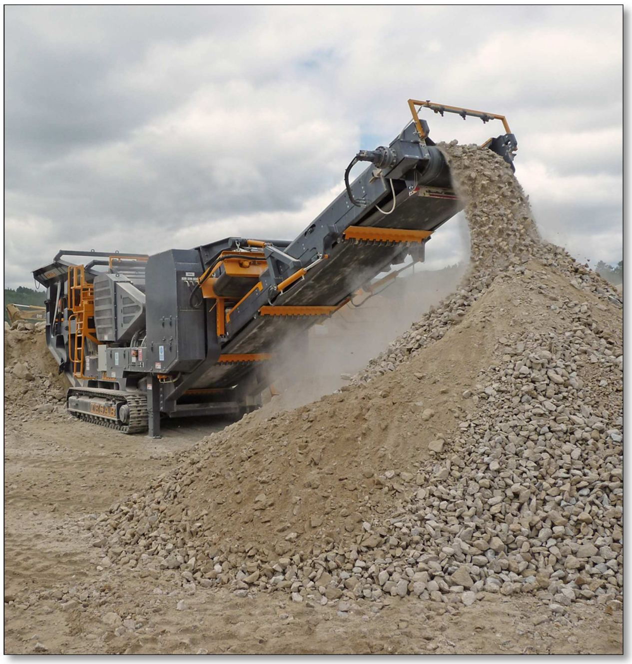

Air Quality Impact Assessment for the Proposed Makwase Crusher Plant near Marikana

As required by the NEMA Act and EIA 2014 regulations

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2017/11/15	VJA_1705 Makwase_Crusher AQIA_Report_2017_11_13_Rev0.docx.docx		

EXECUTIVE SUMMARY

Bobolele Consulting has appointed VJ Air Modelling Services to conduct a screening-level Air Quality Impact Assessment for the proposed development of a mobile crushing plant near Marikana in the North West Province. As such, this assessment evaluates the potential air quality impacts of the proposed crushing plant on the surrounding residential receptors.

As part of the Air Quality Impact Assessment for the proposed Makwase Mobile Crushing Plant, a baseline assessment is undertaken through a review of available meteorological and ambient air quality monitoring data. The potential impact of emissions from the proposed operational activities associated with the crushing plant on the surrounding environment is evaluated through the compilation of an emissions inventory and subsequent dispersion modelling simulations using SCREEN3 model. Comparison with the National Ambient Air Quality Standards is made to determine compliance in terms of potential human health impacts.

An overview of the prevailing meteorological conditions of the surrounding area was undertaken using meteorological data recorded at Anglo Platinum's Klipfontein meteorological station for the period January to December 2008 and weather data obtained from the meteorological data modelled by SAWS (Unified Model) for the period January 2009 to December 2011.The United States Environmental Protection Agency (USEPA) and Australian Government National Pollutant Inventory (NPI) emission factors were utilised to estimate particulate matter with aerodynamic diameters of less than 2.5 micron ($PM_{2.5}$), particulate matter with aerodynamic diameters of less than 10 micron (PM_{10}) and total suspended particulate (TSP) emissions from the proposed crushing plant. A Level 1 (screening) dispersion model, SCREEN3, was applied to predict the extent and magnitude of particulate concentrations during the operational phase. SCREEN3 is a Tier 1 model recommended in The Regulations Regarding Air Dispersion Modelling published in Government Notice 533 of 2014 (Government Gazette 37804, page 9, 10) and was considered applicable for this assessment. Comparison of predicted concentrations was made against the relevant National Ambient Air Quality Standards (NAAQS) to determine compliance. It is important to note that TSP was qualitatively quantified but was not considered further in the assessment as dust deposition cannot be determined using a Level 1 model.

