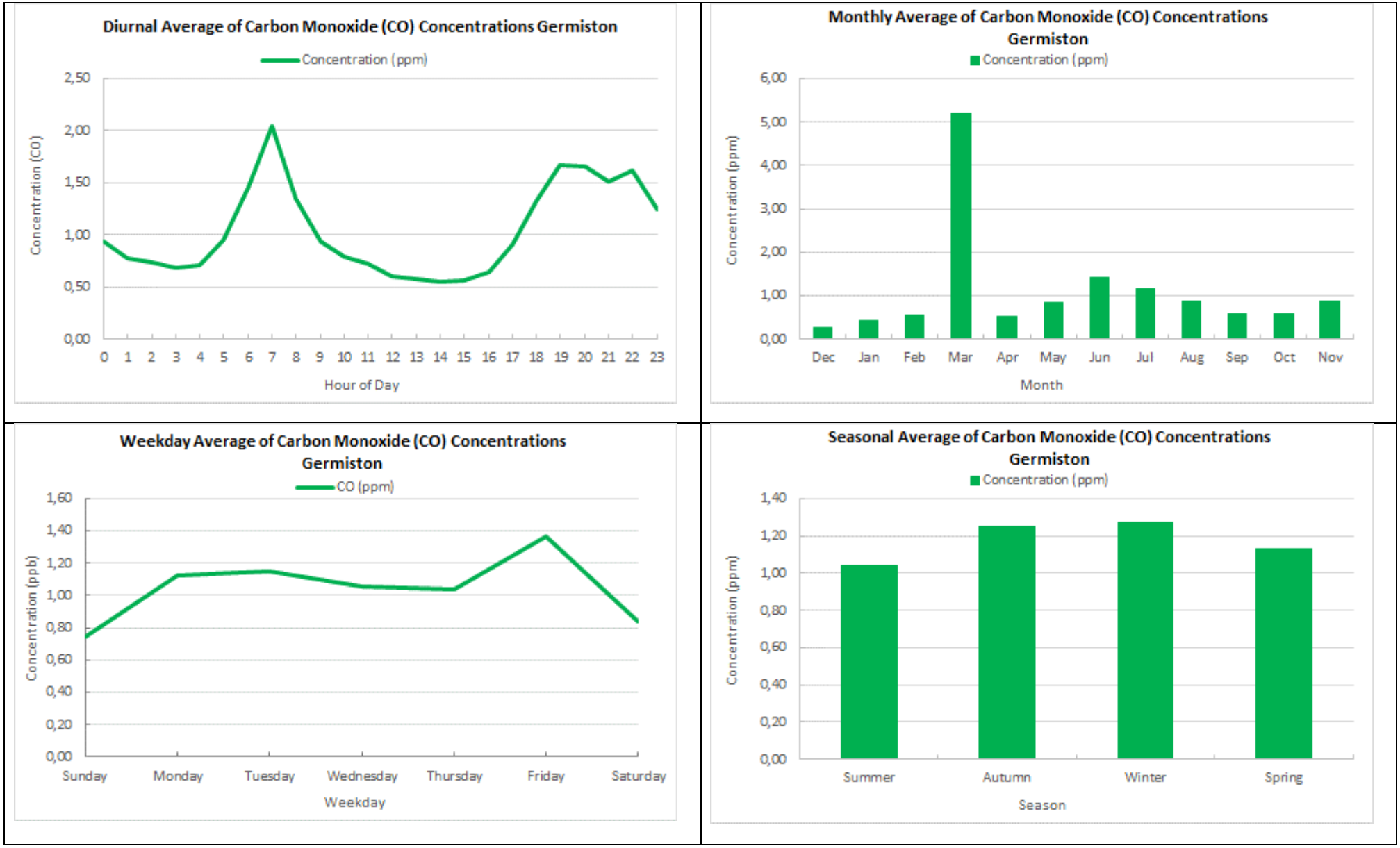


Figure 4-8: Average Diurnal, Weekday, Monthly and Seasonal CO Concentrations (ppm) for the Period January 2011 to December 2016.

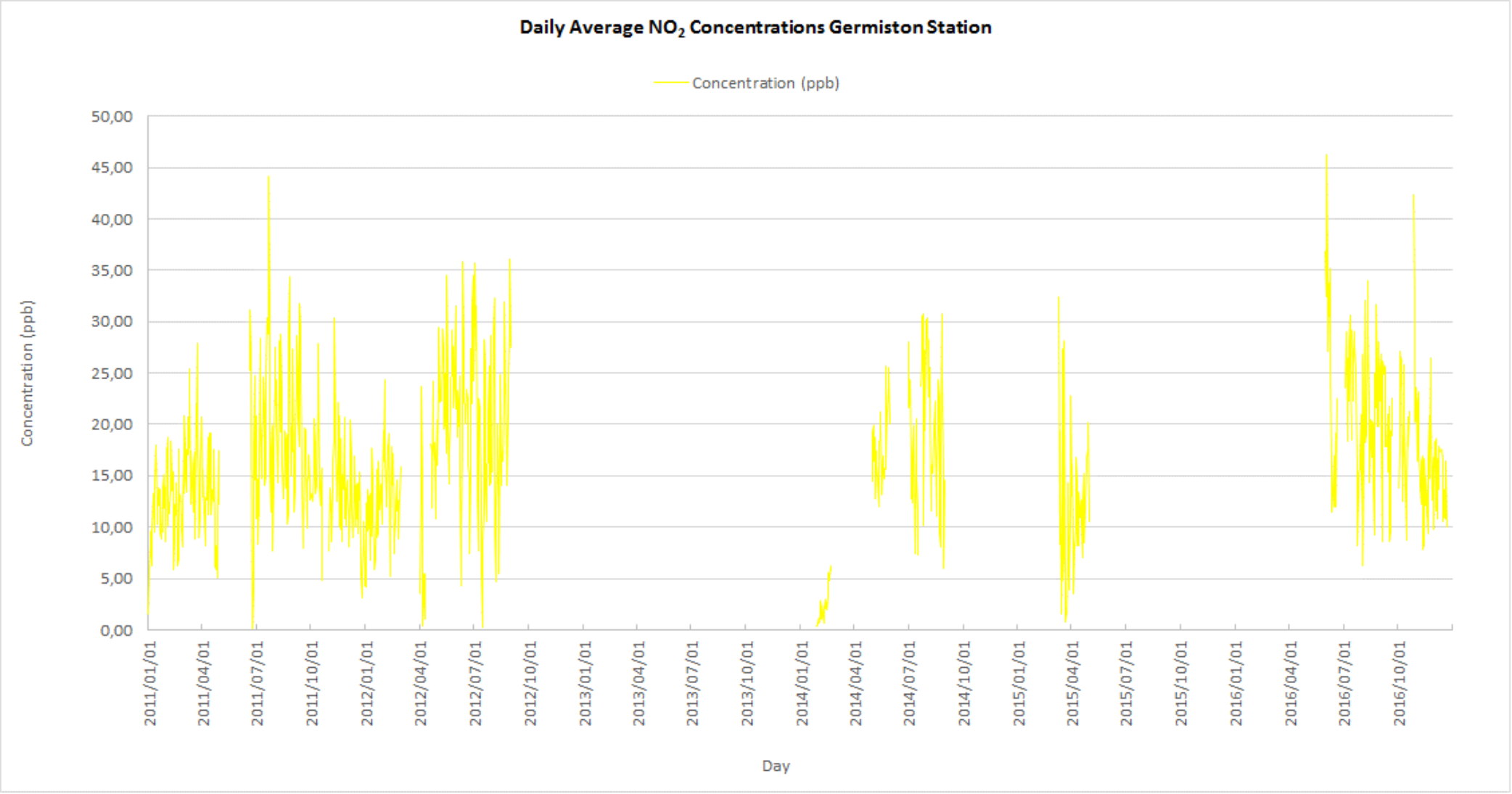


Figure 4-9: Daily Average NO_2 Concentrations (ppb) for the period January 2011 to December 2016.

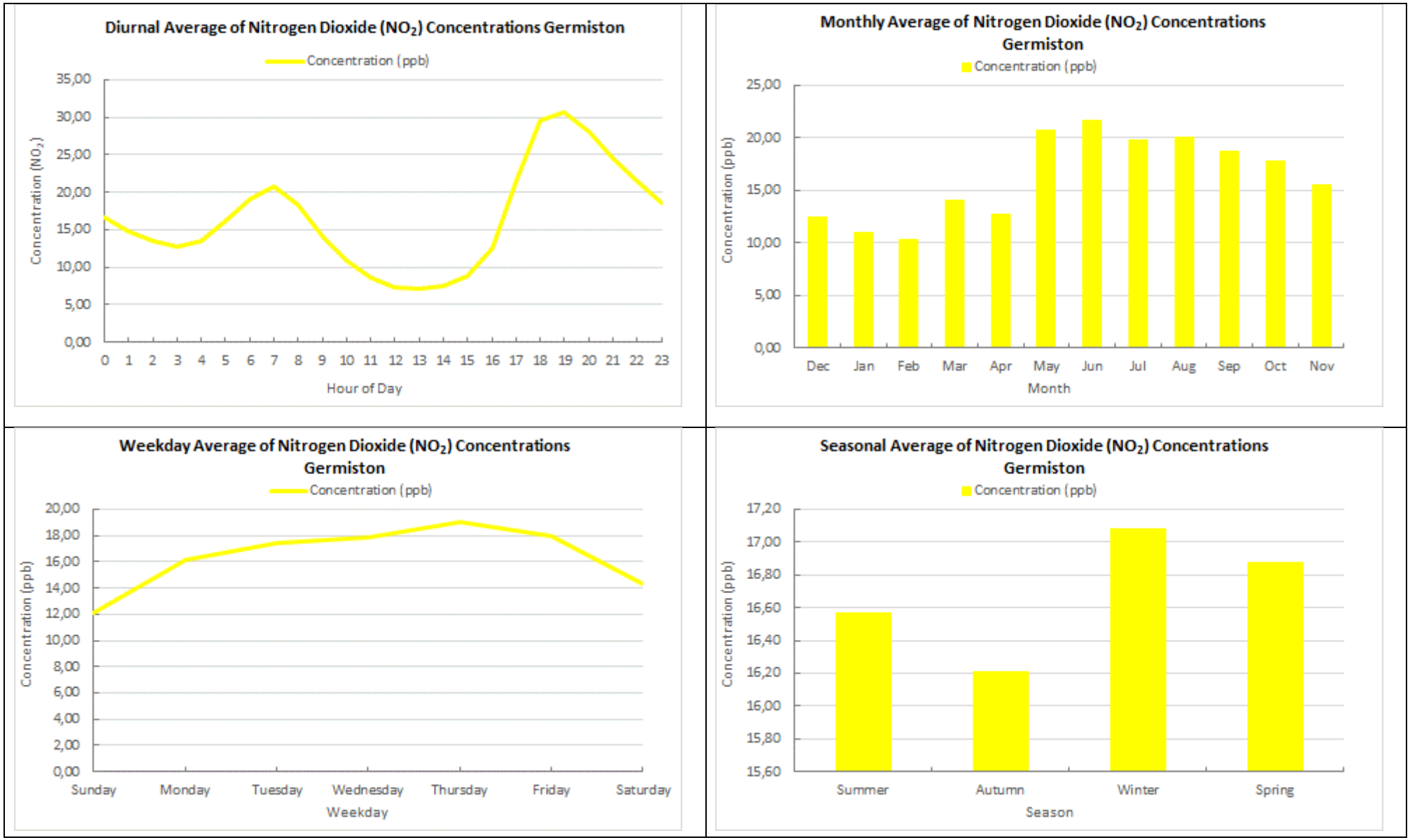


Figure 4-10: Average Diurnal, Weekday, Monthly and Seasonal NO_2 Concentrations (ppb) for the period January 2011 to December 2016.

