Environmental and Engineering Consultants

AIR QUALITY IMPACT ASSESSMENT FOR THE RUSTENBURG STRENGTHENING PHASE 2 PROJECT

RAYTEN PROJECT NO: RES-DIGES-16/1388

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Title	**Air Quality Impact Assessment for the Rustenburg Strengthening Phase 2 Project**		
	Name	**Signature**	**Date**
Author	**Sophia Valsamakis** **Environmental Scientist**		**10 February 2016**
Document Reviewer	**Claire Wray** **Atmospheric Scientist** **(Pri. Sci. Nat)**		**10 February 2016**
Document Authorisation	**Claire Wray** **Atmospheric Scientist** **(Pri. Sci. Nat)**		**10 February 2016**

SUMMARY

Rayten Engineering Solutions was appointed by Dynamic Integrated Geohydro Environmental Services to undertake an Air Quality Impact Assessment for the proposed Rustenburg Strengthening Phase 2 Project. The main objective of the project is to determine the potential impact of emissions from the construction of the substation, substation extension and powerlines on the surrounding environment. The baseline assessment was undertaken through a review of available meteorological and air quality monitoring data. Use was made of local meteorological data obtained from the South African Weather Services for the period January 2010 – December 2012. Ambient air quality monitoring data was obtained from the Boitekong Air Quality Monitoring Station for the period January 2011 – December 2013. The Air Quality Impact Assessment comprised of an emissions inventory and subsequent dispersion modelling simulations to determine TSP (as dust fallout) and PM10 concentrations associated with the construction phase of the substation, substation extension and powerlines. Dispersion modelling simulations were undertaken assuming a) no mitigation measures are employed and b) mitigation measures are employed during the construction phase. Comparison of the modelled concentrations was made with the National ambient air quality and dust fallout standards to determine compliance.

Based on the information obtained during the Baseline Assessment, the main conclusions can be summarised as follows:

- Local meteorological conditions are dominated by slow to moderate winds from the south-west. Based on the prevailing wind fields, emissions from the proposed sites will be transported towards the north-east. Slow to moderate winds will not result in the effective dispersion and dilution of the pollution;
- A comprehensive ambient air quality monitoring dataset from the Boitekong Air Quality Monitoring Station is not available to determine the existing ambient air quality situation in the area. Based on a qualitative assessment of existing air pollution sources in the area, emissions from agricultural activities, domestic fuel burning, mining and vehicle tailpipe emissions are likely to contribute to the ambient particulate loading in the area.

The main conclusions of the Impact Assessment can be summarised as follows for the proposed construction operations:

<u>At Site A, B and C</u>

- For **unmitigated PM10 emissions**, predicted incremental PM10 concentrations are in compliance with the daily average and annual average PM10 standards at Sites A and B. At Site C, predicted incremental PM10 concentrations are in non-compliance with the daily average standard. The highest PM10 concentrations are observed in Boitekong when construction is undertaken at Site C

due to the close proximity of this site to Boitekong, as well as the larger surface area of construction compared to the other two sites;

- For **mitigated PM10 emissions**, predicted incremental PM10 concentrations are in compliance with the daily average and annual average PM10 standards for all three sites;
- For **unmitigated dust fallout emissions**, predicted incremental dust fallout approaches the residential limit of 600 mg/m^2/day at Site A and exceeds the limit at Site C. Dust fallout at Site B is well within the residential limit;
- For **mitigated dust fallout emissions**, predicted incremental dust fallout falls below the residential limit for all three sites.

<u>At the Extension Site:</u>

- For **unmitigated PM10 emissions**, predicted incremental PM10 concentrations are in non-compliance with the daily average and annual average PM10 standards of 75 µg/m^3 and 40 µg/m^3 beyond the extension site;
- For **mitigated PM10 emissions**, predicted incremental PM10 concentrations are in compliance with the daily average and annual average PM10 standards of 75 µg/m^3 and 40 µg/m^3 at surrounding sensitive receptors however, exceedances are observed close to the site boundary.
- For **unmitigated dust fallout emissions**, predicted incremental dust fallout falls below the residential limit of 600 mg/m^2/day at surrounding sensitive receptors. Predicted incremental dust fallout exceeds the residential limit of 600 mg/m^2/day just beyond the site boundary;
- For **mitigated dust fallout emissions**, predicted incremental dust fallout is reduced and falls below the residential limit of 600 mg/m^2/day at surrounding sensitive receptors.

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1 INTRODUCTION

Eskom intends to strengthen the electrical network in Rustenburg by either constructing and operating a new substation, Marang B 400/132 kV and approximately 2 km of 400 kV loop-in loop-out power lines or extending the existing Marang Substation near Rustenburg in the North-West Province. This report assess the impacts of the proposed development on the environment.

As part of the Air Quality Impact Assessment for the proposed Rustenburg Strengthening Phase 2 Project, a baseline assessment is undertaken through a review of available meteorological and air quality monitoring data. The potential impact of emissions from the proposed project on the surrounding environment is evaluated through the compilation of an emissions inventory and subsequent dispersion modelling simulations using AERMOD. Comparison with the National ambient air quality standards is made to determine compliance in terms of potential human health impacts.

On 15 June 2012, the Waterberg District Municipality and the Bojanala Platinum District Municipality were declared the third National priority area in South Africa, known as the Waterberg Priority Area, in terms of section 18(1) of the National Environmental Management: Air Quality Act No 39 of 2004. This implies that the ambient air quality within the Waterberg District Municipality in the Limpopo Province may exceed the ambient air quality standards in the near future and that a trans-boundary situation exists between the Waterberg District Municipality and the Bojanala Platinum District Municipality in the North-West Province which may cause a significant negative impact on air quality in both areas.

The Waterberg Priority Area includes the areas contained within the boundaries of (i) theWaterberg District Municipality in the Limpopo Province; (ii) the Thabazimbi Local Municipality (Waterberg) in the Limpopo Province; (iii) the Modimolle Local Municipality (Waterberg) in the Limpopo Province; (iv) the Mogalakwena Local Municipality (Waterberg) in the Limpopo Province; (v) the Bela-Bela Local Municipality (Waterberg) in the Limpopo Province; (vi) the Mookgopong Local Municipality (Waterberg) in the Limpopo Province; and (vii) the Lephalale Local Municipality (Waterberg) in the Limpopo Province, the Moses Kotane Local Municipality in the North West Province, the Rustenburg Local Municipality in the North West Province, and the Madibeng Local Municipality in the North West Province.

The proposed project is located within the Rustenburg Local Municipality in the North West Province and as such, falls within the Waterberg Priority Area.

Rayten Engineering Solutions was appointed by Dynamic Integrated Geohydro Environmental Services (DIGES) to undertake an Air Quality Impact Assessment for the proposed Rustenburg Strengthening Phase 2 Project. The main objective of the project is to determine the potential impact of emissions from the either the extension of the existing substation or the construction of the substation and powerlines on the surrounding environment.

1.1 Project Description

Marang 400/88kV substation is one of the four Main Transmission Substations (MTS), which are currently supplying Rustenburg's platinum mining, smelting operations and commercial operations. The substation is supplied via the 3x 400kV power lines, i.e., Matimba-Marang, Bighorn-Marang and Midas-Marang. It comprises of 4 x 315 MVA, 400/88kV transformers and has a capacity of 945 MVA. The recorded peak load was 776MVA in years 2010/11 and 694MVA in years 2011/12. As a result, the Marang 400/88kV will exceed the 400/88kV firm capacity limit by 2015/16. To address these transformation capacity constraints and to align with the 20 year load forecast, Eskom initially intended to construct a new substation site since the existing substation has space limitations for an extension. Eskom has since addressed space limitations for the existing substation hence this report has been revised to include the alternative of extending the existing substation. The extension site falls within the proposed substation one (Site A) (FIGURE 1-1 and FIGURE 1-2).

Three alternatives for the construction and operation havve been assessed and the scope of work entails the following:

- A new 3x 500MVA 400/132kV Main Transmission Substation (MTS), Marang B on approximately ±30 hectares; and
- ±2km 400kV loop-in-loop-out power line from the existing Bighorn-Marang, Medupi-Marang or Marang-Midas 400 kV power lines; or
- Extension of the existing of Marang 400/88kV substation.

The alternative of extending the substation will entail making provision for new 3x 500MVA 400/132kV transformers, as follows

· Extension of the existing 400kV Busbar,

· Establish a new 132kV Busbar to enable installation of 2 x 500MVA 400/132kV Transformers initially and 1 x future 500MVA 400/132kV Transformer,

· Establish and Equip 4 x 132kV feeders to allow existing 88kV Marang load shift,

· And establishing 4 x future 132kV feeders.

The site layout of the proposed Marang B sites is shown in FIGURE 1-1. The site layout of the proposed extension site and the proposed Marang B sites is shown in FIGURE 1-2.

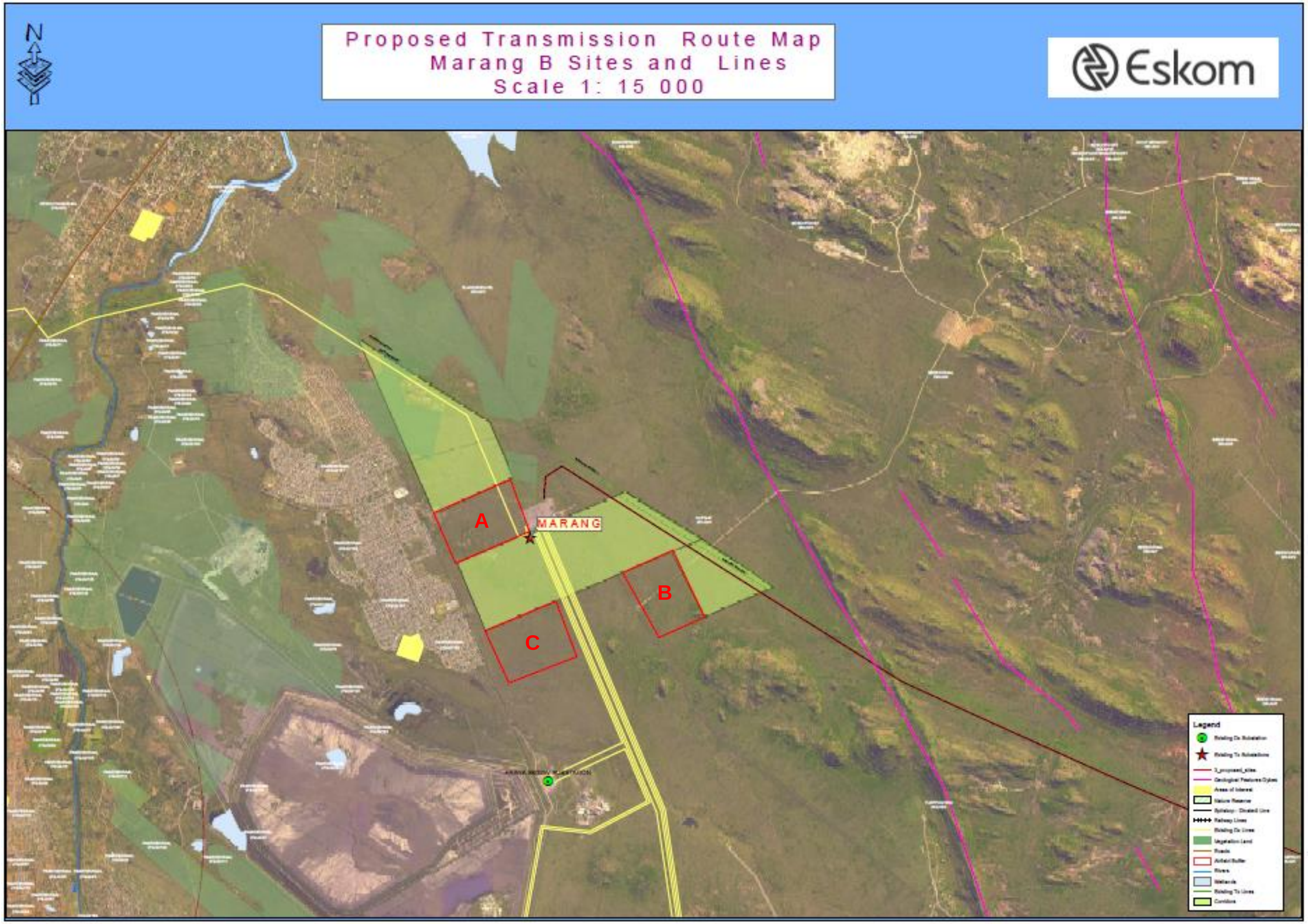


FIGURE 1-1: SITE LAYOUT OF THE PROPOSED MARANG B SITES (RED POLYGONS).

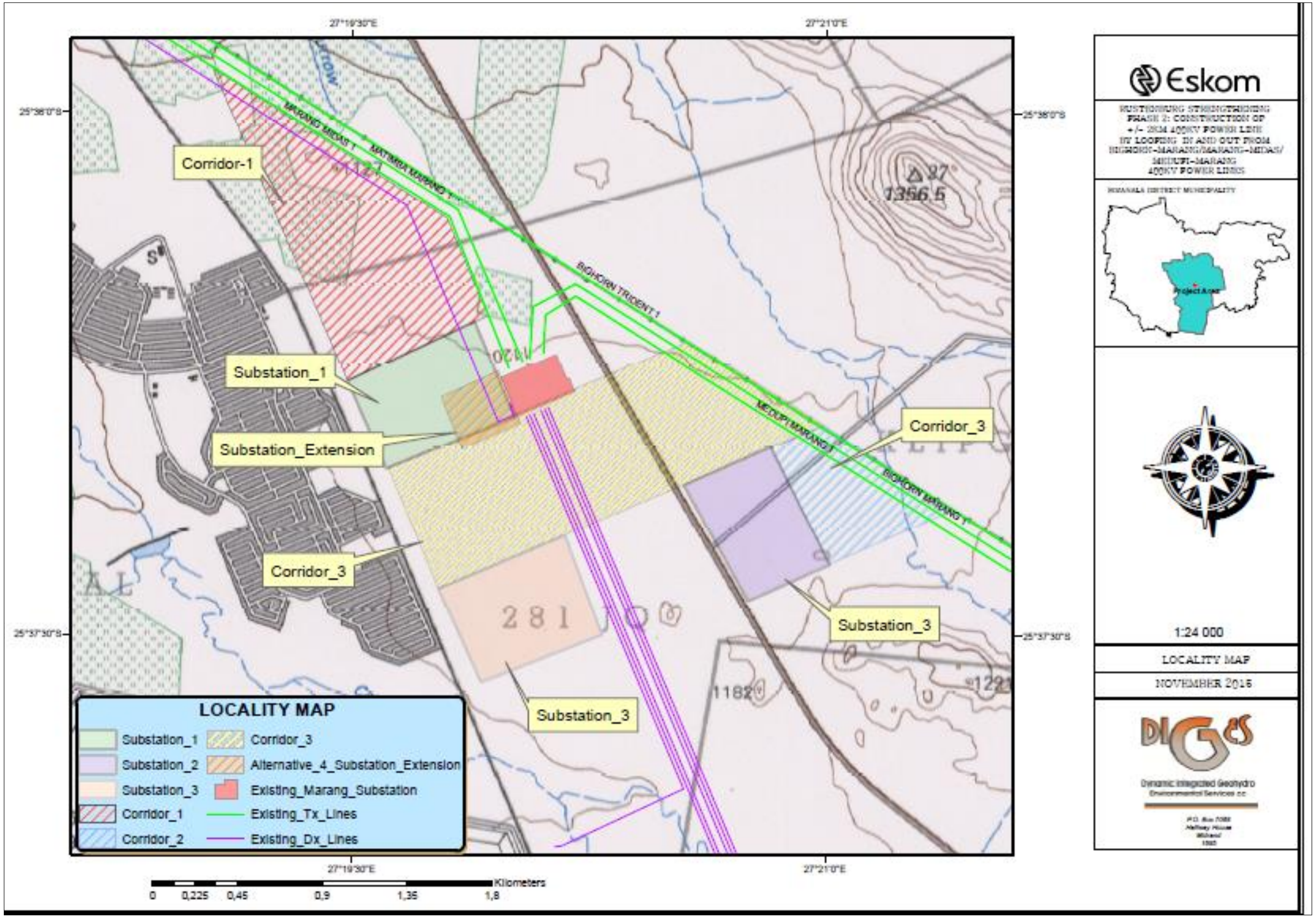


FIGURE 1-2: SITE LAYOUT OF THE PROPOSED MARANG B SITES AND SUBSTATION EXTENSION.

1.2 Terms of Reference

The scope of work for the Air Quality Impact Assessment for the proposed project is as follows:

1.2.1 Air Quality Impact Assessment

- An overview of the prevailing meteorological conditions in the area which influence the dilution and dispersion of pollutants in the atmosphere;
- The identification of existing sources of emissions and characterisation of the ambient air quality within the area using available monitoring data;
- A review of the current legislative and regulatory requirements for air quality;
- A review of emissions from the proposed activities and the associated health effects;
- The identification of sensitive receptors, such as local communities, surrounding the study area;
- The compilation of a detailed emissions inventory for proposed sources of emissions;
- Dispersion modelling simulations of ground level particulate and dust fallout emissions for incremental impacts;
- Provision of recommendations for the mitigation and management of identified potential impacts.

1.3 Outline of Report

An overview of the site characteristics, including surrounding receptors and topography is given in **Section 2**. National ambient air quality standards and associated health impacts for criteria pollutants are provided in **Section 3.** The local meteorological conditions influencing the dilution and dispersion of pollution and the current air quality situation in the area is described in **Section 4**. The air quality impact assessment, comprising of an emissions inventory and dispersion modelling simulations, is given in **Section 5**. Recommended mitigation measures are outlined in **Section 6** with the report summary and recommendations provided in **Section 7.**

2 SITE CHARACTERISTICS

2.1 Site Location

The proposed Marang B sites and extension site are located approximately 14 km to the north-east of Rustenburg in Rustenburg Local Municipality in the North-West Province (FIGURE 2-1). Land-use surrounding the proposed sites includes residential areas, mining and cultivated land. The Bospoort Dam is located approximately 2 km to the north of the proposed sites with Anglo Platinum Mine located to the immediate south.

FIGURE 2-1: LOCATION OF THE PROPOSED MARANG B SITES (RED POLYGONS) AND EXTENSION SITE (WHITE STAR).

2.2 Topography

The topography surrounding the proposed Marang B sites and extension site is shown in FIGURE 2-2 below. Surrounding elevations range from approximately 1040 – 1340 metres above mean sea level with the proposed sites situated at approximately 1122 – 1138 metres above sea level.