Results from the screening dispersion modelling simulations indicate that:

- Maximum $PM_{2.5}$ concentrations are predicted to be compliant with the National 24-hour and annual average standards of 40 µg/m^3 and 20 µg/m^3, respectively. For both scenarios, the highest predicted $PM_{2.5}$ concentrations occurred at a distance of approximately 23 m from the facility.
- Maximum PM_{10} concentrations are predicted to be compliant the National 24-hour and annual average standards of 75 µg/m^3 and 40 µg/m^3, respectively, with the exception of the uncontrolled 24-hour averaging period, which is exceeding the 24-hour average standard. For both scenarios the highest predicted PM_{10} concentrations occurred at a distance of approximately 23 m from the facility.
- 24-hour average $PM_{2.5}$ concentrations at the closest residential receptor, Piet Retief/President van Rensburg school, which is located 1.5 km away from the facility were predicted to be 0.17 µg/m^3 and 0.15 µg/m^3 for the uncontrolled and controlled scenarios, respectively. Annual average $PM_{2.5}$ concentrations at Piet Retief/President van Rensburg school were predicted to be 0.03 µg/m^3 and 0.03 µg/m^3 for the uncontrolled and controlled scenarios, respectively.

- 24-hour average PM_{10} concentrations at Piet Retief/President van Rensburg school were predicted to be 28.8 µg/m^3 and 10.1 µg/m^3 for the uncontrolled and controlled scenarios, respectively. Annual average PM10 concentrations at Piet Retief/President van Rensburg school were predicted to be 1.26 µg/m^3 and 0.51 µg/m^3 for the uncontrolled and controlled scenarios, respectively.

As such, PM concentrations at the closest residential receptor and beyond are expected to be low and are compliant with their respective NAAQS for both scenarios.

It is important to note that SCREEN3 model predictions are inherently conservative and reflect the highest possible ground-level concentrations based on worst-case meteorological conditions. In reality, such conditions and concentrations are unlikely to occur. In addition, emission estimations were based on a constant throughput of 780 000 tonnes/annum for each scenario, resulting in higher concentration predictions than would likely be the case in reality. As such, it is recommended that more refined emissions calculations and dispersion modelling simulations (Level 2) be undertaken once a detailed design basis becomes available to accurately assess the potential air quality impacts associated with the proposed development of the staged mobile crushing plant at the Makwase Crusher Plant.

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ABBREVIATIONS

AEL	Atmospheric Emission Licence
AQA	National Environment Management: Air Quality Act (Act No. 39 of 2004)
AQIA	Air Quality Impact Assessment
AP-42	Compilation of Air Pollutant Emission Factors
APPA	Atmospheric Pollution Prevention Act (Act 45 of 1965)
ASTM	American Society for Testing and Materials
BA	Basic Assessment
DEA	Department of Environmental Affairs
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
GN	Government Notice
km	Kilometre
km^2	Kilometre squared
m	Metre
m^2	Metre squared
MEC	Member of Executive Council
NAAQS	National Ambient Air Quality Standards
NDCR	National Dust Control Regulations
NEMA	National Environment Management Act, 1998 (Act 107 of 1998)
NFAQM	National Framework for Air Quality Management
NPI	National Pollutant Inventory
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter less than 2.5 microns in diameter
PM_{10}	Particulate Matter less than 10 microns in diameter
SANS	South African National Standards
SCREEN3	Gaussian plume model based on ISC3
TSP	Total Suspended Particulates
US EPA	United States Environmental Protection Agency
WHO	World Health Organisation

INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge, as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and VJ Air Modelling Services (Pty) Ltd and its staff reserve the right to modify aspects of the report including the recommendations if and when new information becomes available from ongoing research or further work in this field, or pertaining to this investigation.

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1. INTRODUCTION

Bobolele Consulting has been appointed by the Makwase Projects (Pty) Ltd as independent environmental practitioner (EAP), to facilitate the Basic Assessment (BA) process required in terms of the National Environmental Management Act (NEMA, Act 107 of 1998) for the proposed construction and operation of Crusher Plant on Portion 233 of the farm Kafferskraal 342 JQ within the Rustenburg Local Municipality.

Bobolele Consulting has appointed VJ Air Modelling Services to conduct a screening-level Air Quality Impact Assessment for the proposed development of a crushing plant near Marikana in the North West Province. As such, this assessment evaluates the potential air quality impacts of the proposed crushing plant on the surrounding residential receptors.

Ambient $PM_{2.5}$, PM_{10} and TSP are identified to be the key pollutants of concern from the proposed operations. This report provides a screening level assessment, using a Level 1 dispersion model SCREEN3, to predict the potential air quality impacts associated with the proposed crushing plant. SCREEN3 is a recommended model in The Regulations Regarding Air Dispersion Modelling, published in Government Notice 533 of 2014 (Government Gazette 37804), and is considered applicable for this assessment.