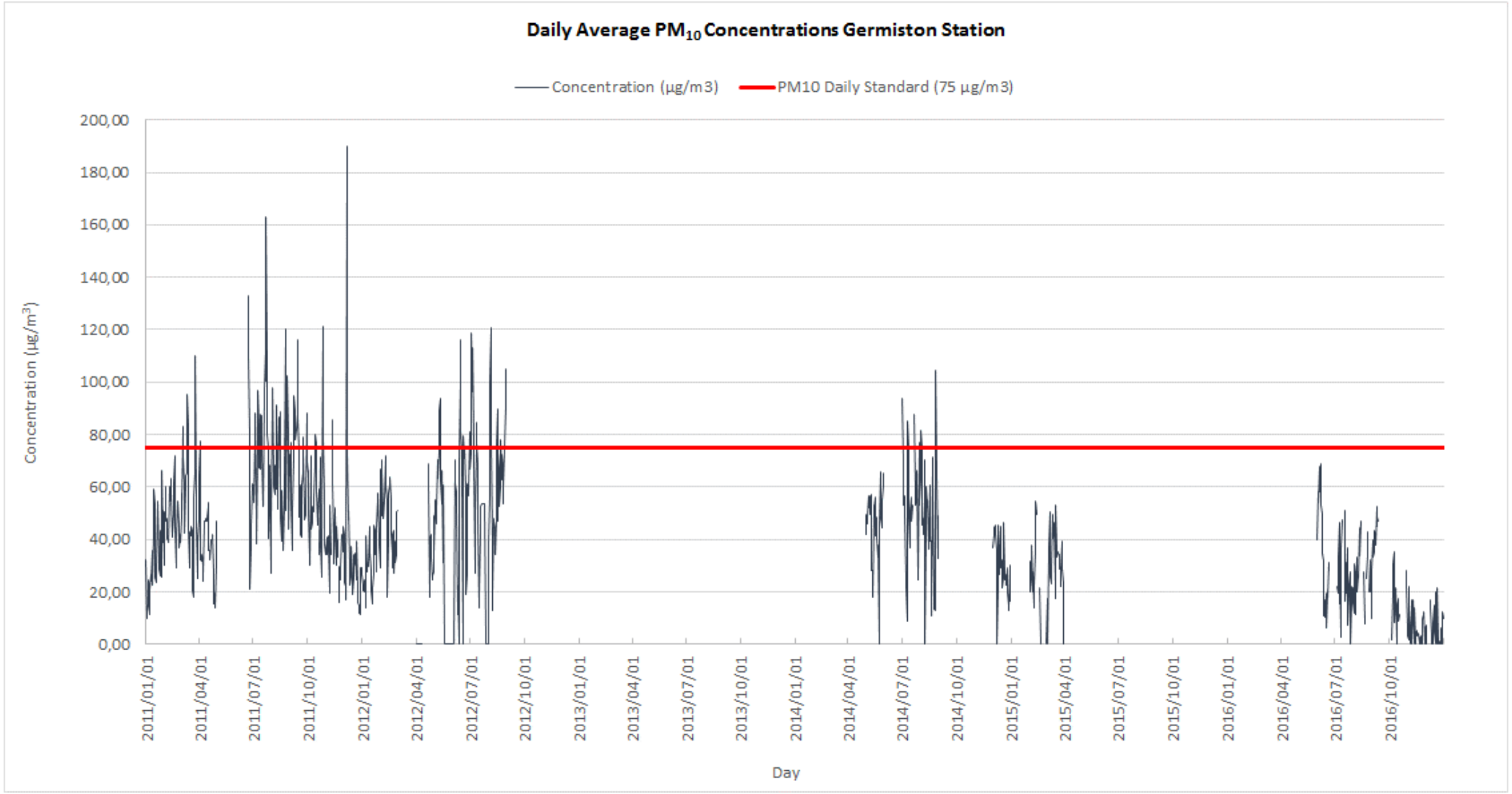
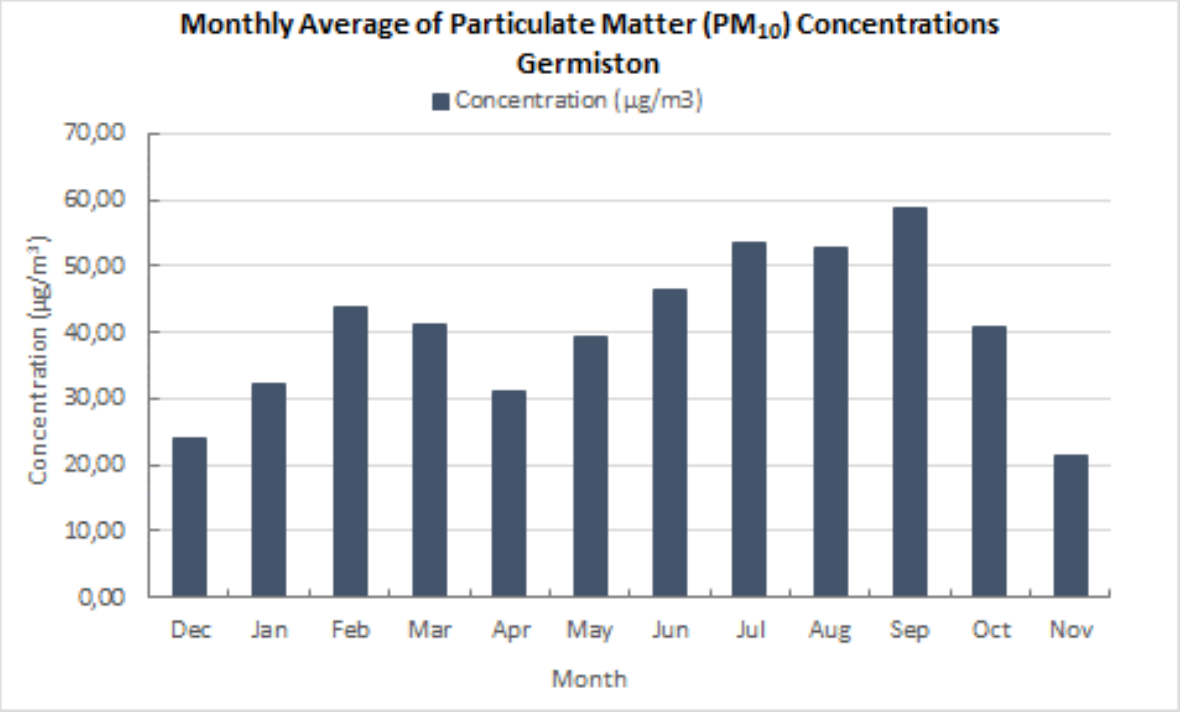


Figure 4-11: Daily Average PM_{10} Concentrations ($\mu g/m^3$) for the period January 2011 to December 2016.



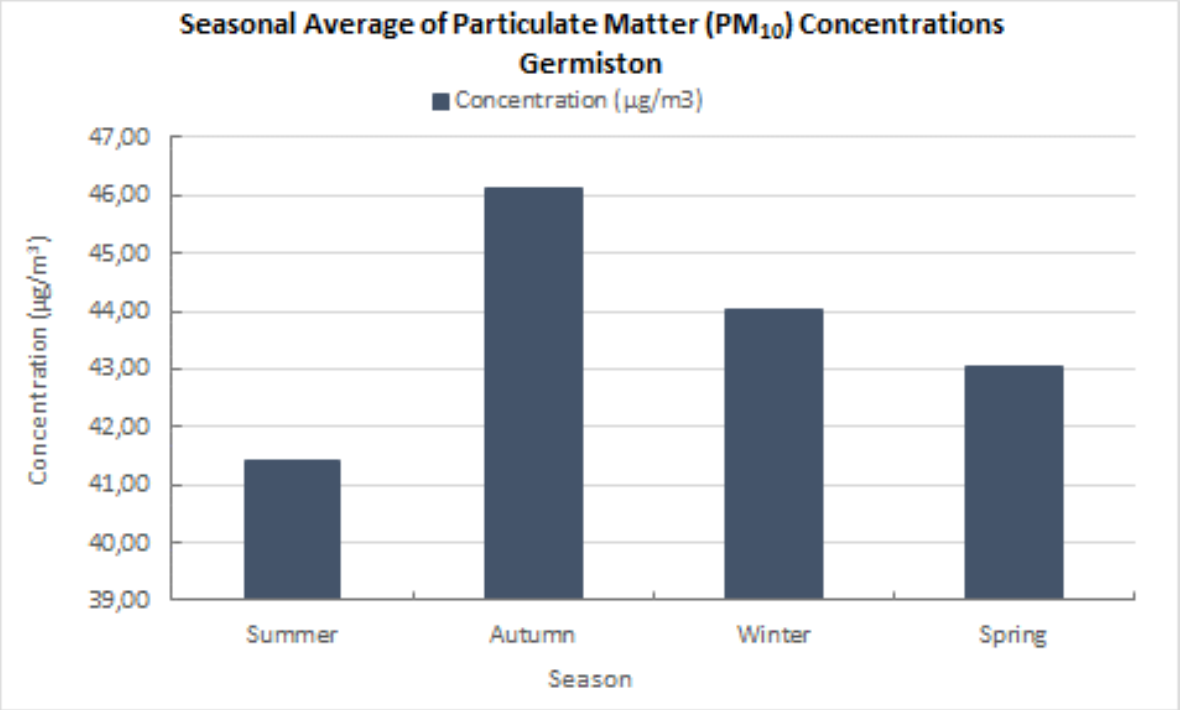


Figure 4-12: Monthly and Seasonal PM_{10} Concentrations (µg/m^3) for the period January 2011 to December 2016.

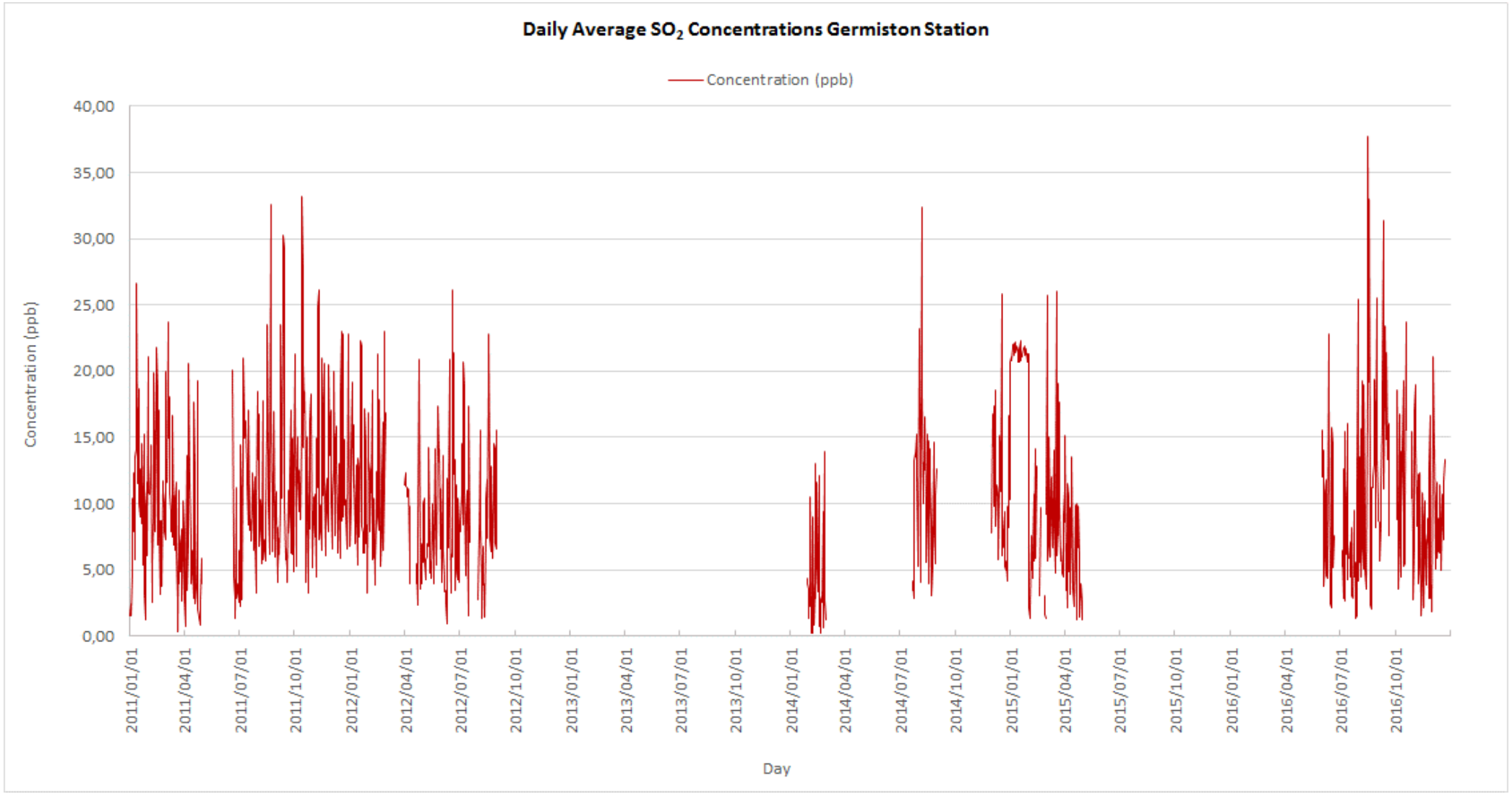


Figure 4-13: Daily Average SO_2 Concentrations (ppb) for the period January 2011 to December 2016.

