Final Air Quality Impact assessment for Coal of Africa Limited (Pty) Ltd: Mopane Project

Royal HaskoningDHV
Enhancing Society Together

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Glossary

Air quality	A measure of exposure to air which is not harmful to your health. Air quality is measured against health risk thresholds (levels) which are designed to protect ambient air quality. Various countries including South Africa have Air Quality Standards (legally binding health risk thresholds) which aim to protect human health due to exposure to pollutants within the living space.
Ambient air	The air of the surrounding environment.
Baseline	The current and existing condition before any development or action.
Boundary layer	Within the earth's atmosphere, the boundary layer is defined as the planets boundary layer which is the air layer near the ground affected by diurnal heat, moisture or momentum transfer to or from the surface.
Climatology	The study of the long term effect of weather over a certain area during a certain period.
Concentration	When a pollutant is measured in ambient air it is referred to as the concentration of that pollutant in air. Pollutant concentrations are measured in ambient air for various reasons, i.e. to determine whether concentrations are exceeding available health risk thresholds (air quality standards); to determine how different sources of pollution contribute to ambient air concentrations in an area; to validate dispersion modelling conducted for an area; to determine how pollutant concentrations fluctuate over time in an area; and to determine the areas with the highest pollution concentrations.
Condensation	The change of physical state of matter from a gaseous phase into a liquid phase.
Dispersion model	A mathematical model which can be used to assess pollutant concentrations and deposition rates from a wide variety of sources. Various dispersion modelling computer programs have been developed.
Dispersion potential	The potential a pollutant has of being transported from the source of emission by wind or upward diffusion. Dispersion potential is determined by wind velocity, wind direction, height of the mixing layer, atmospheric stability, presence of inversion layers and various other meteorological conditions.
Emission	The rate at which a pollutant is emitted from a source of pollution.
Emission factor	A representative value, relating the quantity of a pollutant to a specific activity resulting in the release of the pollutant to atmosphere.
Evaporation	The opposite of condensation
Front	A synoptic-scale swath of cloud and precipitation associated with a significant horizontal zonal temperature gradient. A front is warm when warm air replaces cold on the passage of the front; with a cold front cold air replaces warm air.
Fugitive dust	Dust generated from an open source and is not discharged to the atmosphere in a confined flow stream.
Inversion	An increase of atmospheric temperature with an increase in height.

Middlings	In coal preparation, the material called mid-coal is neither clean nor refuse; due to their intermediate specific gravity, middling sink only pathway in the washing vessels and are removed by auxiliary means.
Mixing layer	The layer of air within which pollutants are mixed by turbulence. Mixing depth is the height of this layer from the earth's surface
Particulate matter (PM)	The collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface and includes dust, smoke, soot, pollen and soil particles. Particulate matter is classified as a criteria pollutant, thus national air quality standards have been developed in order to protect the public from exposure to the inhalable fractions. PM can be principally characterised as discrete particles spanning several orders of magnitude in size, with inhalable particles falling into the following general size fractions: * PM10 (generally defined as all particles equal to and less than 10 microns in aerodynamic diameter; particles larger than this are not generally deposited in the lung); * PM2.5, also known as fine fraction particles (generally defined as those particles with an aerodynamic diameter of 2.5 microns or less) ; * PM10-2.5, also known as coarse fraction particles (generally defined as those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns); and * Ultra fine particles generally defined as those less than 0.1 microns.
Precipitation	Ice particles or water droplets large enough to fall at least 100 m below the cloud base before evaporating.
Relative Humidity	The vapour content of the air as a percentage of the vapour content needed to saturate air at the same temperature

1. INTRODUCTION

Royal HaskoningDHV was appointed by Jacana Environmentals CC to undertake an Air Quality Impact Assessment for the proposed mining rights application for the Mopane Project area which forms part of the Greater Soutpansberg project (GSP) located in Limpopo. The Mopane Project area is situated within the magisterial district of Vhembe, approximately 60km north of the town of Makhado and 7km west of Mopane within the Musina and Makhado local Municipal areas (Figure 1.1).

Most of the Mopane region can be classified as rural with commercial game farming as the main activity. The Mopane Project Mining site is split into two mining areas namely the Jutland and Voorburg Pits (Figure 1.1). The Voorburg Pit covers approximately 905 hectares and the Jutland Pit a further 667 hectares. The mining footprint is restricted by the Sand River running along the northern side of the mining pit. The Mopane Railway Station is situated between the Voorburg and Jutland sections to the east and is linked to the N1 with a surfaced road of 7km in length. The Jutland section is traversed by the R525 road between Mopane and Alldays.

The Mopane project has the potential to produce good quality semi-soft coking coal and domestic thermal coal product. Measured and indicated resources are approximately 633.48 million tonnes of mineable in situ. The current mining plan will commence with construction and mining at the Voorburg section, followed by the Jutland Section as capacity in infrastructure has already been developed. The Voorburg section will be mined at 2.5 million tonnes per annum (Mtpa) product for a period of 33 years followed by the Jutland Section mined at 2.5 Mtpa for a period of 28 years.

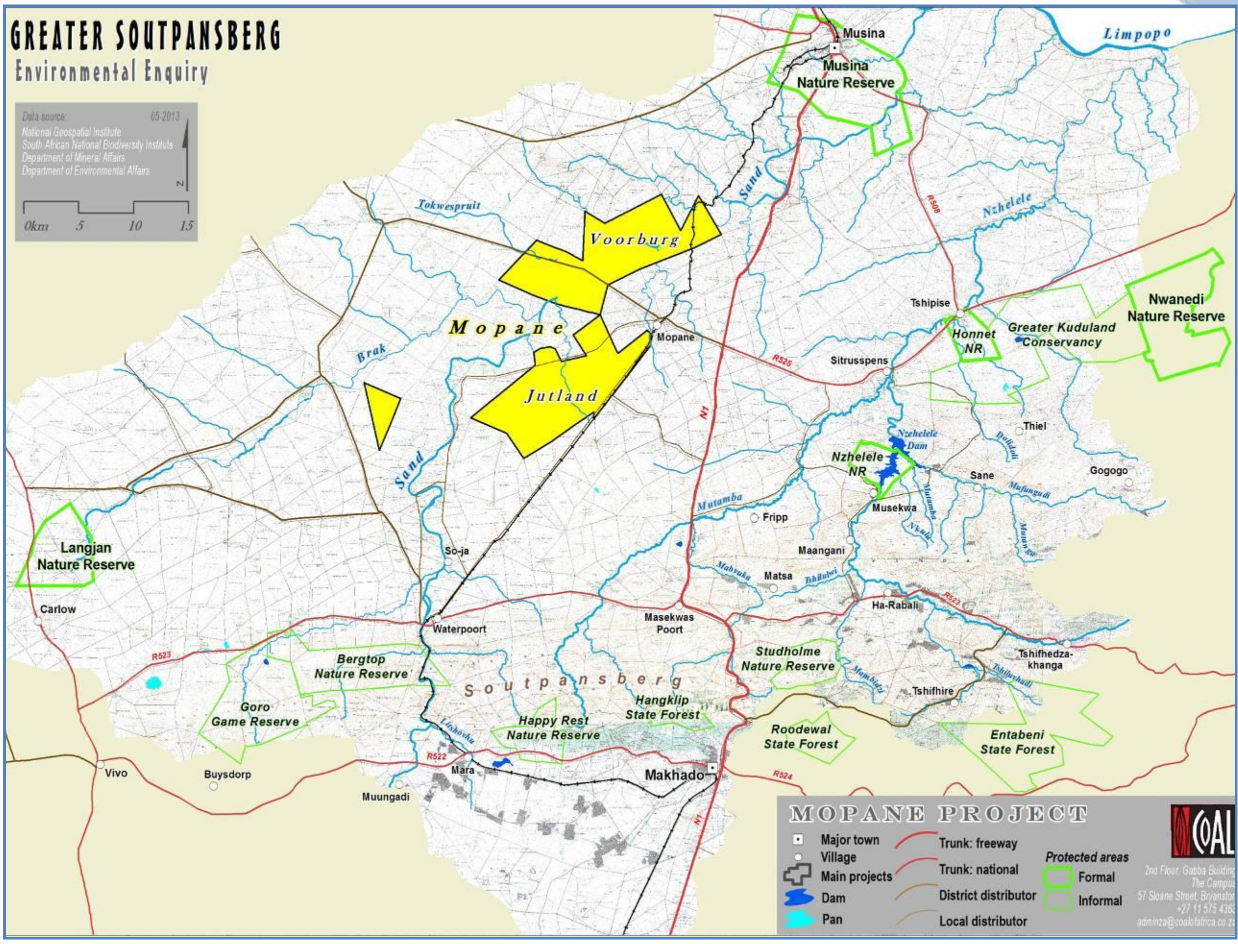

Figure 1.1: Mopane Project Area locality map

1.1. Process Description

The Mopane project has a footprint which covers an area of 1572 ha for mining and a further 1964 ha for infrastructure development. The Mopane project has the potential to produce good semi-soft coking coal with an ash content of 10% and thermal coal with an ash content of 30%. The outcrop is mineable to a depth of 200 m through opencast mining methods.

1.1.1. Mining Operations

The mine design is based on development at a coal production rate of 4 Mtpa RoM (Run of mine) for the full life of mine (LoM). This production profile yields sale tonnages of about 2.5 Mtpa, split between coking and thermal coal. The average yield at the wash plant is 26% for the coking product and 37% for the middling thermal coal with an overall yield of 63%. This profile extracts a reserve estimated to be 133 Mt over the full 33 years.

Coal will be mined with the conventional truck and shovel operation. The truck and shovel method is the most flexible mining method and is best suited for complex geological deposits, varying overburden thickness and similar deposits. The major benefit with this type of method is the ability to haul material over long distances. Coal is modelled to be mined by excavators with a capacity of 1400 bank cubic meters per hour (bcm/h). Interburden units are modelled to be mined by excavators with a capacity of 1500 bcm/h, while overburden units are modelled to be mined by excavators with a capacity of 1650 bcm/h.

Within the first 12 years of mine development, the annual waste movement varies from 14 to 24 million cubic meters (Mbcm) at an average rate of 22 Mbcm. The remainder of the mine life is operated at an annual average waste movement of 11 Mbcm. A fleet of trucks at 220 tonne payload has been allocated for waste movement. Coal mining and reject haulage has been modelled with a fleet of trucks at 150 tonne payload. The schedule waste demand to meet a 2.5 Mtpa coal product production rate is such that 1 coal excavator is required within 3 interburden excavators.

1.1.2. Coal Processing

The first phase of development is to establish a coal beneficiation plant which will process RoM coal from the Voorburg section at a rate of 4 Mtpa and to establish a new facility (of the same capacity) to process RoM coal from the Jutland section at a later stage. The mine schedules for the Voorburg and Jutland resources are similar in capacity but differ in yields of coking and middling coal. It is therefore planned to install a plant of the same design to treat the Jutland resource next to the current proposed facility for the Voorburg resource.

The proposed coal beneficiation plant is selected on the basis of using concepts that ensure efficient and effective beneficiation of the Mopane resource at the required quality within reasonable capital and operating costs. The processing plant utilizes the following technologies:

- A two stage dense medium separation (DMS) for coarse coal beneficiation using cyclone separator to produce a coking and middling plant.
- Two stage of up-flow classification for recovery of fine coal using reflux classifiers to produce a coking and middling product.
- Two stage flotation using micro- bubble and conventional mechanical technologies for the recovery of ultra-fine coking coal product.

The selection of dense medium cyclones allows for the treatment of raw coal with large variation in yield that will be treated during the proposed life of the mine. The use of two-stage reflux classifiers in the fines circuit improves the overall yield of the middling product. The combination of different technologies in the floatation circuit improves the efficiency of separation of coking coal from ultra fine particles. The coarse products will be dewatered by centrifuge while the fine products will be dewatered by filtration.

Fine tails are dewatered using a thickener followed by tailing filtration before being discharged on a common discard conveyor feeding the discard stockpile. The development of the discards stockpile will be done in phases and will be compacted and the sides of the dump soil clad to reduce the risk of heating or spontaneous combustion.

Figure 1.2 below illustrates the First phase in development at the Jutland and Voorburg pits.

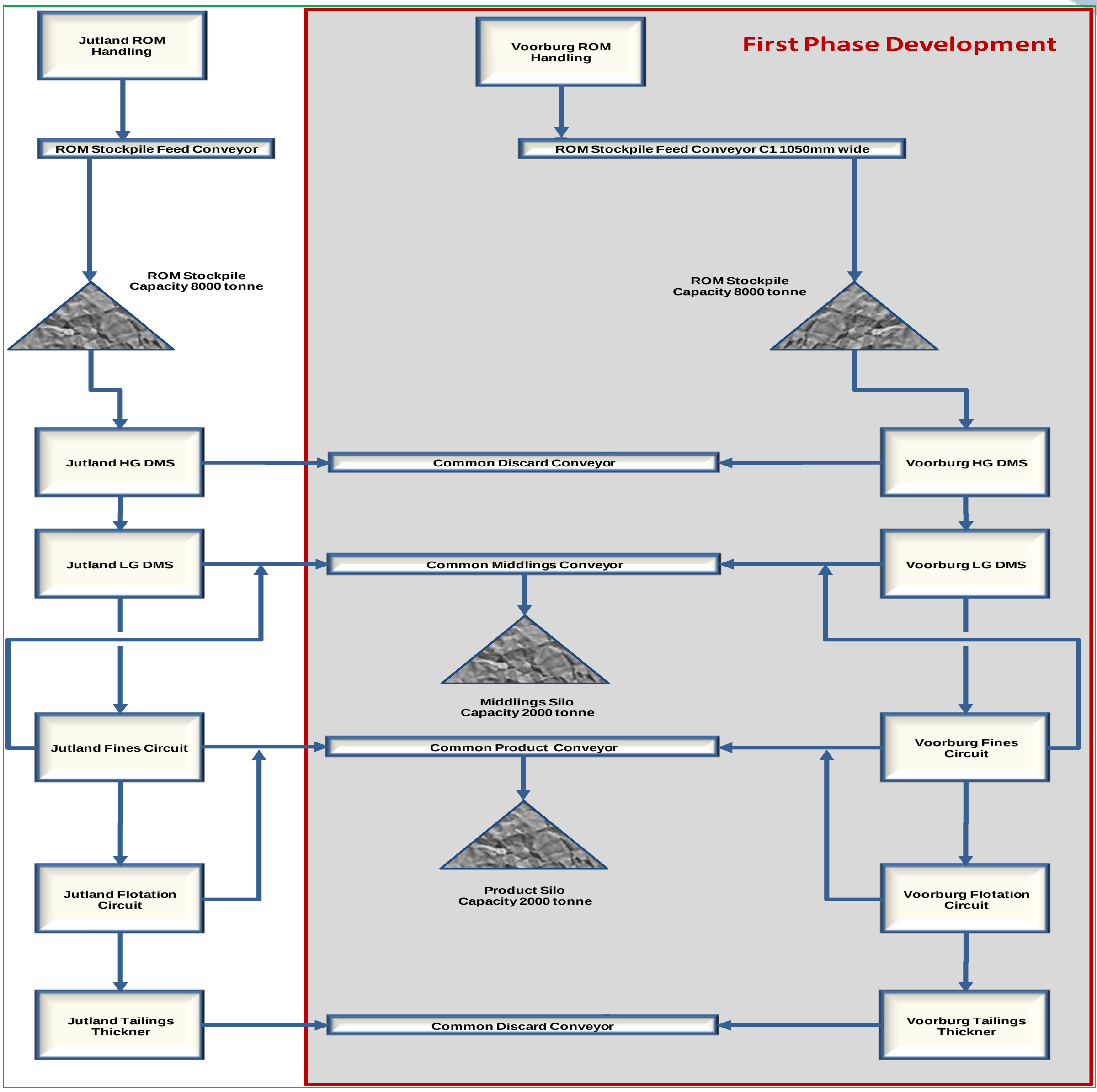

Figure 1.2: Mopane Jutland and Voorburg expansion project

1.1.3. Product Handling

The coarse coking product (~ 50+ 1mm) from the DMS plant, fine coking product from the fines circuit (- 1+0.3 mm) and product filter cake from the product stockpile are transported to the 2,000 tonne product silo via a 750mm wide common product conveyor. The conveyor belt is fitted with a mass meter and an automatic sampler for metallurgical purposes.

The product is withdrawn from the silo using a belt feeder that discharges onto common conveyors to transport final product to the Rapid loading terminal (RLT). The product silo has an overspill chute which feeds an emergency stockpile when the silo is full. The emergency stockpile has an additional 50,000 tonne holding capacity and the product from the emergency stockpile can be reloaded onto the overland product conveyor by means of a reload conveyor that is fed using front-end loaders.

The coarse middling from the DMS plant and the fine middling from the Fines circuit are transported to the 2,000 tonne middling silo via a 750mm wide common middling conveyor. The conveyor is fitted with a mass meter and an automatic sampler for metallurgical purposes accounting purposes.

The middling silo feeds the common overland conveyors via vibrating feeders to transport middling to the RLT. The common overland conveyors can only carry one product at a time to the RLT. The middling silo has an overspill chute which feeds an emergency stockpile when the silo is full. The emergency stockpile has an additional 50,000 tonne holding capacity and the middling from the emergency stockpile can be reloaded onto the overland conveyor by means of a re-load conveyor that is fed using front-end loaders. Figure 1.3 below illustrate the process of product handling.

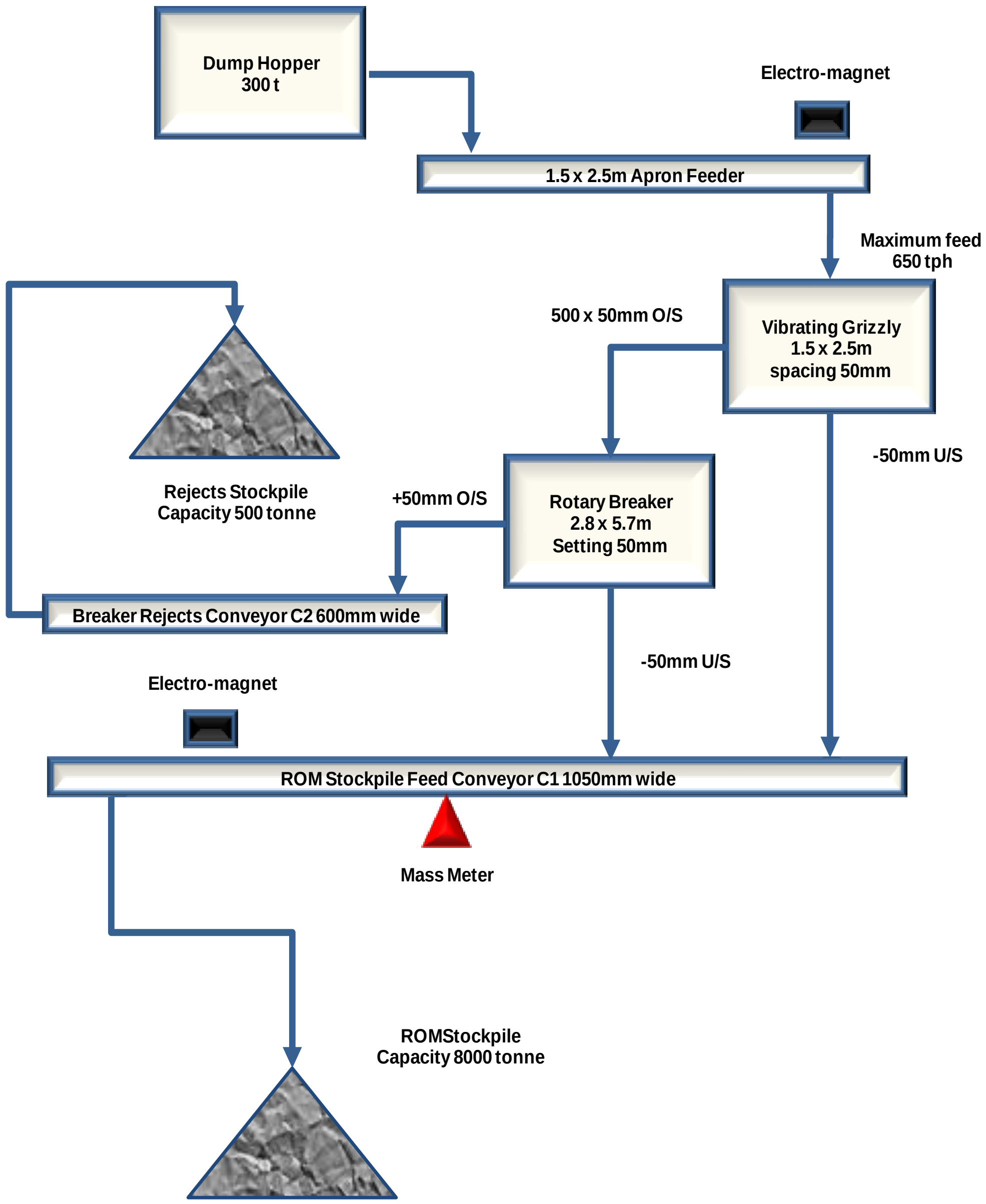

Figure 1.3: Product handling

1.2. Terms of Reference

The terms of reference for the Air Quality Impact Assessment for the proposed project can briefly be summarised as follows:

- **Baseline Assessment**

- Provide an overview of the prevailing meteorological conditions in the area;
- Review applicable legislation and policies related to air quality management which are applicable to the proposed operations;
- Review potential health effects associated with emissions released from the proposed operations;
- Identification of existing sources of emission and surrounding sensitive receptors, such as local communities, surrounding the plant;
- Assess the baseline air quality using available ambient air quality monitored data;

- **Impact Assessment**

- Compilation of an emissions inventory for the proposed air quality related sources identified on site;
- Dispersion modelling simulations undertaken using AERMOD to determine the potential air quality impacts of the proposed activities on the surrounding area;
- Comparison of the modelled results to the National ambient air quality standards to determine compliance;
- Provide recommendations for the implementation of appropriate mitigation measures and a monitoring programme (if required);
- Compilation of an Air Quality Impact Assessment Report.