As part of the Air Quality Impact Assessment for the proposed Makwase Crushing Plant, a baseline assessment is undertaken through a review of available meteorological and ambient air quality monitoring data. The potential impact of emissions from the proposed operational activities associated with the crushing plant on the surrounding environment is evaluated through the compilation of an emissions inventory and subsequent dispersion modelling simulations using SCREEN3 model. Comparison with the National Ambient Air Quality Standards is made to determine compliance in terms of potential human health impacts.

1.1 TERMS OF REFERENCE

The scope of work for the Air Quality Impact Assessment for the Makwase Crushing Plant near Marikana is as follows:

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

1.2 OBJECTIVES OF THE STUDY

The main objective of the project is to determine the potential impact of emissions from the operational activities associated with the development and implementation of the mobile crushing plant on the surrounding environment.

1.3 OUTLINE OF THE REPORT

An overview of the site characteristics, including surrounding receptors is given in Section 2. National ambient air quality standards and associated health impacts for criteria pollutants are provided in Section 3. Description of identified air pollutants and their impacts on human health is given in Section 4. The local meteorological conditions influencing the dilution and dispersion of pollution in the area is described in Section 5. The existing ambient air quality is described in Section 6. The air quality impact assessment, comprising of an emissions inventory and dispersion modelling simulations, is given in Section 7. Conclusions, the report summary and recommendations are outlined in Section 8.

2. PROJECT BACKGROUND

2.1 PROJECT OVERVIEW

Makwase Projects (Pty) Ltd propose to develop a Crusher Plant on Portion 233 of the farm Kafferskraal 342 JQ within the Rustenburg Local Municipality and the Bojanala Platinum District Municipality of the North West Province (**Figure 1**).

The establishment phase will include the preparation of the area for stockpiles, next to the area that will host the mobile crushing plant. The plant will be moved from this location if and when needed. The establishment phase will therefore be limited to the preparation of the levelling of the area that the crushing plant will be located on, and the preparation of the footings of the plant.

The operational phase of the mobile crushing plant will involve the loading of delivered material from the adjacent Tharisa Mine into the primary crushing jaw, with the crushed material moving through the various stages of the plant to provide various aggregate sources as the market demands. It is likely, that the even though provision is made for a mobile plant on the site, the plant will not be moved regularly.

The various product produced by the crushing plant will be transported from the plant to the various product stockpiles within the surrounding area.

The decommissioning of the Makwase crushing plant will take place in conjunction with the decommissioning of the Tharisa mine at the end of the mine life. The plant will be demolished and moved off-site.

The National Environmental Management Act (NEMA) and the associated EIA regulations give effect to the requirement to assess all development activities that have been identified in the EIA regulations published under NEMA regulations.

Activities associated with the crushing have been identified as listed activities according to NEMA EIA 2014 Regulations.

2.2 LOCALITY AND STUDY AREA

Makwase Projects (Pty) Ltd propose to develop a Crusher Plant on Portion 233 of the farm Kafferskraal 342 JQ within the Rustenburg Local Municipality and the Bojanala Platinum District Municipality of the North West Province. The site is situated immediately to the north of the N4 Highway, adjacent to the Buffelspoort / Marikana off-ramp, just south of Tharisa mine (**Figure 2**).

Makwase Crusher plant is situated approximately 25 km east of Rustenburg and 5 km west of the town of Mooinooi. The site is surrounded by other small residential areas such as Thekane (15 km to the north-west), Rooikoppies and Wonderkoppies to the north and Makolokwe and Segwaelane to the north east. The Buffelspoort Dam and Lekkerrus holiday resort are situated 5 km to the south of the proposed site for the plant.