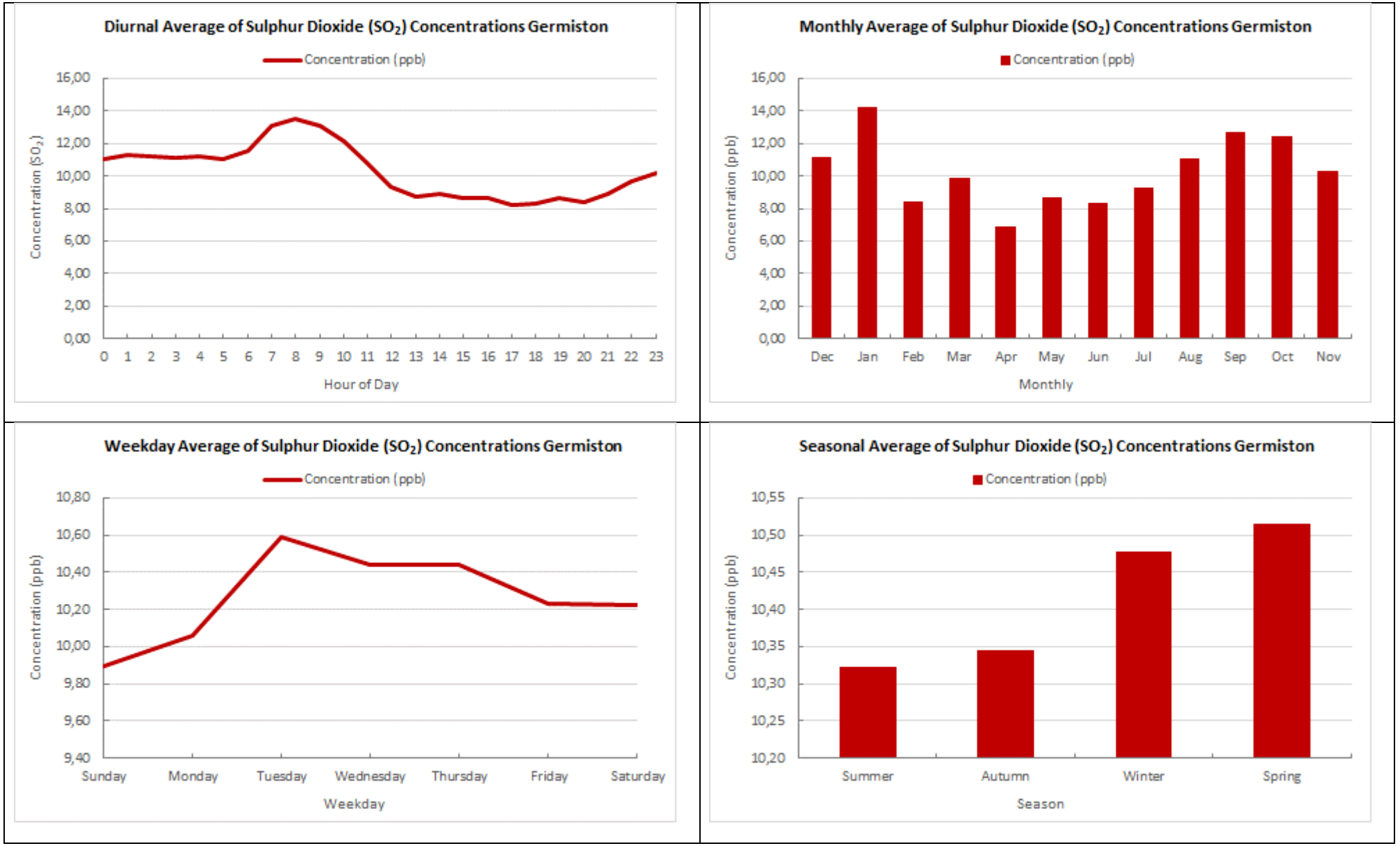


Figure 4-14: Average Diurnal, Weekday, Monthly and Seasonal SO_2 Concentrations (ppb) for the period January 2011 to December 2016.

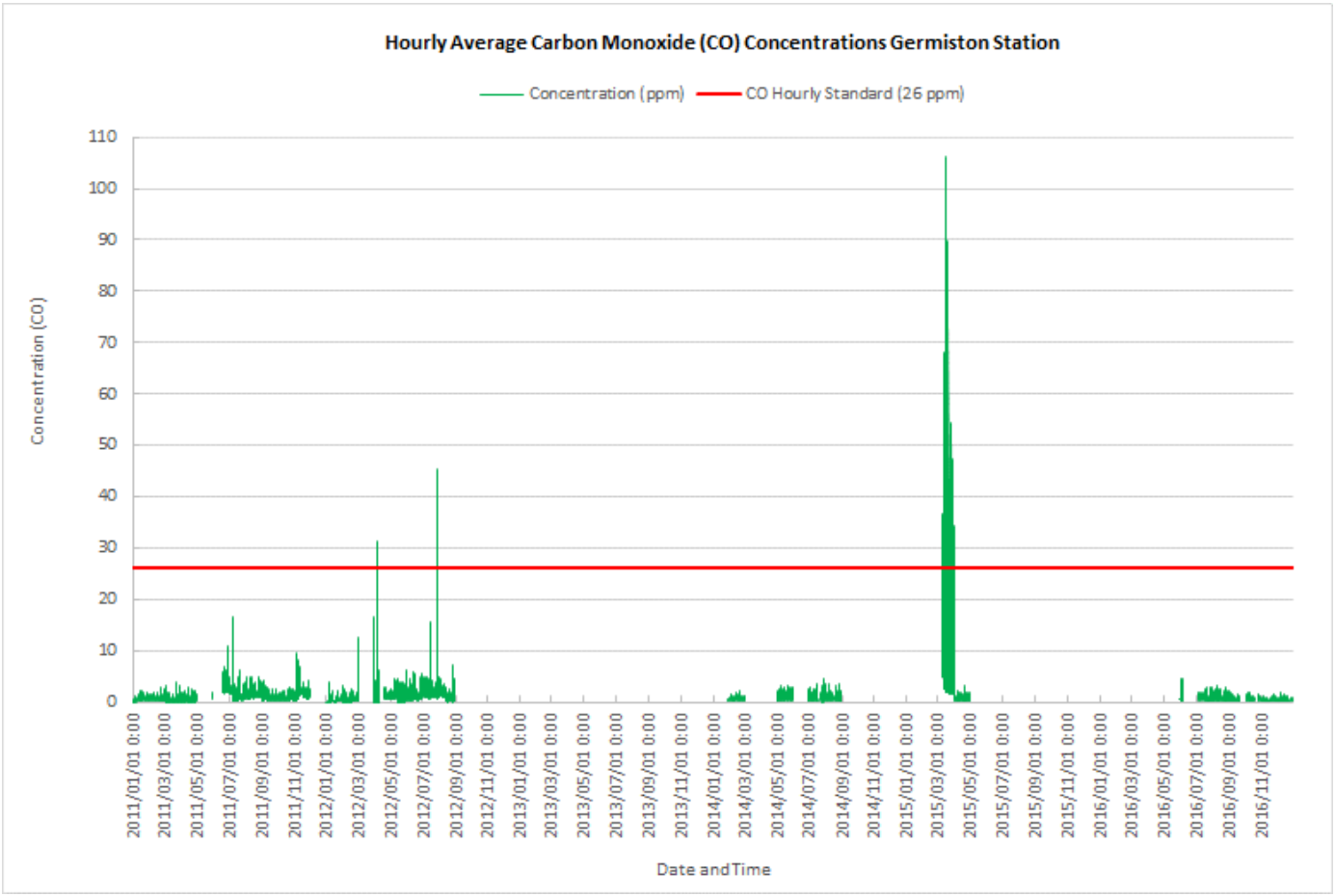


Figure 4-15: Hourly Average CO Concentrations (ppm) for the period January 2011 to December 2016.

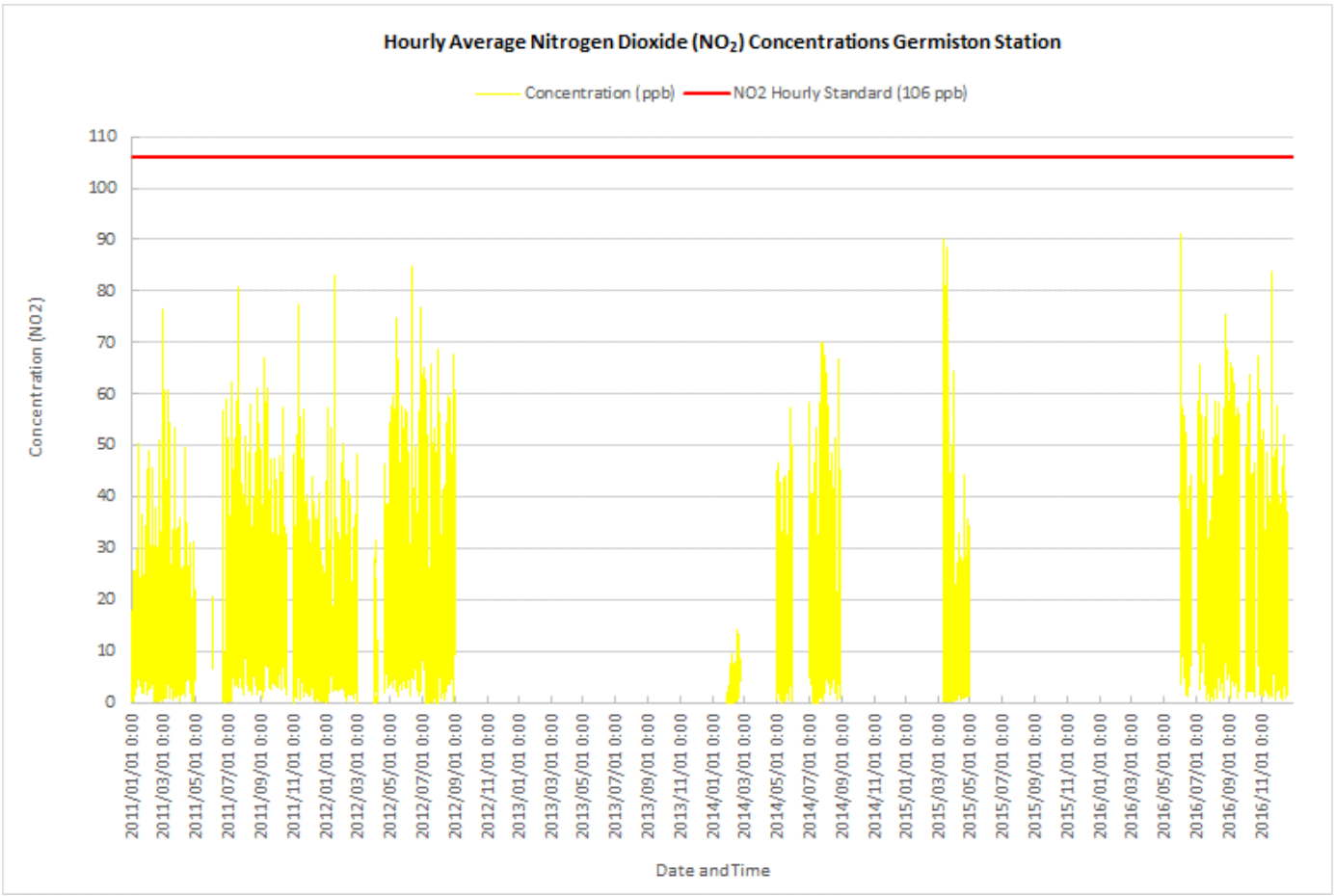


Figure 4-16: Hourly Average NO_2 Concentrations (ppb) for the period January 2011 to December 2016.

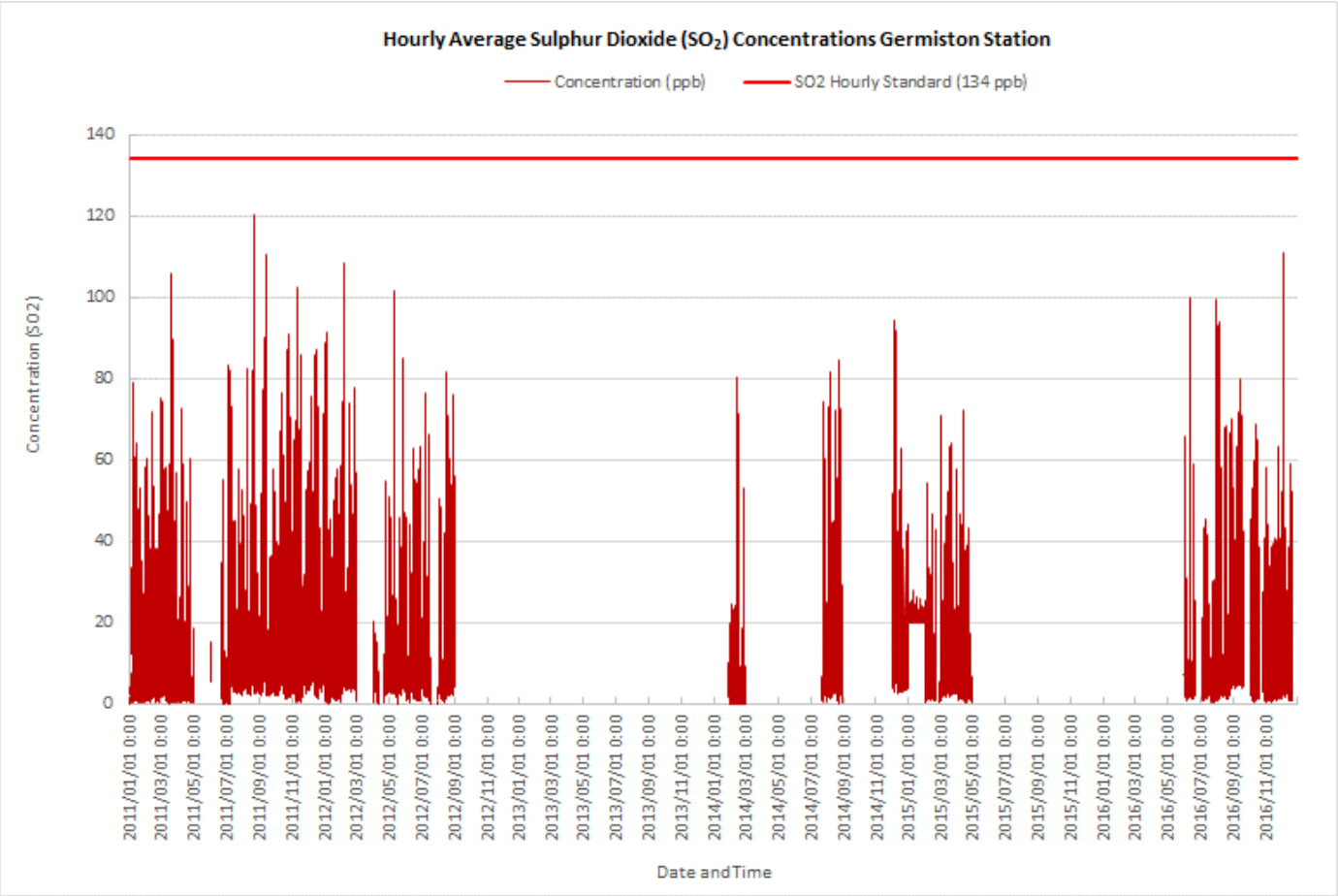


Figure 4-17: Hourly Average SO_2 Concentrations (ppb) for the period January 2011 to December 2016.