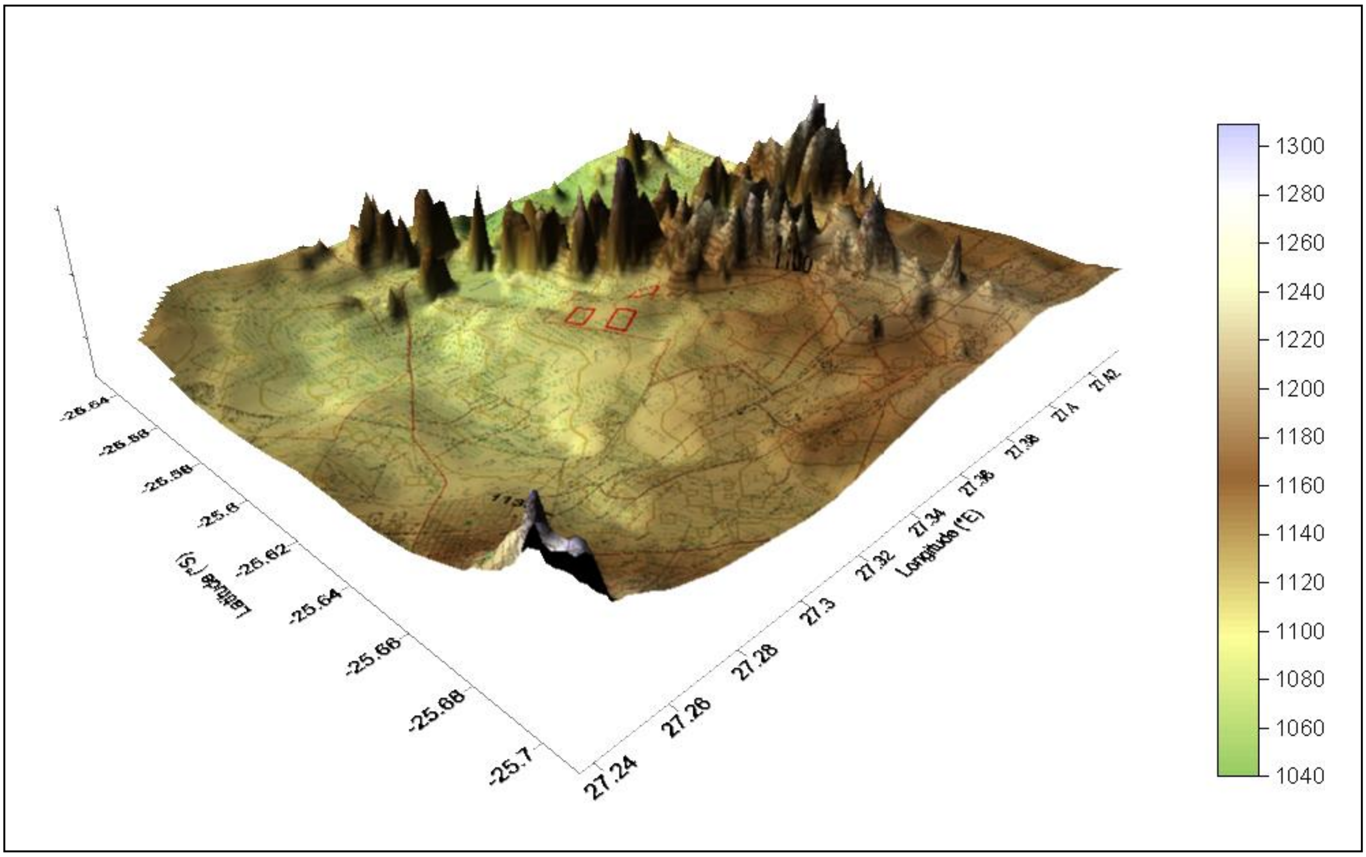


FIGURE 2-2: TOPOGRAPHY SURROUNDING THE PROPOSED MARANG B SITES (RED POLYGONS) AND EXTENSION SITE.

2.3 Sensitive Receptors

A sensitive receptor is defined as a person or place where involuntary exposure to pollutants released by the proposed activities could take place. Sensitive receptors within a 10 km radius surrounding the proposed sites are given in TABLE 2-1.

TABLE 2-1: SENSITIVE RECEPTORS SURROUNDING THE PROPOSED SITES.

RECEPTOR	TYPE OF RECEPTOR	DISTANCE FROM SITE	DIRECTION FROM SITE
Boitekong	Residential	> 1 km	W
Entabeni	Residential	~ 3 km	S
Mfidikoe	Residential	~ 4 km	S
Chachalaza	Residential	~ 4 km	WSW
Thekwane	Residential	~ 4 km	SE
Kanana	Residential	~ 4 km	NW
Boitekong	Residential	~ 5 km	WSW
Bokamoso	Residential	~ 5 km	SSE
Meriting	Residential	~ 7 km	WNW
Tlapa	Residential	~ 8 km	E
Serlaeng	Residential	~ 8 km	W
Waterkloof	Residential	~ 9 km	S
Nkaneng	Residential	~ 9 km	SE
Rankelenyane	Residential	~ 9 km	NE
Rustenburg	Residential	~ 10 km	SW

3 LEGISLATION, POLICIES AND GUIDELINES

3.1 National Environmental Management: Air Quality Act

The National Environmental Management: Air Quality Act 39 of 2004 (AQA) 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 emission 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 was issued by the Department of Environmental Affairs on 31 March 2010 (Government

Gazette No 33064) with a draft amended list of activities published on 23 November 2012 (Government Gazette No 35894). The final amended List of Activiities was published on 22 November 2013 (Government Gazette No 37054).

The proposed project is not categorised as a listed activity and does not require an Atmospheric Licence to operate.

3.3 Ambient Air Quality Standards

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 3-2).

TABLE 3-1: NATIONAL AMBIENT AIR QUALITY STANDARDS FOR CRITERIA POLLUTANTS. THE VALUES INDICATED IN BLUE ARE EXPRESSED IN PPB.

POLLUTANT	AVERAGING PERIOD	CONCENTRATION (µg/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
Ozone (O_3)	8 hours (running)	120 (61)	11
Benzene (C6H6)	1 year	10 (3.2) 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

TABLE 3-2: NATIONAL AMBIENT AIR QUALITY STANDARDS FOR PM2.5.

POLLUTANT	AVERAGING PERIOD	CONCENTRATION (μG/M^3)	FREQUENCY OF EXCEEDANCE
Particulate Matter (PM2.5)	24-hour average	65$^{(1)}$ 40$^{(2)}$ 25$^{(3)}$	0
	Annual average	25$^{(1)}$ 20$^{(2)}$ 15$^{(3)}$	0

Notes:

$^{(1)}$ Immediate compliance – 31 December 2015

$^{(2)}$ Compliance required by 1 January 2016 – 31 December 2029

$^{(3)}$ Compliance required by 1 January 2030

3.4 Dust Deposition Standards and Guidelines

The Department of Environmental Affairs has issued National dust control regulations on 1 November 2013 (TABLE 3-6). The purpose of the regulations is to prescribe general measures for the control of dust in all areas. The regulations prohibits 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 3-3: DUST FALLOUT REGULATIONS.

RESTRICTION AREAS	DUST FALLOUT RATE (MG/M^2/DAY, 30 DAYS AVERAGE)	PERMITTED FREQUENCY OF EXCEEDING DUST FALL RATE
Residential area	D < 600	Two within a year, not sequential months
Non-residential area	600 < D < 1200	Two within a year, not sequential months

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 dusts emissions;

c) Develop and 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 dustfall, 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

3.5.1 Particulates

Particles can be classified by their aerodynamic properties into coarse particles, PM10 (particulate matter with an aerodynamic diameter of less than 10 µm) and fine particles, PM2.5 (particulate matter with an aerodynamic diameter of less than 2.5 µm) (Harrison and van Grieken, 1998). The fine particles contain the secondarily formed aerosols such as sulphates and nitrates, combustion particles and recondensed organic and metal vapours. The coarse particles contain earth crust materials and fugitive dust from roads and industries (Fenger, 2002).

In terms of health impacts, particulate air pollution is associated with effects of 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 are less respirable in that they do not penetrate deep into the lungs compared to smaller particles (Manahan, 1991). Larger particles are deposited into the extrathoracic 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.

3.5.2 Sulphur Dioxide

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 (Maroni *et al*., 1995).

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 bronchconstriction 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 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).

3.5.3 Oxides of Nitrogen

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/m³ NO_2 concentration, where the weekly average concentrations are in the range of 15 – 128 µg/m³. 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).

3.5.4 Carbon Monoxide

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. Neurobehavioural effects include impaired co-ordination, tracking, driving ability, vigilance and cognitive ability (WHO, 2000).

4 BASELINE ASSESSMENT

4.1 Meteorological Overview

4.1.1 Local Wind Field

Local meteorological data was obtained from a meteorological station operated by the Weather Services in Rustenburg (-25.65 °S; 27.23 °E) for the period January 2010 – Parameters recorded include wind speed, wind direction, temperature, pressure, humidity precipitation (

TABLE 4-1). The weather station is located approximately 10 km to the west-south-west of the proposed project sites and as such, the available meteorological data is considered to be site representative of the prevailing meteorological conditions at the proposed sites.

TABLE 4-1: DATA CAPTURE (%) AT THE RUSTENBURG METEOROLOGICAL STATION FOR THE PERIOD JAN 2010 – DEC 2012.

PARAMETER	DATA CAPTURE (%)
Wind speed	89.97
Wind direction	89.97
Temperature	90.88
Pressure	90.40
Humidity	90.87
Precipitation	91.34

The predominant wind direction recorded at Rustenburg is from the south-west (20% of the time) (FIGURE 4-1). Wind speeds are generally slow to moderate with wind speeds exceeding 6 m/s recorded infrequently. Calm conditions, which are defined as wind speeds less than 1 m/s, occur frequently (21% of the time).

Based on the prevailing wind fields, emissions from the proposed sites will be transported towards the north-east, away from the neighbouring area of Boitekong. However, slow to moderate wind speeds will not result in the effective dispersion and dilution of the pollution from the site.

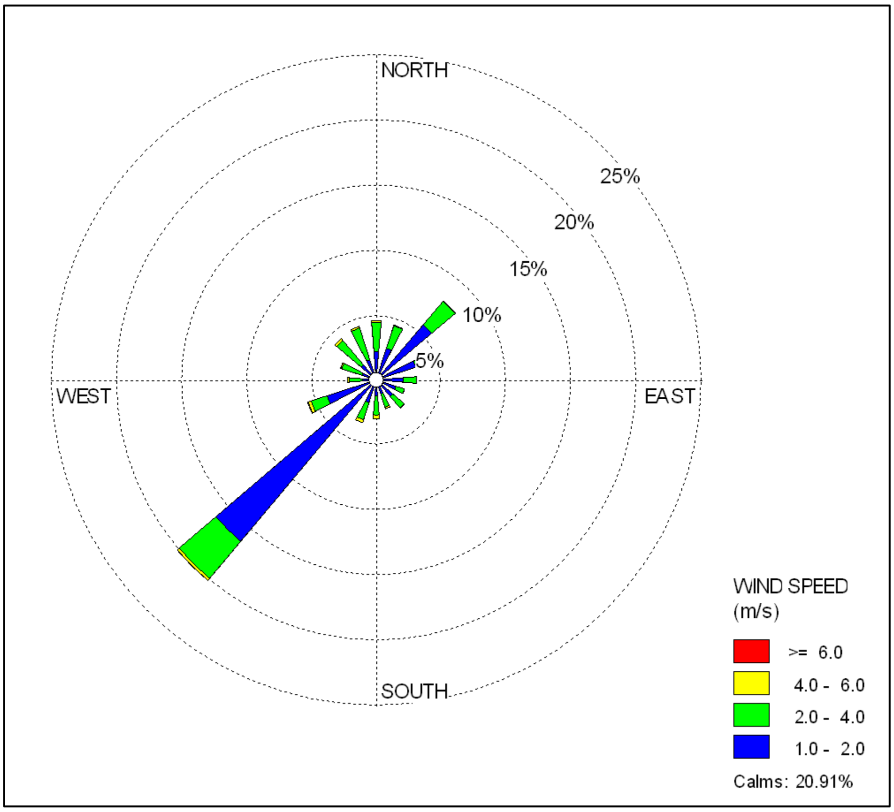


FIGURE 4-1: PERIOD WIND ROSE FOR RUSTENBURG FOR THE PERIOD JANUARY 2010 - DECEMBER 2012.

A distinct diurnal variation in winds is not observed in the meteorological dataset at Rustenburg (FIGURE 4-2). In the early morning (00:00 – 06:00), winds originate predominantly from the south-west. Winds remain from the south-west in the late morning (06:00 – 12:00), although occurring with a lower frequency. Additional stronger components are also observed from the northerly and easterly sectors. During the afternoon (12:00 – 18:00), winds originate predominantly from the westerly, northerly and easterly sectors, with a shift back to the southt-west in the evening period (12:00 – 24:00). Slower winds are recorded during the night-time compared to the day-time, although winds speeds are generally slow to moderate for all time periods.

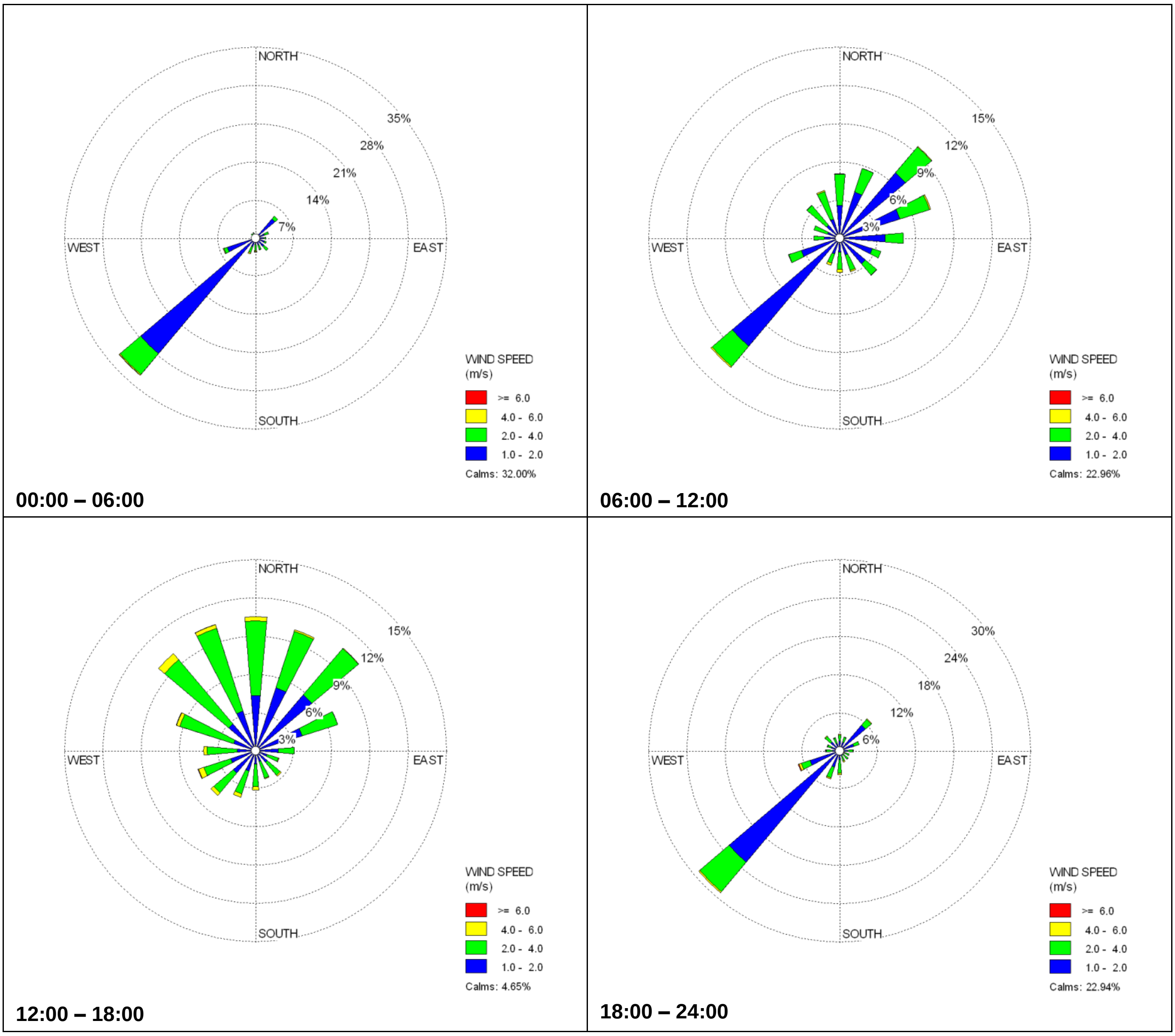


FIGURE 4-2: DIURNAL VARIATION OF WINDS AT RUSTENBURG FOR THE PERIOD JANUARY 2010 - DECEMBER 2012.

The seasonal variation in winds at Rustenburg is shown in FIGURE 4-3. A distinct seasonal variation is not observed with winds originating predominantly from south-west during all seasons. Winds originate with a higher frequency of occurrence from the south-west in winter. Slow to moderate winds are recorded during all seasons although an increase in wind speeds is noted during the spring months (September – November).