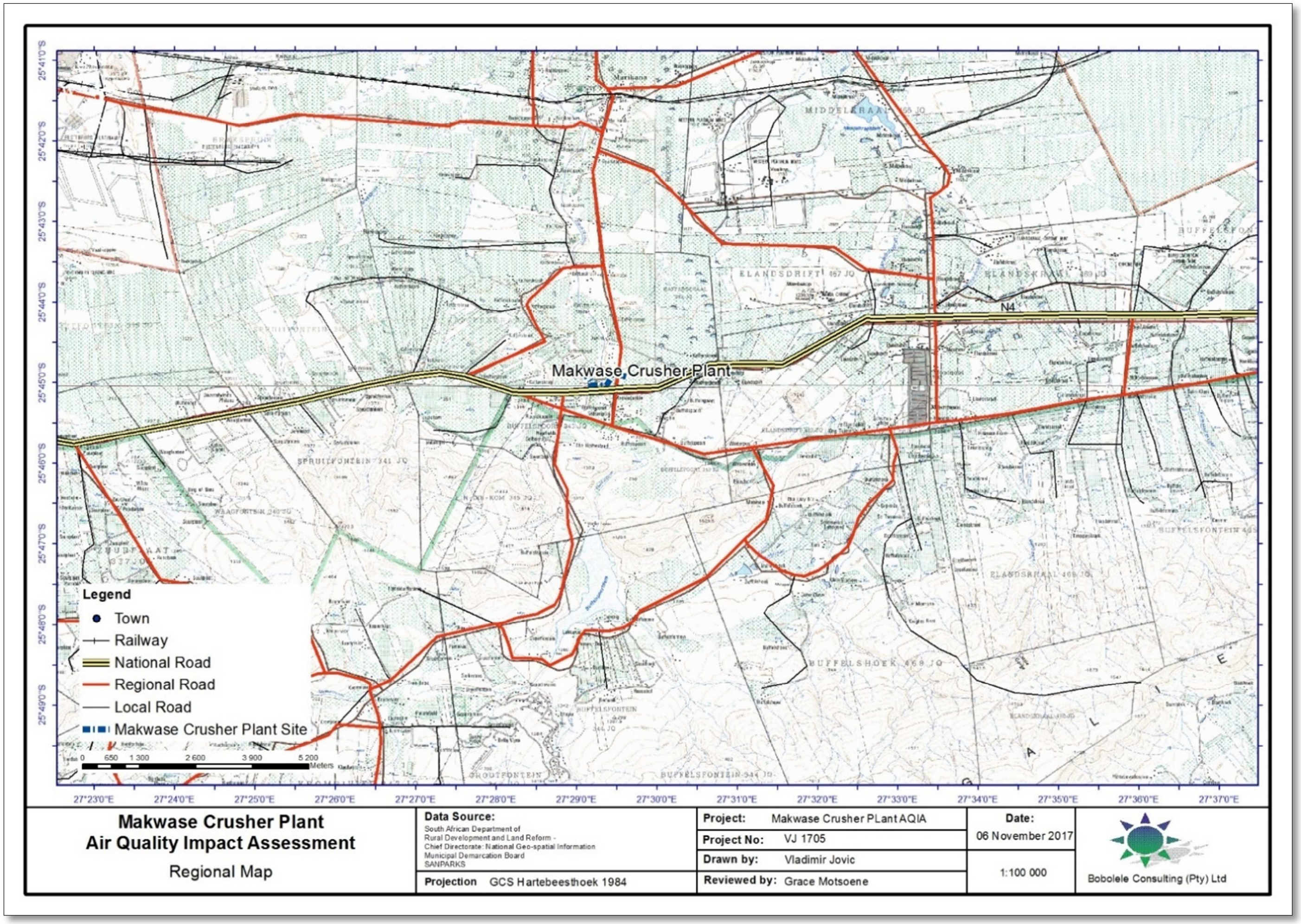

Figure 1: Regional map for Makwase Crusher Plant.

Figure 2: Makwase Crusher Plant – Local setting.

2.3 NAME OF PROPERTY

The property on which the proposed development is to take place belongs to Makwase Projects (Pty) Ltd. Surveyor general's (SG) code is: T0JQ00000000034200233, Kafferskraal 342, refer to **Table 1**. See **Figure 5** for farm portions and parcels in the immediate vicinity of the proposed site.

Table 1: Cadastral farm affected by the proposed activities.

FARM NAME	SG CODE
KAFFERSKRAAL 342	T0JQ00000000034200233

2.4 LOCAL AUTHORITY

The subject property is located within the jurisdiction of the Rustenburg Local Municipality in the Ward 32. The atmospheric emissions licensing authority also resides in the municipality.