Table 4-3: Data Summary Table for Daily Average Concentrations for the Period January 2011 to December 2016.

Data Summary Table	CO (ppm)	NO_2 (ppb)	PM_{10} ($\mu g/m^3$)	SO_2 (ppb)
99th percentile	1,61	27,04	74,63	19,26
75th percentile	0,96	21,18	56,17	13,64
50th percentile	0,62	15,73	40,17	9,28
25th percentile	0,39	11,57	22,45	5,73
Maximum	32,69	46,24	163,14	37,67
Minimum	0,00	0,10	0,00	0,23
Frequency of exceedance of standard	-	-	**82*	*0*
National Ambient Air Quality Standard (Daily)	-	-	*75*	*48*
*The percentile indicates the percentage of time (i.e. 99%) that the concentrations are below the provided daily standard value. *Above the average daily acceptable National Ambient Air Quality Standards, therefore likely effects on human health and the environment.*				

Table 4-4: Annual Average Concentrations and Overall Percentage Data Availability for the Period January 2011 to December 2016.

Year	C_6H_6 (ppb)	CO (ppm)	NO (ppb)	NO_2 (ppb)	NO_X (ppb)	O_3 (ppb)	PM_{10} ($\mu g/m^3$)	SO_2 (ppb)
2011	8,09	1,03	10,99	15,43	26,55	*No data*	*50,73	10,79
2012	*No data*	0,93	16,57	18,04	34,21	*No data*	*43,95	9,70
2013	*No data*	*No data*	*No data*	*No data*	*No data*	*No data*	*No data*	*No data*
2014	*No data*	0,62	14,64	15,11	27,26	-	*43,37	8,97
2015	*No data*	5,07	10,42	11,08	10,21	*No data*	28,53	11,61
2016	*No data*	0,45	15,58	19,53	34,79	*No data*	19,47	10,13
National Ambient Annual Air Quality Standard	*1.6*	-	-	*21*	-	-	*40*	*19*
Data Availability	*12%*	*37%*	*55%*	*54%*	*38%*	*2%*	*37%*	*40%*
**Above the average annual acceptable National Ambient Air Quality Standards, therefore likely effects on human health and the environment.*								

Table 4-5: Data Summary Table for Hourly Average Concentrations for the Period January 2011 to December 2016.

Data Summary Table	CO (ppm)	NO_2 (ppb)	SO_2 (ppb)
99th percentile	1,85	34,82	23,22
75th percentile	1,04	23,40	13,33
50th percentile	0,54	13,22	6,25
25th percentile	0,27	6,80	3,35
Maximum	106,27	91,12	120,19
Minimum	0,00	0,00	0,00
Frequency of Exceedance of Standard	**64*	*0*	*0*
National Ambient Air Quality Standard (Hourly)	*26*	*106*	*134*
*The percentile indicates the percentage of time (i.e. 99%) that the concentrations are below the provided hourly standard value. *Above the average hourly acceptable National Ambient Air Quality Standards, therefore likely effects on human health and the environment.*			

4.2.2 Dust Fallout Rates

Dust fallout monitoring is conducted by a mining company using 27 sites that fall within the south-easterly quadrant, > 1km < 10km from the Kutalo Station project site. Five of the 27 sites (Site 22 – 26) are located around a tailings facility (Figure 4-22). Seven of the dust fallout sites are located < 5km from the Kutalo Station Site (Figure 4-23, Table 4-6).

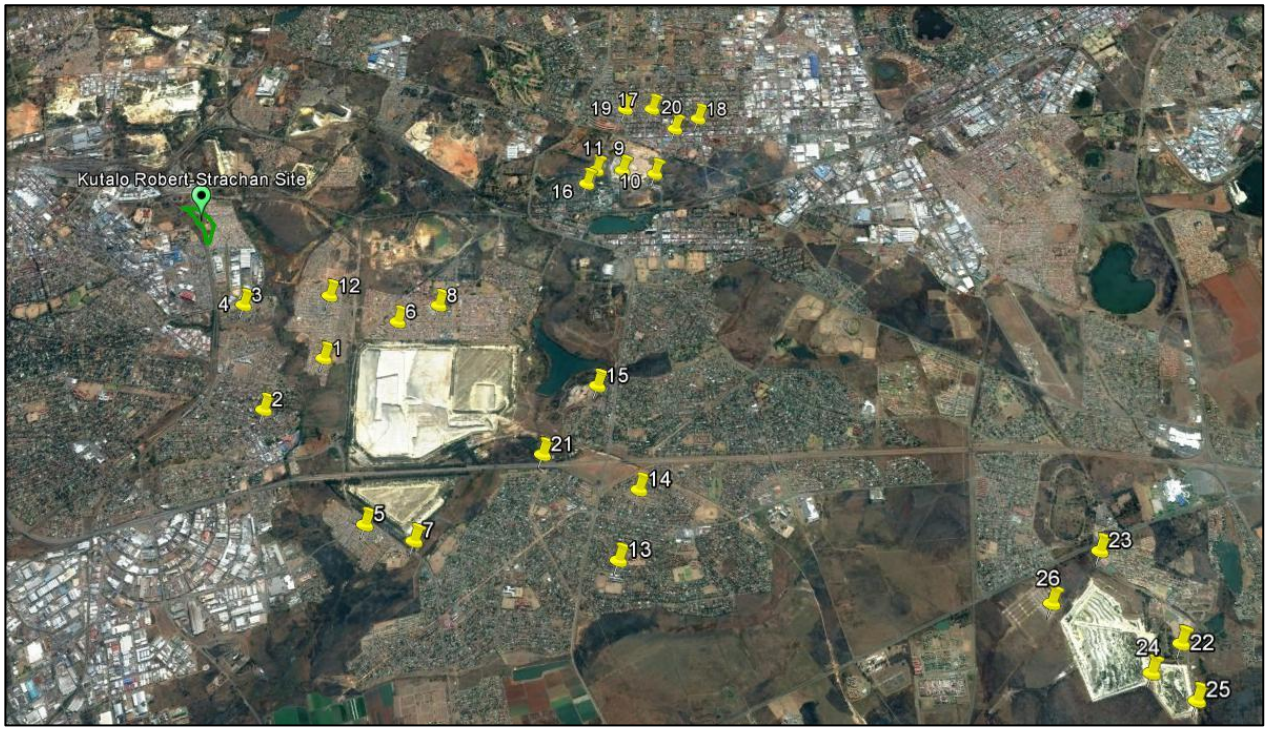


Figure 4-18: Locality of the 27 Dust Fallout Sampling Sites (Yellow Pins) Surrounding the Kutalo Station Site (Green Polygon).

Figure 4-19: Locality of the 5 Dust Fallout Sampling Sites (Yellow Pins) Located < 5km from the Kutalo Station Site (Green Polygon).

Dust fallout monitoring results for all 27 sites for the period July – December 2015 are provided in Figure 4-24. Maximum dust fallout rates for all 27 sites during the 2015 monitoring period ranged from 210 – 1586 mg/m^2/day. A total of two exceedances of the residential limit of 600 mg/m^2/day were recorded in 2015, at Site 1 (July 2015) and site 18 (October 2015). One exceedance of the non-residential standard of 1200 mg/m^2/day was recorded at site 10 (December 2015) (Table 4-7). Site 1 is located 2.78 km from the Kutalo Station Site, whilst sites 10 and 18 are located 6.14 and 6.86 km from the Kutalo Station Site, respectively (Figure 4-22).

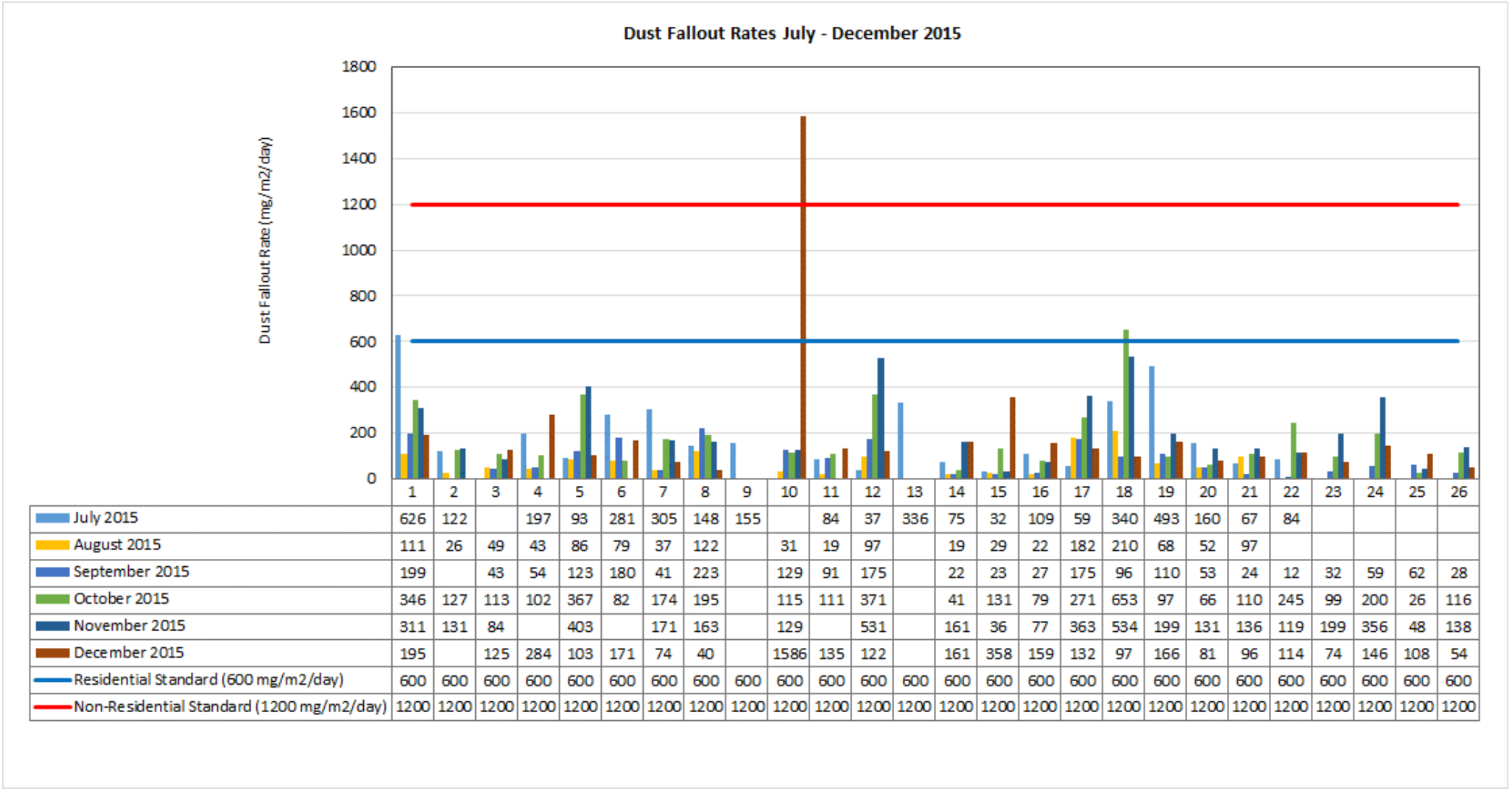
Dust fallout monitoring results for all 27 sites for the period January 2016 – October 2016 are provided in Figure 4-25. Maximum dust fallout rates during the 2016 monitoring period ranged from 107 – 403 mg/m^2/day. There were no exceedances of the residential (600 mg/m^2/day) and non-residential (1200 mg/m^2/day) limits, for all 27 sites during 2016 (Table 4-7).

Dust fallout monitoring results at sites 1 – 4, 6, 8 and 12 for the period July – December 2015 and January – October 2016 are provided in Figure 4-26, Table 4-8 and Figure 4-27, Table 4-19, respectively. Maximum dust fallout rates for the seven sites during 2015 ranged from 122 – 626 mg/m^2/day. One exceedance of the residential limit of 600 mg/m^2/day was recorded at site 1 during the July 2015 monitoring period (Figure 4-26, Table 4-8).

Maximum dust fallout rates for the seven sites during the 2016 monitoring period ranged from 90 – 381 122 – 626 mg/m^2/day. There were no exceedances of the residential (600 mg/m^2/day) and non-residential (1200 mg/m^2/day) limits, for the seven sites during 2016 (Figure 4-27, Table 4-9).