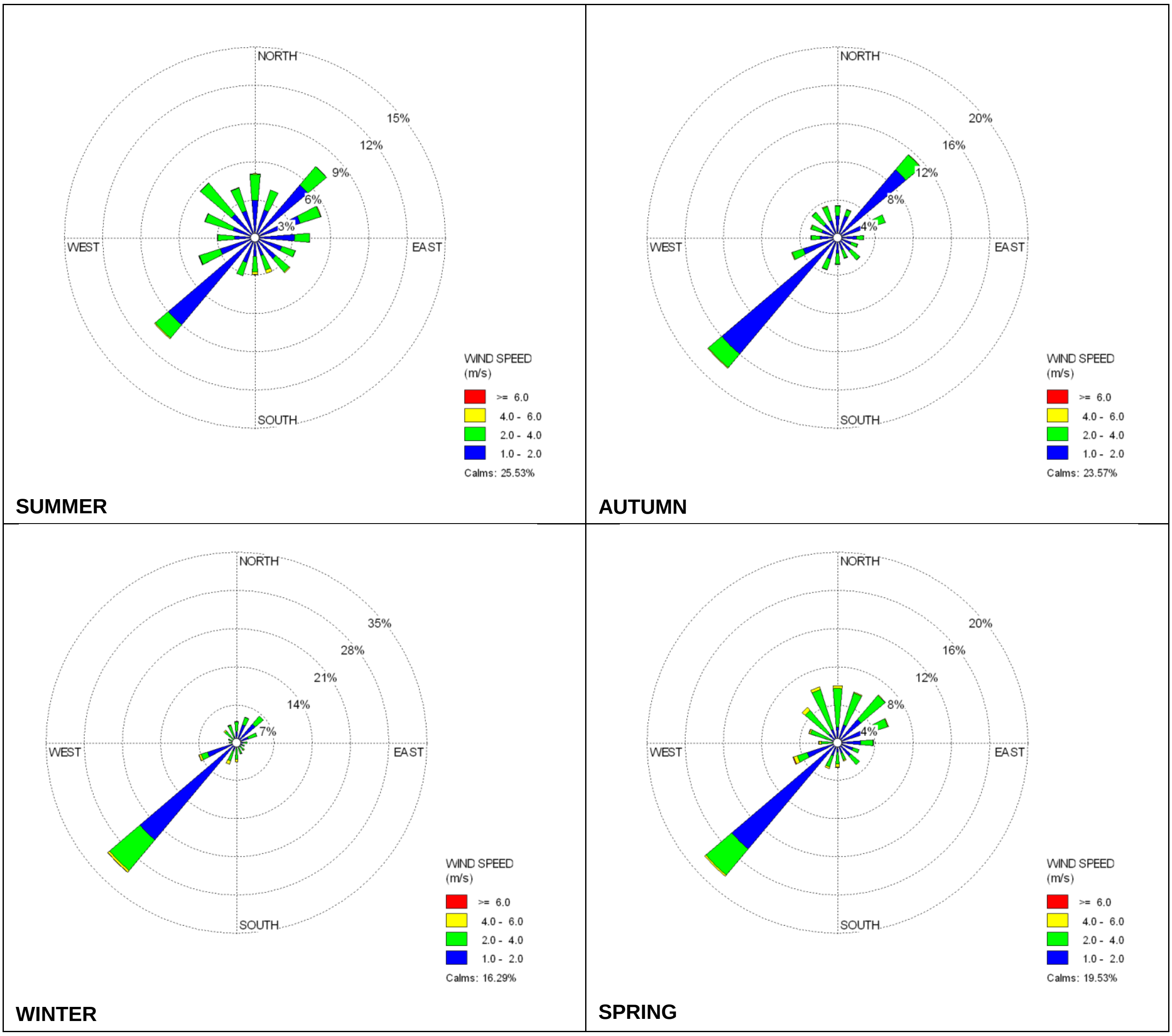


FIGURE 4-3: SEASONAL VARIATION OF WINDS AT RUSTENBURG FOR THE PERIOD JANUARY 2010 - DECEMBER 2012.

4.1.2 Temperature

The North-West Province generally experiences warm to hot summers and mild to cool winters. Monthly average temperatures for Rustenburg for the period January 2010 – December 2012 are given in FIGURE 4-4. Average temperatures at Rustenburg range from approximately 23 to 24 °C in summer to 12 to 15 °C in winter (TABLE 4-2). Relative humidity is lowest during winter and spring and highest during summer and autumn.

TABLE 4-2: HOURLY MINIMUM, MAXIMUM AND MONTHLY AVERAGE TEMPERATURES (°C) FOR RUSTENBURG FOR THE PERIOD JANUARY 2010 - DECEMBER 2012.

HOURLY MINIMUM, MAXIMUM AND MONTHLY AVERAGE TEMPERATURES (°C)												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Minimum	15.7	14.1	13.7	5.2	1.9	-1.5	-1.1	-1.6	4.5	8.0	10.6	14.0
Maximum	34.8	36.5	35.4	30.8	31.3	25.6	25.3	31.6	32.5	38.5	36.7	34.1
Average	23.3	23.7	22.7	18.2	16.3	11.5	12.0	14.8	19.3	22.2	23.5	22.5

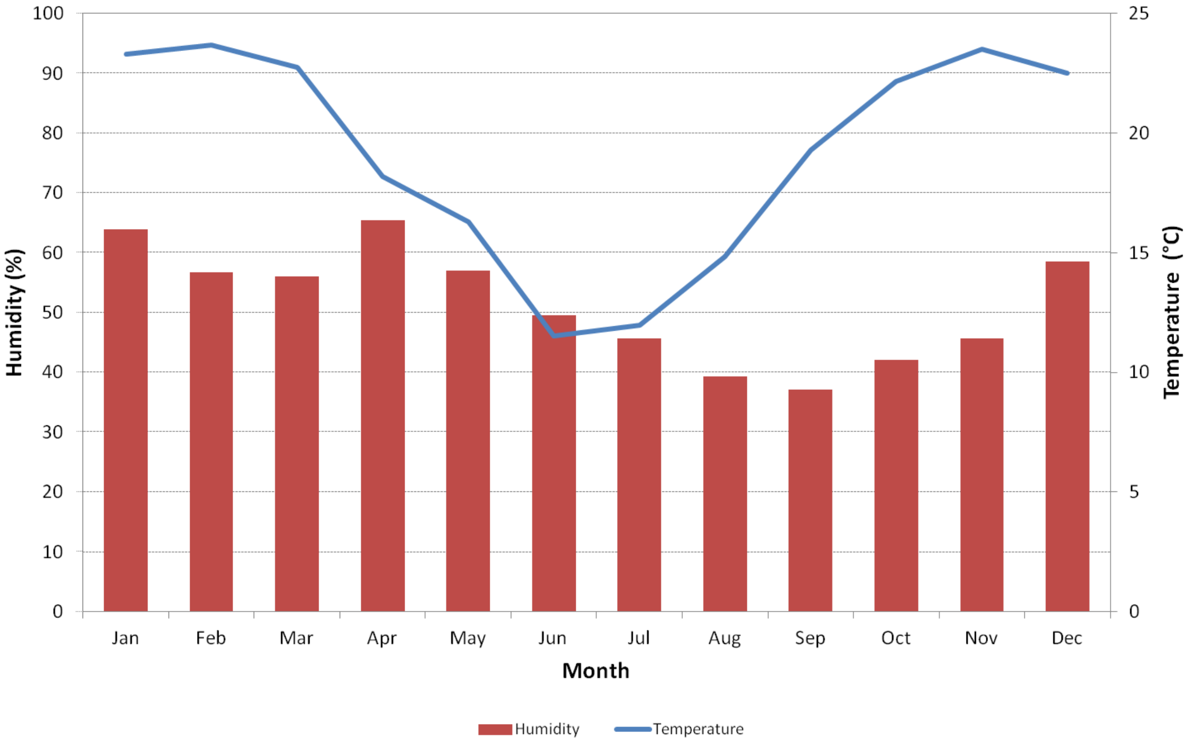
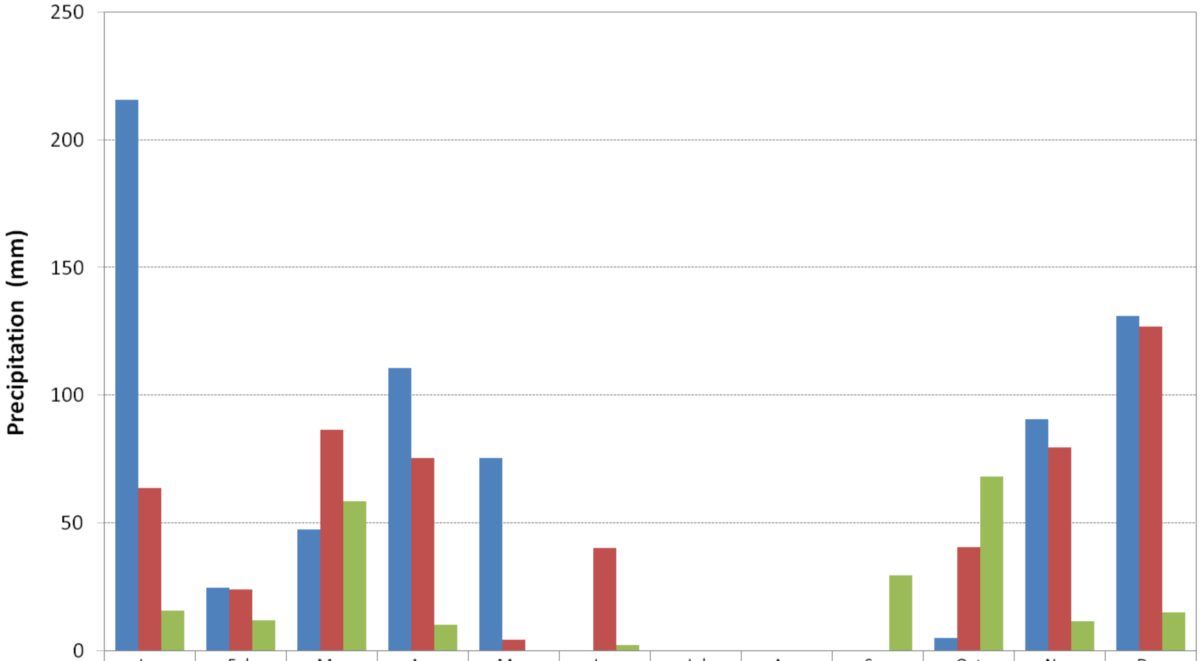


FIGURE 4-4: MONTHLY AVERAGE TEMPERATURES (°C) FOR RUSTENBURG FOR THE PERIOD JANUARY 2010 - DECEMBER 2012.

4.1.3 Precipitation

Monthly precipitation for Rustenburg is given in FIGURE 4-5 for the period January 2010 – December 2012. The area falls in a summer rainfall area, receiving most of its rainfall in the summer months (October – April).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	216	25	48	111	76	0	0	0	0	5	91	131
2011	64	24	87	75	4	40	0	0	0	41	80	127
2012	16	12	59	10	0	2	0	0	29	68	12	15

FIGURE 4-5: MONTHLY AVERAGE RAINFALL (MM) FOR RUSTENBURG FOR THE PERIOD JANUARY 2010 - DECEMBER 2012.

4.2 Baseline Air Quality Situation

Rustenburg Local Municipality operate a network of ambient air quality and meteorological monitoring stations in the area. Ambient air quality monitoring data was obtained from the Boitekong Air Quality Monitoring Station (25° 36' 49.60" S; 27° 18' 49.60" E) for the period January 2011 – December 2013. This station is located approximately 1 km to west of the proposed sites and as such pollutant concentrations recorded at this station are representative of the existing baseline conditions in the immediate area.

Percentage data capture for all pollutant parameters recorded at the Boitekong Air Quality Monitoring Station is given in TABLE 4-3. Data capture for all pollutant parameters falls well below the SANAS requirements of 90% data capture per parameter, and as such, the monitoring data cannot be used to assess the existing baseline air quality situation.

TABLE 4-3: DATA CAPTURE (%) AT THE BOITEKONG STATION FOR THE PERIOD JANUARY 2011 – DECEMBER 2013.

POLLUTANT	DATA CAPTURE (%)
PM10	12.49
SO_2	62.42
NO_2	12.95
CO	14.95
O_3	46.40

4.3 Surrounding Sources of Air Pollution

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

- Agricultural activities;
- Domestic fuel burning;
- Mining;
- Vehicle tailpipe emissions.

4.3.1 Agricultural Activities

Emissions from agricultural activities are difficult to control due to the seasonality of emissions and the large surface area producing emissions (USEPA, 1995). Expected emission resulting from agricultural activities include particulates associated with wind erosion and burning of crop residue, chemicals associated with crop spraying and odiferous emissions resulting from manure, fertilizer and crop residue.

Dust associated with agricultural practices may contain seeds, pollen and plant tissue, as well as agrochemicals, such as pesticides. The application of pesticides during temperature inversions increases the drift of the spray and the area of impact. Dust entrainment from vehicles travelling on gravel roads may also cause increased particulates in an area. Dust from traffic on gravel roads increases with higher vehicle speeds, more vehicles and lower moisture conditions.

The North-West Province is known for cattle farming, while the areas around Rustenburg and Brits are fertile, mixed-crop farming land. Maize and sunflowers are the most important crops, with the Province being the major producer of white maize in South Africa.

4.3.2 Domestic Fuel Burning

Pollutants released from these fuels include 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 (Maroni *et al*., 1995). 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.

Within the informal residential areas surrounding the proposed sites, domestic fuels such as wood and paraffin are still used for heating and cooking purposes (Census 2001, Statistics SA). However, since the census, it is likely that a higher percentage of households in these areas have been electrified. Even in electrified areas, households continue to make use of domestic fuels due to high electricity costs and the traditional use of such fuels. In the nearby town of Rustenburg, most households are electrified.

4.3.3 Mining

Mining operations result in the formation of discard or slimes dams to accommodate the waste material. Wind erosion can be a major cause of the loss and dispersion of tailings material from a tailings dam into the surrounding environment. Dust from tailings dams can be a serious nuisance, as well as a health hazard to inhabitants in nearby residential areas and can also damage the health of animals, degrade crops and cause soil and water pollution. The problem of wind erosion can affect tailings dams in all types of climate, but becomes worse as climatic aridity increases.

Studies of wind erosion from the surfaces of gold tailings dams in the Germiston-Johannesburg-Roodepoort area (Blight, 1989) found that:

- Wind and water are the major agents in eroding the slopes of gold-tailings dams;
- The horizontal top surfaces of gold-tailings dams are relatively little affected by erosion whereas the slopes of the tailings dams are the true major dust source;
- There is a weak negative correlation between the shear strength of the surface of a gold-tailings dam slope and the rate of erosion of the slope;
- There is a weak positive correlation between the length of a slope and the rate of erosion;
- A two-branched correlation exists between the slope angles of gold-tailings dams and the rate of erosion;

- Very flat slopes and very steep slopes erode less than slopes of intermediate angle. At the limits of slope, the horizontal and vertical surfaces erode very little;
- The grassing of slopes appears to be very effective as a means of reducing the rate of erosion.

Major mining operations within the Rustenburg Local Municipality include Anglo Platinum, Impala Platinum, Lonmin Platinum, Xstrata, Omnia Phosphates and Samancor Chrome Mine. Anglo Platinum is located to the immediate south of the proposed project site. Dust emissions from the neighbouring mining operations will contribute to ambient particulate concentrations, particularly during windy conditions.

4.3.4 Vehicle Tailpipe Emissions

Atmospheric pollutants emitted from vehicles include hydrocarbons, CO, CO_2, NO_x, SO_2 and particulates. These pollutants are emitted from the tailpipe, from the engine and fuel supply system, and from brake linings, clutch plates and tyres. Hydrocarbon emissions, such as benzene, result from the incomplete combustion of fuel molecules in the engine. Carbon monoxide is a product of incomplete combustion and occurs when carbon in the fuel is only partially oxidized to carbon dioxide. Nitrogen oxides are formed by the reaction of nitrogen and oxygen under high pressure and temperature conditions in the engine. Sulphur dioxide is emitted due to the high sulphur content of the fuel. Particulates such as lead originate from the combustion process as well as from brake and clutch linings wear (Samaras and Sorensen, 1999).

With Rustenburg being one of the fastest growing cities in South Africa, vehicle emissions are likely to increase in the future. Rustenburg has recently launched the Rustenburg Rapid Transport project which will also assist with reducing vehicle emissions due to the anticipated future growth of the town. The Rustenburg Rapid Transport project will contribute towards achieving South Africa’s objective to reduce carbon emissions growth by 34% by 2020 by reducing the number of vehicles on the road and introducing more carbon efficient passenger transport options.

5 AIR QUALITY IMPACT ASSESSMENT

Emissions generated from construction activities are associated mainly with fugitive dust sources. Fugitive dust emissions (PM10 and dust fallout) were assessed for the construction phase. Emissions were also estimated assuming a) no mitigation measures are employed and b) mitigation measures are employed during the construction phase.

5.1 Construction Phase

Heavy construction is a source of dust emissions that can have a substantial temporary impact on the local air quality situation. Emissions during construction are associated with land clearing, drilling and blasting, ground excavation and cut and fill operations. Dust emissions often vary substantially on a daily basis, depending on the level of activity, the specific operations and the prevailing meteorological conditions. A large portion of the emissions results from equipment traffic over temporary roads at the construction site (USEPA, 1995).

Construction consists of a series of different operations, each with its own duration and potential for dust generation. Construction operations are of a temporary nature, with a definable beginning and end. Dust emissions vary substantially over different phases of the construction process (USEPA, 1995).

The quantity of dust emissions from construction operations is proportional to the area of land being worked and to the level of construction activity. Emissions from heavy construction are positively correlated with the silt content of the soil and the weight and speed of the average vehicle and negatively correlated with the soil moisture content (USEPA, 1995).

The proposed Rustenburg Strengthening Phase 2 Project will be constructed over a period of 24 months. During the construction phase of the proposed project, it is expected that fugitive dust emissions will result from the construction of new infrastructure associated with the proposed project. Vehicle activities associated with the transport of equipment to and from the site, and on-site construction equipment traffic will also contribute to elevated fugitive dust levels. Due to the absence of detailed information regarding specific construction activities during the construction phase, emissions from construction activities at each proposed site were estimated on an area wide basis. The dimensions of each proposed substation site, extension site and corridor are given in TABLE 5-1.

TABLE 5-1: DIMENSIONS OF SUBSTATION SITES AND CORRIDORS.

SOURCE	LENGTH (M)	BREADTH (M)	AREA (M^2)
Substation Site A	600	500	300 000
Corridor A	1100	55	60 500
TOTAL	**1700**	**555**	**360 500**
Substation Site B	640	390	249 600
Corridor B	550	55	30 250
TOTAL	**1190**	**445**	**279 850**
Substation Site C	670	477	319 590
Corridor C	1940	55	106 700
TOTAL	**2610**	**532**	**426 290**
Extension Site	300	340	100 500

Fugitive dust emissions from the construction phase were estimated using the USEPA emission factor for heavy construction activities. The emission factor for construction operations is given as:

$$E = 1.2\ tons/acre/month\ of\ activity$$

The PM10 fraction was assumed to be 35% of TSP for construction. The emission factor is most applicable to construction operations with (i) medium activity levels, (ii) moderate silt contents and (iii) semi-arid climates. Construction activities were assumed to take place 7 hours per day, 6 days per week and over a 24 month period. A control efficiency of 50% (wet suppression) was applied to emissions for the mitigated scenario.

Construction activities that will generate emissions during the construction phase were identified to be:

- General land clearing (debris removal);
- Materials handling operations. i.e loading and offloading of topsoil;
- Wind erosion from open areas and stockpiles;
- Vehicle entrainment on unpaved roads;
- Construction of the towers, substation and associated infrastructure.

TABLE 5-2: ESTIMATED EMISSIONS DURING THE CONSTRUCTION PHASE.