2.5 TOPOGRAPHY

The Magaliesberg Mountain Range is among the oldest mountains in the world. It stretches for 120 km from the Bronkhorstspruit Dam, east of Pretoria, to Rustenburg in the west and separate the Highveld grasslands to the south from the bushveld savannah in the north.

The landscape consists largely of flat regions with scattered trees and grassland. The proposed site is located approximately 3.5 km north of the Magaliesberg range and lies within the valley of the Sterkstroom River that drains Buffelspoort Dam. The topography surrounding the proposed site is shown in **Figure 3**. The site is on average at 1206 m above sea level, with a general slope downwards towards the north. Significant topographical features, such as hills and mountains of the Magaliesberg Range that usually have a bearing on the wind flow patterns and dispersal of pollutants are located on the southern portion of the study area. Surrounding elevations range from approximately 1150 – 1550 metres above mean sea level.

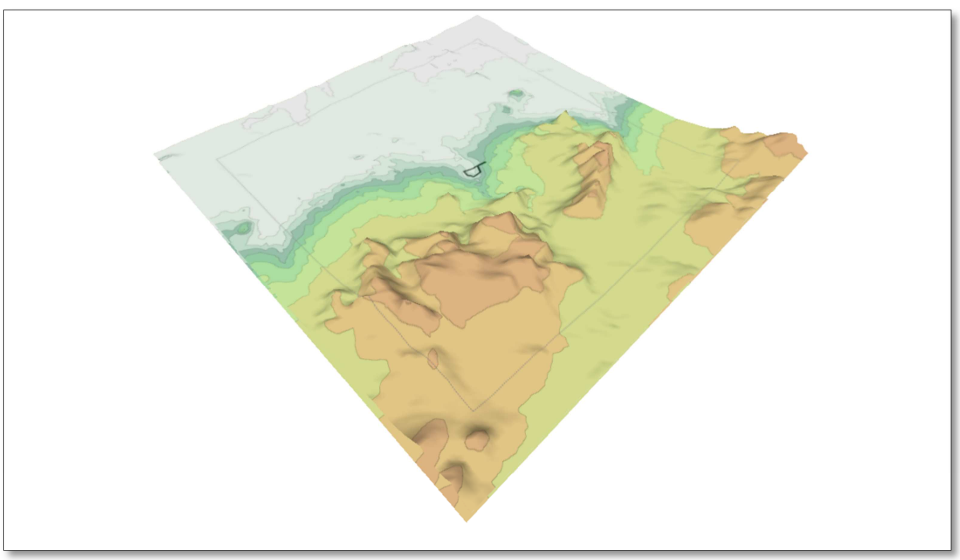

Figure 3: Topography surrounding the proposed crushing plant (the farm portion is depicted as black polygon.

2.6 PRESENT LAND USE

The proposed Makwase Crusher Plant site area is primarily surrounded by mining activity; however, there is cultivated land and residential settlements in relative proximity to the site. Further from the site there is large portion of land dedicated to conservation. The present land-use patterns are demonstrated in **Figure 6.**

2.7 SENSITIVE RECEPTORS

A sensitive receptor is defined as a person or place where involuntary exposure to pollutants released by the operational activities associated with the proposed Makwase Crusher Plant occurs. There are several sensitive receptors surrounding the proposed site.

The sensitive receptors nearest to proposed Makwase Crusher Plant are shown in **Figure 7**. Sensitive receptors in the vicinity of the proposed site boundary include the Madithlokwa/Silver City village and Tsilong village (in the north) and Piet Retief/President van Rensburg school and private dwellings/business (in the northwest). Lapologang village lies to the west of site. The Elandsdrift/Mamba settlement lies east of the site. Further away are Marikana to the north and Mooinooi to the east. Buffelspoort is located further to the south.

Table 2 presents potentially sensitive receptors surrounding the proposed Crusher Plant including school and various villages.

Table 2: Potential sensitive receptors situated within the modelling domain of proposed Makwase Crusher Plant.