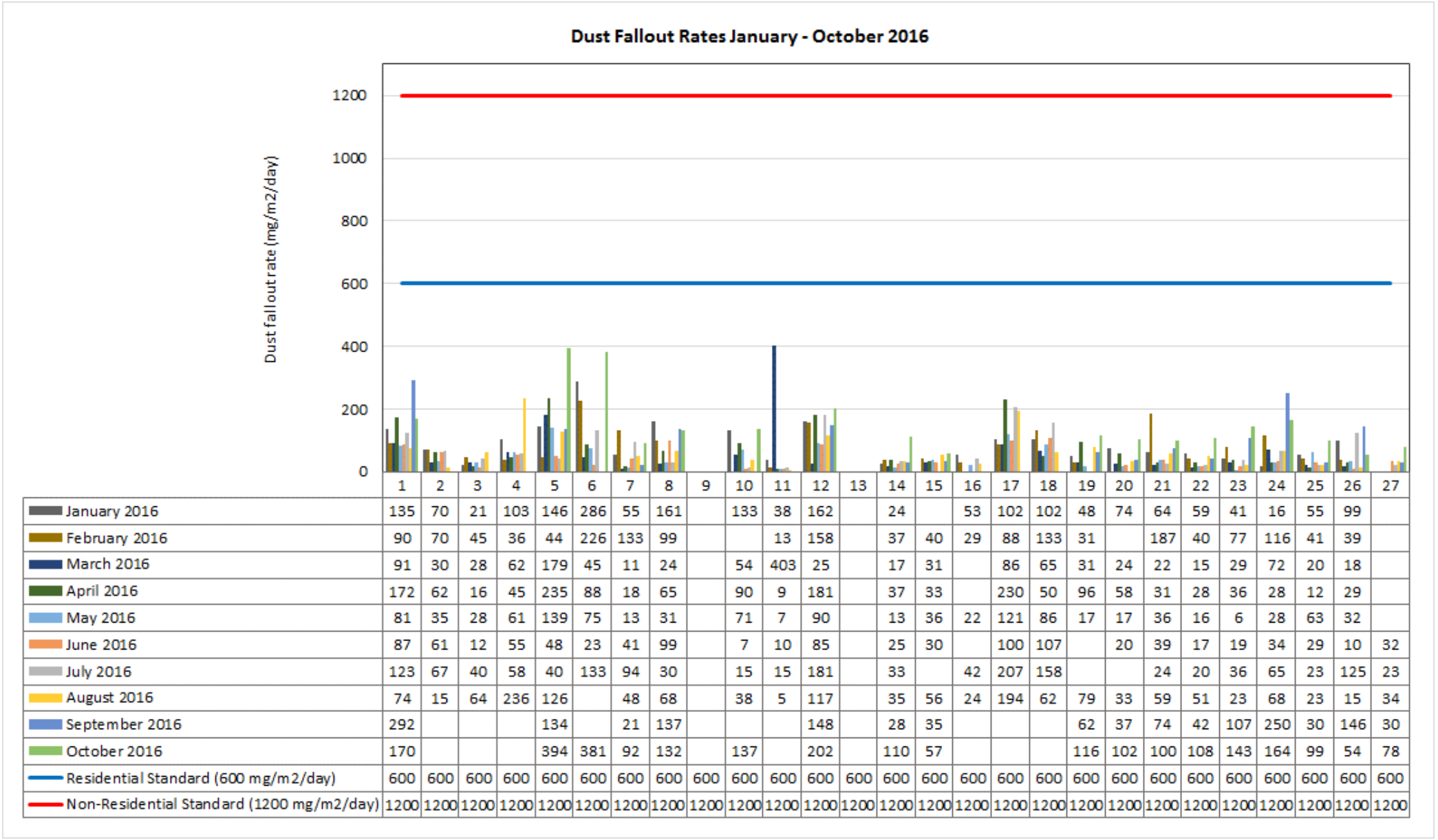
Table 4-6: Dust Fallout Site Description and Location.

Dust Fallout Site Number	Site Classification	Residential Area Standard (mg/m2/day)	Proximity to Project Site (km)	Direction from Project Site
1	Residential	600	2.78	SE
2	Residential	600	3.05	SSE
3	Residential	600	1.49	SSE
4	Residential	600	1.57	SSE
6	Residential	600	3.16	ESE
8	Residential	600	3.56	ESE
12	Residential	600	2.19	ESE



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
July 2015	626	122		197	93	281	305	148	155		84	37	336	75	32	109	59	340	493	160	67	84				
August 2015	111	26	49	43	86	79	37	122		31	19	97		19	29	22	182	210	68	52	97					
September 2015	199		43	54	123	180	41	223		129	91	175		22	23	27	175	96	110	53	24	12	32	59	62	28
October 2015	346	127	113	102	367	82	174	195		115	111	371		41	131	79	271	653	97	66	110	245	99	200	26	116
November 2015	311	131	84		403		171	163		129		531		161	36	77	363	534	199	131	136	119	199	356	48	138
December 2015	195		125	284	103	171	74	40		1586	135	122		161	358	159	132	97	166	81	96	114	74	146	108	54
Residential Standard (600 mg/m2/day)	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
Non-Residential Standard (1200 mg/m2/day)	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200

Figure 4-20: Dust Fallout Rates at all 27 Sampling Sites for the Period July – December 2015.



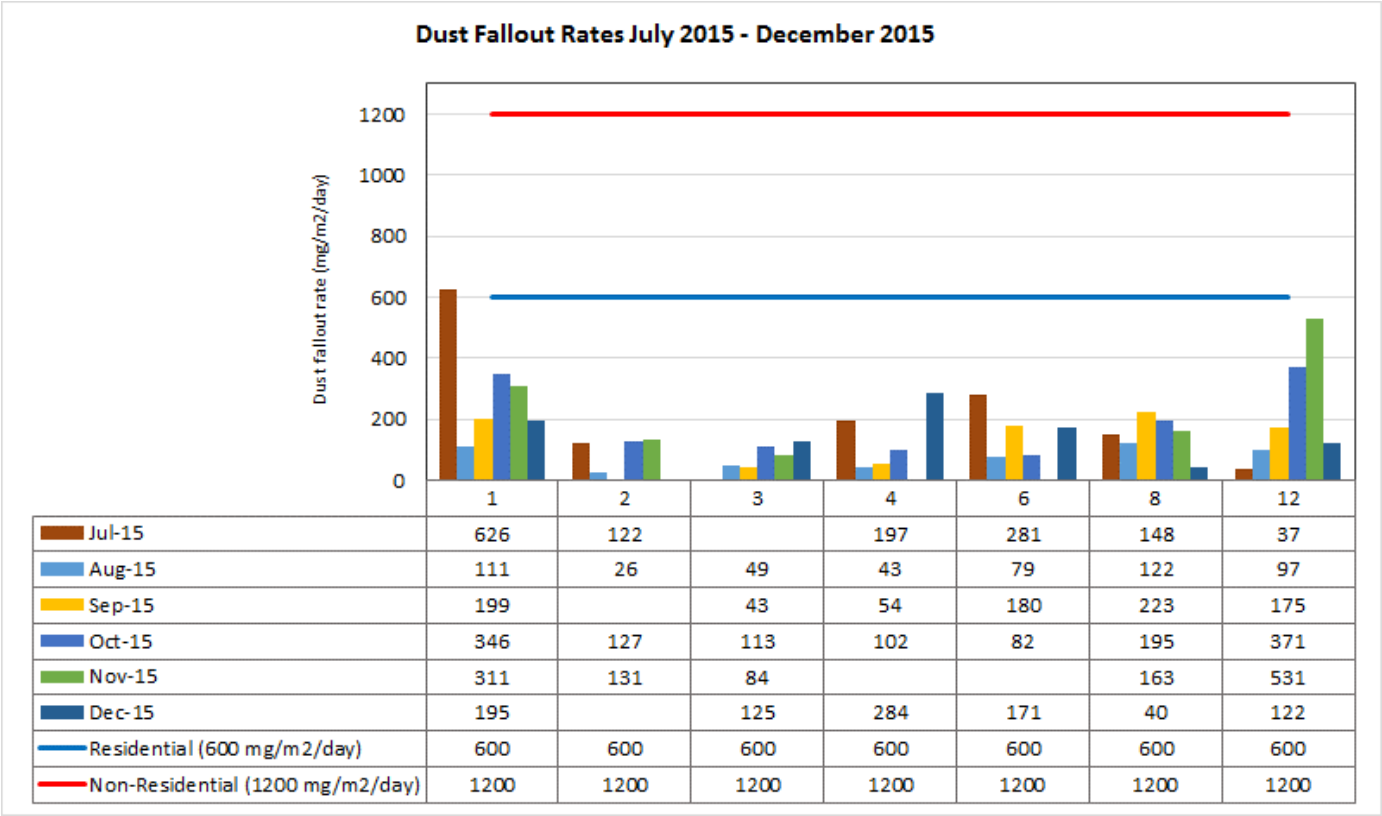
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
January 2016	135	70	21	103	146	286	55	161		133	38	162		24		53	102	102	48	74	64	59	41	16	55	99	
February 2016	90	70	45	36	44	226	133	99			13	158		37	40	29	88	133	31		187	40	77	116	41	39	
March 2016	91	30	28	62	179	45	11	24		54	403	25		17	31		86	65	31	24	22	15	29	72	20	18	
April 2016	172	62	16	45	235	88	18	65		90	9	181		37	33		230	50	96	58	31	28	36	28	12	29	
May 2016	81	35	28	61	139	75	13	31		71	7	90		13	36	22	121	86	17	17	36	16	6	28	63	32	
June 2016	87	61	12	55	48	23	41	99		7	10	85		25	30		100	107		20	39	17	19	34	29	10	32
July 2016	123	67	40	58	40	133	94	30		15	15	181		33		42	207	158			24	20	36	65	23	125	23
August 2016	74	15	64	236	126		48	68		38	5	117		35	56	24	194	62	79	33	59	51	23	68	23	15	34
September 2016	292				134		21	137				148		28	35				62	37	74	42	107	250	30	146	30
October 2016	170				394	381	92	132		137		202		110	57				116	102	100	108	143	164	99	54	78
Residential Standard (600 mg/m2/day)	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
Non-Residential Standard (1200 mg/m2/day)	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200

Figure 4-21: Dust Fallout Rates at all 27 Sampling Sites for the Period January - October 2016.

Table 4-7: Data Summary Table for Dust Fallout Rates (mg/m^2/day) at all 27 Sites for the Period July 2015 – October 2016.

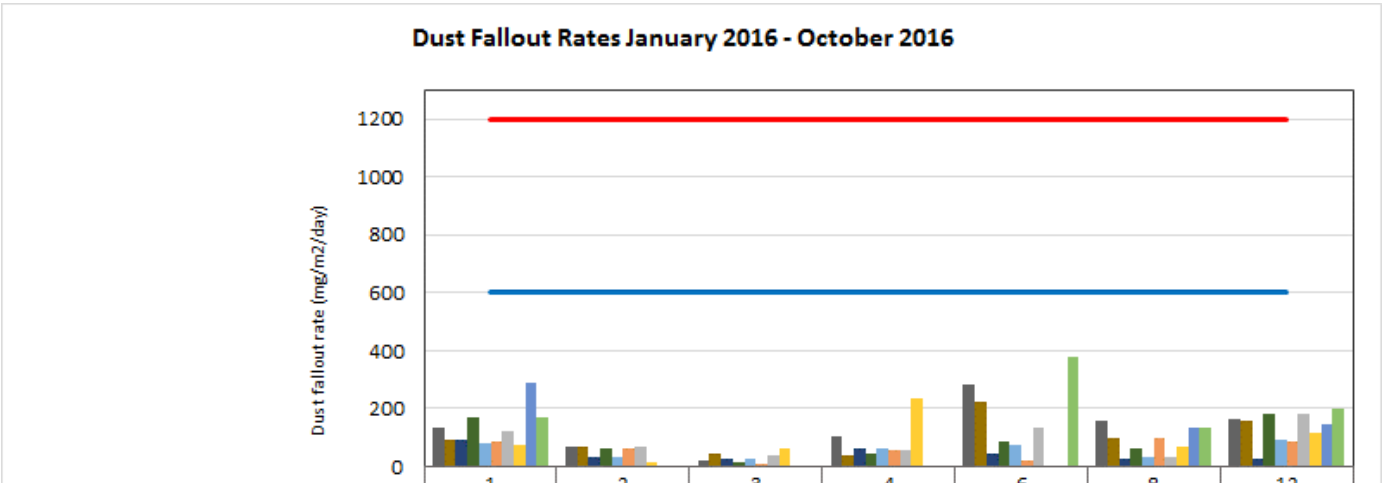
Data Description	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16
90th percentile	355	134	179	361	403	266	158	1556	90	179	89	97	156	123	199	256
75th percentile	287	97	126	211	311	164	118	112	64	89	72	58	116	70	139	159
50th percentile	135	52	59	116	161	125	70	58	30	45	34	32	41	54	68	113
25th percentile	82	30	30	99	129	97	51	39	23	29	17	20	26	31	34	99
Mean	190	73	86	177	210	199	89	81	60	72	47	43	71	64	98	147
Minimum	32	19	12	26	36	40	16	13	11	9	6	7	15	5	21	54
Maximum	*626	210	223	*653	534	*1586	286	226	403	235	139	107	207	236	292	394
Number of Exceedances of 600 mg/m2/day	**1**	0	0	**1**	0		0	0	0	0	0	0	0	0	0	0
Number of Exceedances of 1200 mg/m2/day	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0

*Percentiles indicate the percentage of time that the dust fallout rates fall below the value provided. *Above the daily acceptable dust fallout standards, therefore likely effects on human health and the environment.*



	1	2	3	4	6	8	12
Jul-15	626	122		197	281	148	37
Aug-15	111	26	49	43	79	122	97
Sep-15	199		43	54	180	223	175
Oct-15	346	127	113	102	82	195	371
Nov-15	311	131	84			163	531
Dec-15	195		125	284	171	40	122
Residential (600 mg/m2/day)	600	600	600	600	600	600	600
Non-Residential (1200 mg/m2/day)	1200	1200	1200	1200	1200	1200	1200

Figure 4-22: Dust Fallout Rates at 7 of the 27 Sampling Sites for the Period July – December 2015.