SOURCE	EMISSION RATE (G/S)			
	UNMITIGATED		MITIGATED(1)	
	TSP	PM10	TSP	PM10
Substation Site A	141.20	49.42	70.60	24.71
Corridor A	28.48	9.97	14.24	4.98
TOTAL	**169.68**	**59.39**	**84.84**	**29.69**
Substation Site B	117.48	41.12	58.74	20.56
Corridor B	14.24	4.98	7.12	2.49
TOTAL	**131.72**	**46.10**	**65.86**	**23.05**
Substation Site C	150.42	52.65	75.21	26.32
Corridor C	50.22	17.58	25.11	8.79
TOTAL	**200.64**	**70.23**	**100.32**	**35.11**
Extension Site	10.43	3.65	5.21	1.82

Notes:

(1) 50% control efficiency applied to TSP and PM10 emissions from construction activities

5.2 Model Overview

AERMOD is a state-of-the-art Planetary Boundary Layer (PBL) air dispersion model developed by the American Meteorological Society and USEPA Regulatory Model Improvement Committee (AERMIC). AERMOD utilizes a similar input and output structure to ISCST3 and shares many of the same features, as well as offering additional features. AERMOD fully incorporates the PRIME building downwash algorithms, advanced depositional parameters, local terrain effects, and advanced meteorological turbulence calculations.

The AERMOD atmospheric dispersion modelling system is an integrated system that includes three modules:

- A steady-state dispersion model designed for short-range (up to 50 km) dispersion of air pollutant emissions from stationary industrial sources.
- A meteorological data pre-processor (AERMET) for surface meteorological data, upper air soundings, and optionally, data from on-site instrument towers. It then calculates atmospheric parameters needed by the dispersion model, such as atmospheric turbulence characteristics, mixing heights, friction velocity, Monin-Obukov length and surface heat flux.
- A terrain pre-processor (AERMAP) which provides a physical relationship between terrain features and the behaviour of air pollution plumes. It generates location and height data for each receptor

location. It also provides information that allows the dispersion model to simulate the effects of air flowing over hills or splitting to flow around hills.

AERMOD includes Plume Rise Model Enhancements (PRIME) building downwash algorithms which provide a more realistic handling of building downwash effects. PRIME algorithms were designed to address two fundamental features associated with building downwash; enhanced plume dispersion coefficients due to the turbulent wake and to reduce plume rise caused by a combination of the descending streamlines in the lee of the building and the increased entrainment in the wake.

AERMOD is suitable for a wide range of near field applications in both simple and complex terrain. The evaluation results for AERMOD, particularly for complex terrain applications, indicate that the model represents significant improvements compared to previously recommended models (USEPA, 2005).

AERMOD has been used in various dispersion modelling studies in the United States and around the world (Perry *et al*., 2004). Ventrakam (2003) investigated the ability of AERMOD to model the dispersion of an inert gas, released as a line source, in an urban environment. Comparing monitored and modelled concentrations at 24 receptor locations it was found that the model over predicted average 30 minute concentrations near source and under predicted concentrations further away. The study also found that at night the correlation of measured and modelled concentrations at the closest receptor points to the source were poor. However, the agreement improved with distance (Holmes and Morawska, 2006).

5.2.1 Model Requirements

The approach to this dispersion modelling study is based on the draft Regulations Regarding Air Dispersion Modelling as issued by the Department of Environmental Affairs on 14 December 2012 (DEA, 2012). As per the draft regulations, this assessment is considered to be a Level 2 assessment. Level 2 assessments should be used for air quality impact assessment in standard/generic licence or amendment processes where:

- The distribution of pollutant concentrations and depositions are required in time and space;
- Pollutant dispersion can be reasonable treated by a straight-line, steady-state, Gaussian plume model with first order chemical transformation. Although more complicated processes may be occurring, a more complicated model that explicitly treats these processes may not be necessary depending on the purposes of the modelling and the zone of interest.
- Emissions are from sources where the greatest impacts are in the order of a few kilometres (less than 50 km), downwind.

Data input into the model includes site-specific surface and upper air meteorological data with wind speed, wind direction, temperature, pressure, precipitation and cloud cover for January 2010 – December 2012.

Given the underlying topography at the site, terrain data at a resolution of 90m (SRTM90) was also input into the model. A modelling domain of 10 km × 10 km was used, with multi-tier Cartesian grid receptor spacing's of 50 m and 100 m. The neighbouring residential area of Boitekong was included as a discrete receptor as it borders the proposed sites to the immediate west.

A summary of the key variables input into the AERMOD model is given in TABLE 5-3.

TABLE 5-3: KEY VARIABLES USED IN THE MODELLING STUDY.

PARAMETER	MODEL INPUT
Model	
Assessment Level	Level 2
Dispersion Model	Aermod
Supporting Models	Aermet
Emissions	
Pollutants modelled	Dust Fallout and PM10
Scenarios	Construction Phase for each site
Settings	
Terrain setting	Elevated
Terrain data	SRTM90
Terrain data resolution (m)	90
Land characteristics (bowen ratio, surface albedo, surface roughness)	Urban and Cultivated Land
Grid Receptors	
Modelling domain (km)	10 * 10
Fine grid resolution (m)	50
Coarse grid resolution (m)	100

5.3 Dispersion Modelling Simulations

Dispersion simulations were undertaken for the following scenario for each site to determine the following:

- Predicted zones of maximum ground level impacts from all key sources for TSP (as dust fallout) and PM10 for the **construction** phase for both unmitigated and mitigated scenarios.

The draft regulations for air dispersion modelling (DEA, 2012), recommend the use of the 99th percentile concentrations for short-term assessment with the National Ambient Air Quality Standards since the highest predicted ground-level concentrations can be considered outliers due to complex variability of meteorological processes. This might cause exceptionally high concentrations that the facility may never actually exceed in its lifetime.

Isopleth plots of predicted concentrations for daily and annual average PM10 concentrations and dust deposition rates for the construction phase is given in FIGURE 5-1 – FIGURE 5-12 for the unmitigated scenarios and FIGURE 5-13 – FIGURE 5-24 for the mitigated scenarios. For daily averaging periods, the predicted 99th percentile concentrations are provided. Comparison of the predicted PM10 concentrations has been made with the National ambient air quality standards and allowable frequency of exceedance to determine compliance. Comparison of the predicted TSP (as dust fallout) concentrations is made with the National dust fallout limits to determine compliance.

Ambient air objectives (standards) are applied to areas where there is public access outside the facility fenceline (i.e beyond the facility boundary). Within the facility boundary, environmental conditions are prescribed by occupational health and safety criteria (DEA, 2012).

It should be noted that model output files for construction activities associated with proposed sites A, B and C and powerlines were modelled and presented in 2014 as part of the original air quality impact assessment. The report has been updated to include the model output files for proposed construction activities associated with the proposed extension site.

5.3.1 Unmitigated

5.3.1.1 PM10 Concentrations

<u>Site A</u>

Predicted incremental PM10 concentrations associated with construction activities at Site A are in compliance with the daily average standard and allowable frequency of exceedance at the boundary of the closest residential receptor, namely, Boitekong (FIGURE 5-1 and TABLE 5-4). Predicted annual average concentrations are in compliance with the annual average standard (FIGURE 5-4).

<u>Site B</u>

Incremental PM10 concentrations at Site B are also predicted to be well in compliance with the daily and annual average PM10 standards at the boundary of the residential area of Boitekong (TABLE 5-4). The lowest PM10 concentrations are observed in Boitekong when construction is undertaken at this site.

<u>Site C</u>

Incremental PM10 concentrations at Site C are in non-compliance with the daily average PM10 standard of 75 µg/m^3 in Boitekong (FIGURE 5-3) (TABLE 5-4). Predicted annual average concentrations are in compliance with the annual average standard (FIGURE 5-6). The highest PM10 concentrations are observed in Boitekong when construction is undertaken at this site. The close proximity of this site to

Boitekong, as well as the larger surface area of construction compared to the other two sites, would account for the elevated particulate concentrations observed at this site.

Extension Site

Predicted incremental daily average PM10 concentrations associated with construction activities at the extension site are in non-compliance with the daily average PM10 standard of 75 µg/m^3 beyond the site boundary (FIGURE 5-10). Annual average PM10 concentrations are in non-compliance with the annual average standard of 40 µg/m^3 beyond the site boundary (FIGURE 5-11). Non-compliance with the annual standard is observed close to the site boundary (< 1 km), with low concentrations observed at surrounding sensitive receptors (TABLE5-4).

5.3.1.2 Dust Fallout

Site A

Predicted dust fallout at Site A approaches the allowable dust fallout limit of 600 mg/m^2/day for residential areas (FIGURE 5-7), with a maximum dust fallout level of 567.11 mg/m^2/day recorded at the boundary of Boitekong (TABLE 5-4).

Site B

Predicted dust fallout at Site B is well within the allowable dust fallout limit for residential areas (FIGURE 5-8 and TABLE 5-4). Dust fallout emissions from this site are very low will not impact upon the neighbouring residential area of Boitekong.

Site C

Predicted dust fallout at Site C exceeds the allowable dust fallout limit for residential areas (FIGURE 5-9), with a maximum dust fallout level of 767.43 mg/m^2/day recorded at the boundary of Boitekong (TABLE 5-4). As mentioned above, the close proximity of this site to Boitekong, as well as the larger surface area of construction compared to the other two sites, would account for the elevated dust fallout levels observed at this site.

Extension Site

Predicted incremental dust fallout deposition rates due to construction activities at the extension site exceeded the dust fallout limit of 600 mg/m^2/day for residential areas. Exceedances are observed close to the site boundary (< 1 km) (FIGURE 5-12). Dust fallout rates observed at all surrounding sensitive receptors, including the adjacent residential area Boitekong, fall below the dust fallout limit of 600 mg/m^2/day for residential areas (TABLE 5-4).

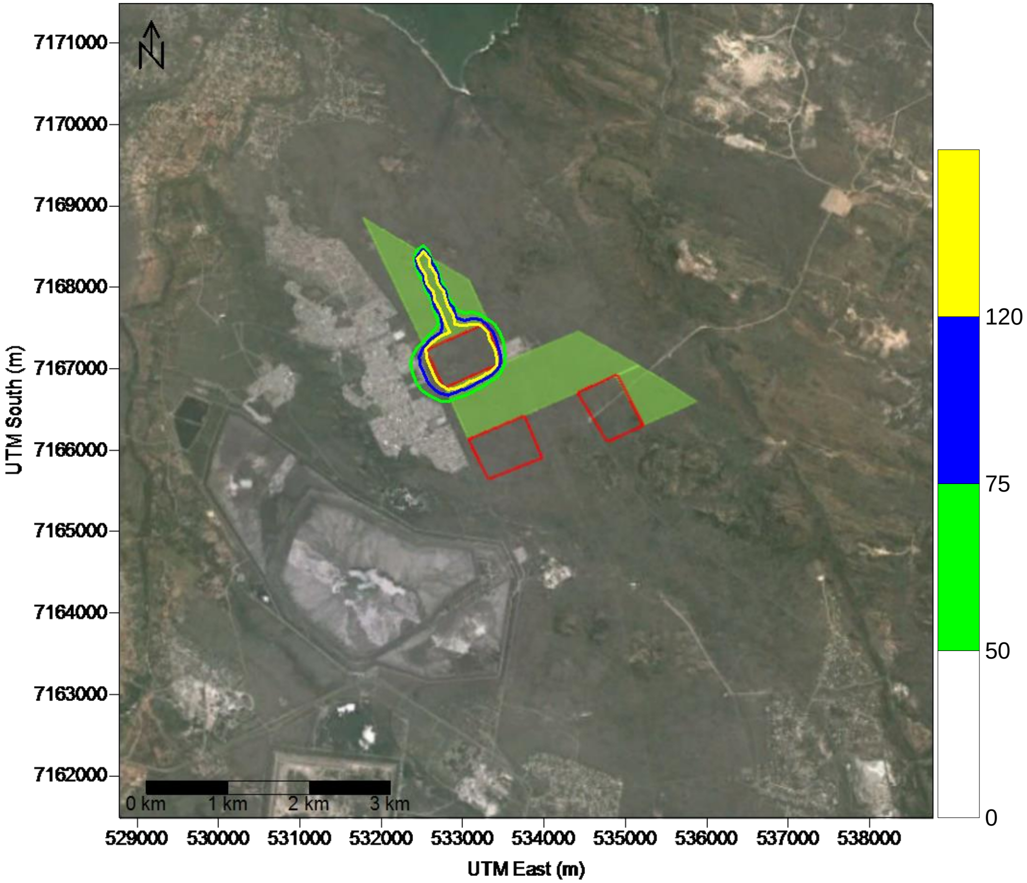


FIGURE 5-1: DAILY AVERAGE PM10 CONCENTRATIONS (µG/M³) DUE TO CONSTRUCTION RELATED ACTIVITIES AT SITE A (UNMITIGATED).

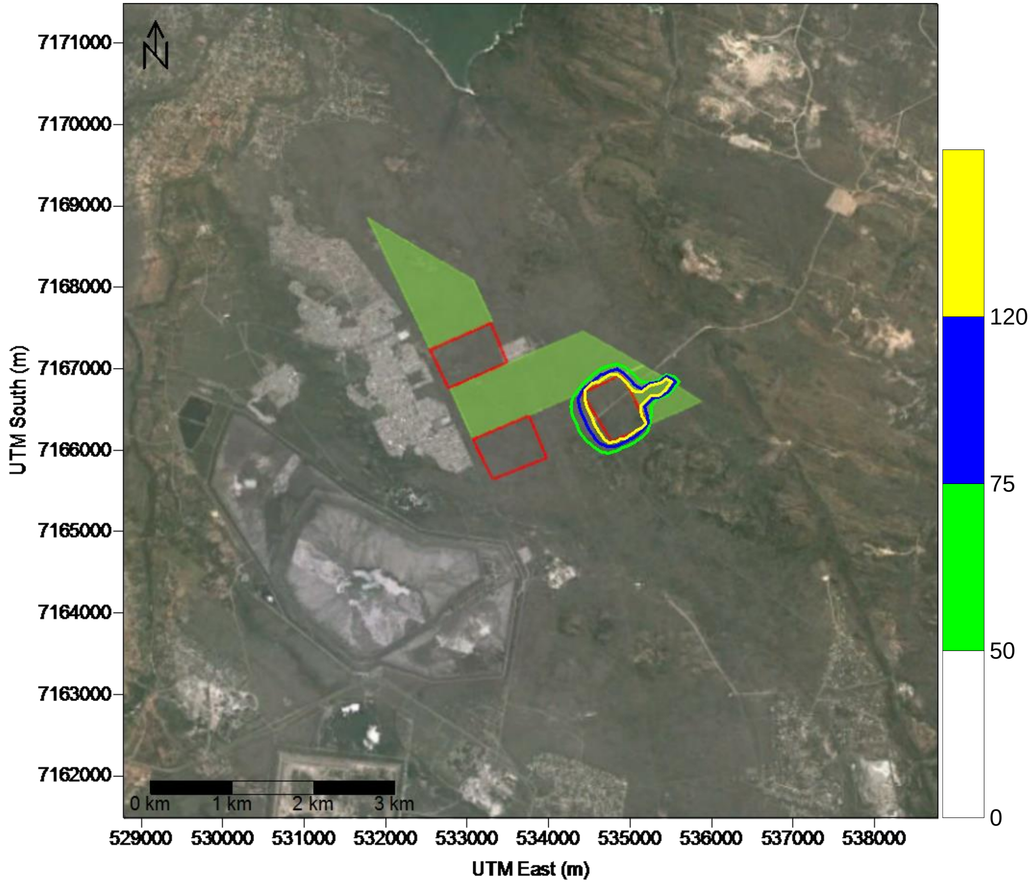


FIGURE 5-2: DAILY AVERAGE PM10 CONCENTRATIONS (µG/M³) DUE TO CONSTRUCTION RELATED ACTIVITIES AT SITE B (UNMITIGATED).

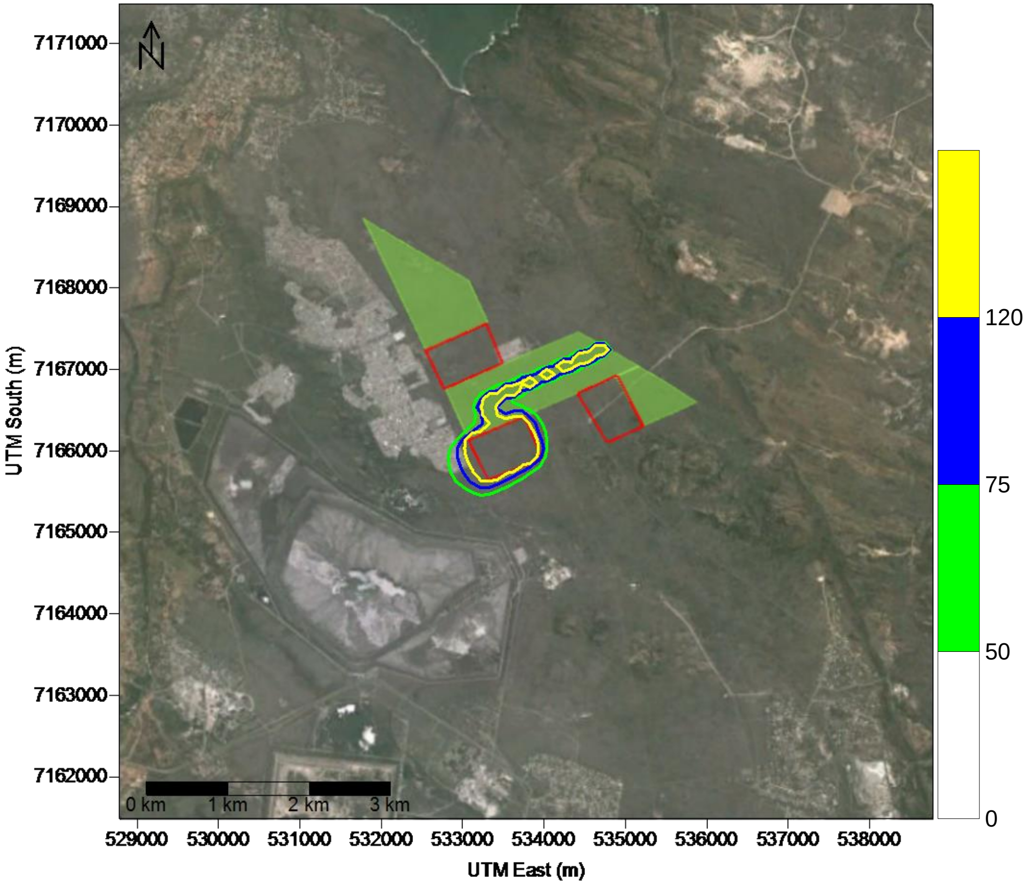


FIGURE 5-3: DAILY AVERAGE PM10 CONCENTRATIONS (µG/M³) DUE TO CONSTRUCTION RELATED ACTIVITIES AT SITE C (UNMITIGATED).