1.3. Methodology

An overview of the methodological approach to be followed during this Air Quality Baseline and Impact Assessment is outlined in the section which follows.

1.3.1. Baseline Assessment

During the baseline assessment, a qualitative approach was used to assess the baseline conditions in the project area. Local meteorological data was obtained from the South African Weather Services located in Mopane for the period of Jan 2008 – Dec 2012. Applicable air quality legislation such as the National Environmental Management: Air Quality Act 39 of 2004 (GN163: 2005) and the Listed Activities and Associated Minimum Emission Standards (GN248: 2010) were reviewed. Criteria pollutants relevant to the project and their potential human health effects are also discussed. Existing sources of air pollution surrounding the Mopane project were qualitatively assessed. Sensitive receptors, such as local communities, in close proximity to the Mopane project were identified using satellite imagery.

1.3.2. Impact Assessment

During this phase, an emissions inventory was compiled to estimate emissions from the identified emission sources associated with the proposed activities. Where information is not available, use was made of available United States Environmental Protection Agency (USEPA) emission factors or emission models to estimate emission releases. Dispersion modelling simulations were undertaken using the AERMOD dispersion model and presented graphically as isopleths plots. Comparison with the National ambient air quality standards (GN263; 2009) was made to determine compliance. Based on the predicted results, recommendations for appropriate mitigation measures and/or ambient air quality management are provided.

1.4. Report Structure

Section 1 of the report provides the background to the project. **Section 2** includes a meteorological overview of the region as well as a review of applicable air quality legislation, pollutants and their potential health effects. **Section 3** provides background information on the Baseline air quality situation. The emissions inventory and impact assessment, general conclusion and recommendations are presented in **Section 4.** The references are provided **in Section 5**.

2. Baseline Description of the Area

2.1. Meso-Scale Meteorology

The nature of local climate will determine what will happen to pollution when it is released into the atmosphere (Tyson and Preston-Whyte, 2000). Pollution levels fluctuate daily and hourly, in response to changes in atmospheric stability and variations in mixing depth. Similarly, atmospheric circulation patterns will have an effect on the rate of transport and dispersion of pollution.

The release of atmospheric pollutants into a large volume of air results in the dilution of those pollutants. This is best achieved during conditions of free convection and when the mixing layer is deep (unstable atmospheric conditions). These conditions occur most frequently in summer during the daytime. This dilution effect can however be inhibited under stable atmospheric conditions in the boundary layer (shallow mixing layer). Most surface pollution is thus trapped under a surface inversion (Tyson and Preston-Whyte, 2000).

Inversion occurs under conditions of stability when a layer of warm air lies directly above a layer of cool air. This layer prevents a pollutant from diffusing freely upward, resulting in an increased pollutant concentration at or close to the earth's surface. Surface inversions develop under conditions of clear, calm and dry conditions and often occur at night and during winter (Tyson and Preston-Whyte, 2000). Radiative loss during the night results in the development of a cold layer of air close to the earth's surface. These surface inversions are however, usually destroyed as soon as the sun rises and warm the earth's surface. With the absence of surface inversions, the pollutants are able to diffuse freely upward; this upward motion may however be prevented by the presence of an elevated inversion (Tyson and Preston-Whyte, 2000).

Elevated inversions occur commonly in high pressure areas. Sinking air warms adiabatically to temperatures in excess of those in the mixed boundary layer. The interface between the upper, gently subsiding air is marked by an absolutely stable layer or an elevated subsidence inversion. This type of elevated inversions is most common over Southern Africa (Tyson and Preston-Whyte, 2000).

The climate and atmospheric dispersion potential of the interior of South Africa is determined by atmospheric conditions associated with the continental high pressure cell located over the interior. The continental high pressure present over the region in the winter months results in fine conditions with little rainfall and light winds with a northerly flow. Elevated inversions are common in such high pressure areas due to the subsidence of air. This reduces the mixing depth and suppresses the vertical dispersion of pollutants, causing increased pollutant concentrations (Tyson and Preston-Whyte, 2000).

Seasonal variations in the positions of the high pressure cells have an effect on atmospheric conditions over the region. For most of the year the tropical easterlies cause an air flow with a north-easterly to north-westerly component. In the winter months the high pressure cells move northward, displacing the tropical easterlies northward resulting in disruptions to the westerly circulation. The disruptions result in a succession of cold fronts over the area in winter with pronounced variations in wind direction, wind speeds, temperature, humidity, and surface pressure. Airflow ahead of a cold front passing over the area has a strong north-north-westerly to north-easterly component, with stable and generally cloud-free conditions. Once the front has passed, the airflow is reflected as having a dominant southerly component (Tyson and Preston-Whyte, 2000).

Easterly and westerly wave disturbances cause a southerly wind flow and tend to hinder the persistence of inversions by destroying them or increasing their altitude, thereby facilitating the dilution and dispersion of pollutants. Pre-frontal conditions tend to reduce the mixing depth. The potential for the accumulation of pollutants during pre-frontal conditions is therefore enhanced over the plateau (Tyson and Preston-Whyte, 2000).

2.2. Site-Specific Dispersion Potential

A period wind rose for the site is presented in Figure 2.1. Wind roses comprise of 16 spokes which represents the direction from which winds blew during the period. The colours reflect the different categories of wind speeds. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories.

Based on an evaluation of the meteorological data obtained from the South African Weather Services, the following deductions regarding the prevailing wind direction and wind frequency can be assessed. Looking at Figure 2.1 below, the predominant wind direction occurs mainly from the south eastern region, with secondary winds seen from the eastern region.

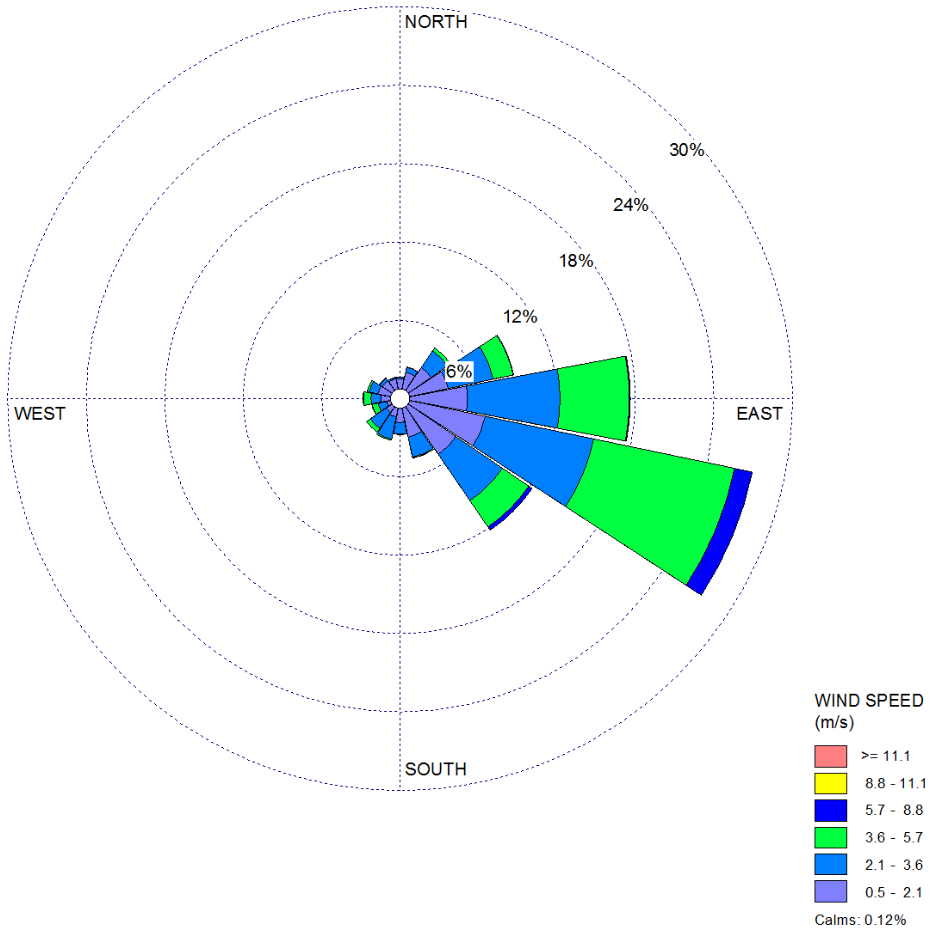

Figure 2.1: Period wind rose for the Mopane project area for the period Jan 2008 – Dec 2012.

At the site, 0.1 % of the time, calm conditions existed over the area. The highest frequency of wind speeds lie between 0.5 -2.1 m/s which occurred for 42 % of the time (Figure 2.2). The second highest wind class 2.1 to 3.6 m/s occurs 34 % of the time.

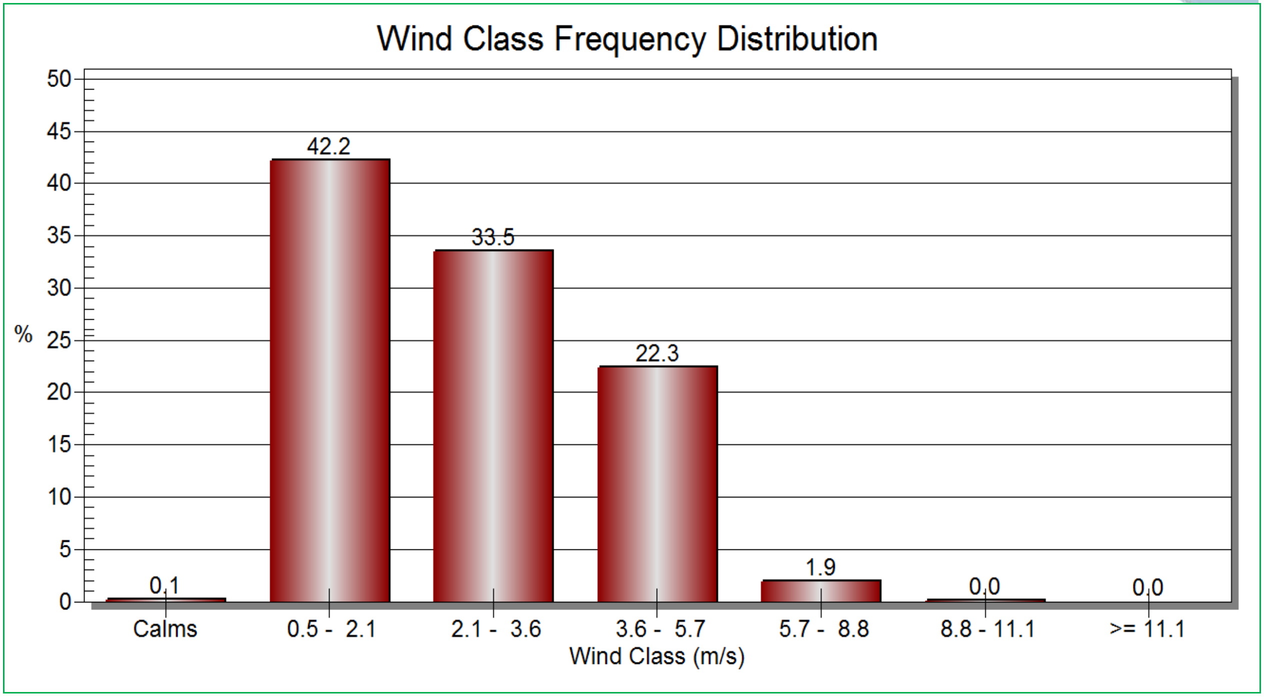

Figure 2.2: Wind Class Frequency Distribution

Diurnal wind roses for the Mopane area are shown in Figure 2.3 below. During the morning hours (00:00 - 06:00) the predominant wind direction is seen from the south eastern region. A slight shift is seen during the daylight (06:00 – 18:00) and nigh time hours (18:00 – 24: 00) with a primary wind direction originating from the south eastern region and secondary winds from the north eastern region.

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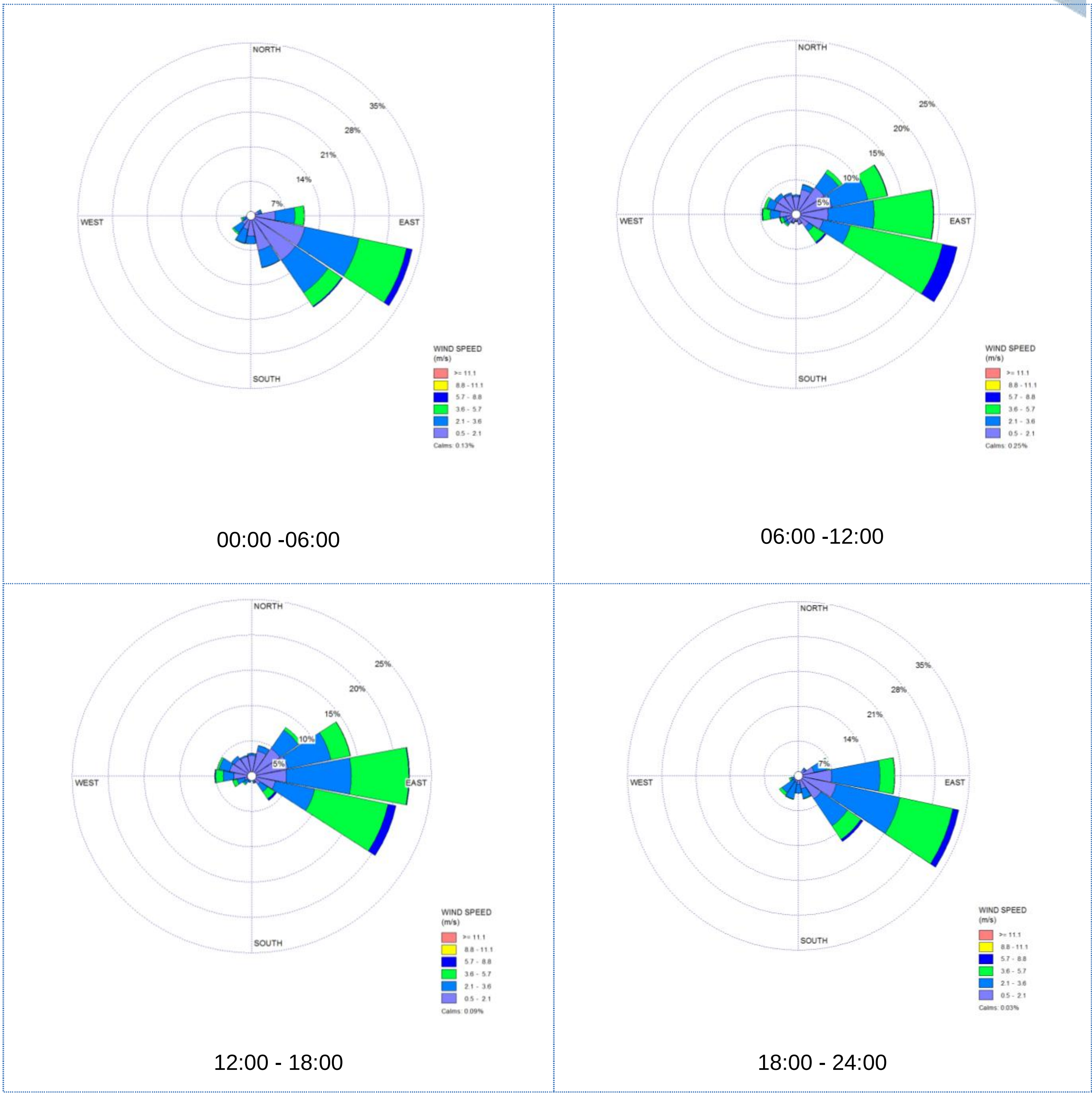

Figure 2.3: Diurnal wind roses for the Mopane project area (Jan 2008-Dec 2012)

Seasonal variability in the wind field for the Mopane project area is shown in Figure 2.4 below. During the spring (Sep, Oct and Nov), autumn (Mar, Apr and May) and summer months (Dec, Jan and Feb) illustrates a predominant wind direction from south eastern region. A sight shift in the wind field in seen during the winter months (Jun, Jul and Aug) with a winds originating from the south eastern and south western region.