	1	2	3	4	6	8	12
16-Jan	135	70	21	103	286	161	162
16-Feb	90	70	45	36	226	99	158
16-Mar	91	30	28	62	45	24	25
16-Apr	172	62	16	45	88	65	181
16-May	81	35	28	61	75	31	90
16-Jun	87	61	12	55	23	99	85
16-Jul	123	67	40	58	133	30	181
16-Aug	74	15	64	236		68	117
16-Sep	292					137	148
16-Oct	170				381	132	202
Residential (600 mg/m2/day)	600	600	600	600	600	600	600
Non-Residential (1200 mg/m2/day)	1200	1200	1200	1200	1200	1200	1200

Figure 4-23: Dust Fallout Rates at 7 of the 27 Sampling Sites for the Period January – October 2016.

Table 4-8: Data Summary Table for Dust Fallout Rates (mg/m^2/day) at 7 of the 27 Sites for the Period July 2015 – December 2015.

Data Description	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
90th percentile	454	115	211	356	443	240
75th percentile	260	104	194	271	311	189
50th percentile	173	79	178	127	163	148
25th percentile	129	46	84	108	131	123
Mean	235	75	146	191	244	156
Minimum	37	26	43	82	84	40
Maximum	*626	122	223	371	531	284
Number of Exceedances of 600 mg/m2/day	1	0	0	0	0	0
Number of Exceedances of 1200 mg/m2/day	0	0	0	0	0	0

**Above the daily acceptable dust fallout standards, therefore likely effects on human health and the environment.*

Table 4-9: Data Summary Table for Dust Fallout Rates (mg/m2/day) at 7 of the 27 Sites for the Period January 2016 – October 2016.

Data Description	16-Jan	16-Feb	16-Mar	16-Apr	16-May	16-Jun	16-Jul	16-Aug	16-Sep	16-Oct
90th percentile	212	185	74	176	85	92	152	177	263	327
75th percentile	162	129	54	130	78	86	128	106	220	247
50th percentile	135	90	30	65	61	61	67	71	148	186
25th percentile	87	58	27	54	33	39	49	65	143	161
Mean	134	103	44	90	57	60	90	96	192	221
Minimum	21	36	24	16	28	12	30	15	137	132
Maximum	286	226	91	181	90	99	181	236	292	381
Number of Exceedances of 600 mg/m2/day	0	0	0	0	0	0	0	0	0	0
Number of Exceedances of 1200 mg/m2/day	0	0	0	0	0	0	0	0	0	0

4.3 Highveld Priority Area

The proposed Kutalo Station Residential Development is located in the Ekurhuleni Metropolitan Municipality which falls within the Highveld Priority Area (HPA) (Figure 4-28). A Priority Area is generally associated with elevated ambient concentrations of pollutants such as PM_{10}, $PM_{2.5}$, SO_2 and NO_x.

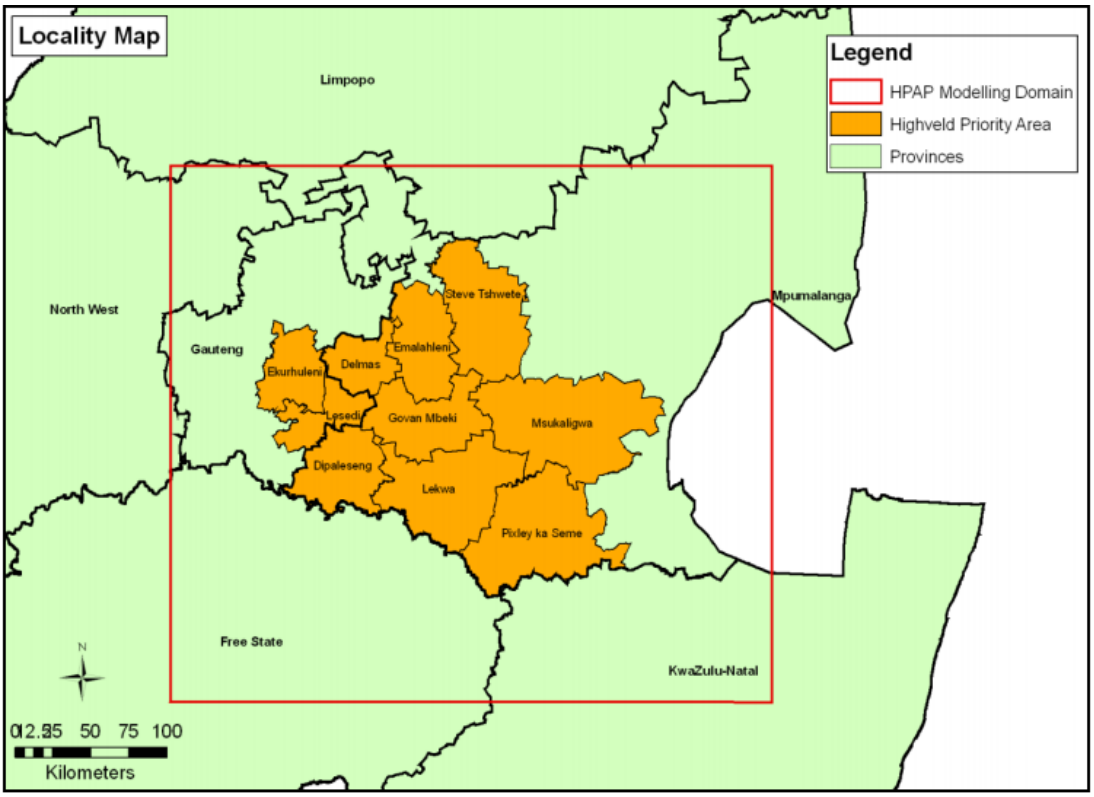


Figure 4-24: Highveld Priority Area (DEA, 2011).

The HPA was declared a priority area by the Minister of Environmental Affairs and Tourism on the 23 November 2007 under the National Environmental Management Air Quality Act (Act No. 39 of 2004) (Government Gazette, No. 30518 of 23 November 2007). A Priority Area is usually associated with elevated ambient concentrations of criteria air pollutants such as PM_{10}, $PM_{2.5}$, SO_2 and NO_x. Generally, a high number of emitters (industrial and non-industrial) are also concentrated in these areas. In order to meet the requirements of Air Quality Act (Act No. 39 of 2004), an Air Quality Management Plan (AQMP) was compiled for the HPA and provides as a management tool that can be used and implemented by departments and industry to ensure effective air quality management within the area. The primary aim of the AQMP is to provide a framework including short to long term strategies and programs that can be used to work towards achieving and maintaining compliance with the National ambient air quality standards within the HPA. In the HPA, industrial emitters were identified as the most significant contributor of emissions accounting for 89% of PM_{10}, 90% of NO_x and 99% of SO_2. Industrial emitters within the HPA include (DEA, 2011):

- Power generation;
- Coal mining;
- Primary & secondary metallurgical operations;

- Brick manufactures;
- Petrochemical industry;
- Ekurhuleni industrial sources (excluding the above);
- Mpumalanga industrial sources (excluding the above).

An assessment of ambient air quality monitoring data within the HPA, allowed for the following areas to be identified as areas of concern. These areas are associated with a high frequency of exceedances of the PM_{10} and SO_2 ambient standards. The air quality monitoring data for the HPA also shows seasonal trends. A higher frequency of exceedances of the standards are observed during the winter season where the dispersion potential of ground level pollutants (e.g. vehicle exhaust emissions) are largely reduced due to the strengthening of surface inversions (DEA, 2011).

- Witbank 2;
- Middelburg;
- Secunda;
- Ermelo;
- Standerton;
- Balfour; and
- Komati.

A comprehensive emissions inventory was compiled for the HPA. A combination of ambient air quality monitoring and dispersion modelling results identified nine areas within the HPA as hotspot areas, where ambient concentrations of PM_{10}, SO_2 and NO_2 frequently exceed and/or were predicted to exceed the ambient standards (Table 4-10). Residential areas associated with a high level of domestic fuel burning (wood and coal) were identified to experience high concentrations of particulates and CO.

Table 4-10: HPA Air Quality Hot Spot Areas (DEA, 2011; 20).

Hot Spot	PM_{10}	SO_2	NO_2
Emalahleni	✓	✓	
Kriel		✓	
Steve Tshwete	✓	✓	✓
Ermelo	✓	✓	
Secunda	✓	✓	✓
Ekurhuleni	✓	✓	
Lekwa	✓	✓	
Balfour	✓		
Delmas		✓	

In order to achieve compliance with the National air quality limits for criteria pollutants within the HPA, the AQPM for the HPA developed seven goals which are given below (DEA, 2011):

1. ***Goal 1:*** *By 2015, organisational capacity in government is optimised to efficiently and effectively maintain, monitor and enforce compliance with ambient air quality standards*

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

4.4 Surrounding Sources of Air Pollution

Existing sources of emissions are all contributing to air pollution and air pollutant concentrations within the area. Existing key sources of air pollution surrounding the project site were identified through a desktop exercise and these have been identified to be:

- Potential domestic fuel burning;
- Industrial Activity;
- Manufacturing Faculties;
- Waste Treatment Plants;
- Vehicle exhaust emissions and vehicle dust entrainment;
- Wind erosion from exposed areas (e.g. tailings, open veld, open degraded/eroded areas, etc.); and
- Mining activity.

A summary of some of the surrounding emission sources is shown in Table 4-11. A spatial representation of the emission sources surrounding the project site is presented in Figure 29 (the data used for input into the figure was sourced from the Ekurhuleni Metropolitan Municipality and exclude any other additional sources within the area).

4.4.1 Domestic Fuel Burning

The burning of domestic fuels for heating and cooking purposes is likely to occur in some of the surrounding informal residential areas surrounding the project area. Even in electrified areas, households make use of domestic fuels due to high electricity costs and the traditional use of such fuels.

Pollutants released from these fuels include PM_{10}, CO, NO_2, SO_2, inhalable particulates and polycyclic aromatic hydrocarbons. Particulates are the dominant pollutant emitted from the burning of wood. Smoke from wood burning contains respirable particles that are small enough in diameter to enter and deposit in the lungs. These particles comprise a mixture of inorganic and organic substances including aromatic hydrocarbon compounds, trace metals, nitrates and sulphates. Polycyclic aromatic hydrocarbons are produced as a result of incomplete combustion and are potentially carcinogenic in wood smoke. The main

pollutants emitted from the combustion of paraffin are NO_2, particulates, carbon monoxide and polycyclic aromatic hydrocarbons.

Domestic fuel burning shows a characteristic diurnal and seasonal signature. Periods of elevated domestic fuel burning, and hence emissions, occurs in the early morning and evening for space heating and cooking purposes. During the winter months, an increase in domestic fuel burning is recorded as the demand for space heating and cooking increases with the declining temperature.

4.4.2 Vehicle Exhaust Emissions and Dust Entrainment

The proposed residential development is located within a built up industrial and informal settlement area near the N17, N12, N3 and M2 main roads where motor vehicle activity is prominent. Vehicle activity is associated with emissions of SO_2, NO_x, CO, PM, VOCs and Pb. Vehicle emissions will vary depending on the distance travelled, the speed of travel, the type of fuel used, the model/age of the engine and the type of emission control technology used by the car. Vehicles that have lower fuel combustion efficiency (generally older models and less well maintained vehicles) are associated with higher emissions. Lower exhaust emissions will result in a more consistent travelling speed and a shorter distance of travel. Hauling trucks, forklifts and front-end loaders used in mining, industrial and manufacturing plants can be a source of both exhaust emissions and fugitive emissions from vehicle dust entrainment from material spills.

There are also urban informal areas and open veld areas located in close proximity to the project site. Vehicle dust entrainment on unpaved roads that may occur within these areas can also be a source of dust in the area.

4.4.3 Industrial Activity

Industrial activities surround the proposed residential site and comprise of metallurgical facilities (foundries and refineries), mills, manufacturing plants, boiler operations, fuel combustion activities, recycling and general and hazardous waste treatment plants. These activities are associated with emissions of pollutants such as PM, SO_2 and NO_x. Furnaces, boilers and stacks are located east of the project site. Emissions due to industrial activity are mainly controlled through compliance with the minimum emission standards for the relevant activities and through the use of emission control technology. Industrial activity within these areas are likely a key source of emissions in the area.

4.4.4 Wind Erosion from Exposed Areas

An open exposed veld area surrounds the proposed residential site, as well as tailings dams particularly to the north-north-east, east and south-east of the site, which could represent significant sources of dust in the area.

Dust emissions due to the erosion of exposed areas occurs when the threshold wind speed is exceeded. The threshold wind speed is dependent on the erosion potential of the exposed surface, which is expressed

in terms of the availability of erodible material per unit area (mass/area). Any factor which binds the erodible material or otherwise reduces the availability of erodible material on the surface thus decreases the erosion potential of the surface. Studies have shown that when the threshold wind speeds are exceeded, particulate emission rates tend to decay rapidly due to the reduced availability of erodible material. Biomass burning in the open veld areas is also likely to occur and will result in emissions of dust and gaseous pollutants.