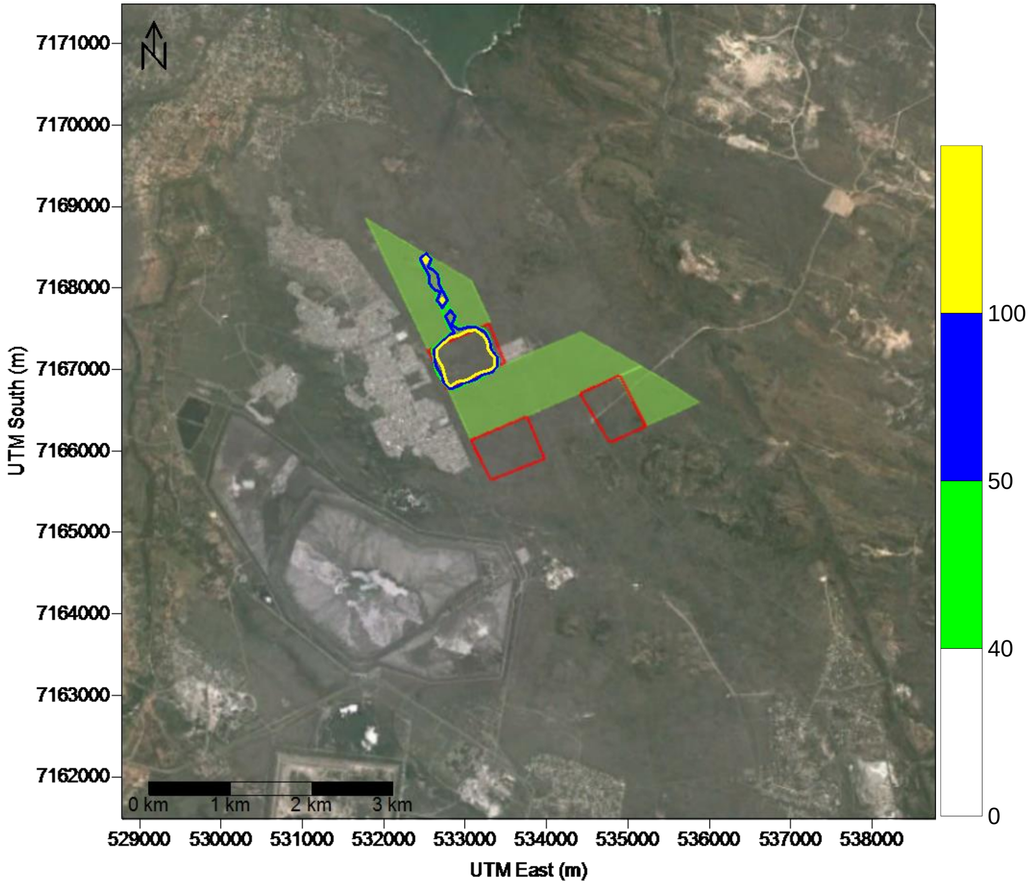


FIGURE 5-4: ANNUAL AVERAGE PM10 CONCENTRATIONS (µG/M³) DUE TO CONSTRUCTION RELATED ACTIVITIES AT SITE A (UNMITIGATED).

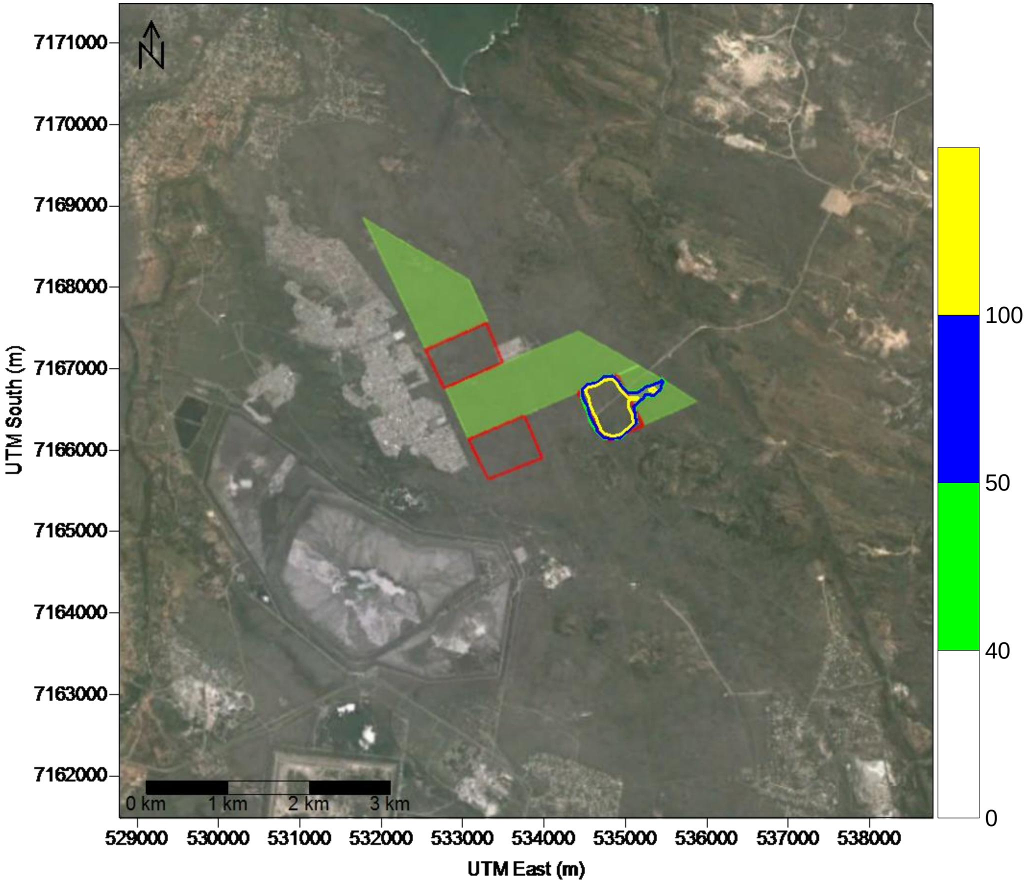


FIGURE 5-5: ANNUAL AVERAGE PM10 CONCENTRATIONS (µG/M³) DUE TO CONSTRUCTION RELATED ACTIVITIES AT SITE B (UNMITIGATED).

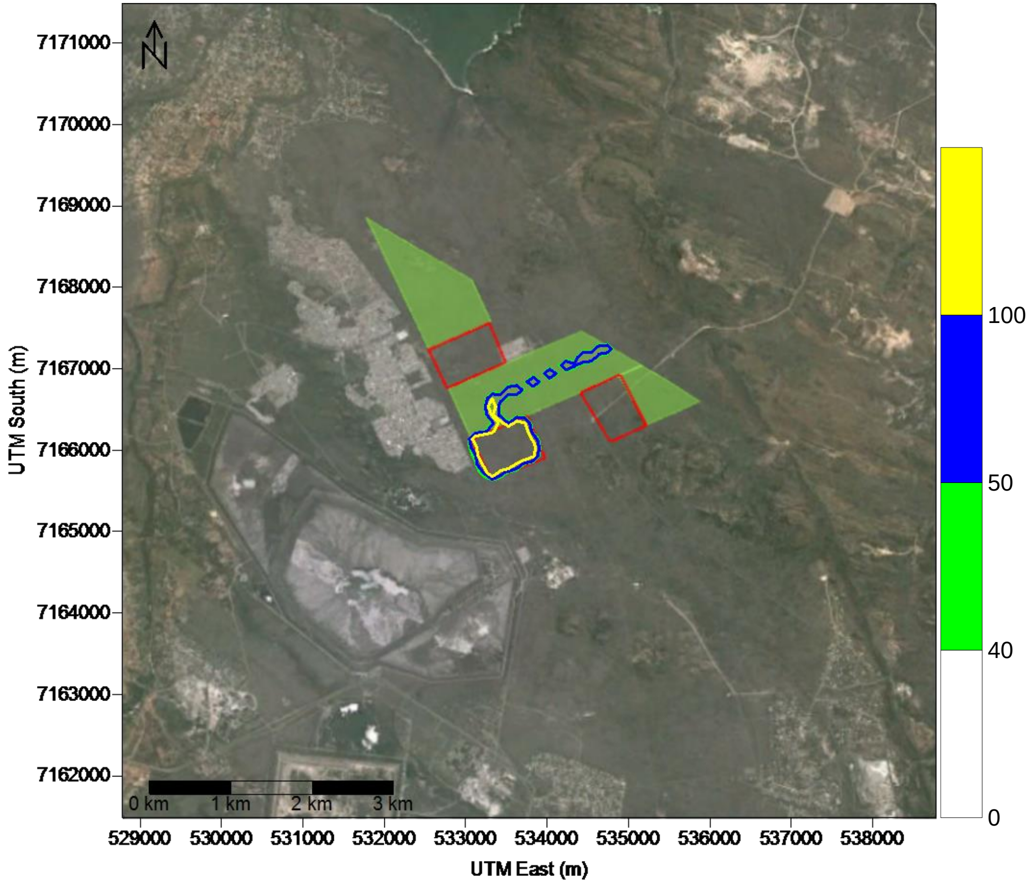


FIGURE 5-6: ANNUAL AVERAGE PM10 CONCENTRATIONS (µG/M³) DUE TO CONSTRUCTION RELATED ACTIVITIES AT SITE C (UNMITIGATED).

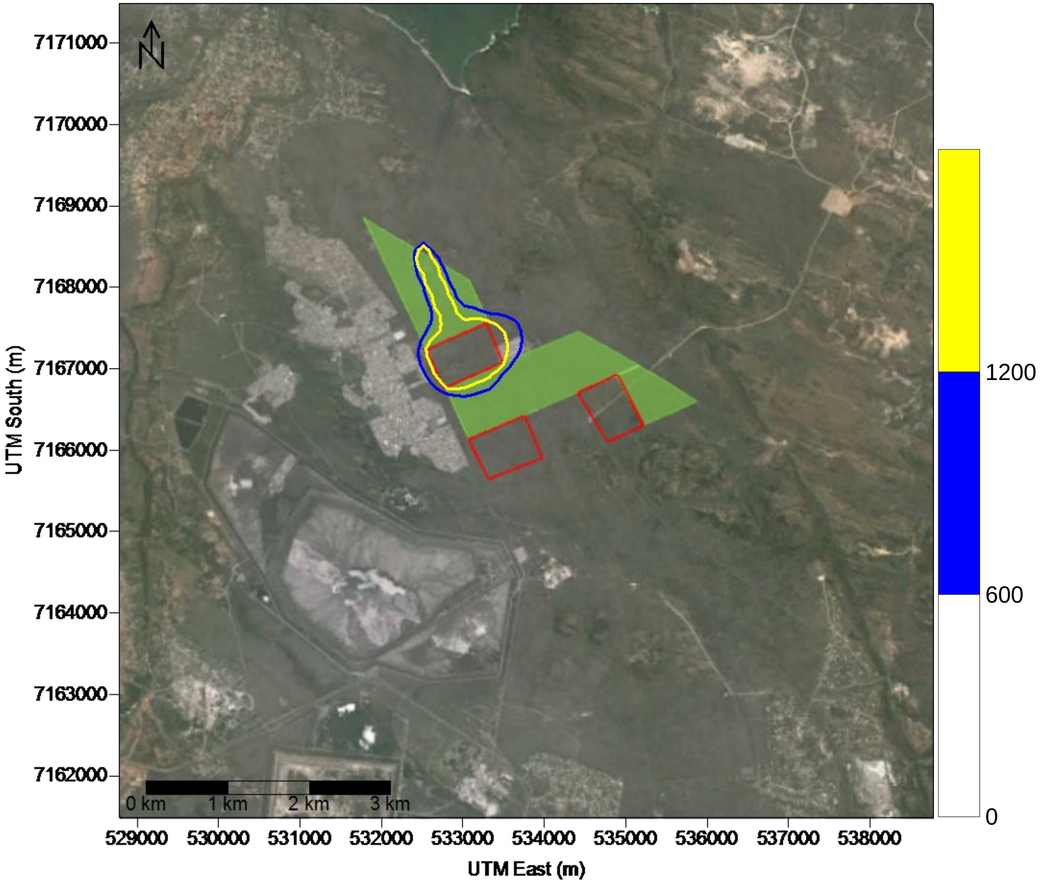


FIGURE 5-7: DUST FALLOUT (MG/M²/DAY) DUE TO CONSTRUCTION RELATED ACTIVITIES AT SITE A (UNMITIGATED).

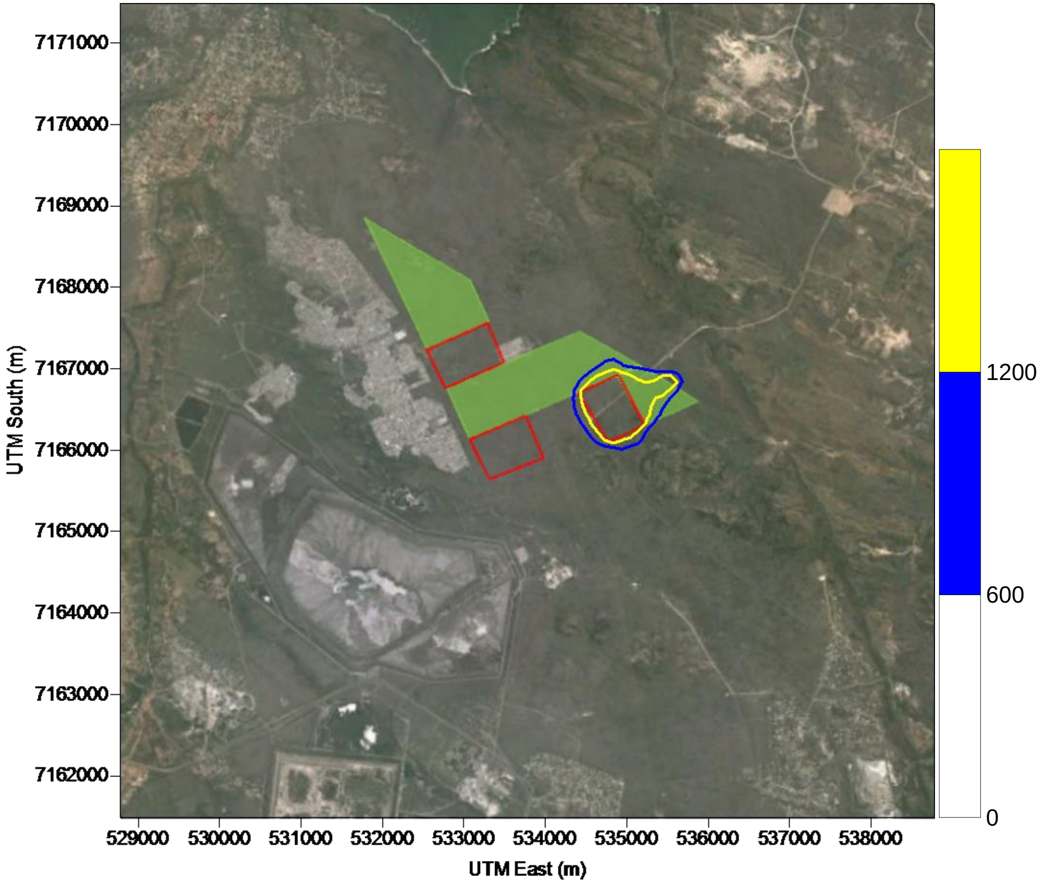


FIGURE 5-8: DUST FALLOUT (MG/M²/DAY) DUE TO CONSTRUCTION RELATED ACTIVITIES AT SITE B (UNMITIGATED).

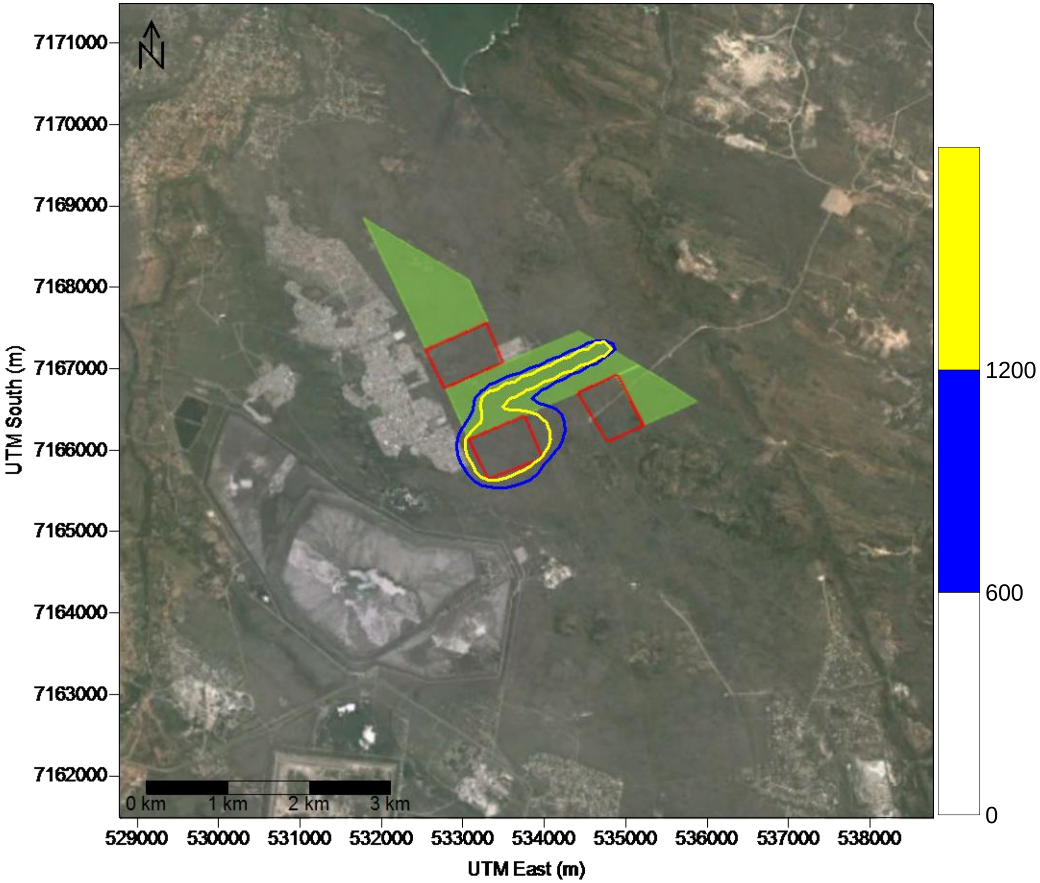


FIGURE 5-9: DUST FALLOUT (MG/M^2/DAY) DUE TO CONSTRUCTION RELATED ACTIVITIES AT SITE C (UNMITIGATED).