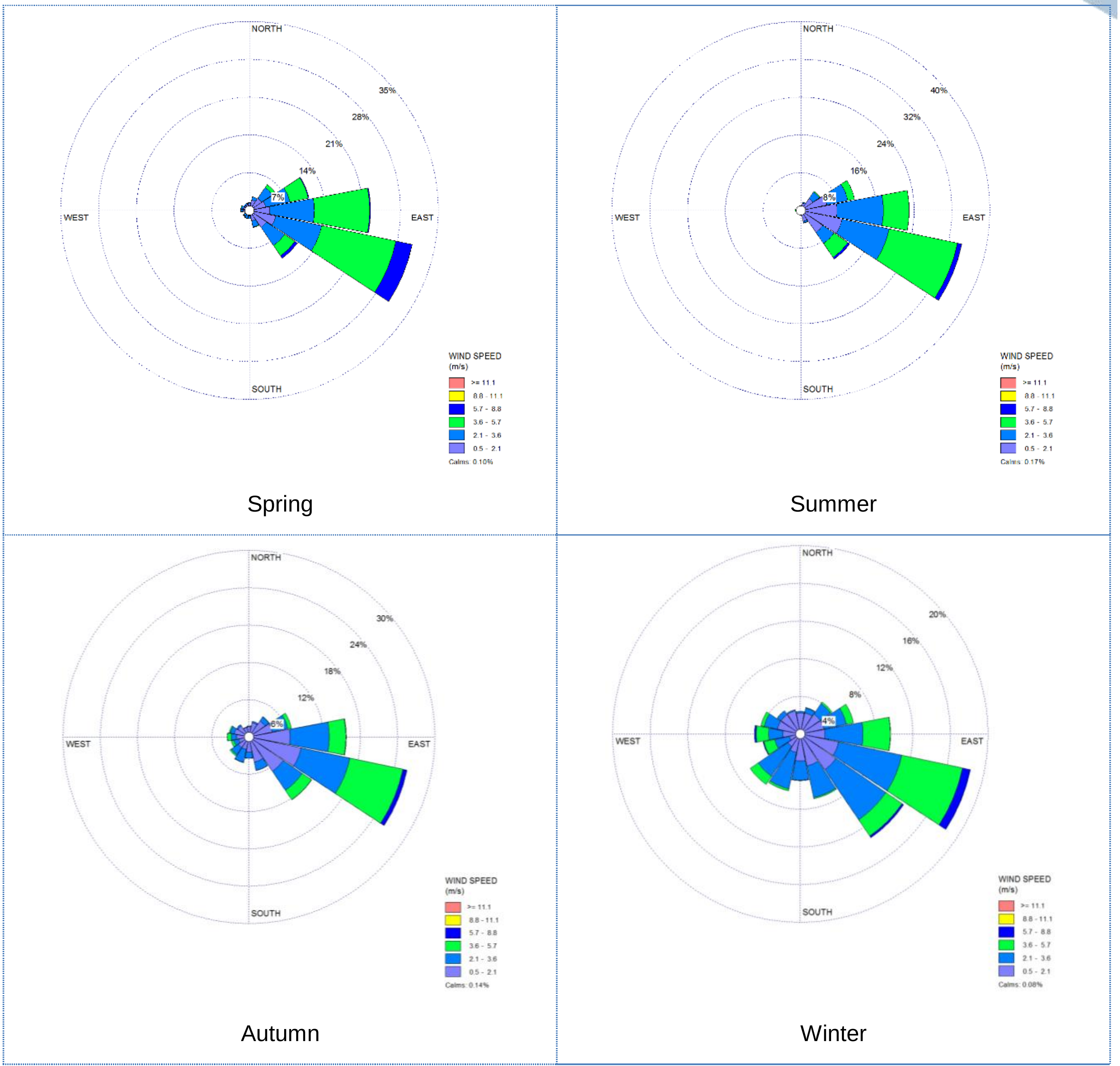

Figure 2.4: Seasonal variation for the Mopane Project area for the Jan 2008 – Dec 2012 monitoring period

2.3. Atmospheric Stability

The tendency of the atmosphere to resist or enhance vertical motion and thus turbulence is termed atmospheric stability. Stability is related to both the change of temperature with height and wind speed. A neutral atmosphere neither enhances nor inhibits mechanical turbulence. An unstable atmosphere enhances turbulence, whereas a stable atmosphere inhibits mechanical turbulence. The turbulence of the atmosphere is the most important parameter affecting dilution of air pollution as the more unstable the atmosphere, the greater the dilution of air pollution.

Atmospheric stability is commonly categorised into six stability classes (Table 2.1). The atmospheric boundary layer is usually unstable during the day due to turbulence caused by the sun's heating effect on the earth's surface. The depth of this mixing layer depends mainly on the amount of solar radiation, increasing in size gradually from sunrise to reach a maximum at about 5 - 6 hours after sunrise. The degree of thermal turbulence is increased on clear warm days with light winds. During the night-time a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral.

Table 2.1: Atmospheric Stability Classes

A	Very unstable	calm wind, clear skies, hot daytime conditions
B	Moderately unstable	clear skies, daytime conditions
C	Unstable	moderate wind, slightly overcast daytime conditions
D	Neutral	high winds or cloudy days and nights
E	Stable	moderate wind, slightly overcast night-time conditions
F	Very stable	low winds, clear skies, cold night-time conditions

A neutral atmospheric potential neither enhances nor inhibits mechanical turbulences. Unstable atmospheric condition enhances turbulence, whereas stable conditions inhibit mechanical turbulence. Figure 2.5 illustrates the stability class frequency distribution. The site experienced very stable conditions.

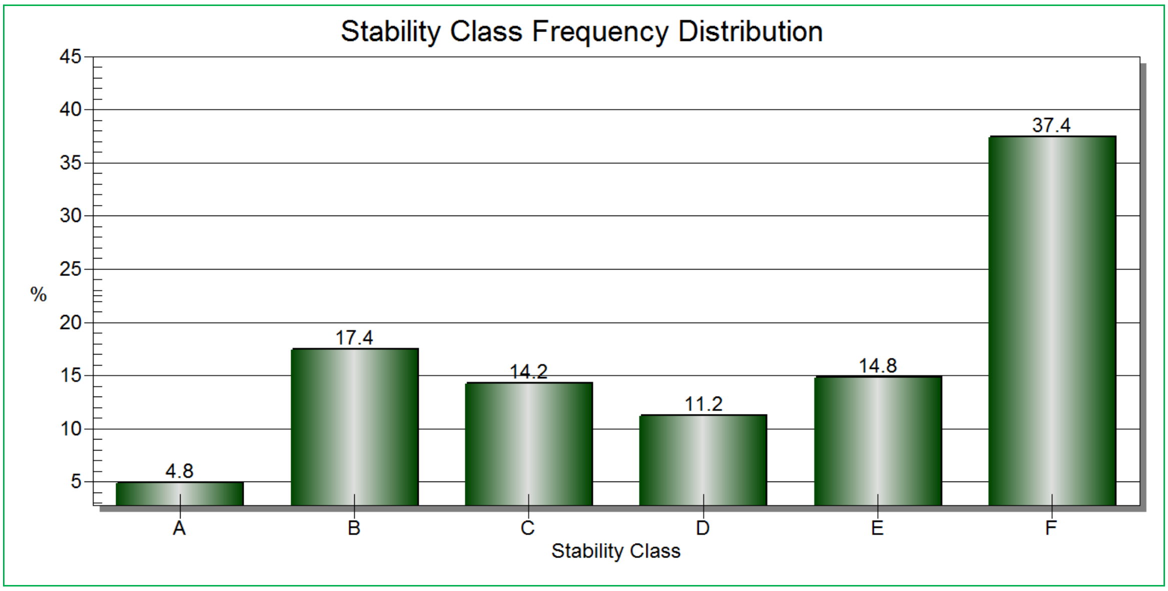

Figure 2.5: Stability class frequency distribution

2.4. Temperature and Humidity

Temperature affects the formation, action, and interactions of pollutants in various ways (Kupchella and Hyland, 1993). Chemical reaction rates tend to increase with temperature and the warmer the air, the more water it can hold and hence the higher the humidity. When relative humidity exceeds 70%, light scattering by suspended particles begins to increase, as a function of increased water uptake by the particles (CEPA/FPAC Working Group, 1999). This results in decreased visibility due to the resultant haze. Many pollutants may also dissolve in water to form acids. Temperature also provides an indication of the rate of development and dissipation of the mixing layer.

The average monthly temperature and relative humidity for the Mopane project area for the period Jan 2008 – Dec 2012 is presented in Figure 2.6 below. Daily average summer temperatures range between 23 ºC -24 ºC., while winter temperatures range between 13 ºC – 15 ºC. Relative humidity is highest during the summer months and lowest during the winter months (Jun, Jul and Aug).

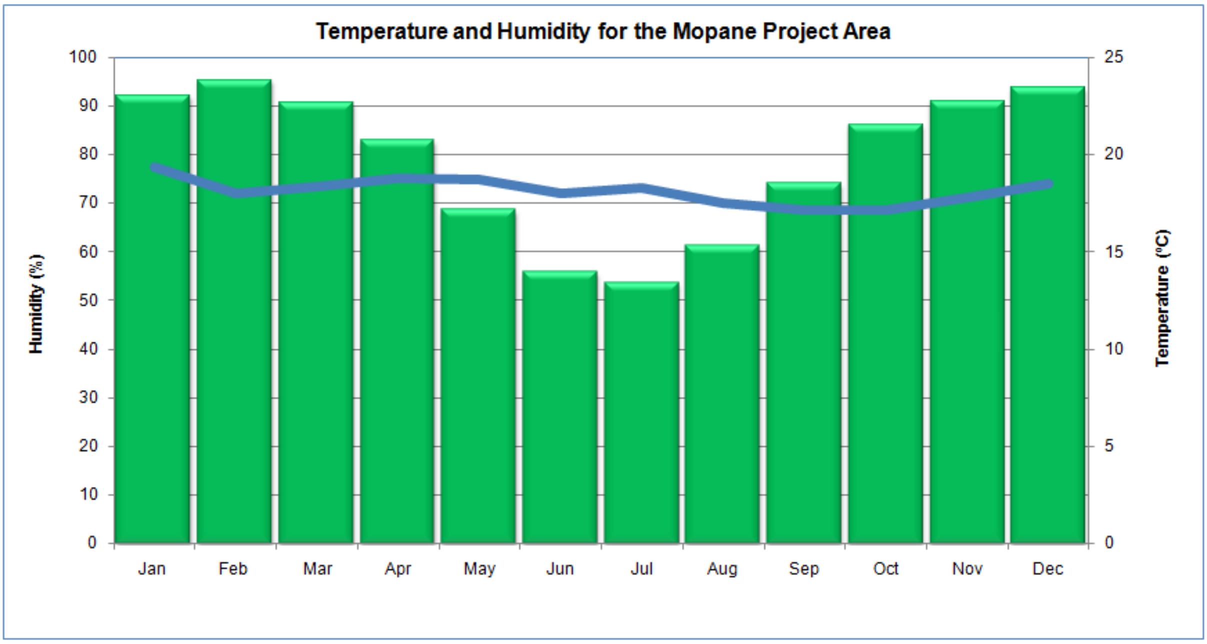

Figure 2.6: Temperature and relative humidity for the Mopane project area (Jan 2008- Dec 2012).

2.5. Precipitation

Precipitation cleanses the air by washing out particles suspended in the atmosphere (Kupchella & Hyland, 1993). It is calculated that precipitation accounts for about 80-90% of the mass of particles removed from the atmosphere (CEPA/FPAC Working Group, 1999). The total precipitation experienced at the Mopane project area is shown in Figure 2.7 below. The highest precipitation was experienced during the month of April with a total precipitation of 405 mm. Annual rainfall for monitoring period was recorded at 982 mm.

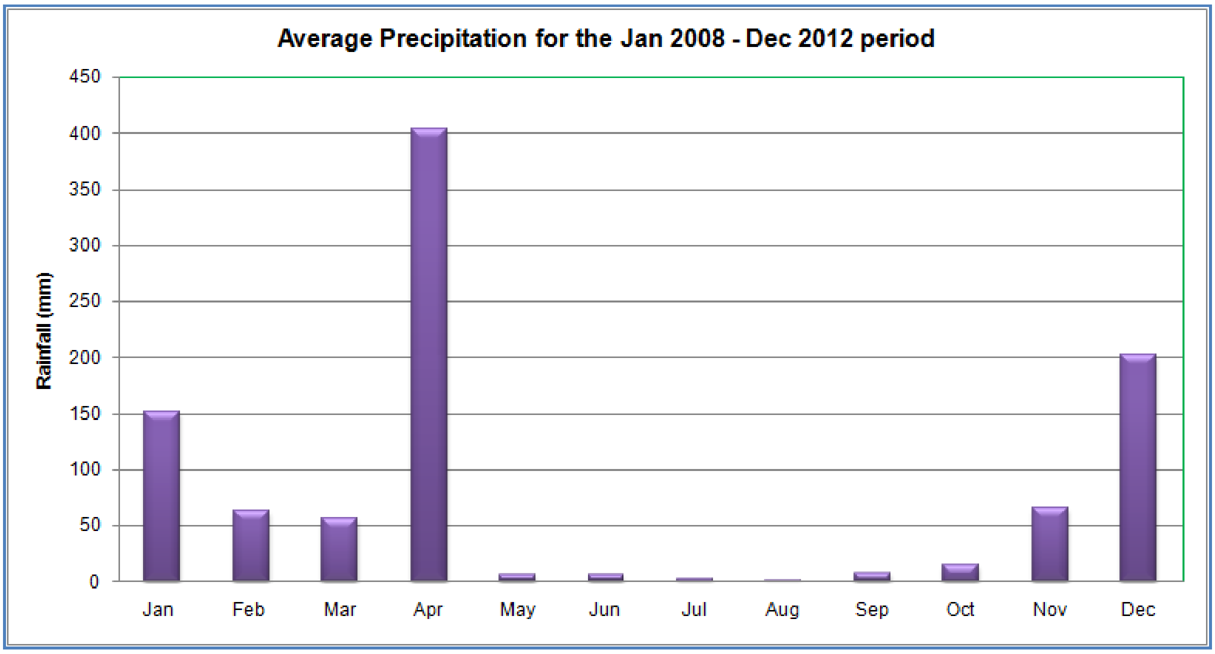

Figure 2.7: Total precipitation for the Mopane project area for the period Jan 2008 – Dec 2012.

3. Applicable Air Quality Legislation

3.1. National Environmental Management Act: Air Quality Act 39 of 2004

The National Environmental Management: Air Quality Act (39 of 2004 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 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 to have 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 is 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. National Ambient Air Quality Standards

Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality guideline values indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Air quality guidelines and standards are normally given for specific averaging periods. These averaging periods refer to the time-span over which the air concentration of the pollutant was monitored at a location. Generally, five averaging periods are applicable, namely an instantaneous peak, 1-hour average, 24-hour average, 1-month average, and annual average.

The Department of Environmental Affairs and Tourism (DEAT) have issued ambient air quality guidelines to support receiving environment management practices. Ambient air quality guidelines are only available for such criteria pollutants which are commonly emitted, such as SO_2, Pb, NO_x, benzene, particulates and CO. The pollutant of importance during this assessment is Benzene, the guidelines specific to this pollutant are listed in the subsection which follows.

3.2.1. Particulate Matter

Particulate matter is the collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface. Particulate matter includes dust, smoke, soot, pollen and soil particles (Kemp, 1998). Particulate matter has been linked to a range of serious respiratory and cardiovascular health problems. The key effects associated with exposure to ambient particulate matter include: premature mortality, aggravation of respiratory and cardiovascular disease, aggravated asthma, acute respiratory symptoms, chronic bronchitis, decreased lung function, and an increased risk of myocardial infarction (USEPA, 1996).

Particulate matter represents a broad class of chemically and physically diverse substances. Particles can be described by size, formation mechanism, origin, chemical composition, atmospheric behaviour and method of measurement. The concentration of particles in the air varies across space and time, and is related to the source of the particles and the transformations that occur in the atmosphere (USEPA, 1996).

Particulate Matter can be principally characterised as discrete particles spanning several orders of magnitude in size, with inhalable particles falling into the following general size fractions (USEPA, 1996):

- PM10 (generally defined as all particles equal to and less than 10 microns in aerodynamic diameter; particles larger than this are not generally deposited in the lung);
- PM2.5, also known as fine fraction particles (generally defined as those particles with an aerodynamic diameter of 2.5 microns or less)
- PM10-2.5, also known as coarse fraction particles (generally defined as those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns); and
- Ultra fine particles generally defined as those less than 0.1 microns.

Fine and coarse particles are distinct in terms of the emission sources, formation processes, chemical composition, atmospheric residence times, transport distances and other parameters. Fine particles are directly emitted from combustion sources and are also formed secondarily from gaseous precursors such as sulphur dioxide, nitrogen oxides, or organic compounds. Fine particles are generally composed of sulphate, nitrate, chloride and ammonium compounds, organic and elemental carbon, and metals.

Table 3.1-2: Ambient Air Quality Standards and Guidelines for Particulate Matter

Pollutant	Averaging period ($\mu g/m^3$)	Guideline ($\mu g/m^3$)	Number of Exceedance Allowed Per Year
PM10	Daily average	120 (1) 75 (2)	4 4
	Annual average	50 (1) 40 (2)	0 0
PM2.5	Daily average	65 (3) 40 (4) 25 (5)	4 4 4

	Annual average	25 (3) 20 (4) 15 (5)	0 0 0

3.2.2. Nuisance Dust (Dust fallout)

On the 7th of December 2012 the minister of Water and Environmental affairs published the new National Dust Control Regulations. This document now enforces the monitoring of dust fallout from activities that is suspected of contributing significantly to dust fallout in its region. The regulation provides a set standard for dust fallout to comply to, enforces that a baseline should be established to projects that would give rise to increased dust fallout, specifications for dust fallout monitoring and the format of reports if the activity should exceed the thresholds.

If an activity exceeds the standard the entity must submit a dust monitoring report to the air quality officer (local authority), before December 2013 (Section 4, GN1007 of 2012). The entity must develop a dust management plan, within three months after the submission of a dust monitoring report (Section 5, GN1007 of 2012). If the dust fallout is continued to be exceeded, the authority may request that continuous PM_{10} monitoring be conducted at the site.

Table 3.2: Acceptable dustfall rates as measured (using ASTM d1739:1970 or equivalent) at and beyond the boundary of the premises where dust originates.

Restriction area	Dustfall rate, D (mg/m²/day, 30-day average)	Comment
Residential	D < 600	Two within a year, not sequential months.
Non residential	600 < D < 1200	Two within a year, not sequential months.

3.2.3. Methane

Methane is not toxic to humans but is of concern in terms of its explosion potential and its impact on the global climate. The most commonly accepted flammability ranges for methane in air mixtures are given as 5.3% to 14%. The flammability range becomes slightly extended to 5.0% to 15% when mixtures of methane in air are retained with a small void such as might occur should the gas collect within an enclosed void within buildings (Campbell, 1996). Methane is one of the most significant greenhouse gases known (21 times stronger than carbon dioxide). Over the last two centuries, methane concentrations in the atmosphere have more than doubled, largely due to human-related activities.

The potential exists for pockets of methane to be present in the coal seams which are mined. The methane present in the coal seams enters the atmosphere when it is disturbed or exposed to the atmosphere. Due to studies undertaken using the IPCC it was identified that methane emissions from coal are extremely erratic and will vary depending on mining rates, rainfall, atmospheric pressure and temperature and therefore are not possible to determine amount or concentrations of the methane which will be released, especially with reference to surface and open cast mining operations. As the potential for explosion does exist it is recommended that regular monitoring of the methane be carried out to ensure the levels as well below explosive limits, especially in the underground mining sectors where ventilation should be well maintained.

3.2.4. Licensing requirement

The National Environmental Management: Air Quality Act (39 of 2004) includes the following regarding Atmospheric Emission Licenses.

22. No person may without a provisional atmospheric emission license or an atmospheric license conduct an activity: (a) Listed in the National List anywhere in the Republic; or (b) Listed on the list applicable in a province anywhere in that province; **AQA Implementation** Listed Activities and Minimum Emission Standards Listed Activities and associated minimum emission standards identified in terms of section 21 of the National Environmental Management: Air Quality Act, 39 of 2004 (31 March 2010 GG Vol. 537 No. 33064) **Category 5. Mineral Processing Industry** Number 5.1: Storage and handling of ore and coal not situated on the premises of a mine or works as defined in the Mines Health and Safety Act 29/1996. Locations designed to hold more than 100 000 tons. Notes: Should this be triggered an Atmospheric Emissions licence would be required.

3.3. Identified Sensitive Receptors

A sensitive receptor for the purpose of this study is defined as a person or place where involuntary exposure to pollutants released by the proposed project could take place. Receptors surrounding the proposed site were identified from a site visit and through satellite imagery (Figure 3.1). They are as follows:

- The Mopane railway station which consists of a railway station, a school and a number of houses.
- Farm houses, guesthouses, lodges and local residences on farms.
- Schools located within the vicinity of the mining project.
- Clinics

Other sensitive receptors within the area would be the local fauna and flora. It has been identified that dust may result in sickness and associated lung disease for wildlife and human which will arise as a result of mining operations. A more detailed inventory of settlements and sensitive receptors will be obtained during a site visit.