4.4.5 Mining Activity

There are existing gold mining operations surrounding the project site (Figure 4-30). Mines and quarries are predominantly situated to the north, east, east-south-east, west and north-west of the proposed residential site. Material handling, material storage, tailings dams, exposed bare soil, material processing and truck hauling activities associated with mining activity are all a significant source of fugitive dust emissions; which could be a key source of emissions in the area (Table 4-11).

Table 4-11: Summary of Emission Sources Surrounding Kutalo Station Development Site.

Source	Associated Activities	Associated Emissions	Proximity to Project Site (km)
Mining Activities			
Gold Mines *Point, Area and Mobile Sources*	Tailings dams Material stockpiles Excavation and extraction Crushing Kilns Conveyor systems Truck, forklift, and front-end loader emissions Vehicle dust entrainment	Dust PM_{10} $PM_{2.5}$ SO_2 NO_X CO Hg	~3.5
Metallurgical Industries			
Foundries *Point, Area and Mobile Sources*	Melting of scrap steel in furnaces Material stockpiles Combustion of fossil fuels (Figure 4-26 B, C) Truck, forklift, and front-end loader emissions Vehicle dust entrainment	Dust PM_{10} $PM_{2.5}$ SO_2 NO_X CO	5 km radius
Refineries *Point, Area and Mobile Sources*	Melting of scrap steel in furnaces Material stockpiles Combustion of fossil fuels Truck, forklift, and front-end loader emissions Vehicle dust entrainment	Dust PM_{10} $PM_{2.5}$ SO_2 NO_X CO	5 km radius
Industry			
Sugar Mills *Point, Area and Mobile Sources*	Grain handling Grinding Milles Combustion of fossil fuels (Figure 4-26 B, C) Combustion of bagasses (material combusted) Boilers for the purpose of heating	Dust PM_{10} (fly ash) $PM_{2.5}$ SO_2 NO_X CO Odour Flue gases from boilers	~1.2

General Manufacturing Plants *Point, Area and Mobile Sources*	Material stockpiles (Figure 4-26 A) Combustion of fossil fuels Truck, forklift, and front-end loader emissions Vehicle dust entrainment	Dust PM_{10} $PM_{2.5}$ SO_2 NO_X	5 km radius
Waste Facilities			
Storage, Recycling and Treatment of Hazardous and General Waste **Refuse Derived Fuel (RDF) Plant** **Waste Water Treatment Plant** **Acid Mine Drainage Treatment Basin** *Point, Area and Mobile Sources*	Material stockpiles Material handling Sorting Shredding Crushing Baling Thermal treatment of hazardous waste Combustion of fossil fuels Truck, forklift, and front-end loader emissions Vehicle dust entrainment	PM_{10} $PM_{2.5}$ SO_x VOCs Chemical spills Odours	~2
Mobile Sources			
Cars, Buses, Trucks, Forklifts, Front-End Loaders	By-products of combustion	PM_{10} $PM_{2.5}$ SO_2 NO_X CO VOCs Pb	General Area
Other			
Domestic Fuel Burning *Point and Area Source*	Burning of coal, paraffin, LPG and wood used for cooking, lighting and heating (Figure 4-26 D)	PM_{10} $PM_{2.5}$ SO_2 NO_X CO Benzene	Settlement Area
Airport *Area Source*	Traffic Exhaust fumes Service equipment and machinery	SO_2 NO_X CO	~5
Open Areas *Area Source*	Open veld (Figure 4-26 D) Open degraded / eroded areas Tailings Mines Quarries	Dust PM_{10} $PM_{2.5}$	5 km radius

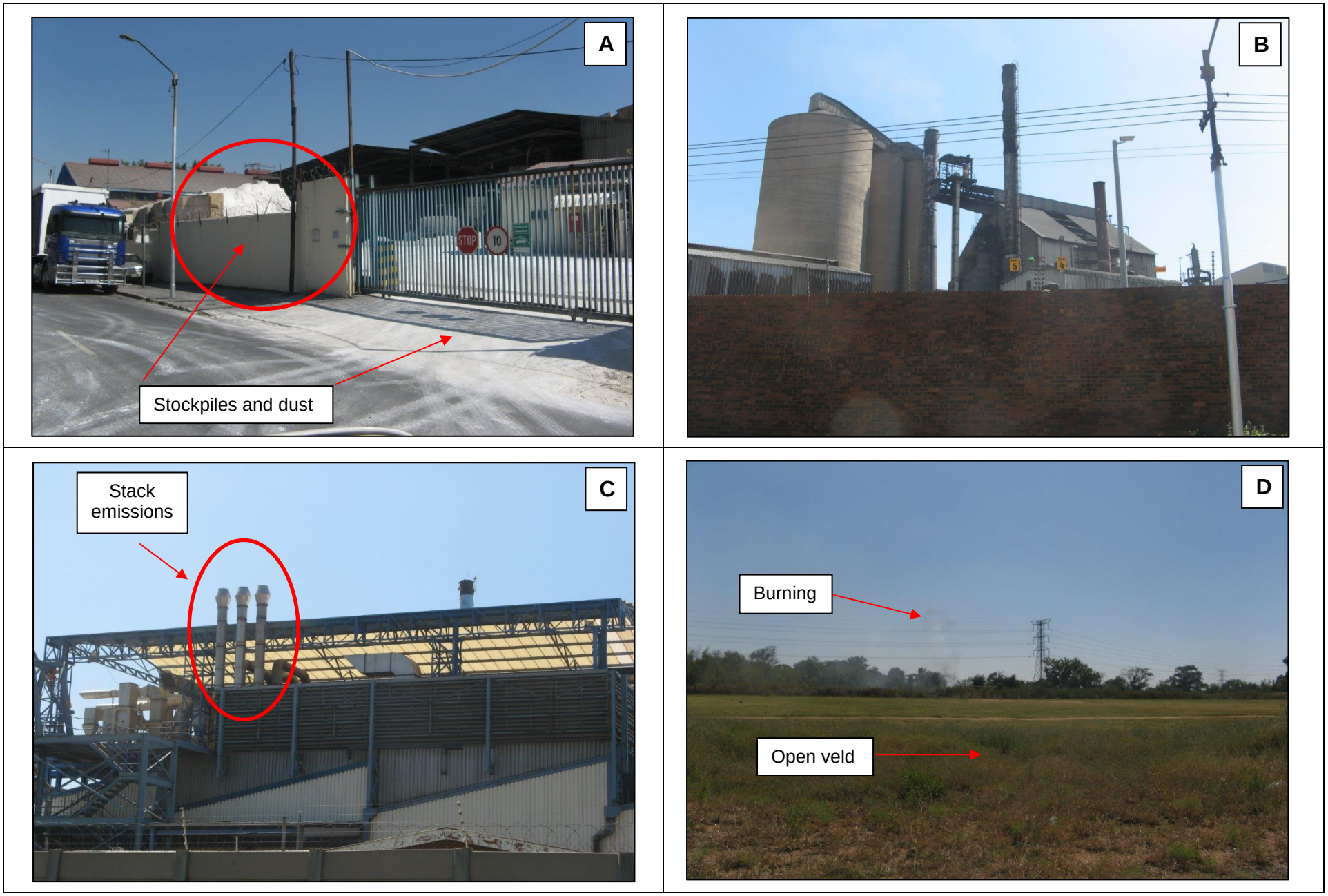


Figure 4-25: Emission sources surrounding the Kutalo Station Project Site.

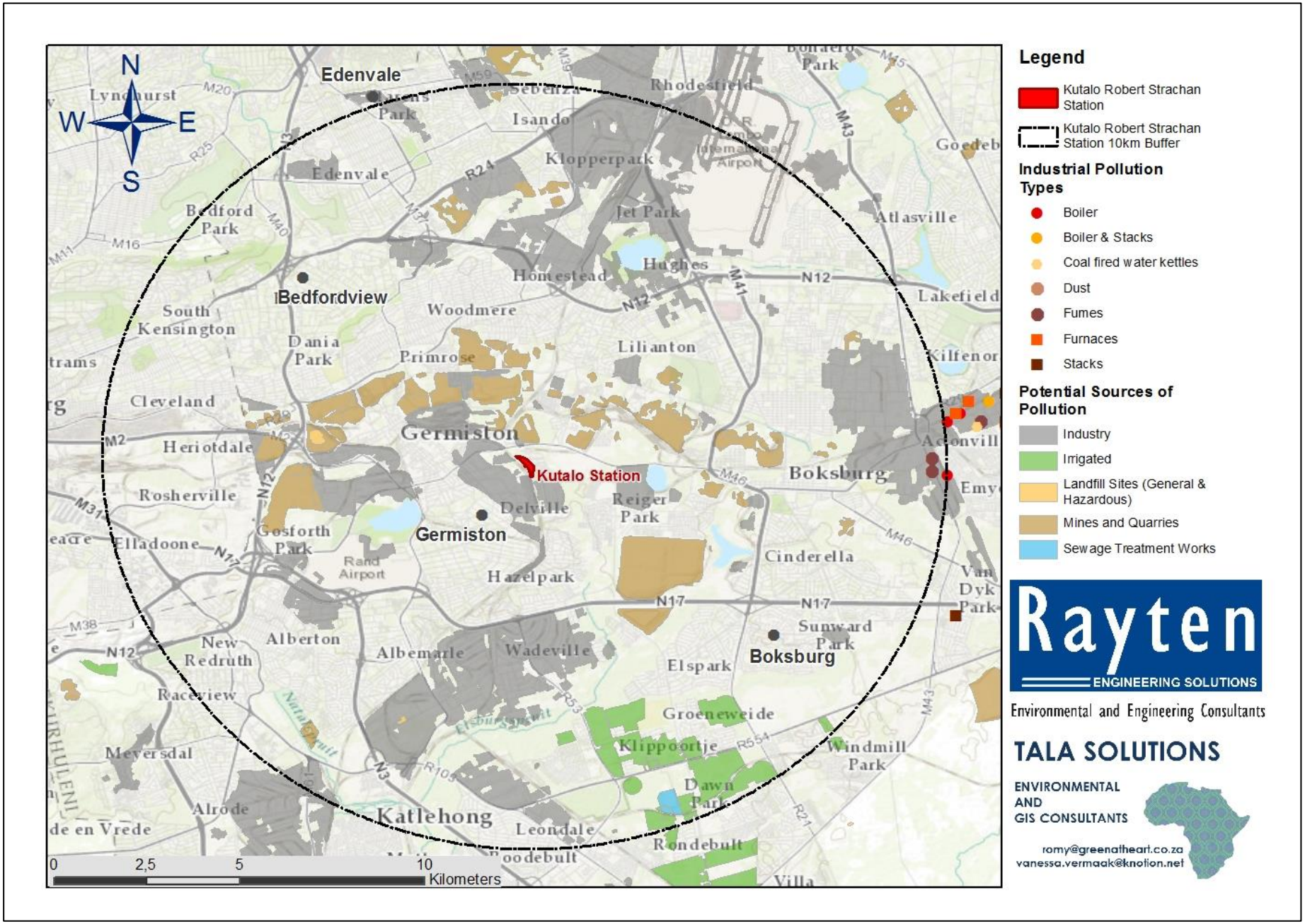


Figure 4-26: Surrounding Sources of Emissions (Ekurhuleni Metropolitan Municipality).

4.1 Assumptions and Limitations

The following key assumptions and limitations of the study are given below:

I. Data provided for the Germiston Ambient Air Quality Monitoring Station and for the dust fallout sampling sites were assumed to be correct;
II. The nearest Weather Station to the project site where data were available for the required parameters was the OR Tambo International Airport. This weather station is located approximately 8.45 km from the proposed residential development site. The meteorological conditions may vary slightly between the two sites.
III. The air pollutant concentrations in the ambient air could only be assessed based on the data that is available from the nearby monitoring station, Germiston; and
IV. The ambient pollutant concentrations for some of the criteria air pollutants such as $PM_{2.5}$, O_3, benzene and lead could not be determined; as there was poor data capture or no data available for these pollutants at the nearest monitoring station.

4.2 Summary

Rayten Engineering Solutions were appointed to conduct an Air Quality Baseline Assessment for a proposed residential development at the Kutalo Robert Strachan site, located in Ekurhuleni, Gauteng. The main objectives of the Air Quality Baseline Assessment are to:

a) Present the baseline ambient concentrations of the criteria air pollutants (air pollutants that are known to have a negative impact on human health and environmental well-being) using available data from a nearby monitoring station;
b) Determine the frequency of exceedance of the air pollutants in line with the South African National Ambient Air Quality Standards;
c) Present the baseline dust fallout rates surrounding the proposed development site using available monitoring data; and
d) Identify existing sources of emissions surrounding the proposed development site through a desktop exercise.

The main conclusions based on the information obtained during the Baseline Assessment can be summarised as follows: The proposed Kutalo Station residential development is located within the Ekurhuleni Metropolitan Municipality (EMM) which falls within the Highveld Priority Area (HPA). Land use immediately surrounding the proposed residential development site is predominantly used for mining, industry and residential settlements. Mining activities are predominantly located in the north-east, south-east and north-west quadrants from the project site while industrial activities surround the proposed site

within a 10-km buffer. Kutalo Train Station, Rand Airport and OR Tambo International Airport are located in close proximity to the project site.