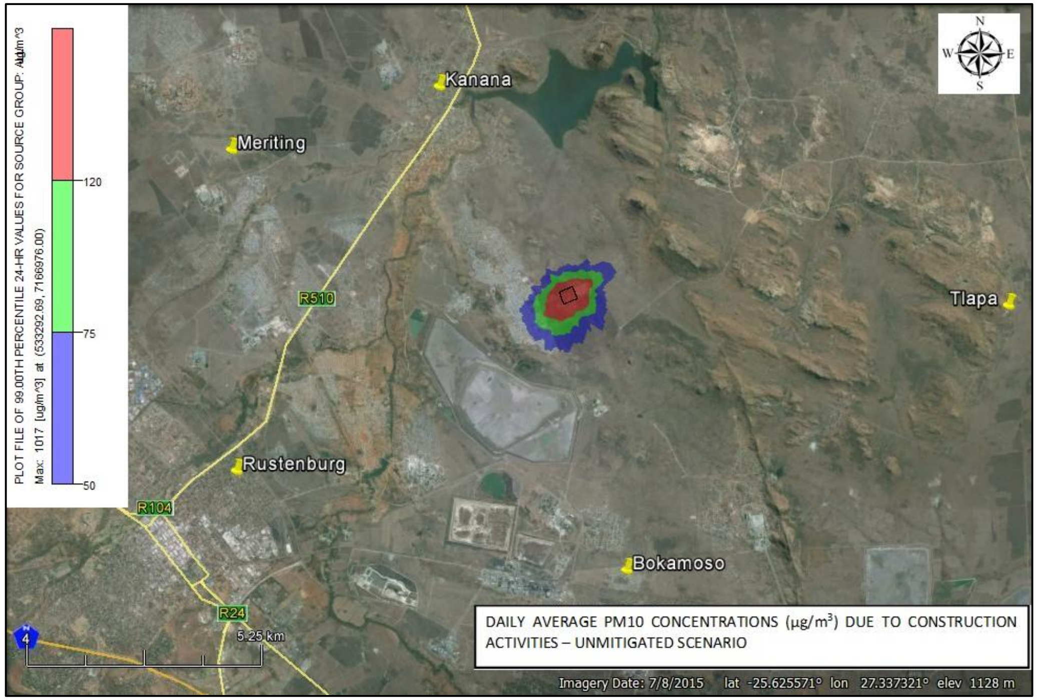


FIGURE 5-10: DAILY AVERAGE PM10 CONCENTRATIONS (μG/M^3) DUE TO CONSTRUCTION RELATED ACTIVITIES AT THE EXTENSION SITE (UNMITIGATED).

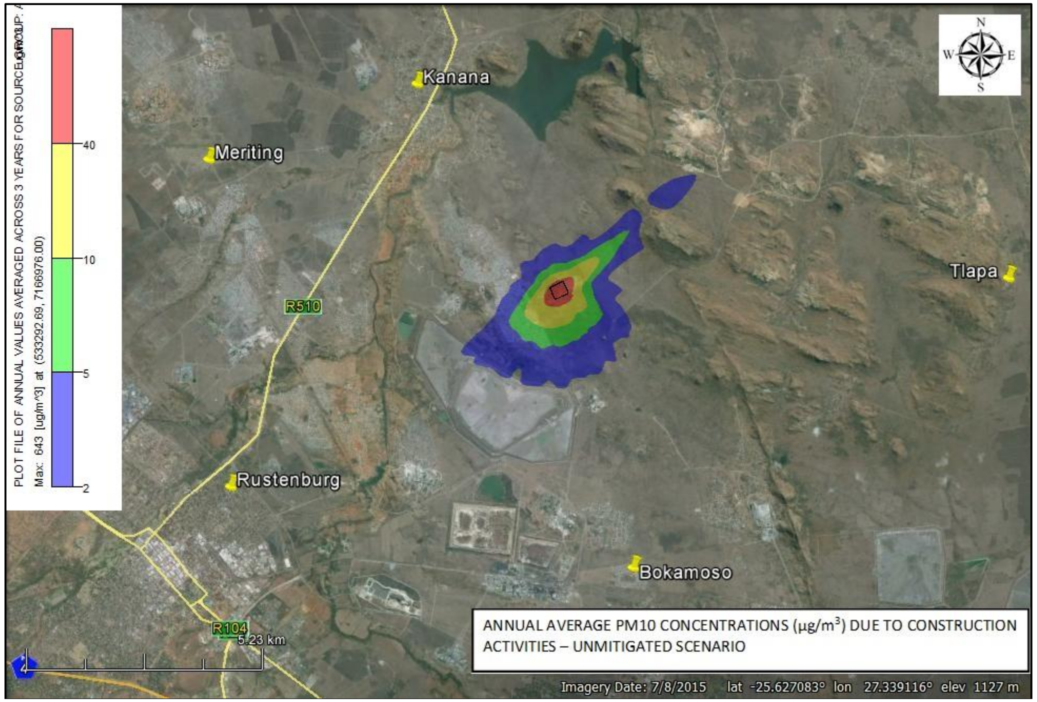


FIGURE 5-11: ANNUAL AVERAGE PM10 CONCENTRATIONS (μG/M^3) DUE TO CONSTRUCTION RELATED ACTIVITIES AT THE EXTENSION SITE (UNMITIGATED).

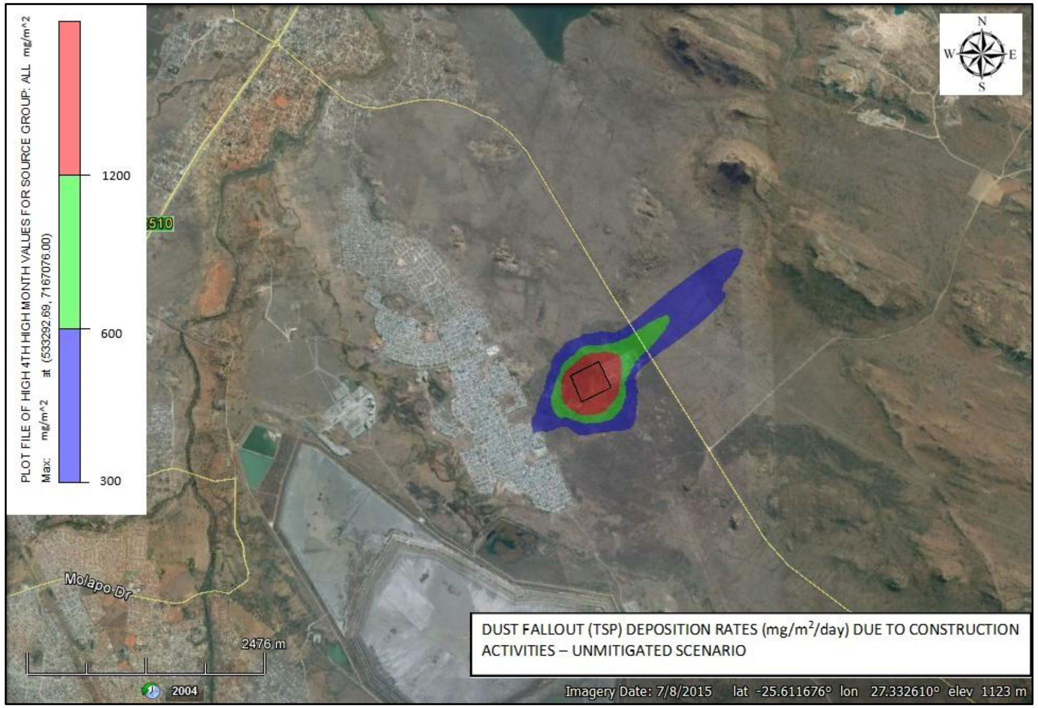


FIGURE 5-12: DUST FALLOUT (MG/M²/DAY) DUE TO CONSTRUCTION RELATED ACTIVITIES AT THE EXTENSION SITE (UNMITIGATED).

5.3.2 Mitigated

5.3.2.1 PM10 Concentrations

Site A

Predicted incremental PM10 concentrations fall well in compliance with the daily and annual average PM10 standards for mitigated emissions (FIGURE 5-13 and FIGURE 5-16) (TABLE 5-4).

Site B

Predicted incremental PM10 concentrations at Site B remain low at this site with the implementation of mitigation measures (FIGURE 5-14 and FIGURE 5-17) (TABLE 5-4).

Site C

Predicted incremental PM10 concentrations will be in compliance with both the daily average PM10 standard with the implementation of mitigation measures (FIGURE 5-15) (TABLE 5-4). Annual average PM10 concentrations remain in compliance with the annual average standard (FIGURE 5-18).

Extension Site

Predicted incremental daily and annual average PM10 concentrations are also reduced with the implementation of mitigation measures and are in compliance with the daily average PM10 standard of 75 $\mu g/m^3$ and annual standard of 40 $\mu g/m^3$ at surrounding residential area (FIGURE 5-22 and FIGURE 5-23). Exceedances of the standards are observed just beyond the site boundary. No exceedances of the daily and annual PM10 standards were observed at Boitekong (TABLE 5-4).

5.3.2.2 Dust Fallout

Site A

Predicted dust fallout at Site A is reduced with the implementation of mitigation measures and falls well within the allowable dust fallout limit of 600 mg/m^2/day for residential areas (FIGURE 5-19 and TABLE 5-4).

Site B

Predicted dust fallout at Site B remains well within the allowable dust fallout limit for residential areas (FIGURE 5-20 and TABLE 5-4).

Site C

With the implementation of mitigation measures at Site C, predicted dust fallout will be in compliance with the allowable dust fallout limit for residential areas at the boundary of Boitekong (FIGURE 5-21 and

TABLE 5-4). If construction is to be undertaken at this site, mitigation measures will need to be implemented to ensure dust fallout levels in Boitekong are within acceptable limits.

Extension Site

Predicted dust fallout deposition rates at the extension site are reduced with the implementation of mitigation measures and fall within the allowable dust fallout limit of 600 mg/m^2/day at surrounding residential areas (FIGURE 5-24 and TABLE 5-4).

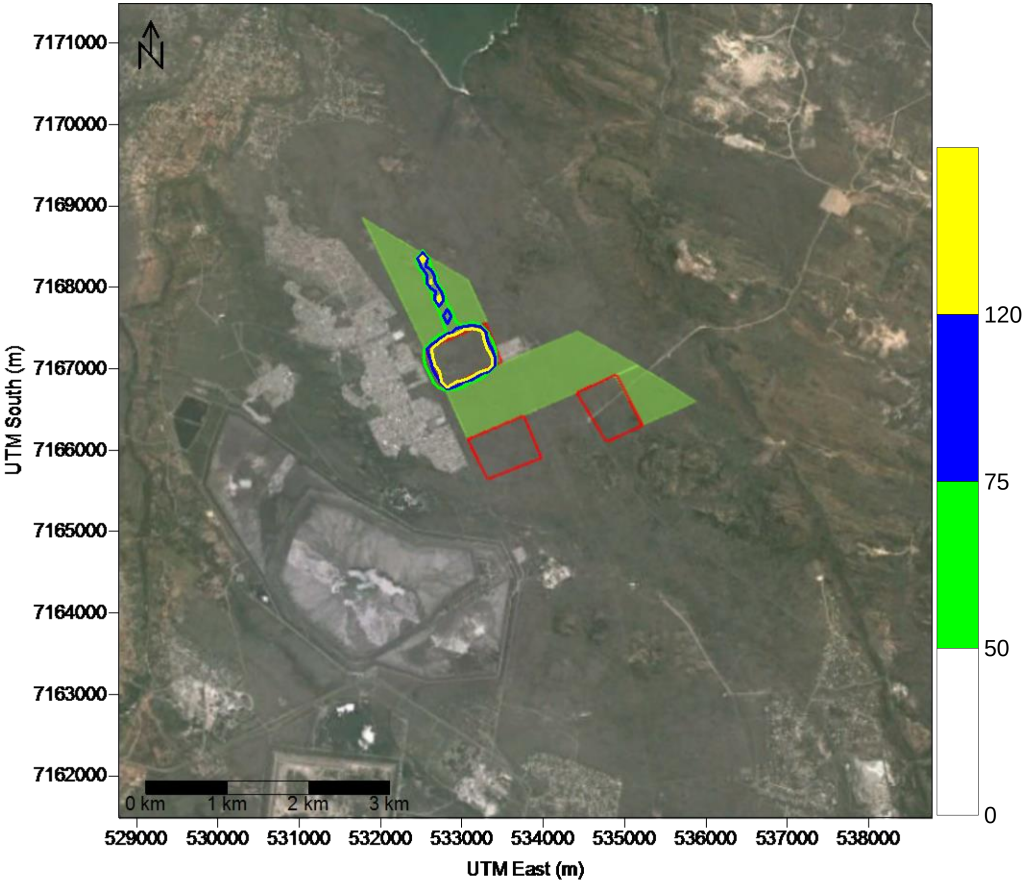


FIGURE 5-13: DAILY AVERAGE PM10 CONCENTRATIONS (µG/M³) DUE TO CONSTRUCTION ACTIVITIES AT SITE A (MITIGATED).

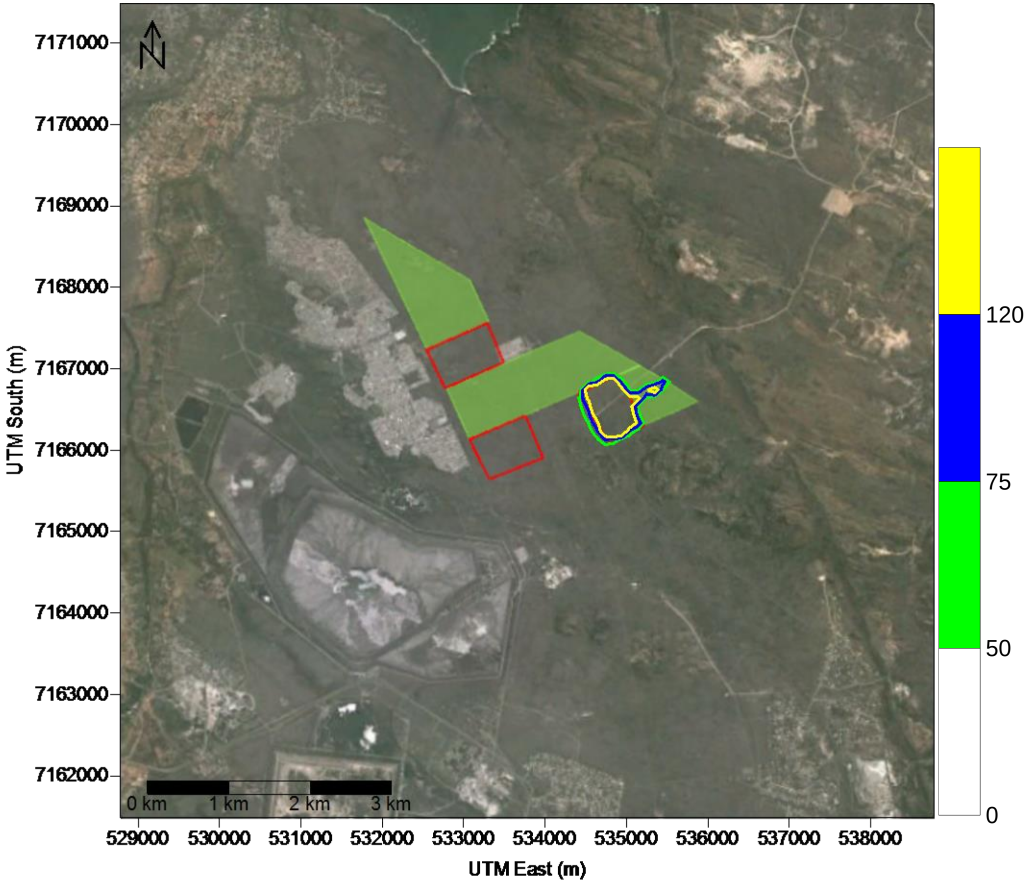


FIGURE 5-14: DAILY AVERAGE PM10 CONCENTRATIONS (µG/M³) DUE TO CONSTRUCTION ACTIVITIES AT SITE B (MITIGATED).

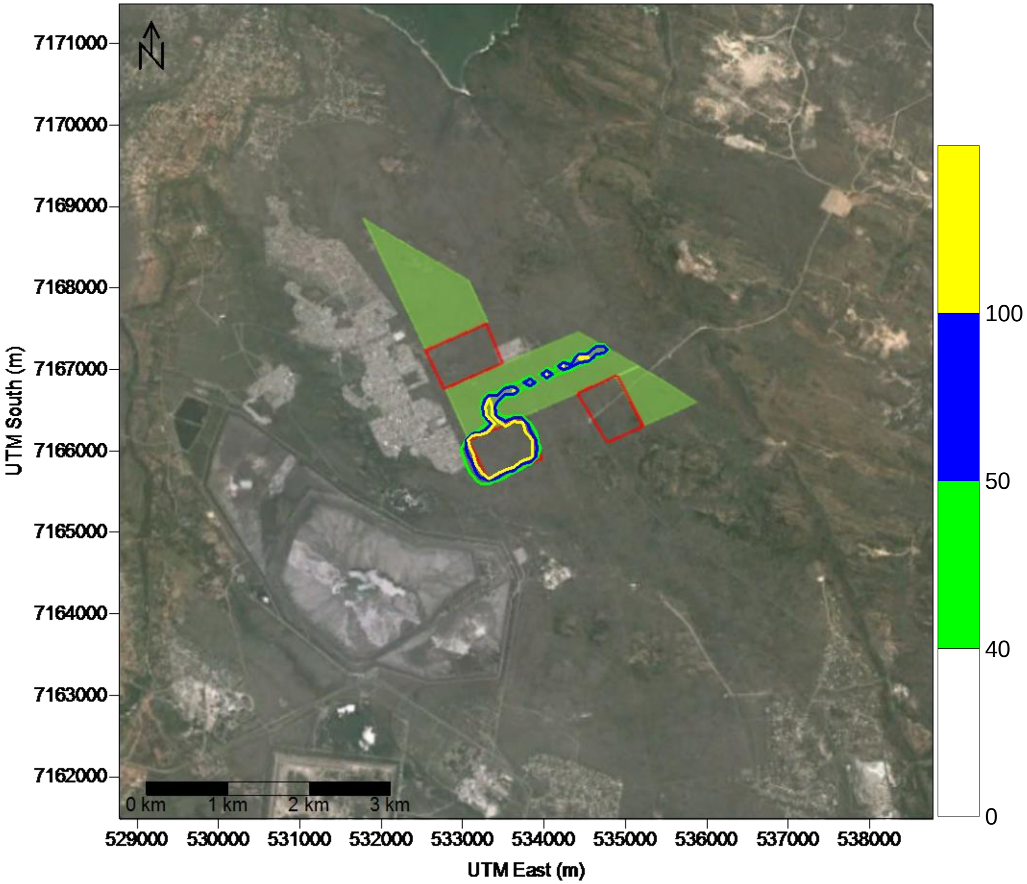


FIGURE 5-15: DAILY AVAERAGE AVERAGE PM10 CONCENTRATIONS (μG/M^3) DUE TO CONSTRUCTION ACTIVITIES AT SITE C (MITIGATED).