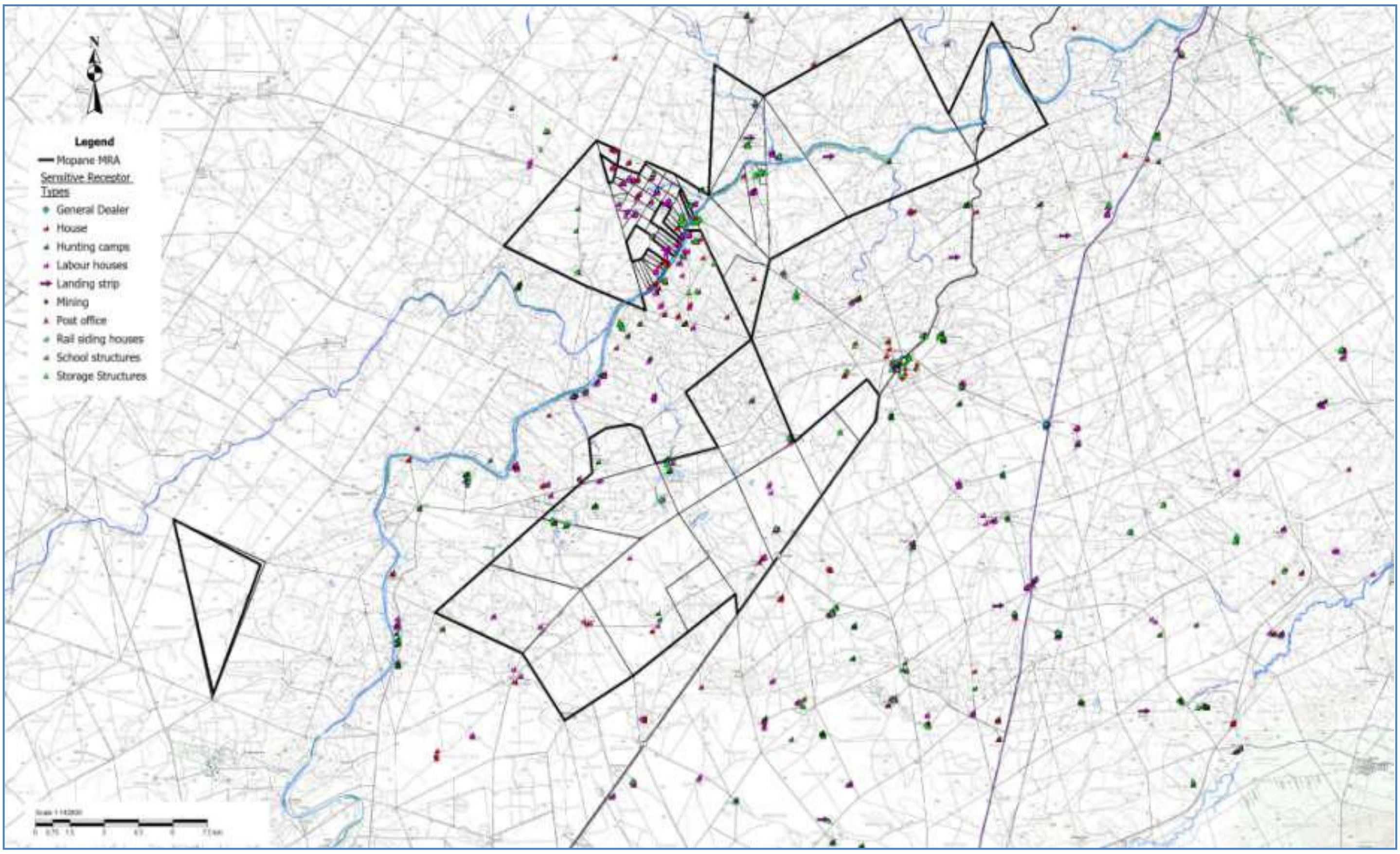

Figure 3.1: Sensitive receptors in the Mopane project area.

3.4. Existing sources of air pollution

Based on satellite imagery and a site visit; the following surrounding sources of air pollution have been identified in the area:

- Agricultural activities
- Veldt fires
- Domestic fuel burning
- Quarries

A qualitative discussion of each identified source is provided in the subsection below. The aim of this section is to highlight the potential contribution of surrounding sources to the overall ambient air quality in the area.

3.4.1. Agricultural activities

Agricultural activity can be considered a significant contributor to particulate emissions, although tilling, harvesting and other activities associated with field preparation are seasonally based. The main focus internationally with respect to emissions generated due to agricultural activity is related to animal husbandry, with special reference to malodours generated as a result of the feeding and cleaning of animals. Agriculture is an important sector within the Mopane district cultivating fruits such as citrus, subtropical fruits including mangoes, avocados and bananas. Emissions assessed include ammonia and hydrogen sulphide (USEPA, 1996). Little information is available with respect to the emissions generated due to the growing of crops. The activities responsible for the release of particulates and gases to atmosphere would however include:

- Particulate emissions generated due to wind erosion from exposed areas;
- Particulate emissions generated due to the mechanical action of equipment used for tilling and harvesting operations;
- Vehicle entrained dust on paved and unpaved road surfaces;
- Gaseous and particulate emissions due to fertilizer treatment; and
- Gaseous emissions due to the application of herbicides and pesticides.

3.4.2. Veldt fires

A veld fire is a large-scale natural combustion process that consumes various ages, sizes, and types of flora growing outdoors in a geographical area. Consequently, veld fires are potential sources of large amounts of air pollutants that should be considered when attempting to relate emissions to air quality. The size and intensity, even the occurrence, of veld fires depend directly on such variables as meteorological conditions, the species of vegetation involved and their moisture content, and the weight of consumable fuel per hectare (available fuel loading). Once a fire begins, the dry combustible material is consumed first. If the energy released is large and of sufficient duration, the drying of green, live material occurs, with subsequent burning of this material as well. Under suitable environmental and fuel conditions, this process may initiate a chain reaction that results in a widespread conflagration. It has been hypothesized, but not proven, that the nature and amounts of air pollutant emissions are directly related to the intensity and direction (relative to the wind) of the veld fire, and are indirectly related to the rate at which the fire spreads. The factors that affect the rate of spread are (1) weather (wind velocity, ambient temperature, relative humidity); (2) fuels (fuel type, fuel bed array, moisture content, fuel size); and (3) topography (slope and profile). However, logistical problems (such as size of the burning area) and difficulties in safely situating personnel and equipment close to the fire have prevented the collection of any reliable emissions data on actual veld fires, so that it is not possible to verify or disprove the hypothesis.

The major pollutants from veld burning are particulate matter, carbon monoxide, and volatile organics. Nitrogen oxides are emitted at rates of from 1 to 4 g/kg burned, depending on combustion temperatures. Emissions of sulphur oxides are negligible (USEPA, 1996). A study of biomass burning in the African savannah estimated that the annual flux of particulate carbon into the atmosphere is estimated to be of the order of 8 Tg C, which rivals particulate carbon emissions from anthropogenic activities in temperate regions (Cachier *et al*, 1995).

Figure 3.2 below illustrates the Risk potential of veld fires across the country. Limpopo province has an extremely high risk of veld fires.

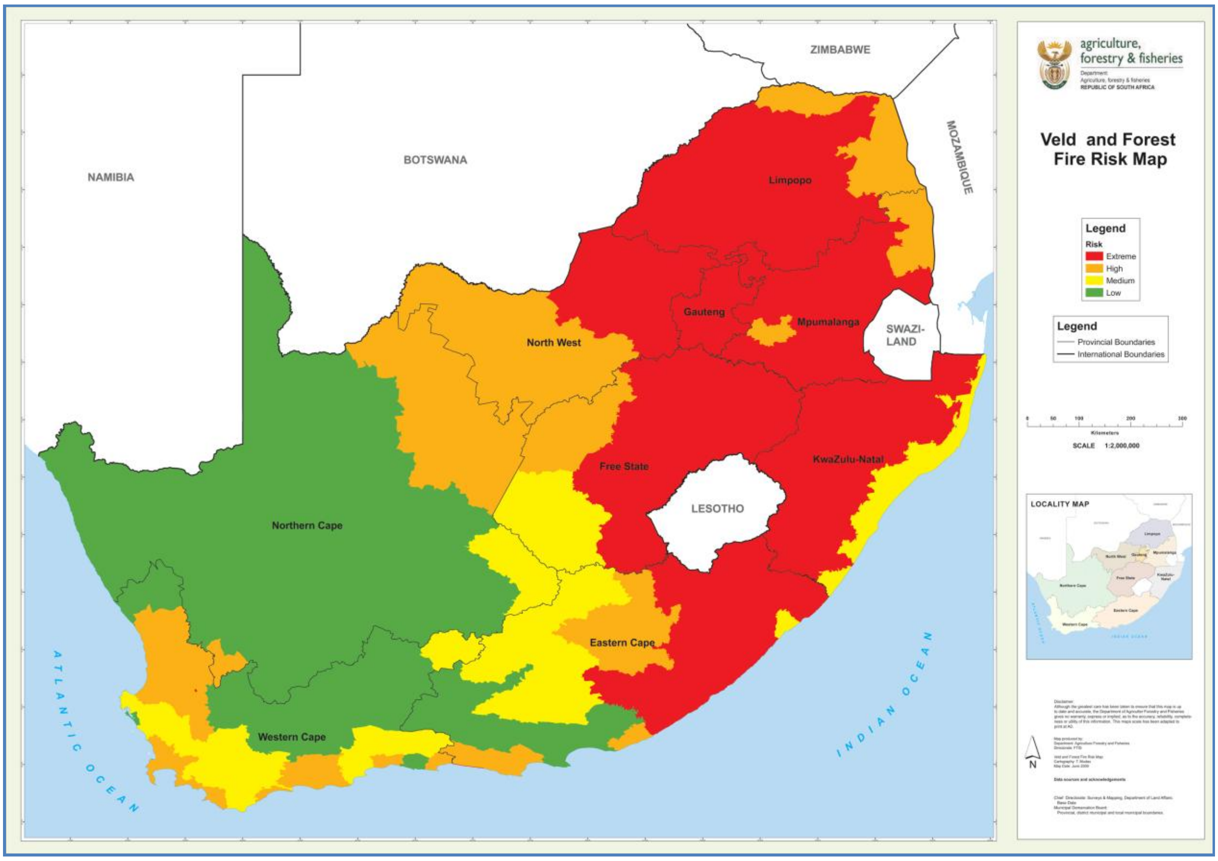

Figure 3.2: Veldt fire risk map

3.4.3. Domestic fuel burning

There are numerous farms and game ranches located in close vicinity to the proposed mining area, and are classified as sensitive receptors. The informal settlement of Mudimeli is located south east to the proposed mining area. It is anticipated that low income households in the area are likely to combust domestic fuels for space heating and/ or cooking purposes. Exposure to indoor air pollution (IAP) from the combustion of solid fuels is an important cause of morbidity and mortality in developing communities. Biomass and coal smoke contain a large number of pollutants and known health hazards, including PM, CO, NO_2, SO_2 (mainly from coal), formaldehyde, and polycyclic organic matter, including carcinogens such as benzo[*a*]pyrene (Ezzati and Kammen, 2002).

Exposure to indoor air pollution (IAP) from the combustion of solid fuels has been implicated, with varying degrees of evidence, as a causal agent of several diseases in developing countries, including acute respiratory infections (ARI) and otitis media (middle ear infection), chronic obstructive pulmonary disease (COPD), lung cancer (from coal smoke), asthma, cancer of the nasopharynx and larynx, tuberculosis, perinatal conditions and low birth weight, and diseases of the eye such as cataract and blindness (Ezzati and Kammen, 2002).

Monitoring of pollution and personal exposures in biomass-burning households has shown concentrations are many times higher than those in industrialized countries. The latest International Ambient Air Quality Standards, for instance, required the daily average concentration of PM10 to be < 180 $\mu g/m^3$ (annual average < 60 $\mu g/m^3$). In contrast, a typical 24-hr average concentration of PM10 in homes using bio fuels may range from 200 to 5 000 $\mu g/m^3$ or more throughout the year, depending on the type of fuel, stove, and housing. Concentration levels, of course, depend on where and when monitoring takes place, because significant temporal and spatial variations may occur within a house. Field measurements, for example, recorded peak concentrations of > 50 000 $\mu g/m^3$ in the immediate vicinity of the fire, with concentrations falling significantly with increasing distance from the fire. Overall, it has been estimated that approximately 80% of total global exposure to airborne particulate matter occurs indoors in developing nations. Levels of CO and other pollutants also often exceed international guidelines (Ezzati and Kammen, 2002).

3.4.4. Quarries

Quarries are a type of open pit mine in which rocks and minerals are extracted. Quarries are generally used for the extraction of building material. There is an operational quarry located within the Mopane District Municipality. Typical quarry operations involves not only extraction of materials (rock) but also crushing and screening that makes the material suitable for use in construction. In quarrying operations the major pollutant of concern are related to nuisance dust and particulate matter. The apprehension regarding quarries is that it often results in a loss of habitat and the subsequent depletion of diversity is one of the most worrisome problems associated with the activity. Many municipalities regard quarries as an eyesore and most require abatement methods to counter the impacts of dust, noise and appearance. Once mining in a quarry is complete and it has reached its lifespan, the area can be used as a landfill.

Another factor to consider regarding quarries is fugitive dust emissions and particulate matter by unpaved roads. When mining vehicles travel on the unpaved roads, the force of the wheels on the road surface causes the pulverisation of surface material. Particles are lifted and dropped from the rolling wheels and the road is exposed to stronger air currents in turbulent shear with the surface.

3.5. Baseline ambient air quality

3.5.1. Dust fallout monitoring

The Makhado Mining Project currently carries out dust fallout monitoring at three locations, Fripp, Windhoek and MCC. Figure 3.3 below illustrates the dust fallout for the monitoring period of August 2010 – April 2013. The industrial limit of 1200 mg/m^2/day was exceeded at MCC monitoring point during August 2012 (1254 mg/m^2/day). The domestic standard of 600 mg/m^2/day was exceeded at MCC monitoring point on 7 occasions. The domestic standard of 600 mg/m^2/day was exceeded at the Windhoek monitoring point on 4 occasions. The Fripp monitoring point recorded no exceedences during the monitoring period.

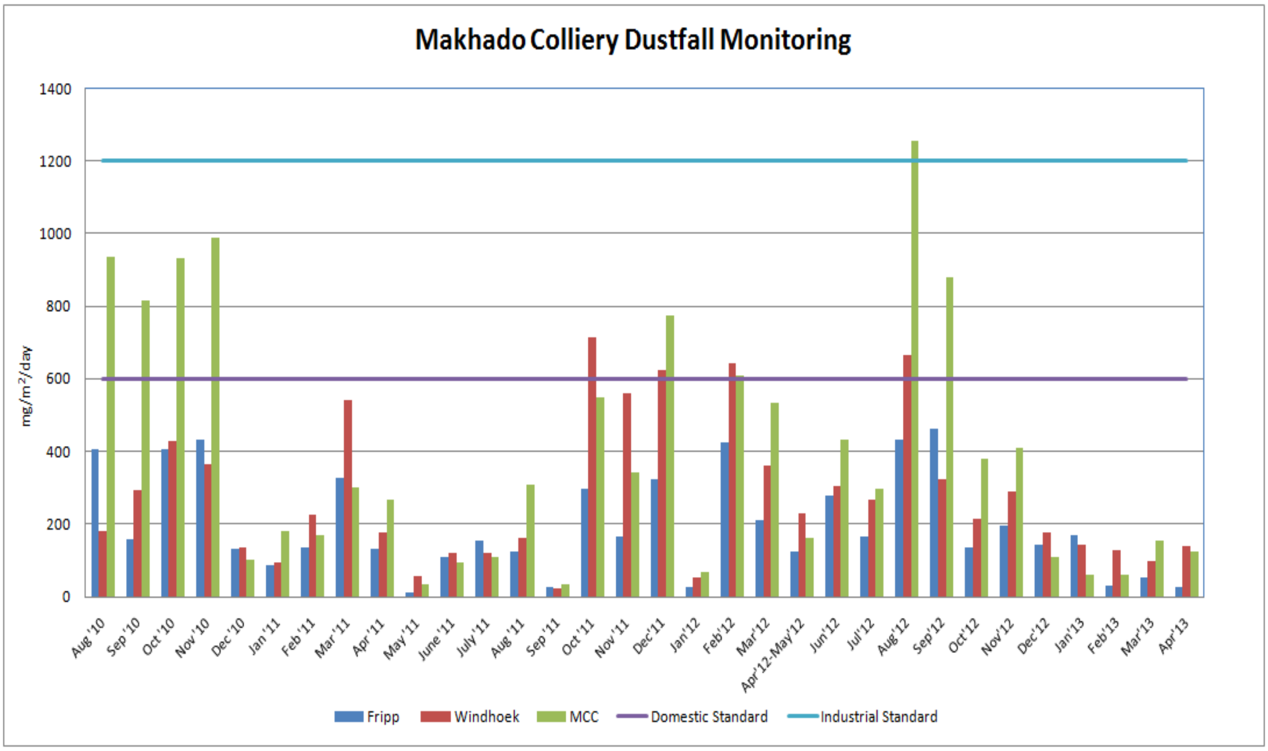

Figure 3.3: Makhado Colliery Dust fallout monitoring Aug 10 – Apr 13

3.5.2. Particulate Matter

Ambient monitoring of Particulate matter is carried out within the Mudimeli village using the Grimm and Davis monitoring equipment, which meets the quality standards of SANS (South African National Standards). Figure 3.4 below illustrates PM_{10} and $PM_{2.5}$ levels for the July 2012 – April 2013 monitoring period. Figure 8 below illustrates the predominant wind direction during the July 2012 – April 2013 monitoring period. Variable levels of PM were experienced. The SANS standard of 120 µg/m^3 were exceeded on 5 occasions:

- 28 July (130.3 µg/m^3)
- 16 August (120.95 µg/m^3)
- 26 August (169.66 µg/m^3)
- 1 September (120.95 µg/m^3)
- 2 September (175.2 µg/m^3)

There were no exceedences of the newly gazetted $PM_{2.5}$ standard of 65 µg/m^3.

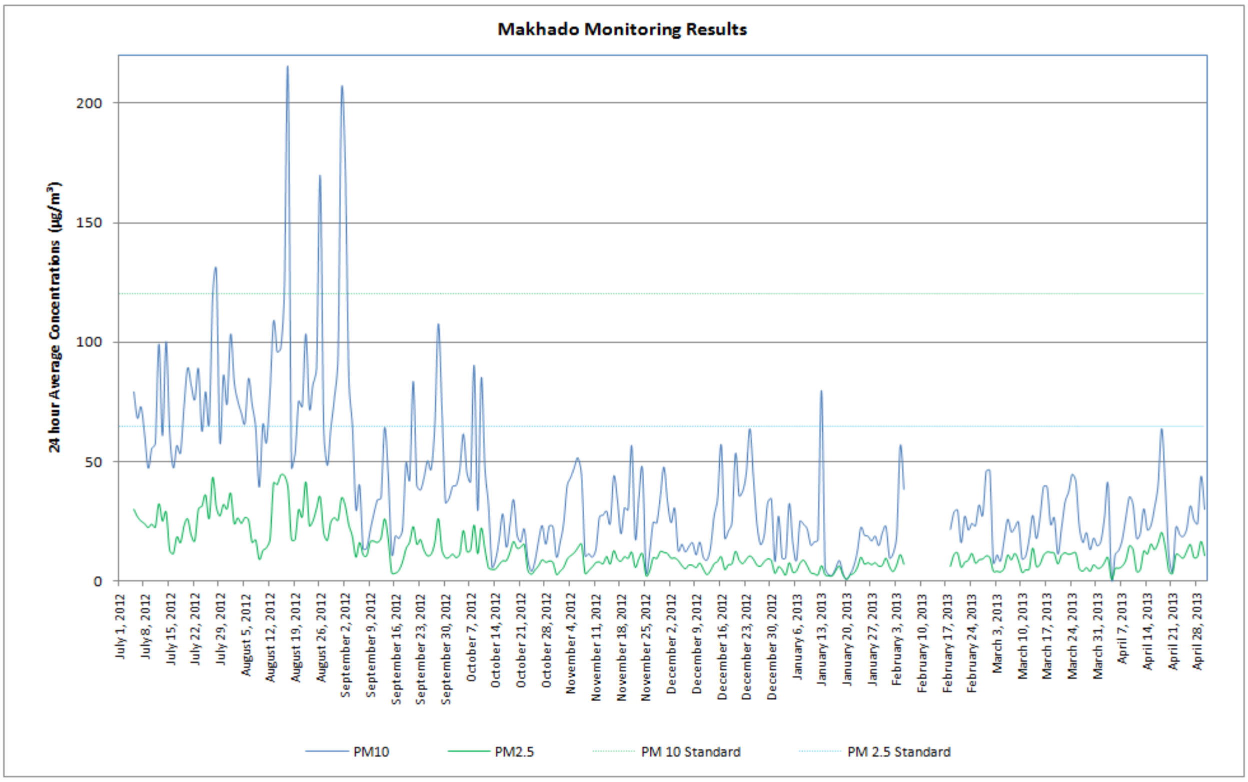

Figure 3.4: Makhado Monitoring results July 2012 – April 2013.