Existing key sources of air pollution surrounding the project site have been identified to be:

- Potential domestic fuel burning;
- Industrial Activity;
- Manufacturing Faculties;
- Waste Treatment Plants;
- Vehicle exhaust emissions and vehicle dust entrainment;
- Wind erosion from exposed areas (e.g. tailings, open veld, open degraded/eroded areas, etc.); and
- Mining activity.

Meteorological data were obtained from the OR Tambo International Airport weather station for the period January 2013 to December 2016. Based on the prevailing wind fields for the period, emissions from surrounding sources are likely transported towards the southern, south-eastern and south-south-eastern regions. The Kutalo Station site is downwind from mining, industrial and business/commercial activities. Moderate to fast wind speeds observed may result in effective dispersion and dilution of emissions. However, moderate to fast wind speeds may also facilitate dust emissions from open storage piles and exposed areas surrounding the site. Removal of pollutants via wet depositional processes would be evident during the spring and summer seasons, thus lower ambient concentrations of pollutants (particularly dust) are expected during these seasons. Elevated levels of pollutants would be expected during the autumn and winter seasons due to reduced wet depositional process. Higher ambient concentrations of pollutants would also be evident during the autumn and winter seasons due to reduced vertical dispersion of pollutants as a result of the winter inversion layers.

Ambient air quality standards have been developed for eight criteria air pollutants in South Africa. These pollutants are considered to be harmful to human health. People who are exposed to pollutant concentrations that frequently exceed the acceptable ambient air quality standards, are considered to be vulnerable to potential health risks. South Africa has also developed Dust Control Regulations which provide acceptable dust fallout limits for residential and non-residential areas. High dust fallout rates can act as a nuisance and damage property or crops and can also create irritation of the skin, eyes, nose and throat in people. In order to assess the existing air quality situation and establish whether the criteria air pollutants and dust fallout rates fall within the acceptable limits, air quality monitoring data is required. These data are usually obtained from permanent ambient air quality monitoring stations and dust fallout networks operated within close proximity to the project site.

The Germiston Ambient Air Quality Monitoring Station (hereafter Germiston Station) is the closest station to the project site where data is available on the SAAQIS. The Germiston Station is situated approximately <2 km west-south-west of the Kutalo Station proposed residential development site. Baseline concentrations

for CO, NO_2, PM_{10} and SO_2 were assessed for the period January 2011 to December 2016. Dust fallout rates for seven sites located <5 km from the proposed residential site were also provided by Ekurhuleni Metropolitan Municipality for the period July 2015 – October 2016.

The baseline air quality data can be summarised as follows:

- There was only 12% data availability for C_6H_6 (Benzene) concentrations and 2% data availability for O_3 (Ozone) concentrations. Therefore, no analysis was conducted with these parameters.
- Annual average NO_2 and SO_2 concentrations were below the acceptable standards of 21 and 19 ppb for the period, respectively.
- There was no exceedance of the daily limit of 48 ppb for SO_2 concentrations.
- No exceedances of the NO_2 and SO_2, hourly standards of 106 and 134 ppb, respectively, were observed for the monitoring period.
- Exceedances of the hourly limit of 26 ppm were recorded for CO concentrations.
- Exceedances of both the daily (75 ppb) and annual (40 ppb) limits were recorded for PM_{10} concentrations.
- Diurnal variation is observed for CO, NO_2 and SO_2 concentrations. Concentrations typically increase during the morning and evening periods. Higher concentrations of gaseous pollutants are also observed over the autumn and winter seasons compared to the summer and spring seasons. People in the area will likely be exposed to higher concentrations of pollutants during these periods.
- Exceedances of the short term (hourly) CO standards were recorded; suggesting that people in the area could potentially be exposed to future high concentrations, and may represent a concern for human health and environmental impacts. However, the NO_2 and SO_2 concentrations in the area are expected to be in compliance for most of the time based on the data provided.
- Exceedances of daily and annual PM_{10} concentrations are a result of the surrounding mining activities (quarries, tailings, etc.), industrial activities and informal settlements (immediately east of the project site). Mining and industrial activity, wind erosion from exposed surfaces and domestic fuel burning are all key sources of particulate matter, thus, accounting for the high concentrations of PM_{10} recorded over the monitoring period.
- Exceedances of the short term (daily) and long term (annual) PM_{10} standards; suggest that people in the area will likely be exposed to future high concentrations, and may represent a concern for human health and environmental impacts.
- There was no data available for $PM_{2.5}$ concentrations for the Germiston Station.
- The site is also located in the HPA; which is associated with relatively poor air quality where PM_{10} and $PM_{2.5}$ concentrations frequently exceed ambient air quality standards (DEA 2011).
- Dust fallout rates, one exceedance of the residential limit of 600 mg/m^2/day was recorded at site 1 during 2015 (July 2015 to December 2015). There were no exceedances of the non-residential limit of 1200 mg/m^2/day during the 2015 monitoring period for the seven buckets located in close proximity to the project site. During the 2016 monitoring period (January 2016 – October 2016) dust

fallout rates fell below the residential limit (600 mg/m^2/day) and non-residential limit (1200 mg/m^2/day) for the seven buckets located in close proximity to the project site.

- Based on the data provided for the 2016 monitoring period, the dust fallout rates for the seven sites which are in close proximity to the Kutalo Station do not exceed the acceptable applicable limits.

5 CONCLUSIONS AND RECOMMENDATIONS

The ambient concentrations of CO and PM_{10} from surrounding sources represent a concern for human health and environmental nuisance, due to hourly, daily and annual exceedances recorded for the monitoring period, suggesting that people in the area of the Kutalo Station site could potentially be exposed to future high concentrations (based on the acceptable applicable limits for these criteria pollutants). Due to the project site being predominantly surrounded by mining activity (quarries, tailings, etc.), industrial activity and informal settlements (domestic fuel burning), which are considered key sources of particulate matter, people residing in this area may likely be exposed to above standard concentrations of both PM_{10} and $PM_{2.5}$ on a regular basis (this is based on available monitoring data and data from other nearby monitoring stations). Further monitoring will need to be conducted in order to determine the ambient concentrations of $PM_{2.5}$, O_3, benzene and lead.

Air pollution is controlled at the emission source by standard practice, however, some general measures can be considered to try reduce exposure to air pollutants in terms of the building design. These can include:

- Automated entrance and exit doors
    - This would ensure that doors will remain closed at all times to reduce the amount of airborne dust entering the buildings.
- Climate control with filtration system
    - Climate control with a filtration ventilation system would ensure that windows do not need to be left open, while ensuring air circulation. This will reduce the amount of dust from entering the building as well as dilution of potential radon gas and dust particles.
- Exterior wind breaks
    - These would be in the form of indigenous hedges and/or trees to act as a dust trap as well as a wind break to minimize dust onto the site.

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Appendix A – Specialist Details and CV's

NAME	ROLES AND RESPONSIBILITIES
Claire Wray *Managing Director* *(Member)*	Manage and co-ordinate all projects within Rayten
Clive Wray *Engineering Manager* *(Member)*	Manage and co-ordinated all engineering related projects within Rayten Lead project manager and engineer for abatement equipment, stack emissions monitoring, Air Quality Impact Assessments and ambient air quality monitoring stations
Sophia Valsamakis *Environmental Scientist*	Air quality monitoring and reporting, co-ordination of air quality impact assessments and monitoring projects, AEL's, GHG inventory and reporting.
Amy Atherstone *Junior Environmental Scientist*	Air quality reporting, co-ordination of air quality baseline assessments and monitoring projects, AEL annual reporting and compliance audits.

***Please see separate attached pdf documents for CVs.*

Appendix B – Company Profile

Rayten Engineering Solutions was established in 2009 and has since been providing professional environmental and engineering consulting services to a wide range of industries, mines and government departments.

Our key services are given below:

AIR QUALITY MANAGEMENT

- Air quality impact assessments and dispersion modelling
- Ambient air quality monitoring
- Dust fallout monitoring
- Stack emissions monitoring
- Atmospheric Emission Licence (AEL) applications
- Atmospheric Emission Licence (AEL) annual reporting requirements
- Atmospheric Emission Licence (AEL) compliance audits
- Air quality management plans
- Fugitive emission reduction plans
- Installation and commissioning of extraction systems & pollution control technology
- National Atmospheric Emissions Inventory System (NAEIS) submissions
- GHG emission inventories and reports

WATER QUALITY MANAGEMENT

- Water Use Licence (WUL) applications
- Monitoring programs for surface and ground water
  - Water quality control & management
- Ground water investigations
- Surface water assessments
- Acid mine and acid rock drainage prediction and management
- Specialist wetland studies
  - Wetland and riparian delineations
  - Wetland health and Eco Services evaluation
  - Wetland rehabilitation scoping and recommendations

GEOGRAPHICAL INFORMATION SYSYTEM (GIS) SUPPORT

- GIS mapping & plan creation
- GIS map figures for specialist reports, EIAs, EMPs, EMPRs, BA, Scoping Reports, etc.
- Spatial database design and development
- Spatial data capture and conversion
- Geo-referencing and coordinate transformations
- Digitising and geocoding
- Integration of GPS and field data
- Spatial data integration and analysis
- Site analysis
- Target generation
- Quantitative change analysis
- Corporate GIS implementation and maintenance
- Terrain modelling

NOISE

- Environmental noise monitoring
- Environmental noise impact assessments

WORKPLACE MONITORING

- Occupational hygiene surveys
- Hazardous chemicals substance exposure surveys
- Ventilation
- Illumination
- Noise
- Ergonomics
- Thermal comfort

SECTORS WE HAVE WORKED WITH

- Asphalt processing facilities
- Clay mining & brick manufacturers
- Coal mines
- Crematorium incinerating facilities
- Diamond mines
- Environmental consulting companies
- Food and beverage processers
- Foundries
- Galvanizing plants
- Glass manufacturing plants
- Gold mines
- Governmental departments
- Jewellery manufacturers
- Power generation facilities
- Plastic manufacturing facilities
- Refineries
- Soda ash mine and manufacturers
- Various companies within the corporate sector
- Waste & oil recycling
- Wear and tear tile manufactures
- Zinc and magnesium processing facilities

Postal address:
PO Box 1369
Bromhof
RSA
2188

Physical address:
Building 2, Boskruin Office Park
Corner Hawken Ave and President Fouche Drive
Boskruin, Randburg
2154

Website:
www.rayten.co.za

Email:
info@rayten.co.za

Telephone:
+27 (0) 11 792 0880

Fax:
+27 (0) 865 920 298

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ENGINEERING SOLUTIONS
Environmental and Engineering Consultants

Appendix C – Missing Data

Pollutant	Total Hours	Number of Missing Hours	Missing Hours	Number of Available Hours	Available Data
Benzene C_6H_6	52608	46532	88%	6076	12%
Carbon Monoxide CO	52608	33283	63%	19325	37%
Nitrogen Oxide NO_2	52608	24310	46%	28298	54%
Ozone O_3	35064	34495	98%	569	2%
Particulate Matter PM_{10}	52608	33100	63%	19508	37%
Sulphur Dioxide SO_2	52608	31799	60%	20809	40%

Benzene C_6H_6					
Year	Total Hours	Number of Missing Hours	Missing Hours	Number of Available Hours	Available Data
2011	8760	3441	39%	5319	61%
2012	8784	8770	100%	14	0%
2013	0	0	0%	0	0%
2014	0	0	0%	0	0%
2015	8760	8017	92%	743	8%
2016	0	0	0%	0	0%

Carbon Monoxide CO					
Year	Total Hours	Number of Missing Hours	Missing Hours	Number of Available Hours	Available Data
2011	8760	2076	24%	6684	76%
2012	8784	4105	47%	4679	53%
2013	0	0	0	0	0
2014	8760	5890	67%	2870	33%
2015	8760	7552	86%	1208	14%
2016	8784	4900	56%	3884	44%

Nitrogen Oxide NO_2					
Year	Total Hours	Number of Missing Hours	Missing Hours	Number of Available Hours	Available Data
2011	8760	1677	19%	7083	81%
2012	8784	4104	47%	4680	53%
2013	0	0	0	0	0
2014	8760	6071	69%	2689	31%
2015	8760	7566	86%	1194	14%
2016	8784	4892	56%	3892	44%

Ozone O_3					
Year	**Total Hours**	**Number of Missing Hours**	**Missing Hours**	**Number of Available Hours**	**Available Data**
2011	0	0	0	0	0
2012	0	0	0	0	0
2013	0	0	0	0	0
2014	8760	8192	94%	568	6%
2015	0	0	0	0	0
2016	0	0	0	0	0

Particulate Matter PM_{10}					
Year	**Total Hours**	**Number of Missing Hours**	**Missing Hours**	**Number of Available Hours**	**Available Data**
2011	8760	1531	17%	7229	83%
2012	8784	4104	47%	4680	53%
2013	0	0	0	0	0
2014	8760	5898	67%	2862	33%
2015	8760	7669	88%	1091	12%
2016	8784	5138	58%	3646	42%

Sulphur Dioxide SO_2					
Year	**Total Hours**	**Number of Missing Hours**	**Missing Hours**	**Number of Available Hours**	**Available Data**
2011	8760	1340	15%	7420	85%
2012	8784	4429	50%	4355	50%
2013	0	0	0	0	0
2014	8760	6304	72%	2456	28%
2015	8760	6207	71%	2553	29%
2016	8784	4759	54%	4025	46%