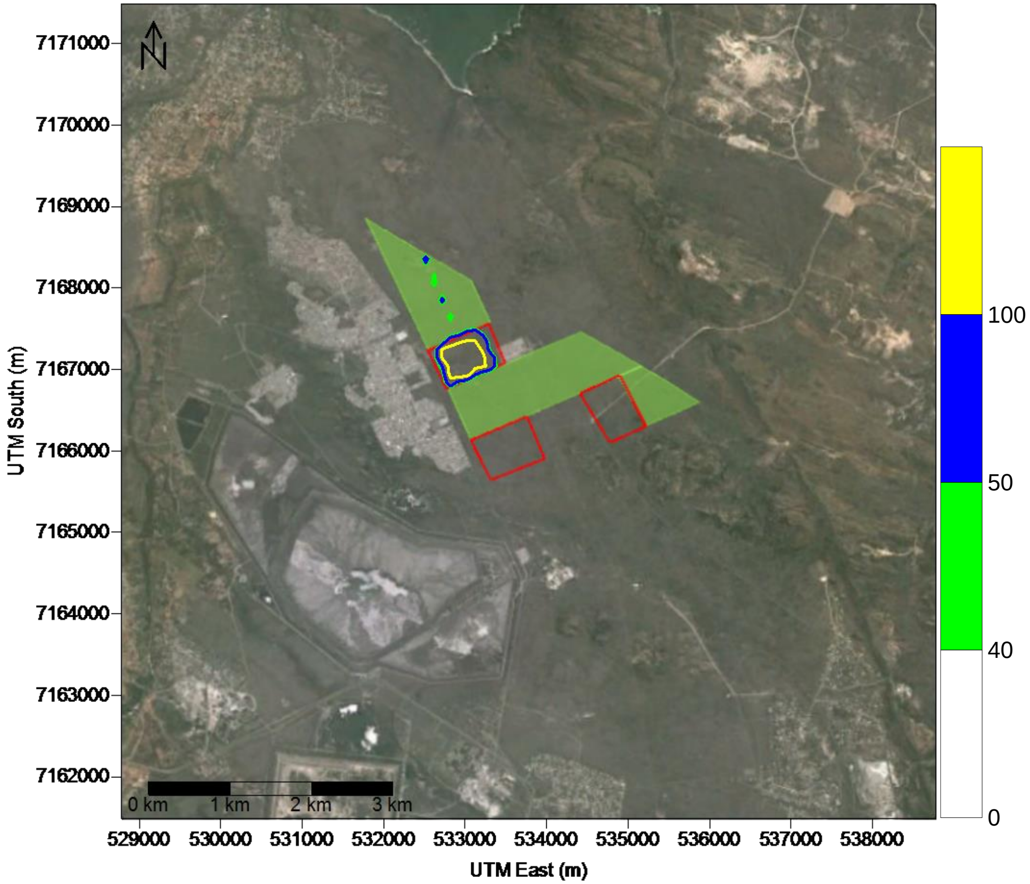


FIGURE 5-16: ANNUAL AVERAGE PM10 CONCENTRATIONS (μG/M^3) DUE TO CONSTRUCTION ACTIVITIES AT SITE A (MITIGATED).

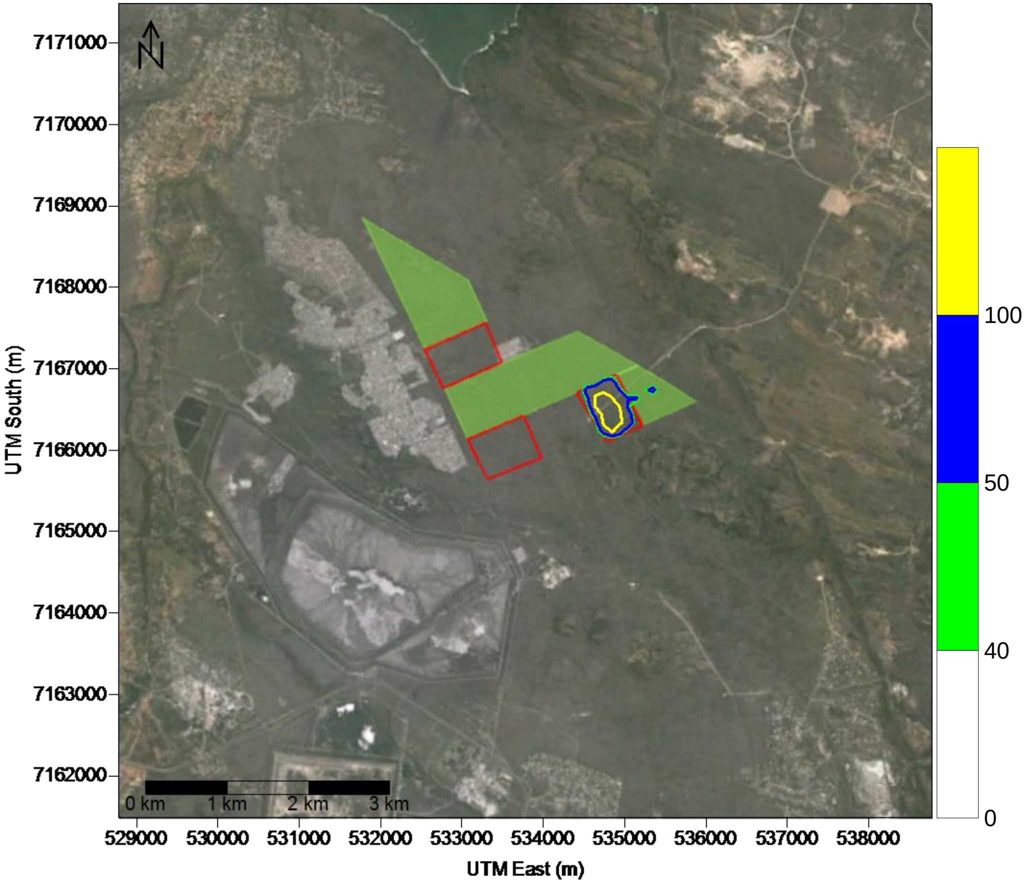


FIGURE 5-17: ANNUAL AVERAGE PM10 CONCENTRATIONS (µG/M^3) DUE TO CONSTRUCTION ACTIVITIES AT SITE B (MITIGATED).

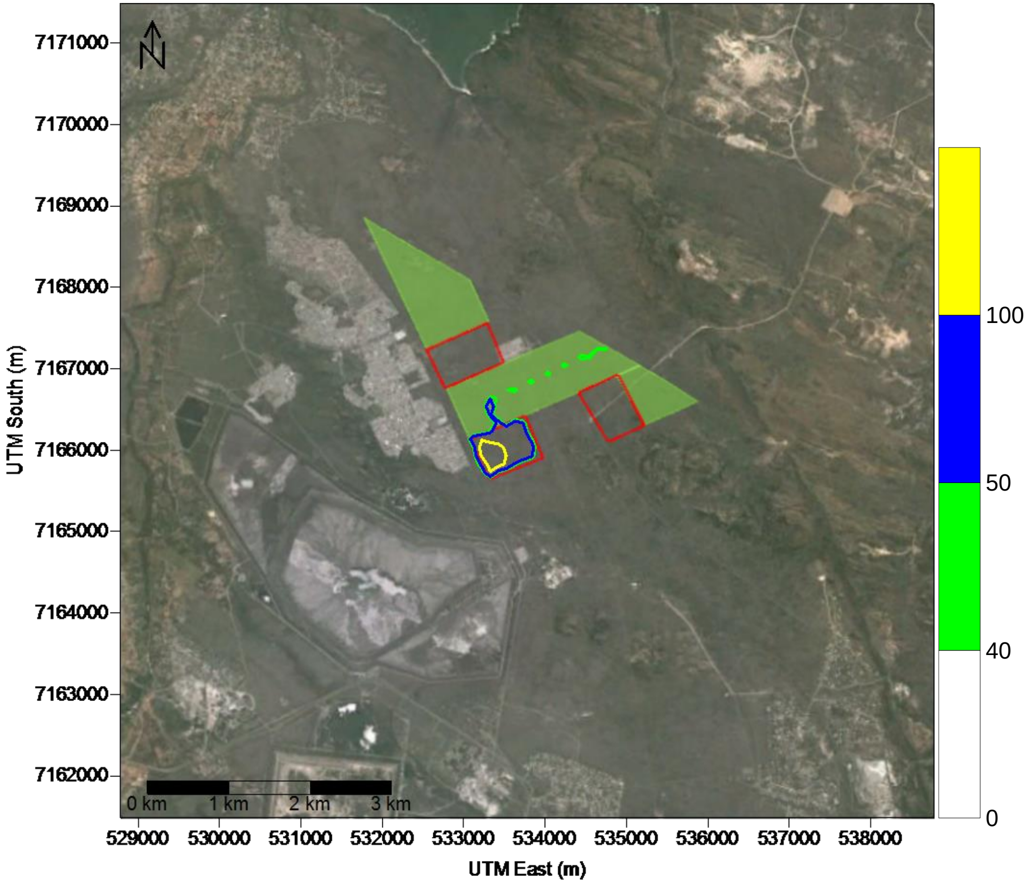


FIGURE 5-18: ANNUAL AVERAGE PM10 CONCENTRATIONS (µG/M^3) DUE TO CONSTRUCTION ACTIVITIES AT SITE C (MITIGATED).

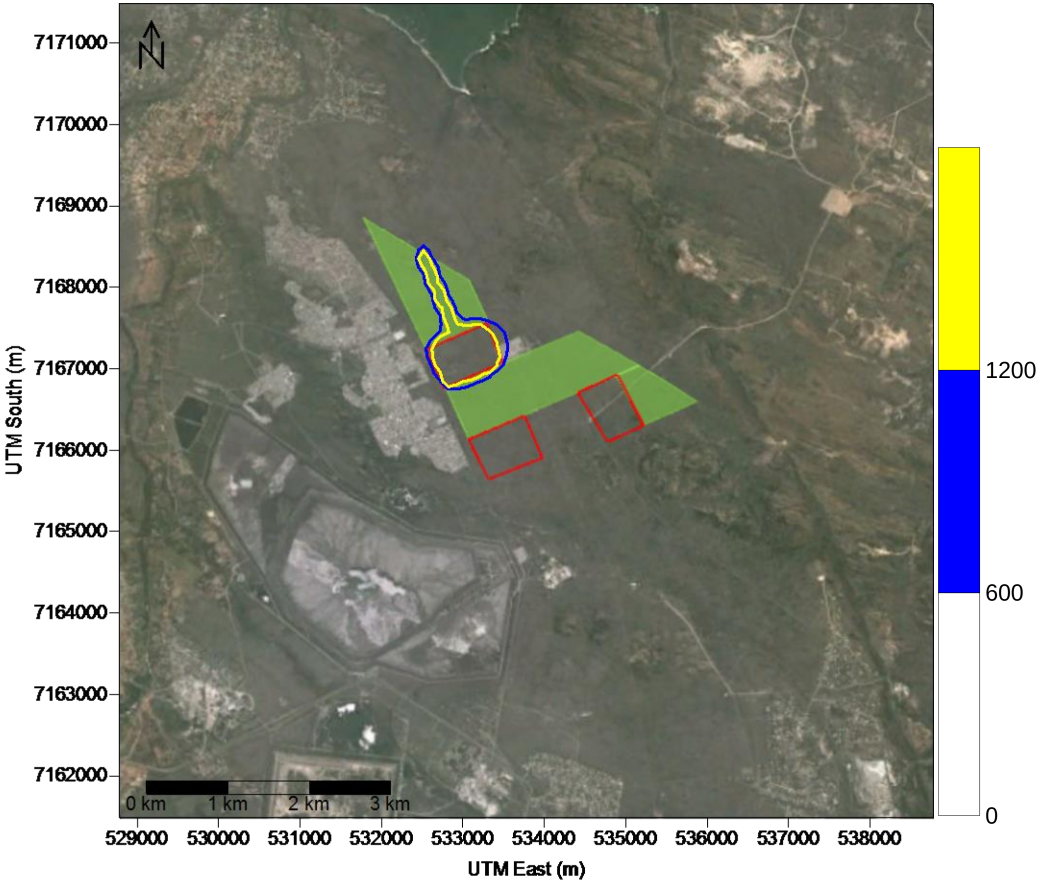


FIGURE 5-19: DUST FALLOUT (MG/M²/DAY) DUE TO CONSTRUCTION ACTIVITIES AT SITE A (MITIGATED).

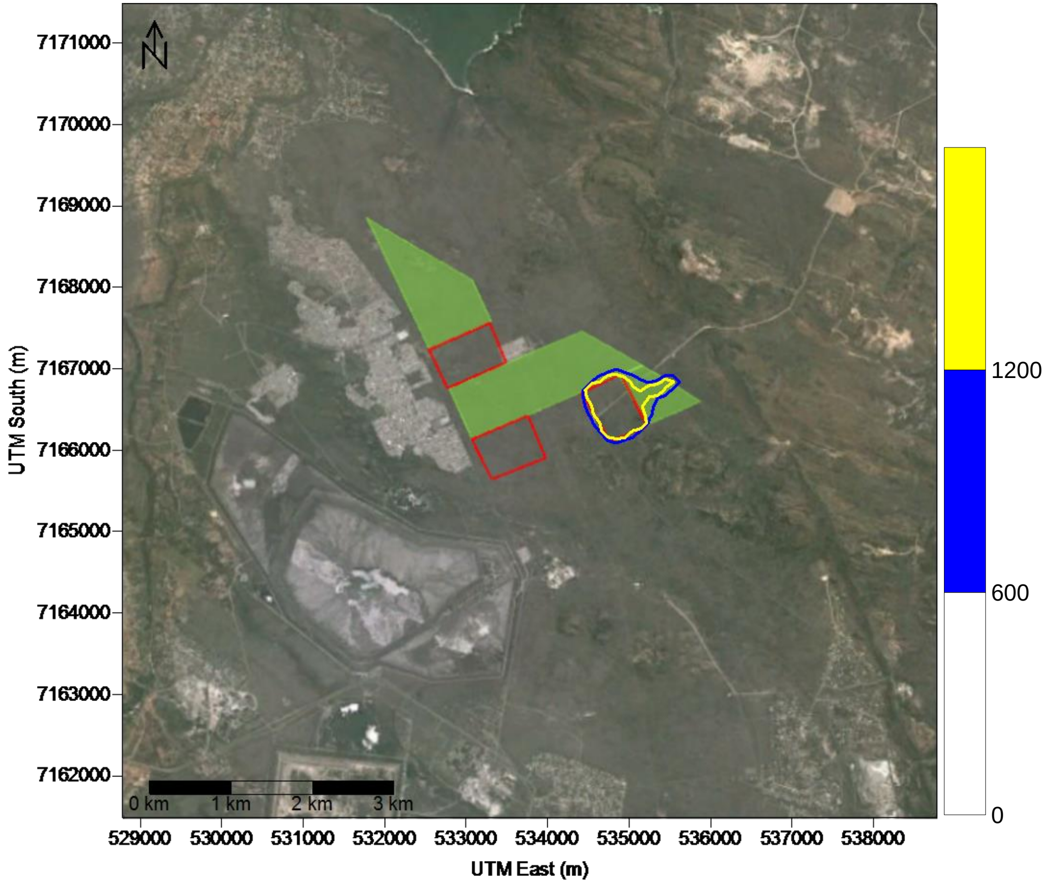


FIGURE 5-20: DUST FALLOUT (MG/M²/DAY) DUE TO CONSTRUCTION ACTIVITIES AT SITE B (MITIGATED).

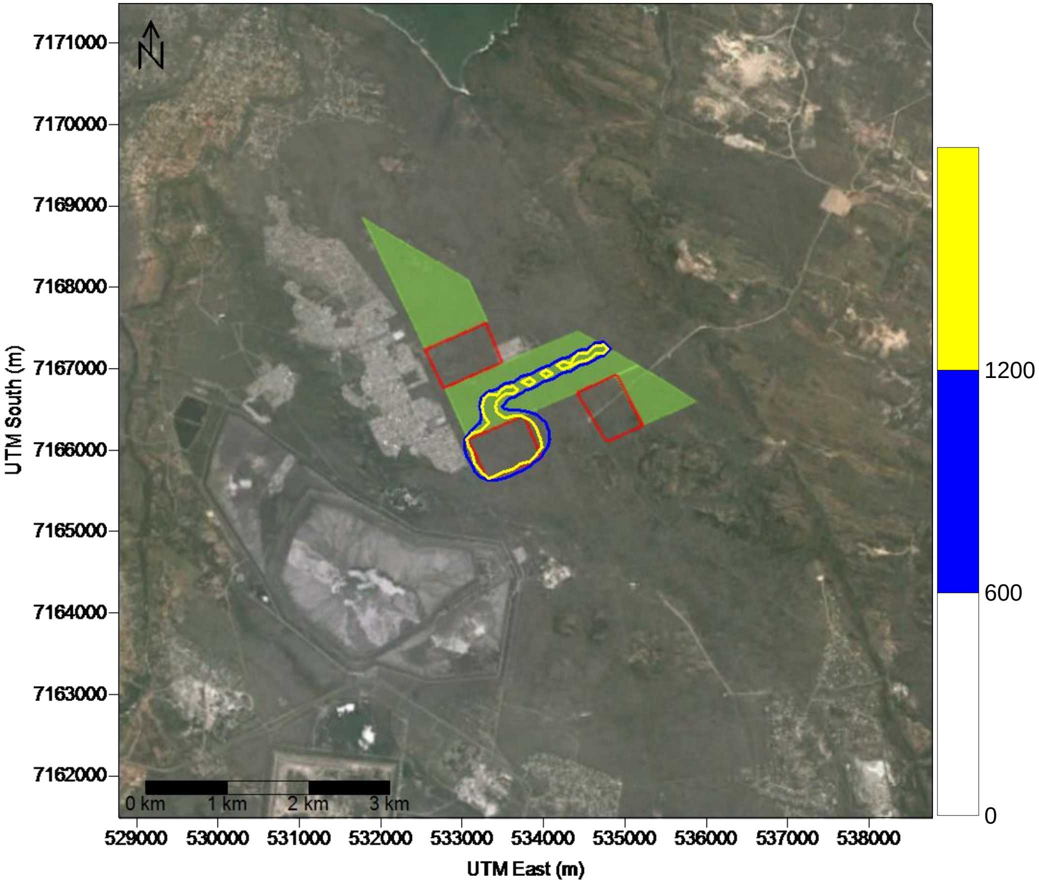


FIGURE 5-21: DUST FALLOUT (MG/M²/DAY) DUE TO CONSTRUCTION ACTIVITIES AT SITE C (MITIGATED).