The predominant wind direction experienced at the Makhado site during the July 2012 – April 2013 monitoring period is mainly from the South eastern region (Figure 3.5).

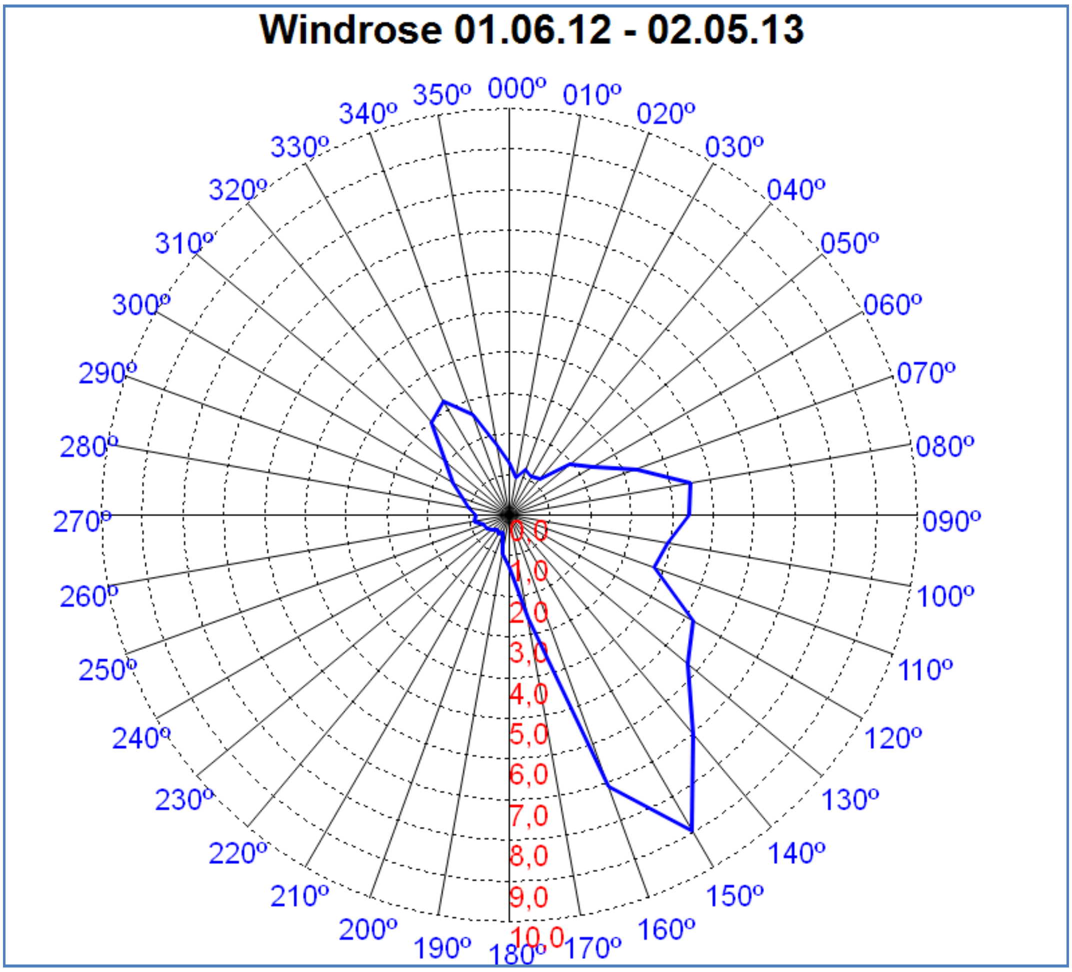

Figure 3.5: Period wind rose for the Mopane Grimm for the July 2012 – April 2013 monitoring period.

A comparison with the 2008-2012 Meteorological wind rose (Figure 2.1) data from the South African weather services and the wind rose output from the Mopane Grimm illustrated a predominant wind direction from the south eastern region.

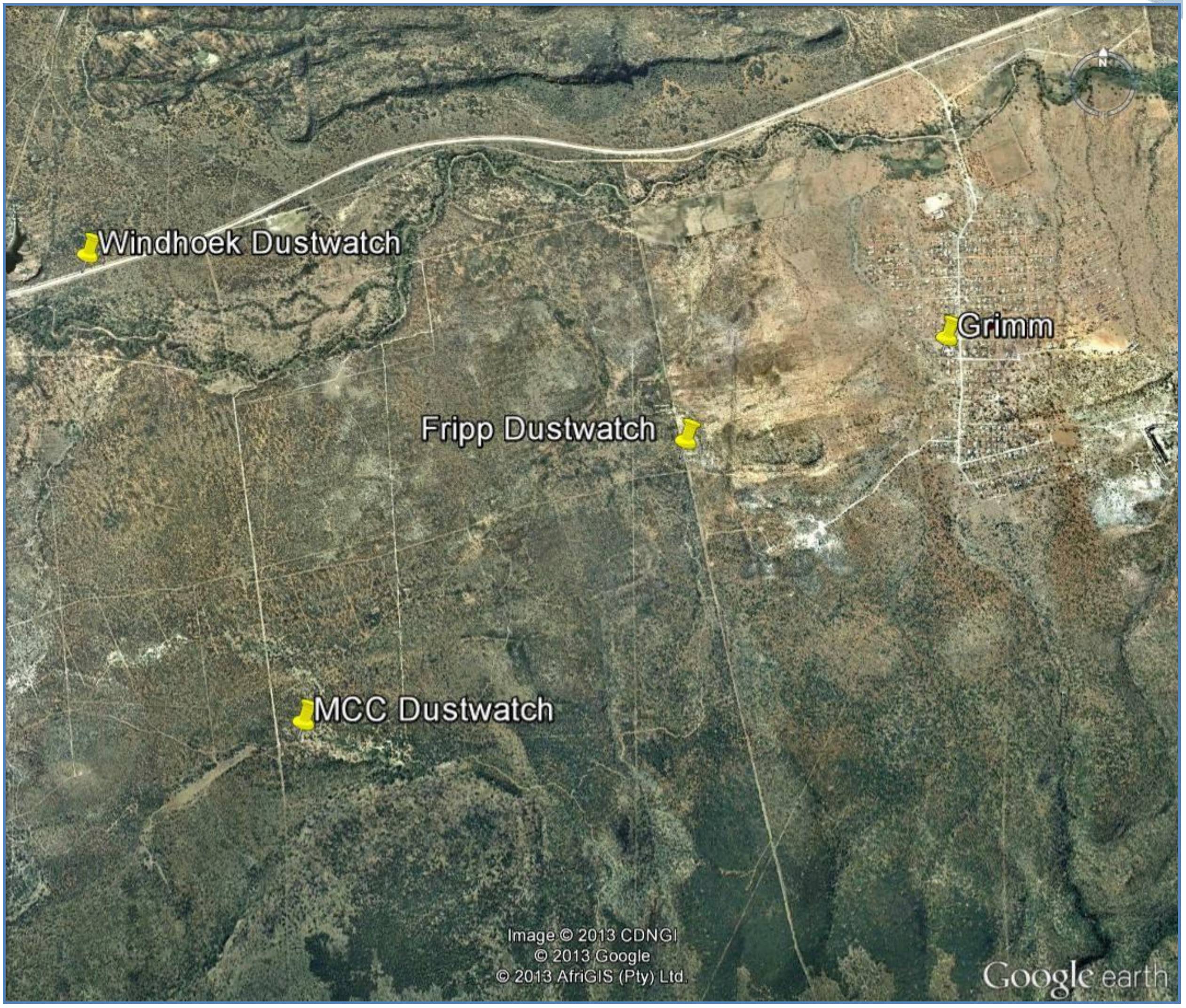

Figure 3.6: Map indicating the location of the ambient monitoring network at Makhado Colliery.

Based on the dust fallout and particulate matter monitoring data, it is evident that peak concentrations are highest during the winter months (June, July and August). Low concentrations are experienced during the summer months (December, January and February). Dust suppression techniques for example continuous watering should be considered during the dry and windy seasons in order to limit the impacts of dust fallout within the area.

4. IMPACT ASSESSMENT

This section of the report outlines the potential ambient air quality impacts associated with the proposed activities. A detailed emissions inventory was compiled as part of this assessment to determine emissions released from the landfill, brickworks and mine. Dispersion modelling simulations were undertaken using the AERMOD dispersion model and presented graphically as isopleths plots.

4.1. Methodology

4.1.1. Model Overview

AERMOD, a state-of-the-art Planetary Boundary Layer (PBL) air dispersion model, was 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.

4.1.1. Model Requirements

Input data requirements for Aermod include meteorological and emissions source data. Meteorological data which includes wind speed, wind direction, relative humidity, pressure and temperature was obtained from the South African weather services for the Jan 2008 – Dec 2011 monitoring period. Source and emission parameters for the model are detailed in the section below.

The emissions inventory will need to be developed to determine the emissions generated from each source. This is likely to be undertaken using the US-EPA AP42 emission factors. These emission factors will be calculated based on standard operating conditions for various industries, and activities, and are used as an accepted alternative if no site specific or monitored data are available. The inventory will be developed based on the mine and plant operations and will require information relating to processes for mineral concentrate, tonnages processed and mining activity information.

4.2. Emissions inventory

The emissions inventory is developed to determine the emissions generated from each source. This is likely to be undertaken using the US-EPA AP42 emission factors. These emission factors will be calculated based on standard operating conditions for various industries, and activities, and are used as an accepted alternative if no site specific or monitored data are available. The inventory will be developed based on the mine and plant operations and will require information relating to processes for mineral concentrate, tonnages processed and mining activity information.

Emissions for the Mopane project were based upon the US EPA's AP42 Sections: 11.9: Western surface coal mining; 13.2.3 heavy construction operations, 13.2.4: Aggregate Handling and Storage piles and the Australian NPI (National pollutant inventory). Calculations were applied to individual processes in order to obtain an emission to air estimate, based on mass balance information sought from literature review and the client.

The anticipated key pollutant to be released from the proposed activities at the Mopane Project is mainly Particulate matter. Particulate matter is a criteria pollutant which represents a broad and diverse class of chemically and physically diverse substances. Particulates can be described by size formation mechanism, origin, chemical composition, atmospheric behaviour and method of measurement. The concentration of particles in the air varies across space and time, and is related to the source of the particles and the transformations that occur in the atmosphere (USEPA, 1996). Particulate matter includes dust, smoke, soot, pollen and soil particles (Kemp, 1998). Particulate matter has been linked to a range of serious respiratory and cardiovascular health problems. The key effects associated with exposure to ambient particulate matter include: premature mortality, aggravation of respiratory and cardiovascular disease, aggravated asthma, acute respiratory symptoms, chronic bronchitis, decreased lung function, and an increased risk of myocardial infarction (USEPA, 1996).

4.2.1. Heavy construction activity

Particulate emissions estimates from the construction activity of the Mopane project are presented below.

$$E_{TSP} = 1.2\ (ton/ha/month\ of\ activity)$$

The quantity of emissions arising from construction activities is proportional to the area of land being worked and to the level of construction. There is currently no emission factor for PM 10 for construction activities, therefore a factor of 50% was applied to the calculated TSP emission rates according to best international practice, unless specified elsewhere in the Emissions Inventory.

Table 4.1: Heavy Construction Emission Rate

AREA	Area (hectares)	Emission rate for TSP ($g/m^2/s$)	Emission rate for PM_{10} ($g/m^2/s$)
Jutland	667	1.18E-08	5.94E-08
Voorburg	905	8.74E-09	4.37E-09

4.2.2. Bulldozing

The USEPA provides an emissions equation specifically for activities from bulldozers since this equation takes silt content and moisture into account. This was taken from the AP42 Western Surface Coal Mining specifications for opencast mining activities. Emissions from dozing of topsoil, overburden and ore were calculated using the following equations:

$$E_{TSP} = 2.6 \times \frac{(s)^{1.2}}{(M)^{1.3}}$$

$$E_{PM10} = 0.34 \times \frac{(s)^{1.5}}{(M)^{1.4}}$$

Where:

E_{TSP} = Total Suspended Particulates emission factor (kg dust/hr)

E_{PM10} = Particulate emission factor (kg dust/hr) for particulates less than 10 µm

M = material moisture content (%)

s = material silt content (%)

Table 4.2: Emission rate for bulldozing activities at the Voorburg and Jutland, Mopane Project

Source	Emission rate
Non Carbonaceous	6.57E-01
Carbonaceous	6.57E-01

4.2.3. Blasting

The US EPA provides an emission equation for blasting activities. This was taken from the AP42 western coal mining specifications for open cast coal mining.

$$EF_{TSP\ (kg/blast)} = 0.00022 \times A_{(m^2)}^{1.5}$$

Where:

A (m^2) = the area blasted (m^2)

M (%) = the moisture content of the blasted material (% by weight)

D (m) = the depth of the blast hole (m)

Table 4.3: Emission rate for blasting activities at the Voorburg and Jutland mines.

Blasting Activities	TSP (g/s)	PM10 (g/s)
Blasting activities (3 x per week)	1.93E +00	1.01E+00

4.2.4. Materials handlings operations (Tipping)

Materials handling operations associated with the proposed mine that are predicted to result in significant fugitive dust emissions include the transfer of material by means of tipping onto stockpiles and dumps. The quantity of dust which will be generated from such loading and off-loading operations will depend on various climatic parameters, such as wind speed and precipitation, in addition to non-climatic parameters such as the nature (moisture content) and volume of the material handled. Fine particulates are more readily disaggregated and released to the atmosphere during the material transfer process, as a result of exposure to strong winds. Increase in the moisture content of the material being transferred would decrease the potential for dust emission, since moisture promotes the aggregation and cementation of fines to the surfaces of larger particles (USEPA, 1995).

The USEPA does not have an emission factor or equation specific for calculating emissions from excavators or shovels. The Australian NPI, however, provides the same equation as for tipping to be applied to excavators and shovels. The following equations were used to calculate TSP and PM10 emissions respectively:

$$E_{(kg/Mg)} = k \times 0.0016 \times \left[\frac{\left(U/_{2.2}\right)^{1.3}}{\left(M/_{2}\right)^{1.4}} \right]$$

Where:

U = mean wind speed

M = the moisture content of material (%)

k = the empirical constant per size fraction

Table 4.4: Empirical constants for different particle sizes (material handling)

Constant	TSP	PM10
k	0.74	0.35

Table 4.5: Emission rate at material handling area

Area	TSP (g/s)	PM10 (g/s)
Stockpiles	9.78 E+00	3.425E+00

4.2.5. Wind erosion from exposed areas

Dust emissions due to the erosion of open storage piles and exposed areas occur when the threshold wind speed is exceeded (Cowherd *et al.*, 1988; EPA, 1995). 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 (Cowherd *et al.*, 1988).

Significant amounts of dust will be eroded from open, exposed areas at the proposed mine under wind speeds of greater than 5.4 m/s (i.e. threshold friction velocity of 0.26 m/s). Fugitive dust generation resulting from wind erosion under high winds (i.e. > 5.4 m/s) is directly proportional to the wind speed.

The particulate matter equation from the wind erosion of exposed ground was calculated using the following equation (NPI Mining):

$$E_{TSP} = 1.9 \times \left(\frac{s}{1.5}\right) \times \left(\frac{365-p}{235}\right) \times \left(\frac{f}{15}\right)$$

$$E_{PM10} = 1.9 \times \left(\frac{s}{1.5}\right) \times \left(\frac{365-p}{235}\right) \times \left(\frac{f}{15}\right) \times 0.5$$

Where:

E_{TSS} = total suspended particles emission factor, kg/day/ha

S = silt content of aggregate (%)

p = number of days with .0.25mm of precipitation per year

f = percentage of time that the unobstructed wind speed exceeds 5.4m/s.

Table 4.6: Wind erosion emission rates calculated for stockpiles.

Area	Area m²	PM10
Jutland		
Carbonaceous stockpile	422035.3	3.03E-04
Non carbonaceous stockpile	727864.5	3.03E -04
Topsoil	218885.5	3.03E -04
Voorburg		
Carbonaceous stockpile	173898.2	3.03E -04
Carbonaceous stockpile	86104.6	3.03E -04
Non Carbonaceous stockpile	606423.5	3.03E- 04
Topsoil	445696.9	3.03E-04

4.2.6. Methane emissions

Methane is formed in coal during coalification. The quality and the quantity of methane created depend on the composition of the organic matter. Methane is retained within the coal bed and surrounding strata. As long as the gas remains under pressure and assuming there is no geological processes to influence the reservoir, mining activities releases the pressure and methane escapes. In area where miners are working, methane level are required to be at 0.5%, this can be achieved by continuous ventilation. Methane in general is not toxic to humans but it is of concern in terms of its explosive potential and its impact on the global climate. The most common accepted flammability range for methane in air mixtures are given as 5.3% to 14%. The flammability range becomes slightly extended to 5.0% - 15% when mixtures of methane in air are retained. Methane is one of the most significant greenhouse gases (21 times stronger than carbon dioxide).

4.3. Impact assessment

Dispersion modelling simulations were undertaken to determine the potential air quality impacts associated with the proposed activities. These impacts are reflected as isopleths plots. The isopleths plots reflect the gridded contours (lines of equal concentration) of zones of impact at various distances from the contributing sources. The patterns generated by the contours are representative of the maximum predicted ground level concentrations for the averaging period being represented. The Mopane project was assessed based on two scenarios, namely the construction impacts and the Life of mine (Operational impacts).

4.3.1. Construction Impacts

During the construction assessment phase it is expected that the main impact will result due to the construction of access haul roads, the plant area and the mining pit area. These predicted impacts cannot be quantified extensively due to the lack of detailed information related to scheduling and positioning of construction related activities.

Construction is commonly of a temporary nature with a definite beginning and end. It usually consists of a series of different operations, each with its own duration and potential for dust generation. Dust emission will vary from day to day depending on the phase of construction, the level of activity and the prevailing meteorological conditions (USEPA, 1996).

The following possible sources of fugitive dust have been identified as activities which could potentially generate dust during construction operations at the mine:

1. Product Transport
    - Scraping;
    - Debris handling;
    - Debris stockpiles; and
    - Truck transport and dumping of debris.
2. Coal Processing Plant
    - Clearing of area for infrastructure;
    - Debris handling;
    - Debris stockpiles; and
    - Truck transport and dumping of debris.
3. Opencast Mining
    - Removal of overburden; and
    - Haul Roads (scraping etc)

Access roads are constructed by the removal of overlying topsoil, whereby the exposed surface is graded to provide a smooth compacted surface for vehicles to drive on. Material removed is often stored in temporary piles close to the road edge, which allows for easy access once the road is no longer in use, whereby the material stored in these piles can be re-covered for rehabilitation purposes. Often however, these unused haul roads are left as is in the event that sections of them could be reused at a later stage.

A large amount of dust emissions are generated by vehicle traffic over these temporary unpaved roads (USEPA, 1996). Substantial secondary emissions may be emitted from material moved out from the site during grading and deposited adjacent to roads (USEPA, 1996). Passing traffic can thus re-suspend the deposited material. To avoid these impacts material storage piles deposited adjacent to the road edge should be vegetated, with watering of the pile prior to the establishment of sufficient vegetation cover. Piles deposited on the verges during continued grading along these routes should also be treated using wet or chemical suppressants depending on the nature and extent of their impacts.

A positive correlation exists between the amount of dust generated (during vehicle entrainment) and the silt content of the soil as well as the speed and size of construction vehicles. Additionally, the higher the moisture content of the soil the lower the amount of dust generated.

The periodic watering of these road sections will aid in the reduction of dust generated from these sources. Cognisance should be taken to increase the watering rate during high wind days and during the summer months when the rate of evaporation increases.

The following components of the environment may be impacted upon during the construction phase:

- ambient air quality;
- local residents and neighbouring communities;
- employees;
- the aesthetic environment; and
- possibly fauna and flora

A quantitative assessment of the construction phase was calculated based on the US EPA Heavy construction emission factors. The construction activities took into account the construction of the Voorburg and Jutland pits. Figure 4.1 below illustrates the maximum predicted daily concentration (µg/m^3) of PM10 from construction related activities. The predicted PM10 concentration falls below the average daily concentration of 120 µg/m^3. The maximum predicted annual concentration of particulate matter was estimated at 2.00E-01 (Figure 4.2) which falls below the annual standard of 50 µg/m^3.