FIGURE 5-22: DAILY AVAERAGE AVERAGE PM10 CONCENTRATIONS (µG/M³) DUE TO CONSTRUCTION ACTIVITIES AT THE EXTENSION SITE (MITIGATED).

FIGURE 5-23: ANNUAL AVAERAGE AVERAGE PM10 CONCENTRATIONS (µG/M³) DUE TO CONSTRUCTION ACTIVITIES AT THE EXTENSION SITE (MITIGATED).

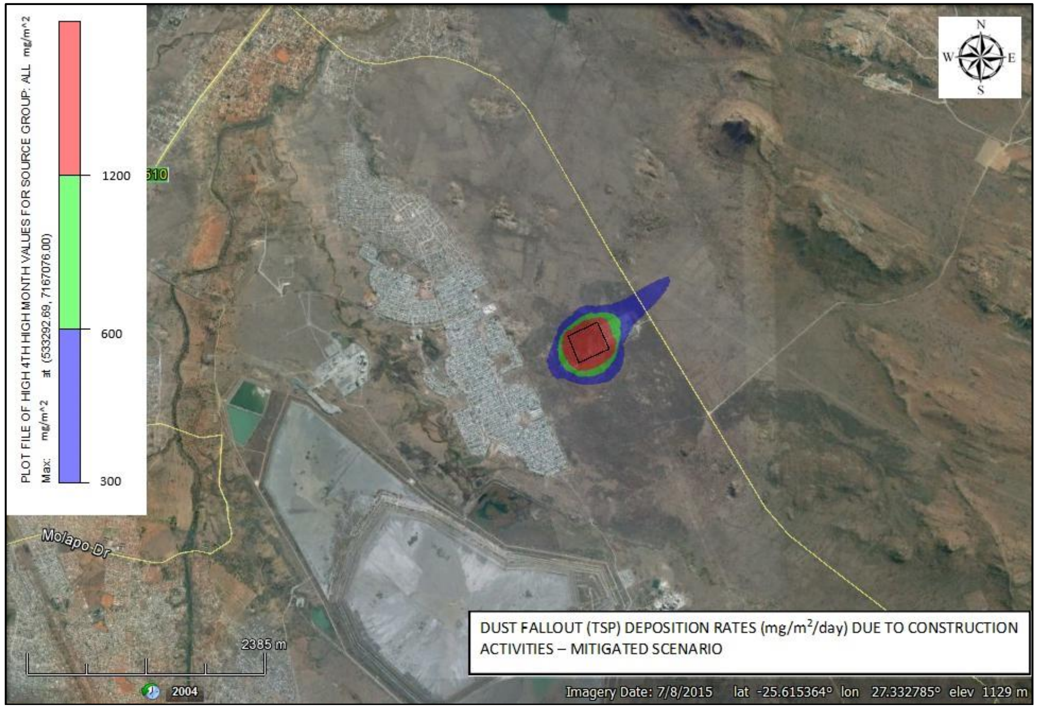


FIGURE 5-24: DUST FALLOUT (MG/M^2/DAY) DUE TO CONSTRUCTION ACTIVITIES AT THE EXTENSION SITE (MITIGATED).

TABLE 5-4: PREDICTED MAXIMUM INCREMENTAL PM10 AND DUST FALLOUT CONCENTRATIONS AT BOITEKONG BOUNDARY.

POLLUTANT	AVERAGING PERIOD	GUIDELINE / STANDARD	PREDICTED INCREMENTAL PM10 CONCENTRATION ($\mu G/M^3$)				PREDICTED INCREMENTAL DUST FALLOUT CONCENTRATION ($MG/M^2/DAY$)	
			UNMITIGATED	FOE	MITIGATED	FOE	UNMITIGATED	MITIGATED
SITE A								
PM10	Daily average	75	73.09	0	36.56	0	-	-
	Annual average	40	14.71	-	7.36	-	-	-
TSP	Daily average	600(1)	-	-	-	-	567.11	283.55
SITE B								
PM10	Daily average	75	6.51	0	3.26	0	-	-
	Annual average	40	0.99	-	0.49	-	-	-
TSP	Daily average	600(1)	-	-	-	-	35.55	17.76
SITE C								
PM10	Daily average	75	**92.73**	**16, 12, 16** (2)	46.39	0	-	-
	Annual average	40	18.02	-	9.01	-	-	-
TSP	Daily average	600(1)	-	-	-	-	**767.43**	383.55
EXTENSION SITE								
PM10	Daily average	75	75 – 120	> 4	30	0	-	-
	Annual average	40	10 - 40	-	5 - 15	-	-	-
TSP	Daily average	600(1)	-	-	-	-	300	< 300

Notes:

(1) Residential dust fallout limit
(2) Frequency of exceedance of the daily average PM10 standard for 2010, 2011 and 2012

5.3.3 Cumulative Impacts

Given the location of the proposed sites in the Waterberg Priority Area, emissions from the proposed sites need to be assessed in terms of the cumulative impacts in the area. For the purposes of determining cumulative impacts, the draft Guideline to Air Dispersion Modelling for Air Quality Management in South Africa (2012) outlines the following for facilities influenced by background sources e.g in urban areas and priority areas:

- For annual averages, the sum of the highest predicted concentration (Cp) and the background concentration (Cb) should be less than the National ambient air quality standards;
- For short-term averages, the sum of the 99th percentile concentrations and background concentrations should be less than the National ambient air quality standards.

In determining the cumulative impacts, predicted incremental off-site (as determined beyond the site boundary) concentrations should be added to the measured concentrations for the applicable pollutant averaging periods. A comprehensive ambient air quality monitoring dataset from the Boitekong Air Quality Monitoring Station is not available therefore cumulative impacts cannot be assessed. While predicted incremental PM10 and dust fallout concentrations are in compliance with the relevant standards at all sites for **mitigated emissions**, cumulative PM10 and dust fallout concentrations are likely to be non-compliant due to existing elevated background particulate concentrations in the Rustenburg area.

5.1 Assumptions and Limitations

The following assumptions and limitations of the study were identified:

- Use was made of site-specific meteorological data from the South African Weather Services meteorological station in Rustenburg for the period January 2010 – December 2012. This station is located approximately 10 km to the west-south-west of the proposed sites and is considered to be site representative of the prevailing meteorological conditions at the proposed site;
- Emission calculations were based on the operational times provided for the construction phase by the Client;
- Data input into the model has been based on the parameters provided by the Client. It is assumed that the information provided by the Client is accurate and complete at the time of modelling;
- Due to the absence of detailed information regarding specific construction activities during the construction phase, emissions from construction activities at each proposed site were estimated on an area wide basis using the USEPA emission factor for heavy construction activities;
- Ambient air quality monitoring data was obtained from the Boitekong Air Quality Monitoring Station for the period January 2011 – December 2013. However, data capture for all pollutant parameters fell well below the SANAS requirements of 90% data capture per parameter, and as such, the monitoring data could not be used to assess the existing baseline air quality situation in the area. Furthermore, ambient air quality monitoring data could not be obtained from the Boitekong Air Quality Monitoring Station for the period January 2015 – November 2015. As such, the predicted concentrations are limited to incremental impacts from the proposed sites. Given the location of the proposed sites in the Waterberg Priority Area, overall compliance would need to be assessed in terms of cumulative impacts.

6 MITIGATION MEASURES

6.1 Construction Phase

Fugitive dust emissions during the construction phase can be minimised with wet suppression, wind speed reduction methods or chemical suppression. Wet suppression is the most common and affordable control method although it only provides temporary dust control. Wet suppression of unpaved areas can achieve dust emission reductions of approximately 70% or more, which can be increased by up to 95% through the use of chemical stabilisation. The use of chemicals provides for longer dust suppression but is more costly and may have adverse environmental effects. Windbreaks and source enclosures are often impractical because of the size of fugitive dust sources (USEPA, 1995). Wet suppression is the recommended method to control dust emissions during the construction phase of the substation and powerlines. A summary of the available dust control measures during the construction phase of the substation and powerlines is given in TABLE 6-1 and TABLE 6-2.

TABLE 6-1: RECOMMENDED MEASURES TO CONTROL DUST EMISSIONS DURING CONSTRUCTION (USEPA, 1995).

SOURCE	RECOMMENDED CONTROL MEASURES
Debris Handling	Wind Speed Reduction
	Wet Suppression
Truck Transport	Wet Suppression
	Paving
	Chemical Stabilisation
Bulldozers	Wet Suppression
Pan Scrapers	Wet Suppression
Cut/Fill Material Handling	Wind Speed Reduction
	Wet Suppression
Cut/Fill Haulage	Wet Suppression
	Paving
	Chemical Stabilisation
General Construction	Wind Speed Reduction
	Wet Suppression
	Early Paving or Permanent Roads

TABLE 6-2: DUST CONTROL MEASURES (DEC, 2011).

DUST CONTROL MEASURE	DESCRIPTION
Limit Cleared Areas	Before the commencement of any site works and during the operation, as much vegetation as possible should be retained, including patches and strips to minimise dust. Dust emissions can be controlled using the following procedures: • Before any site works commence, plan and locate the vegetation cover that needs to be retained; • Protect this vegetation by fencing or blocking off from the rest of the site operations; • In other areas, maintain the original vegetation cover for as long as possible; • Avoid clearing the entire site at once, instead clear areas as required in stages of the operation. Retaining the original trees, shrubs and grasses is one of the most efficient and effective ways of minimising dust emissions. Even low or sparse vegetation can be very effective at dissipating wind velocity at the ground surface, where dust lift off occurs.
Vegetative Stabilisation	Vegetation is a very effective form of reducing dust emissions. The following procedures should be considered in minimising dust emissions: • Retain as much existing vegetation as possible; • If an area needs to be cleared, transplant established plants that must be disturbed to areas that need vegetation; • If existing vegetation must be removed and cannot be immediately transplanted elsewhere, remove and maintain them for replanting at project completion. If trees and plants must be removed and it is not possible for them to be replanted, consider chipping and using the material as mulch – the advantage is that reseeding of original vegetation can occur. Where possible, restore vegetation that is native to the area to maximise plant success and improve environmental conditions.
Timing of Development	Activities with high dust-causing potential, such as topsoil stripping, should not be carried out in sensitive areas during adverse wind conditions. When necessary, topsoil should be stripped in discrete sections, allowing buffer strips (windbreaks) between clearings.
Wind Barriers	Having appropriate wind barriers can be an effective measure for the control of dust over short distances. Wind barriers provide protection against the movement and impact of dust on nearby land uses. Wind barriers should be placed on site before commencement of works and when it is apparent that one is required during the phase of the operation. Consider the following options when placing barriers to prevent dust emissions: • Wind barriers are most effective when placed perpendicular to the direction of the prevailing wind, but will have little or no effect when the wind direction is parallel to the fence; • When choosing wind barriers it has been observed that solid barriers provide significant reductions in wind velocity for relatively short leeward distances, whereas porous barriers provide smaller reductions in velocity for more extended distances; • Wind barriers should be at least 2 metres high; • The screening material should have a porosity of 50% or less.
Earth Moving Management	Earth-moving works have the potential to generate large amounts of dust. Planning earth-moving works particularly at the start of an operation can reduce dust emissions by limiting the time the site is exposed. Options for dust control can include the following:

	• Plan earth-moving works so that they are completed just prior to the time they are needed; • Observe weather conditions and do not commence or continue earth moving works if conditions are unsuitable e.g., under conditions of strong winds; • Reduce off-site hauling via balanced cut and fill operations; • Pre-water areas to be disturbed.
Stockpiles	Material stockpiles are capable of generating large amounts of dust. In particular, fine materials stored in stockpiles can be subject to dust pick-up. Materials being loaded onto conveyor belts or into trucks are also potential sources of dust emissions. Dust emissions from material stockpiles can be minimised through the use of the following procedures: • Locate stockpiles in sheltered areas. Otherwise, stockpiles should be covered; • Where stockpiles are located in open areas, limit the height and slope of the stockpiles to reduce wind pick up, orient stockpiles lengthwise into the wind so they offer the minimum cross-sectional area to prevailing winds, install wind barriers on three sides of the stockpile; • Limit activity to the downwind side of the stockpile; • Limit drop heights from loading facilities and use closed conveyors where possible; • Transfer points should also be minimised.
Watering	Watering is applicable to almost every aspect of site operations, from reducing dust lift off from roads and other traffic areas and during earthworks, to controlling dust during movement of materials such as loading/offloading and transportation of materials. Watering is a very effective short-term measure. However, its efficiency decreases as wind velocity and evaporation rate increase. Dust emissions can be minimised using the following watering procedures: • The surface should be dampened to prevent dust from becoming airborne but should not be wet to the extent of producing run-off. Alternatively, wetting agents could be used, particularly for non-wetting soils; • Watering is more effective when undertaken prior to strong breezes; • Use watering sprays on materials to be loaded and during loading; • Real time automated response systems to turn on water cannon systems in response to dust levels or high wind speeds could be used. These can help save water by only turning on water cannons during adverse conditions and also help reduce the possibility of operator error; • In cases where severe water restrictions are imposed, other measures like the use of wetting agents such as chemical stabilisation or hydromulch, could be considered.
Chemical Stabilisation	Chemical stabilisers provide immediate coverage and protection and are effective in areas that receive little traffic or disturbance. They provide a longer-term solution compared to watering, although it may be necessary for the chemical ingredients to be evaluated with regard to their environmental effects. Chemical stabilisers work by binding the soil particles together to create an artificial crust on the soil surface that is less prone to disturbance by wind. The following options should be considered when using chemical stabilisers to reduce dust emissions: • Physical barriers or other methods of preventing traffic access should be used to protect stabilised areas;

	• The manufacturer's instructions should be followed to optimise performance.
Maintenance	The following routine maintenance procedures should also be implemented as a dust control measure: • There should be a nominated person with the responsibility for dust management; • All staff should be aware of the potential for dust generation and inducted on dust minimising practice;. • Dust control equipment should be inspected regularly and defects repaired promptly. Spares should be kept on site for critical items of control equipment, such as water pumps for dust suppression sprays; • Trucks carrying contaminated soil from the site for disposal off-site should be washed down prior to leaving the site to prevent spreading contamination off-site.

7 SUMMARY AND RECOMMENDATIONS

Rayten Engineering Solutions was appointed by Dynamic Integrated Geohydro Environmental Services to undertake an Air Quality Impact Assessment for the proposed Rustenburg Strengthening Phase 2 Project. The main objective of the project is to determine the potential impact of emissions from the construction of the substation, substation extension and powerlines on the surrounding environment. The baseline assessment was undertaken through a review of available meteorological and air quality monitoring data. Use was made of local meteorological data obtained from the South African Weather Services for the period January 2010 – December 2012. Ambient air quality monitoring data was obtained from the Boitekong Air Quality Monitoring Station for the period January 2011 – December 2013. The Air Quality Impact Assessment comprised of an emissions inventory and subsequent dispersion modelling simulations to determine TSP (as dust fallout) and PM10 concentrations associated with the construction phase of the substation, substation extension and powerlines. Dispersion modelling simulations were undertaken assuming a) no mitigation measures are employed and b) mitigation measures are employed during the construction phase. Comparison of the modelled concentrations was made with the National ambient air quality and dust fallout standards to determine compliance.

Based on the information obtained during the Baseline Assessment, the main conclusions can be summarised as follows:

- Local meteorological conditions are dominated by slow to moderate winds from the south-west. Based on the prevailing wind fields, emissions from the proposed sites will be transported towards the north-east. Slow to moderate winds will not result in the effective dispersion and dilution of the pollution;
- A comprehensive ambient air quality monitoring dataset from the Boitekong Air Quality Monitoring Station is not available to determine the existing ambient air quality situation in the area. Based on a qualitative assessment of existing air pollution sources in the area, emissions from agricultural activities, domestic fuel burning, mining and vehicle tailpipe emissions are likely to contribute to the ambient particulate loading in the area.

The main conclusions of the Impact Assessment can be summarised as follows for the proposed construction operations:

<u>At Site A, B and C</u>

- For **unmitigated PM10 emissions**, predicted incremental PM10 concentrations are in compliance with the daily average and annual average PM10 standards at Sites A and B. At Site C, predicted incremental PM10 concentrations are in non-compliance with the daily average standard. The highest PM10 concentrations are observed in Boitekong when construction is undertaken at Site C due to the close proximity of this site to Boitekong, as well as the larger surface area of construction compared to the other two sites;

- For **mitigated PM10 emissions**, predicted incremental PM10 concentrations are in compliance with the daily average and annual average PM10 standards for all three sites;
- For **unmitigated dust fallout emissions**, predicted incremental dust fallout approaches the residential limit of 600 mg/m^2/day at Site A and exceeds the limit at Site C. Dust fallout at Site B is well within the residential limit;
- For **mitigated dust fallout emissions**, predicted incremental dust fallout falls below the residential limit for all three sites.

At the Extension Site:

- For **unmitigated PM10 emissions**, predicted incremental PM10 concentrations are in non-compliance with the daily average and annual average PM10 standards of 75 µg/m^3 and 40 µg/m^3 beyond the extension site;
- For **mitigated PM10 emissions**, predicted incremental PM10 concentrations are in compliance with the daily average and annual average PM10 standards of 75 µg/m^3 and 40 µg/m^3 at surrounding sensitive receptors however, exceedances are observed close to the site boundary.
- For **unmitigated dust fallout emissions**, predicted incremental dust fallout falls below the residential limit of 600 mg/m^2/day at surrounding sensitive receptors. Predicted incremental dust fallout exceeds the residential limit of 600 mg/m^2/day just beyond the site boundary;
- For **mitigated dust fallout emissions**, predicted incremental dust fallout is reduced and falls below the residential limit of 600 mg/m^2/day at surrounding sensitive receptors.

7.1 Recommendations

- Mitigation measures such as wet suppression should be employed to reduce particulate emissions during the construction phase, particularly during construction at Sites A, Site C and the extension site, due to their close proximity to Boitekong;
- While particulate emissions in Boitekong are predicted to be within acceptable levels at all three proposed sites with the implementation of mitigation measures, Site B is the preferred site for the construction of the substation and power lines as particulate emissions from this site will have the least impact on residents in Boitekong.

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