Table 4.7: Maximum predicted ambient ground level concentration (µg/m^3) of Particulate Matter during the construction phase.

Source	Maximum predicted ground level Concentration of PM_{10} (µg/m^3)	Ambient air quality standard	Fraction of the standard (%)
Daily			
Cumulative impact	0.700	120	0.6
Annual			
Cumulative impact	0.200	50	0.4

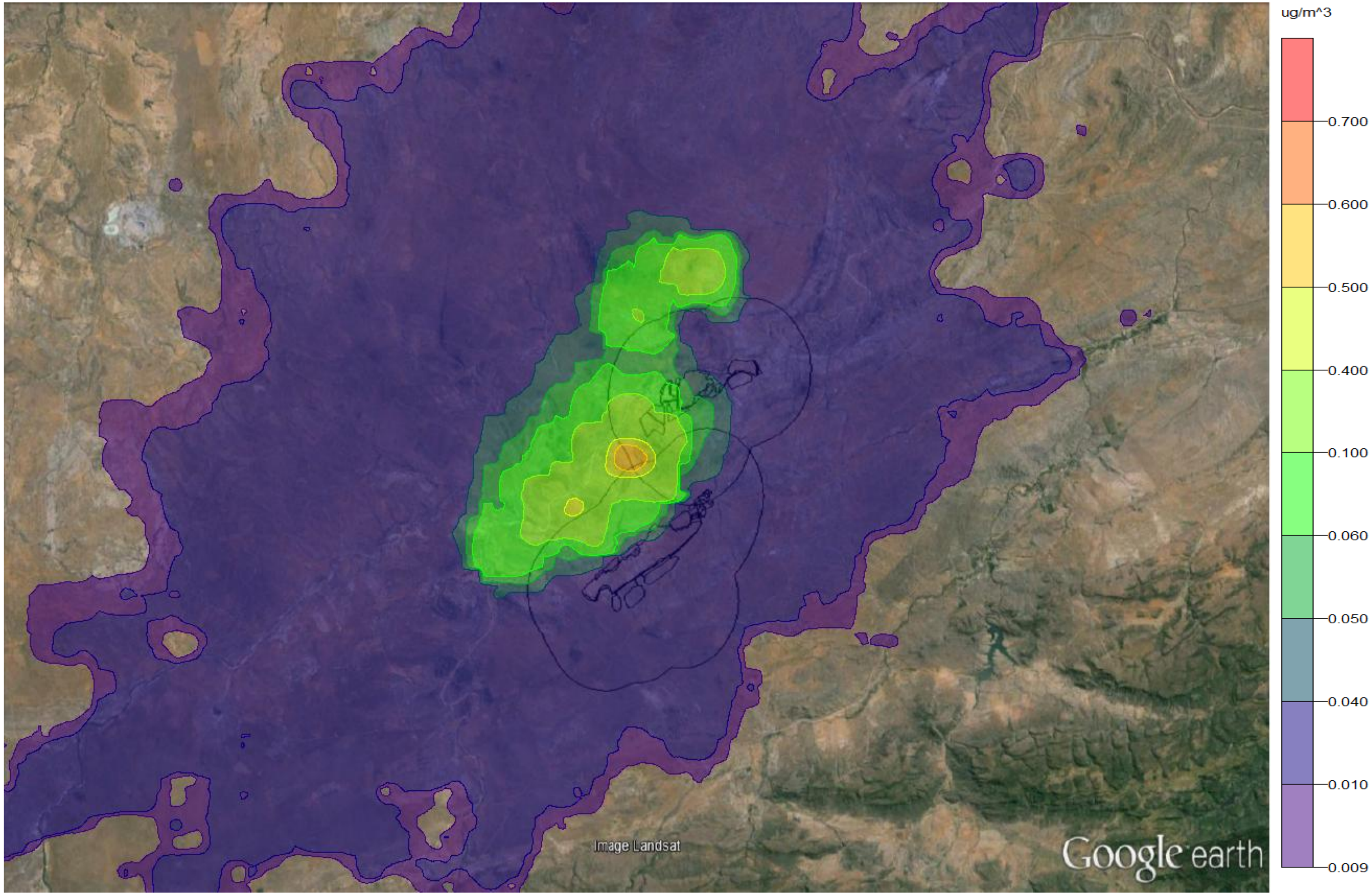

Figure 4.1: Maximum predicted Daily concentration (µg/m^{3}) of Particulate Matter.

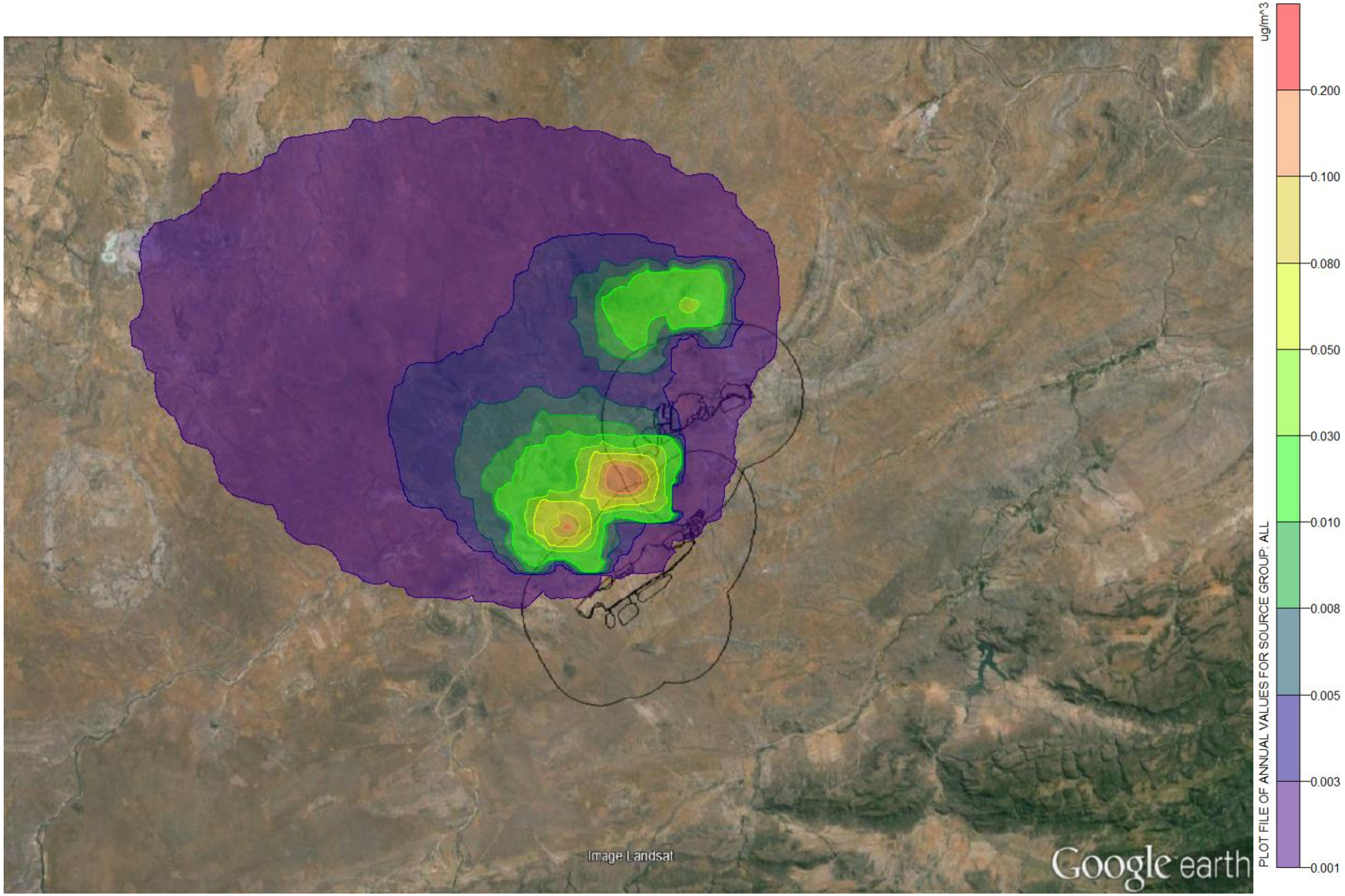

Figure 4.2: Maximum Predicted Annual ground level concentration (µg/m^{3}) of Particulate Matter.

4.3.2. Operational Phase

This section of the report aims to deal with the air quality impacts associated with the proposed mining activities scheduled to commence at Voorburg at a mining rate of 2.5 Mtpa for a period of 33 years and at Jutland at a mining rate of 2.5 Mtpa for a period of 28 years.

Details regarding the source characteristics were extrapolated from site layout plans. Sources that were included in this assessment are:

- Coal processing (storage piles, crushing and screening activities), and
- Opencast mining and in-pit activities (blasting, drilling, bulldozing, tipping)

Table 4.8 below indicates the maximum predicted daily ground level concentrations for PM10 during the operational conditions of the Mopane Mine. The cumulative impact of 30 µg/m^3 falls below the daily standard of **120** µg/m^3 for PM10 (Figure 4.3). When compared against the stricter standard of **75** µg/m^3 to be implemented in 2015, the maximum predicted ground level concentration still falls below this daily limit.

The highest contributor of particulate matter during the operational phases is from Jutland and Voorburg pit activities such as Bulldozing, drilling, crushing and tipping activities.

Table 4.8: Maximum predicted ambient ground level concentration (µg/m^3) of Particulate Matter during the operational phase.

Source	Maximum predicted daily ground level Concentration of PM_{10} (µg/m^3)	Ambient air quality standard	Fraction of the standard (%)
Mining Pit activities Jutland	30.00	120	25
Mining Pit activities Voorburg	20.00	120	17
Stockpiles	7.00	120	6
Cumulative impact	30.01	120	25

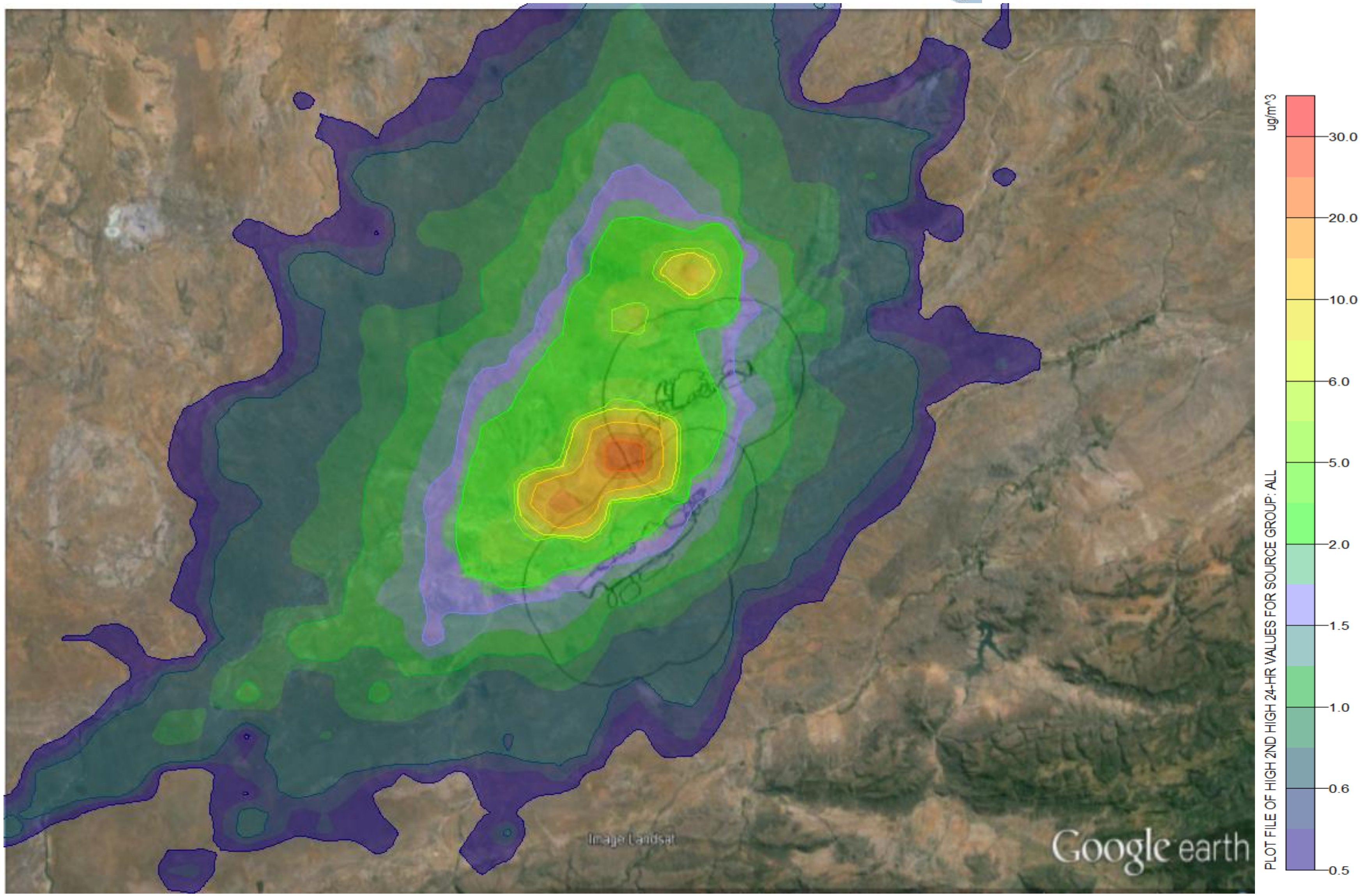

Figure 4.3: Maximum cumulative Predicted daily ground level concentration (µg/m^{3}) of Particulate Matter

Table 4.9 below indicates the maximum predicted annual ground level concentration for particulate matter during the operational activities at the Mopane Mine. The cumulative impact recorded a maximum annual emission concentration of 7µg/m^3. This predicted annual concentration falls below the annual standard of 50 µg/m^3 for Particulate matter. Figure 4.4 below illustrates the annual concentration dispersion potential.

The highest contributor to the Particulate matter concentration is mainly from the Jutland and Voorburg pit activities.

Table 4.9: Maximum predicted annual ground level concentration (µg/m^3) of Particulate Matter during the operational phase

Source	Maximum predicted annual ground level Concentration of PM_{10} (µg/m^3)	Ambient air quality standard	Fraction of the standard (%)
Mining Pit activities Jutland	7	50	14
Mining Pit activities Voorburg	4	50	8
Stockpiles	1	50	2
Cumulative impact	7	50	14

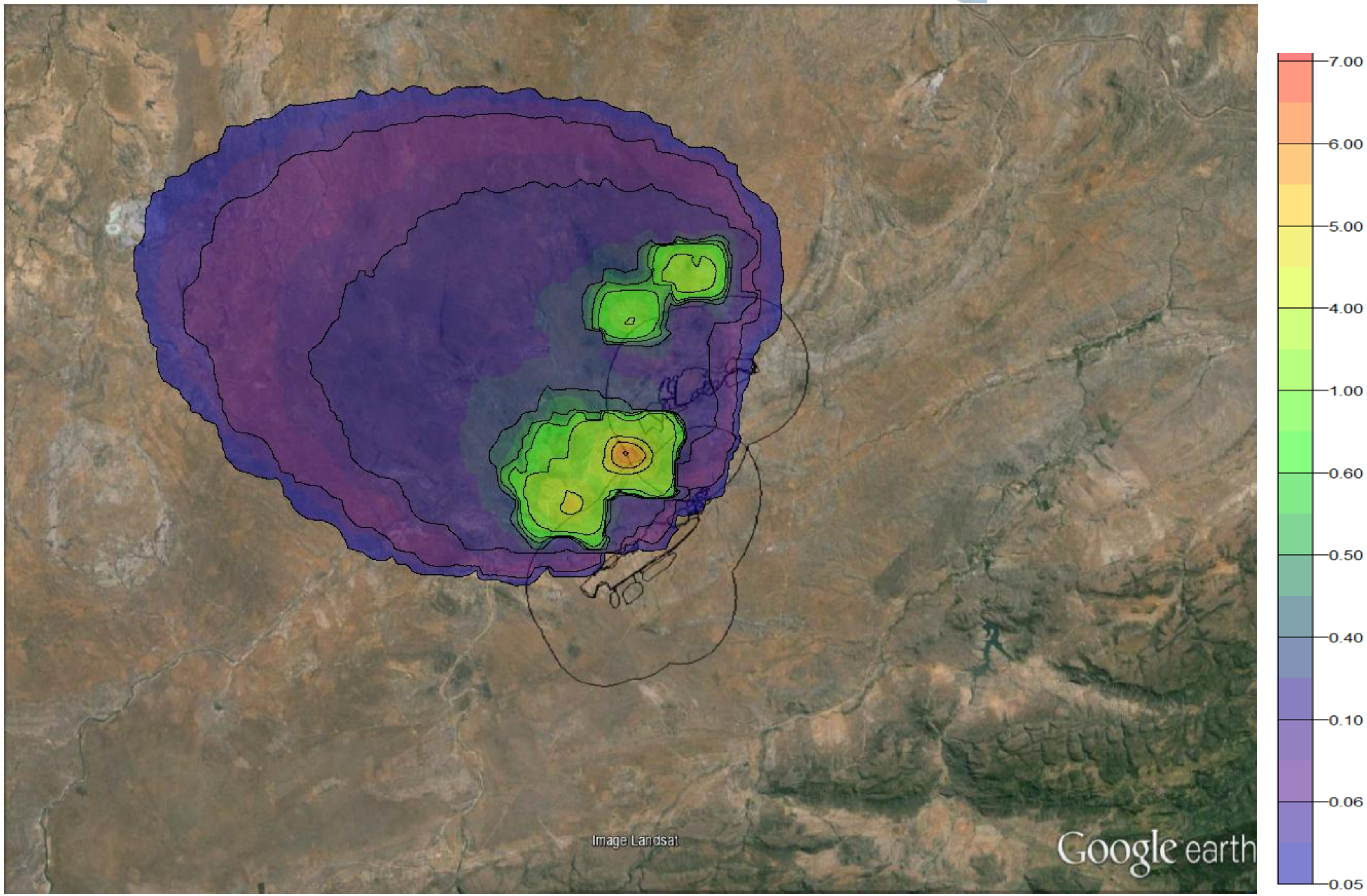

Figure 4.4: Maximum cumulative Predicted annual ground level concentration (μg/m^3) of Particulate Matter

The blasting impacts were modelled separately as blasting was modelled at an average of 3 times per week for intervals of approximately 10 minutes. Figure 4.5, Figure 4.6 and Figure 4.7 below indicates the hourly, daily and annual concentrations of particulate matter from blasting activities respectively. The daily and the annual concentrations for blasting activities both fell below the daily and annual standard for particulate matter.

Blasting is not a continuous activity and is limited to a maximum of three times a week, thus the initial impact of blasting is relatively high with the annual concentration being minimum.

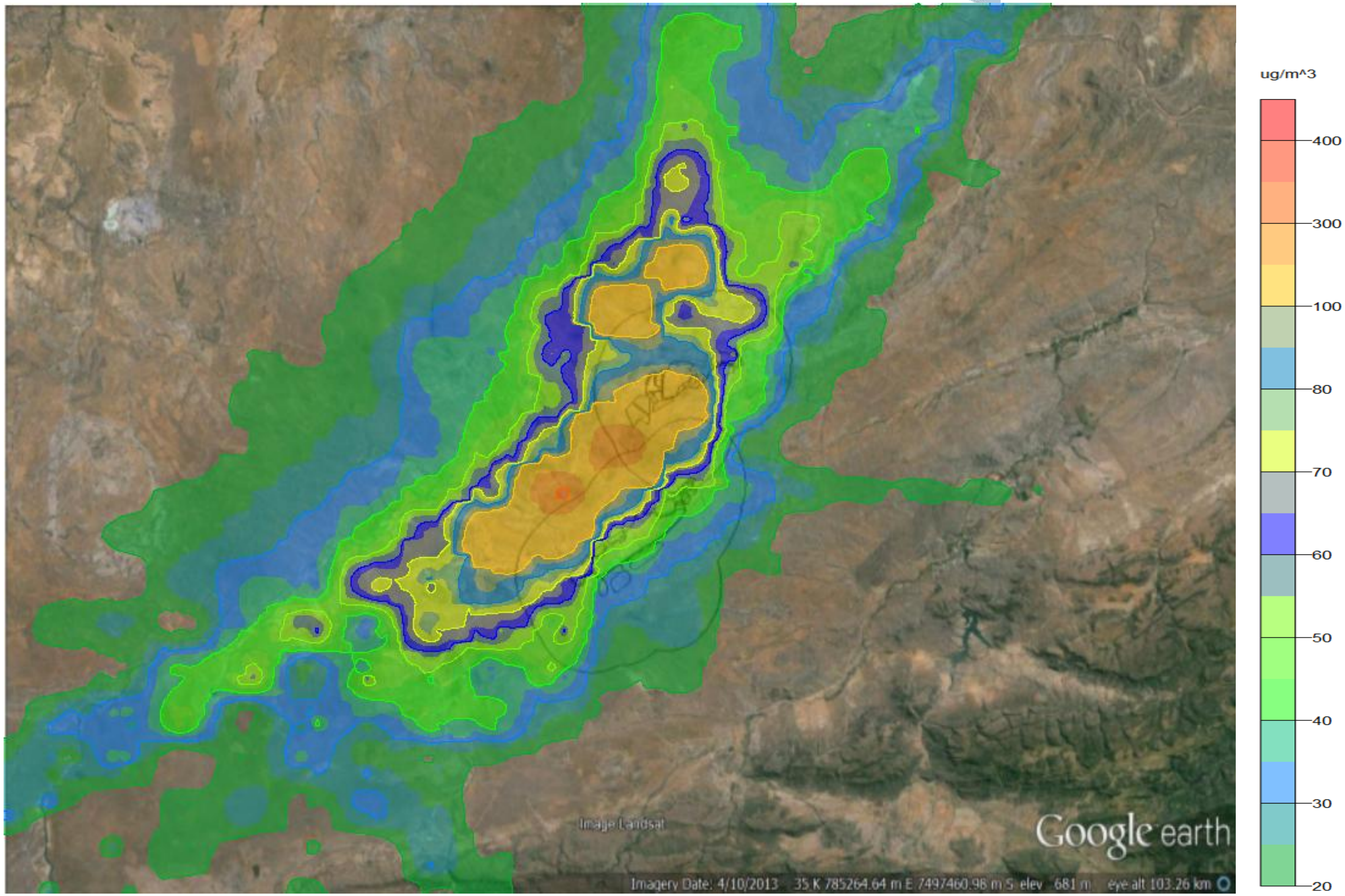

Figure 4.5: Maximum predicted Hourly concentration (µg/m^3) of Particulate Matter from Blasting Activities

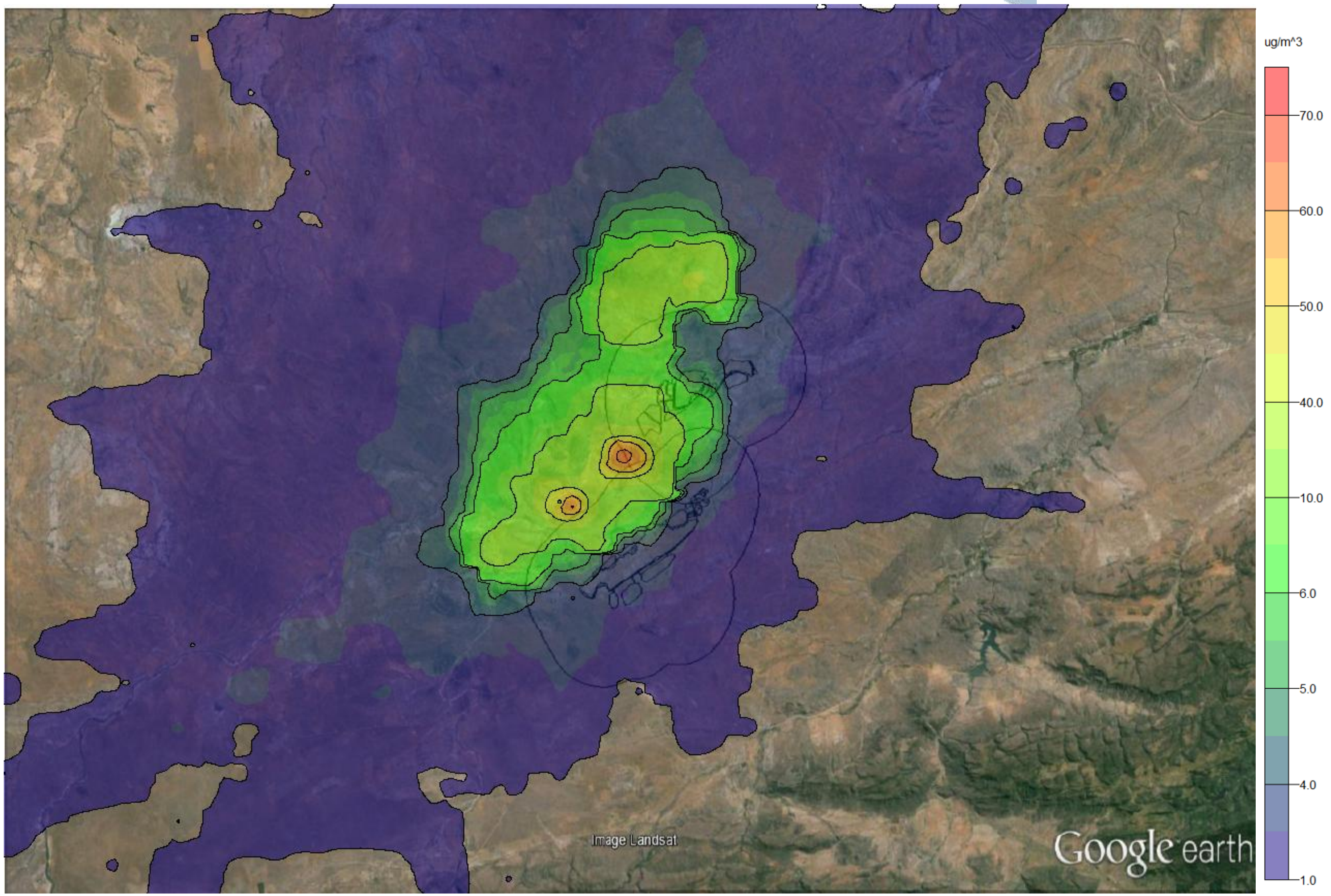

Figure 4.6: Maximum predicted daily concentration (µg/m^3) of particulate matter from blasting activities.

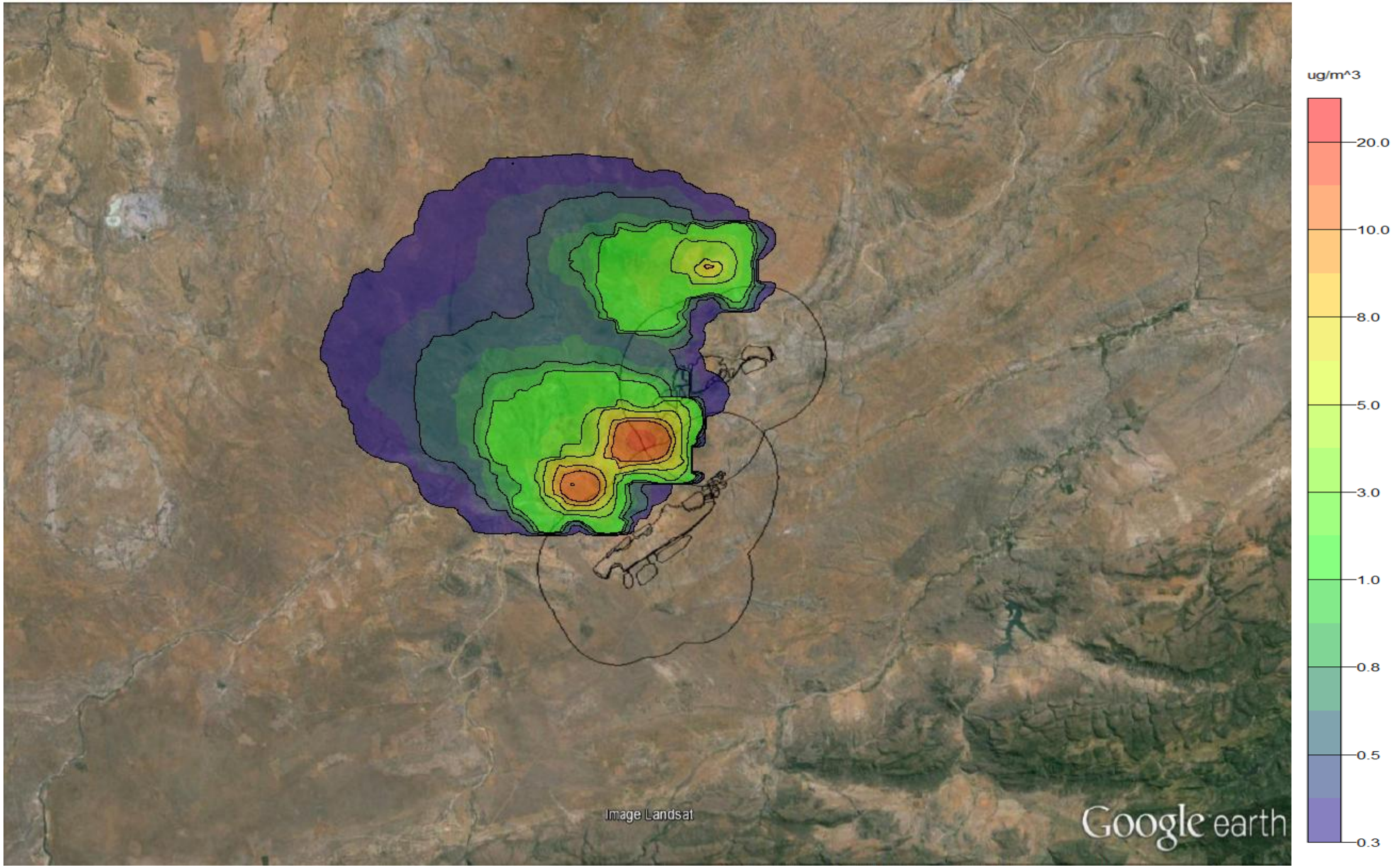

Figure 4.7: Maximum Predicted Annual concentration (µg/m^3) of Particulate matter from blasting activities

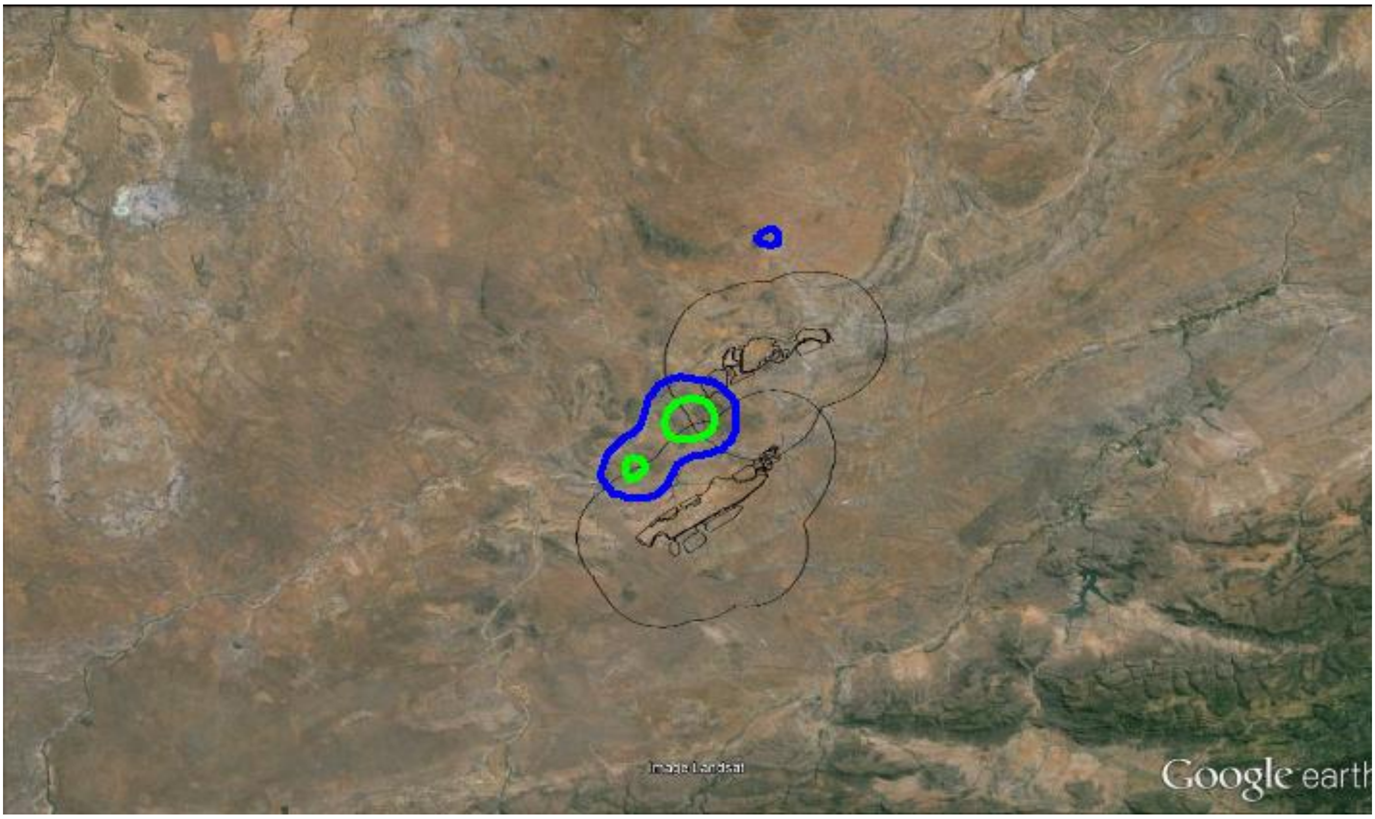

Figure 4.8: Dust fallout impacts recorded during the Operational phases of the Mopane Project.

Dust fallout concentration in mg/m^2/day	300	600

Figure 4.8 above illustrates the maximum predicted dust fallout impacts anticipated to occur during the operational activities at the Voorburg and Jutland mine. The dust fallout threshold of 600 mg/m^2/day occurs at the boundary between the Voorburg and Jutland mines, where the stockpiles are expected to be. The average dust fallout concentration expected to be released from the mining operations fall within the 300 mg/m^2/day standard.

When compared to the monitored data of August 2010 – April 2013, the average dust fallout threshold was 390 mg/m^2/day. Higher dust fallout rates are expected during the winter months of July – August. An increase in activity will result in an increase in the dust fallout rate.

4.3.3. Decommissioning phase

The decommissioning phase is associated with activities related to the demolition of infrastructure and the rehabilitation of disturbed areas. The total rehabilitation will ensure that the total area will be a free draining covered with topsoil and grassed. The following activities are associated with the decommissioning phase (US-EPA, 1996):

- Existing buildings and structures demolished, rubble removed and the area levelled;
- Remaining exposed excavated areas filled and levelled using overburden recovered from stockpiles;
- Stockpiles and tailings impoundments to be smoothed and contoured;
- Topsoil replaced using topsoil recovered from stockpiles; and
- Land and permanent waste piles prepared for re-vegetation.

Possible sources of fugitive dust emission during the closure and post-closure phase include:

- Smoothing of stockpiles by bulldozer;
- Grading of sites;
- Transport and dumping of overburden for filling;
- Infrastructure demolition;
- Infrastructure rubble piles;
- Transport and dumping of building rubble;
- Transport and dumping of topsoil; and
- Preparation of soil for re-vegetation – ploughing and addition of fertiliser, compost etc.

Exposed soil is often prone to erosion by water. The erodability of soil depends on the amount of rainfall and its intensity, soil type and structure, slope of the terrain and the amount of vegetation cover (Brady, 1974). Revegetation of exposed areas for long-term dust and water erosion control is commonly used and is the most cost-effective option. Plant roots bind the soil, and vegetation cover breaks the impact of falling raindrops, thus preventing wind and water erosion. Plants used for re-vegetation should be indigenous to the area, hardy, fast-growing, nitrogen-fixing, provide high plant cover, be adapted to growing on exposed and disturbed soil (pioneer plants) and should easily be propagated by seed or cuttings.

4.4. Assumptions and limitations

The following assumptions were made as part of this assessment:

- The volume and height of the stockpiles and discard dumps were estimated based on previous impact assessments and the US-EPA emission models for mining activities.
- The moisture content for the different type of materials was not available therefore use was made of the moisture content values given in the USEPA for quarrying and processing.
- Use was made of the US-EPA AP42 for all calculations as no detailed source specific information is available at the commencement of this project.

4.5. Proposed Mitigation

4.5.1. Construction phase

It is recommended that the precautionary principle be followed and dust control measures be implemented. Recommendations for the control of fugitive dust emissions are given in Table 4.10 below. Wet suppression with water is the least expensive of the possible control measures but is temporary in nature.

Table 4.10: Recommended Mitigation measures during operational phase.

Emission Source	Recommended Control Methods
Debris handling and debris piles	Wet suppression (1)
Truck transport (2)	Wet suppression
	Paving
	Chemical stabilisation (3)
Pan scrapers	Wet suppression of travel routes
Cut/fill haulage	Wet suppression
	Paving
	Chemical stabilisation
General construction	Wind speed reduction
	Wet suppression
	Early paving of permanent roads

Note: (1) Dust control plans should contain precautions against watering programs that confound track out problems.

(2) Loads could be covered to avoid loss of material in transport, especially if material is transported offsite.

(3) Chemical stabilisation is usually cost-effective for relatively long-term or semi-permanent unpaved roads.

Water may be combined with a surfactant as a wetting agent. Surfactants increase the surface tension of water, reducing the quantity of water required. Chemical stabilisation is of longer duration but is not cost effective for small-scale operations. Dust-A-Side (DAS) represents an example of a chemical product, which is commercially available and widely used by mines and quarries. The DAS product binds with the aggregate used to build on-site roads. It should be noted however, that the treatment with chemical stabilisers can have adverse effects on plant and animal life and can contaminate the treated material (USEPA, 1996).

Dust and mud should be controlled at vehicle exit and entry points to prevent the dispersion of dust and mud beyond the site boundary. Facilities for the washing of vehicles could be provided at the entry and exit points. A speed limit of 40 km/hr should be set for all vehicles travelling over exposed areas or near stockpiles. Traffic over exposed areas should be kept to a minimum (USEPA, 1996).

Additional preventative techniques include the reduction of the dust source extent and adjusting work processes to reduce the amount of dust generation (USEPA, 1996).

4.5.2. Operational phase

Based on studies undertaken by C.B. Arpacioglu and C.Er., they indicate that most of the dust impacts associated with mining will occur within the mine site area, and will not be very significant and unlikely to exceed World Bank ambient air quality standards. Based on the dispersion simulation undertaken for the site, the particulate matter and dust fallout impacts resulting from the activities do not extend beyond the mine area.

Table 4.11: Recommended Mitigation measures during operational phase

Emission Source	Recommended Control Methods
Material handling	Wet suppression [1]
Truck transport [2]	Wet suppression
	Paving
	Chemical stabilisation [3]
Bulldozers	Wet suppression
Blasting	Wet suppression during blasting operations

Note: [1] Dust control plans should contain precautions against watering programs that confound track out problems.

[2] Loads could be covered to avoid loss of material in transport, especially if material is transported offsite.

[3] Chemical stabilisation is usually cost-effective for relatively long-term or semi-permanent unpaved roads.

4.5.3. Decommissioning phase

Revegetation of exposed areas for long-term dust and water erosion control is commonly used and is the most cost-effective option. The area should be re-vegetated as soon as the mining within the open pit stops. Plant roots bind the soil, and vegetation cover breaks the impact of falling raindrops, thus preventing wind and water erosion. Plants used for re-vegetation should be indigenous to the area, hardy, fast-growing, nitrogen-fixing, provide high plant cover, be adapted to growing on exposed and disturbed soil (pioneer plants) and should easily be propagated by seed or cuttings.

5. Conclusions

The air quality impact assessment undertaken for the Mopane Project includes a meteorological overview of the area. Meteorological data was obtained from the South African Weather Services for the period Jan 2008- Dec 2012. An emissions inventory was undertaken with the aim of quantifying emissions associated with the activities involved in the mining and processing of coal. The emissions for specific activities such as bulldozing, blasting, tipping, wind erosion and materials handling activities were calculate and the cumulative impacts were compared to the relevant ambient air quality standards to determine legal compliance.

The construction and operational phases were assessed. Based on the dispersion modelling simulations, the following conclusions can be summarised as follows:

- Construction impacts

The maximum predicted annual ground level concentration of PM_{10} resulting from all construction activities at the Jutland and Voorburg pit were estimated at 2.00E-01 µg/m^3. The maximum predicted daily concentration of PM_{10} was estimated at 0.2E-01 µg/m^3. Both the annual and the daily concentrations of Particulate matter fell below the annual and daily standard of 50 µg/m^3 and 120 µg/m^3 respectively. When compared to the stricter 2015 standards to be implemented, the maximum annual and daily limit of 40 µg/m^3 and 75 µg/m^3 were complied with.

- Operational phase

The maximum annual ground level concentration of PM_{10} for all operational activities was estimated at 7.00E +00 µg/m^3. The highest concentration of Particulate matter was attributed to the Pit activities such as bulldozing, drilling, material handling and tipping. Crushing activities such as primary, secondary and tertiary is not a major contributor to the emission of particulate matter and dust fallout. The Jutland pit recorded a maximum daily concentration of 3.00E+01, while the Voorburg pit activities recorded a maximum daily concentration of 2.00E+01. Both concentrations fell below the daily standard of 120 µg/m^3. When compared to the stricter standard to be implemented in 2015, the annual and daily concentration complied with the annual and daily limit of 40 µg/m^3 and 75 µg/m^3 respectively. The dust fall out concentration was highest at the mine pit. There were no exceedances of the 1200 mg/m^2/day limit for a non- residential site. The concentration at the mine boundary was estimated at 300 mg/m^2/day.

The impacts from dust fallout and Particulate matter can be reduced by implementing dust control measures. The highest intensity of the construction work should be carried out during the summer months and not over the harsh winter months as can result in increased dispersion of fugitive dust. The Mopane mine should ensure that unpaved roads are continuously watered and treated with dust-a-side products to reduce the volume of fugitive dust emitted from unpaved roads. The use of wind screens on open ground surfaces during periods of extreme windy conditions.

Overall the impacts arising from the mining activities at both the Jutland and Voorburg area are within the ambient air quality standards.

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Appendix A - Stuart Thompson CV

CURRICULUM VITAE

Name of Firm:	**Royal HaskoningDHV**		
Name of Staff:	Stuart John Thompson		
Profession:	Environmental Scientist		
Date of Birth:	07/11/1981		
Years of Experience:	12	**Nationality:**	South African

Professional Registrations and Institutional Memberships:
Society South African Geographers,
South African Geophysical Association, M07/007
National Association for Clean Air,
Air Pollution Information Network - Africa, Life time Membership
Astronomical Society for SA, Committee Member, THO003

Key Qualifications:
Stuart Thompson is a senior environmental consultant for SSI Engineers and Environmental Consultants, and a specialist in the field of air quality assessments. Qualified as an Applied Environmental Scientist (BSc. Hons) from the University of Natal in 2004. He is currently a Member of the South African Geophysical Association (SAGA) as well as the Society of South African Geographers (SSAG), Stuart has 8 years experience in the environmental field, including 6 years in the field of air quality. He has managed and contributed to a variety of project in South Africa, as well as further afield on the African Continent, including Tanzania, Malawi, DRC, Mozambique, Mauritius, Swaziland and Botswana on assessment ranging from large-scale commercial developments and Power Generation Projects to numerous mining operations. Stuart spent 6 months working with the SSI parent company DHV B.V. based in Amersfoort, Netherlands. During this time he worked on several projects for the Europe Union, as well as acting as a specialist technical advisor for a large scale environmental project in India.

Education:

2004	BSc (Hons), Environmental Science, University of Natal, South Africa
2003	BSc, Geography - Environmental Science, University of Natal, South Africa

Employment History:

2012 to date	**Royal HaskoningDHV** formerly SSI Engineers and Environmental Consultant (Pty) Ltd, South Africa Associate, Senior Air Quality Specialist
2007 to 2012	**SSI Engineers and Environmental Consultant (Pty) Ltd, South Africa** Senior Air Quality Specialist
2006 to 2007	**SiVest SA (Pty) Ltd** Project Planner
2006	**University of KwaZulu-Natal, Pietermaritzburg, South Africa** Part time lecturer for Climatology to second year and honours students

2005 to 2006 **Simpson Ryder & Associates**
Air Quality Specialist

2003 to 2005 **Department of Agriculture and Environmental Affairs**
EIA Auditor

Employment Experience:

2012 **Environmental Impact Assessment (EIA) and Waste Management Licence for the Matimba Ash Disposal Facility, Johannesburg, South Africa**

Client: Eskom Holdings SOC Limited

Position: Specialist

Brief Description: Environmental Impact assessment and waste management license for Matimba ash disposal facility.

Assigned Tasks: Air quality

Project Value: R3,430,630.00

Services Value: R660,552.10

Project Number: E02.JNB.001222

2012 **Waste Management License and Atmosphere Emissions License for an Animal Incinerator, , South Africa**

Client: NSL Distributors CC

Position: Specialist

Brief Description: SSI was appointed by the JV of NSL Distributors and Plumbing Sewage Solutions to conduct an Air Quality Impact Study (required for the Emission Licence application) and obtain a Waste Management Licence for animal carcass incinerator, located in Middledrift in the Eastern Cape.

Assigned Tasks: Air Quality Impact Assessment specialist report input and collation.

Project Value: R355,680.00

Services Value: R249,560.00

Project Number: E02.ELS.000006

2012 **Air Quality and Noise Assessment for Baobab Resources Tete Iron Ore Mine, Tete, Mozambique**

Client: Coffey Environmental Australia (Pty) Ltd

Position: Project Manager

Brief Description: Coffey Environments has requested that SSI provide a quotation for an Air Quality and Noise Impact Assessment for a proposed iron ore mine in Mozambique. The proposed project covers an area of 632 km2 and is located immediately north of the provincial capital of Tete and shares licence boundaries with Vale and Riversdale's mega coal projects. The project is strategically located to access abundant, low tariff hydro-electric power from existing and developing schemes on the Zambezi River. The ports of Beira and Nacala are being refurbished, as are all the corridors through to Tete.

Assigned Tasks: Project Manager, Air Quality Assessment and Air Quality Specialist input into report.

Project Value: R132,000.00

Services Value: R52,300.00

Project Number: E02.JNB.001050

2012 **Sebilo Perth Mine, Hotazel, South Africa**

Client: Sebilo Resources (Pty) Ltd

Position: Project Principal, Project Manager

Brief Description: Irene Lea Environmental and Hydrogeology (iLEH) has appointed SSI to conduct an Air Quality and Noise Impact Assessments for their Sebilo Perth Mine located near Hotazel in the Northern Cape.

Assigned Tasks: Quality controller and final reviewer
Project Management, Report compilation and Air Quality Assessment.

Project Value: R109,200.00

Services Value: R122,400.00

Project Number: E02.JNB.001203

2011 **Air and Water Quality Assessment for Maputo Coal Terminal, Maputo, Mozambique**

Client: Hatch Africa (Pty) Limited

Position: Project Manager

Brief Description: Air Quality and Water Quality work specific work with specific reference to enable Grinrod to extend these into monitoring programme prior to construction as well as into the future phases.

Assigned Tasks: Air Quality Monitoring

Project Value: R116,945.00

Services Value: R139,297.66

Project Number: E02.JNB.001055

2011 **Ghanzi Copper-Silver Mine, Northern Botswana, Botswana**

Client: Loci Environmental (Pty) Ltd

Position: Project Manager

Brief Description: Air Quality Impact Assessment for the proposed Hana Silver and Copper Mine in Ghanzi, Botswana.

Assigned Tasks: Overall Project Management and quality control Final review of the report, as well as technical support for emission inventory development.

Project Value: R158,848.00

Services Value: R127,552.75

Project Number: E02.JNB.000851

2011 **Tivani Iron Mine Limpopo Air Quality Impact Assessment (AQIA), Tzaneen, South Africa**

Client: Jacana Environmental cc

Position: Project Principal, Project Manager

Brief Description: Air Quality Impact Assessment (AQIA) for input to an Environmental Impact Assessment required for an Iron Mine in Tzaneen, Limpopo Province

Assigned Tasks: Responsible for the quality control of the project. Overall Project Management and quality control

Project Value: R98,850.00

Services Value: R69,720.00

Project Number: E02.JNB.000678

2011 **Environmental and Social Impact Study (ESIA) for Envelor Lda in Mozambique, , Mozambique**

Client: Envalor Lda

Position: Specialist

Brief Description: Appointed to obtain environmental authorisation to develop plantations, generate electricity and produce Ethanol from sugarcane and sweet sorghum, as well as the production of food corps.

Assigned Tasks: Air Quality Study - Specialist

Project Value: R2,535,604.48

Services Value: R841,236.96

Project Number: E02.JNB.000900

2010 **Coal to gas conversion for Rosslyn Brewery, Pretoria, South Africa**

Client: SAB Miller South Africa

Position: Project Manager

Brief Description: This will entail the establishment of emissions inventory identifying pollutants from both point and fugitive emissions sources. Levego CC will be undertaking the sampling of stacks at the site with ambient and fugitive emissions monitoring being undertaken by SSI.

Assigned Tasks: Monitoring, Modelling and Emissions Inventory Development.

Project Value: R190,228.00

Services Value: R102,300.00

Project Number: E02.JNB.000849

2010 **EIA for the Gas Plant Upgrade at the Coke battery within the ArcelorMittal PTA Works, , South Africa**

Client: Arcelor Mittal (Pty) Ltd

Position: Specialist

Brief Description: ArcelorMittal South Adrica (AMSA) proposes to undertake the necessary environmental studies to obtain environmental authorisation for the proposed Pretoria Gas Plant as the Coke Battery within the AMSA Pretoria Works Premises.

Assigned Tasks: Compilation of Air Quality Impact Assessment Report. Undertake emission calculations, dispersion modelling and baseline characterisation.

Project Value: R308,857.00

Services Value: R191,227.50

Project Number: E02.PTA.000305

2010 **Olifants River Air Monitoring, , South Africa**

Client: Aurecon South Africa (Pty) Ltd

Position: Environmentalist, Project Manager

Brief Description: Undertake and air quality baseline assessment for the length of a 200 km water pipeline in the Steelpoort Area. Monitoring will focus on PM10 sampling and dust dallout sampling.

Assigned Tasks: Will project manage the monitoring aspects of the project which will include the setup and maintenance of the PM10 monitors and will assist with report compilations Overall Project Management and quality control

Project Value: R864,410.00

Services Value: R315,720.00

Project Number: E02.JNB.000800

2010 **La Mercy Air Quality Monitoring, La Mercy, South Africa**

Client: Airports Company South Africa

Position: Specialist

Brief Description: Air Quality Monitoring to determine baseline conditions in order to produce a monitoring strategy and management plan for the La Mercy International Airport.

Assigned Tasks: Monitoring

Project Value: R180,000.00

Services Value: R163,759.00

Project Number: E02.JNB.000700

2009 **Air Quality Baseline Assessment for inclusion in an Environmental Management Plan for the installation of a water pipeline at Komati, Witbank, South Africa**

Client: AECOM SA (Pty) Ltd

Position: Project Manager

Brief Description: Air Quality Impact Assessment for the construction of new Water pipeline for Duhva Power Station

Assigned Tasks: Overall Project Management and quality control

Project Value: R87,340.00

Services Value: R66,100.00

Project Number: E02.JNB.000531

2009 **Air Quality Impact Assessment for the Bio-ethanol Plant in Mozambique, , Mozambique**

Client: Coastal and Environmental Services (CES)

Position: Project Manager

Brief Description: Air Quaility Impact Assessment for the proposed Bio-ethanol production facility and power generation unit to be build in Mozambique.

Assigned Tasks: Specialist Studies - Air Quality Impact Assesment and report compilation, and overall project management duties.

Project Value: R80,640.00

Services Value: R90,572.50

Project Number: E02.JNB.000498

2009	**Bioethanol Mozambique, , Sierra Leone**

Client: Coastal and Environmental Services (CES)

Position: Project Manager

Brief Description: Air Assessment for the Bio-ethanol production facilit and power generation unit to be built in Sierra Leone

Assigned Tasks: Impact assessment and report compilation

Project Value: R80,640.00

Services Value: R80,212.50

Project Number: E02.JNB.000499

2009	**Nampula Brewery, , Mozambique**

Client: DHV Mozambique

Position: Specialist

Brief Description: Appointed by SEED to undertake an air quality impact assessment for the EIA to be undertaken for the Nampula Brewery project. SEED was appointed by CES to facilitate the submission of an EIA for the project. The work SEED was to undertaken included liaison with the authorities, the undertaking of a traffic impact assessment, an air quality impact assessment and the public consultation during the EIA process.

Assigned Tasks: Compilation of air quality impact assessment report. Undertake emission calculations, dispersion modelling and baseline characterisation.

Project Value: R37,500.00

Services Value: R37,500.00

Project Number: E02.JNB.000486

Appendix B – Nicole Singh CV

CURRICULUM VITAE

Name of Firm: **Royal HaskoningDHV**

Name of Staff: Nicole Singh

Profession: Environmental Scientist

Date of Birth: 25/02/1988

Years of Experience: 3 **Nationality:** South African

Nicole Singh is currently working as an Environmental consultant for Royal HaskoningDHV. Qualified with a BSc degree in Biological sciences from the University of Kwa Zulu Natal in 2009. Being extremely analytical and technically minded, this career path suited her well. Nicole worked as a nutrient analyst (laboratory assistant) for the School of Biological and Conservation Sciences, University of Kwa-Zulu Natal from June 2009 till June 2010. Her main role involved statistically analyzing all nutrient water samples for chemicals such as phosphate, silicate, nitrate, nitrite and ammonium for national leading institutes such as UKZN, UCT, ACEP (African coelomate ecosystem project) and ORI (Oceanographic research institute). Nicole then went on to work as a Specialist in Environmental Air Quality for SGS. Her main responsibilities were managing air quality projects for clients such as SASOL, Eskom, Anglo- American, Anglo Coal and RPM.

Education:	
2010	BSc Biological Science, University of Kwa Zulu Natal, South Africa

Employment History:

2013 (April) — **Royal HaskoningDHV, South Africa**
Environmental Consultant

2012 (August – April 2013) — **Royal HaskoningDHV, South Africa**
Junior Air Quality Specialist

2011 (November – August 2012) — **SGS**
Specialist: Ambient reporting and client liaison

2011 (July – November) — **SGS**
Junior specialist: Ambient reporting and client liaison

2010-2011 — **University of KwaZulu-Natal, Westville, South Africa**
Nutrient analyst

Employment Experience:

2013 **EON Consulting Busby Renewable Energy project, South Africa**

Client: Farmsecure

Project Value: R40, 000.00

Brief Project Description: It is our standing that the air quality aims to assess the baseline environmental impacts associated with construction operational and decommissioning of the proposed biomass combustion plant located in Amsterdam Mpumalanga.

- Position: Project Manager
- Assigned Tasks: Fatal flaw assessment
- Project Number : I10.JNB.400005

2013 **Eon Consulting Lazy Bend AQ, South Africa**

Client: Farmsecure

Project Value: R40, 000.00

Brief Project Description: It is our standing that the air quality aims to assess the baseline environmental impacts associated with construction operational and decommissioning of the proposed biomass combustion plant located in Amsterdam Mpumalanga

- Position: Project Manager
- Assigned Tasks: Fatal flaw assessment
- Project Number :I10.JNB.400006

2013 **Verref Landfill Air Quality Impact Assessment**

Client: AECOM SA (Pty)Ltd

Project Value: R 72, 380.00

Brief Description: Air Quality Impact assessment and buffer zone delineation for a general waste disposal site. The study was aimed at assessing the potential environmental impacts associated with the gaseous and particulate emissions released from the proposed general waste disposal site in Springs.

- Position : Project Manager
- Assigned Tasks: Air Quality Specialist
- Project Number: I10.JNB.400004

2012 **Appointment of professional services: Development of an environmental pollution control plan, South Africa**

Client: Amathole District Municipality

Project Value: R395,260.00

Brief Description: Development of a pollution plan for the Amathole District Municipality.

- Position: Air Quality Specialist
- Assigned Tasks: Technical input – Air Quality
- Project Number: E02.ELS.000030

2012 **GGV Air Quality Impact Assessment**

Client: Jacana Environmentals CC

Project Value: R 80,050.00

Brief Description: Air Quality Impact assessment for an Environmental Impact assessment for a Coal Mine, located in Mpumalanga.

- Position: Project Manager and Specialist
- Assigned Tasks: Air quality specialist, EIA and modelling

E02.JNB.001293

2012 **Komati Power Station S24G Rectification Application Ash Dam, South Africa**

Client: Iliso Consulting (Pty)Ltd

Project Value: R 65,200.00

Brief Description: The project entails the assessment of several unauthorised activities which have begun at the Komati Power Station near Middelburg. The project would therefore involve an air quality impact assessment to provide specialist input into the S24G rectification application.

- Position: Air Quality Specialist
- Assigned Tasks: Technical input – Air Quality
- Project Number: E02.JNB.001285

2012 **Meyerton Waste Water Treatment Works (Air Quality Assessment), South Africa**

Client: MSA Group Services

Project Value: R 86,400.00

Brief Description: Air Quality Impact Assessment and a determination of the Buffer Zone Study for the Meyerton Waste Water Treatment Works.

- Position: Project Manager and Specialist
- Assigned Tasks: Air quality specialist, EIA and modelling
- E02.JNB.001280

2012 **Western Cape State of Environment Report (SOER)**

Client: Western Cape Department of Environmental Affairs and development planning.

Project Value: R 938,200.00

Brief Description: Compilation of the First update of the state of environment for the Western Cape province.

- Position: Air Quality Specialist
- Assigned Tasks: Air quality specialist
- E02.CPT.000330

2012 **Waste Management License and Atmospheric emissions license for an Animal carcass incinerator, South Africa**

Client: NSL Distributors CC

Project Value: R 355,680.00

Brief Description: Royal HaskoningDHV was appointed by the JV of NSL Distributors and Plumbing Sewage Solutions to conduct an Air Quality Impact Study (required for the Emission Licence application) and obtain a Waste Management Licence for animal carcass incinerator, located in Middledrift in the Eastern Cape.

- Position: Air Quality Specialist
- Assigned Tasks: Technical input – Air Quality Modelling and AEL application
- Project Number: E02.ELS.000006

2012 **Environmental Assessment services and water use license application for the proposed BRT line 1, South Africa**

Client: A-M Consulting Engineers (Pty) Ltd

Project Value: R551, 250.00

Brief Description: Appointment for conducting all the General Environmental Assessment Services and Public Participation Process work related to the managing the process in obtaining the required environmental authorisation and Water Use Licence for the relevant authorities, for the proposed BRT Line.

- Position: Environmental Consultant
- Assigned Tasks: Support during the Public participation process
- E02.JNB.001167

2012 **Environmental Impact assessment for the Sasol Secunda Growth programme 1B Proposed retrofitting of Gas turbines, South Africa**

Client: Sasol Technology (Pty)Ltd

Project Value: R 302,175.00

Brief Description: Environmental Impact Assessment for the Sasol Secunda Growth

Programme 1B.

- Position: Air Quality Specialist
- Assigned Tasks: Technical input – Air Quality Modelling and AEL application

Project Number : E02.PTA.000407