RECEPTOR	LATITUDE (°S)	LONGITUDE (°E)	DIRECTION FROM SITE BOUNDARY	DISTANCE FROM SITE BOUNDARY (km)
Madithlokwa/Silver City	25.7253	27.48611	N	2.5
Mooinooi	25.7504	27.55014	E	6.1
Piet Retief/President van Rensburg School	25.7391	27.47679	NW	1.5
Lapologang Village	25.7378	27.46866	NW	2.3
Marikana	25.7008	27.47546	N	5.3
Buffelspoort	25.7899	27.48176	S	4.6
Tsilong Village	25.7261	27.47852	N	2.6
Elandsdrift	25.7240	27.54568	NE	6.4

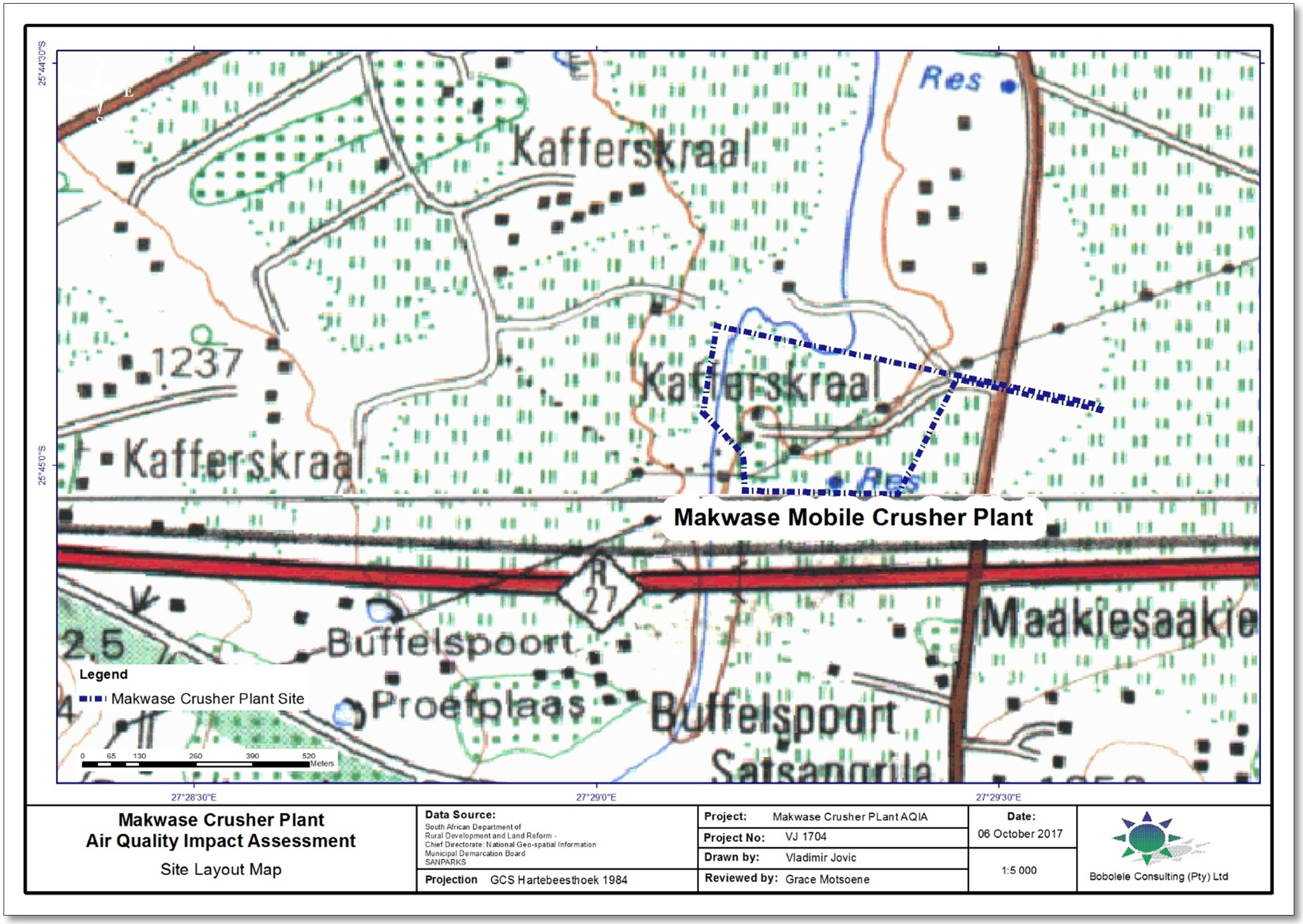

Figure 4: Study area and the immediate vicinity of proposed Makwase Crusher Plant (Blue line).

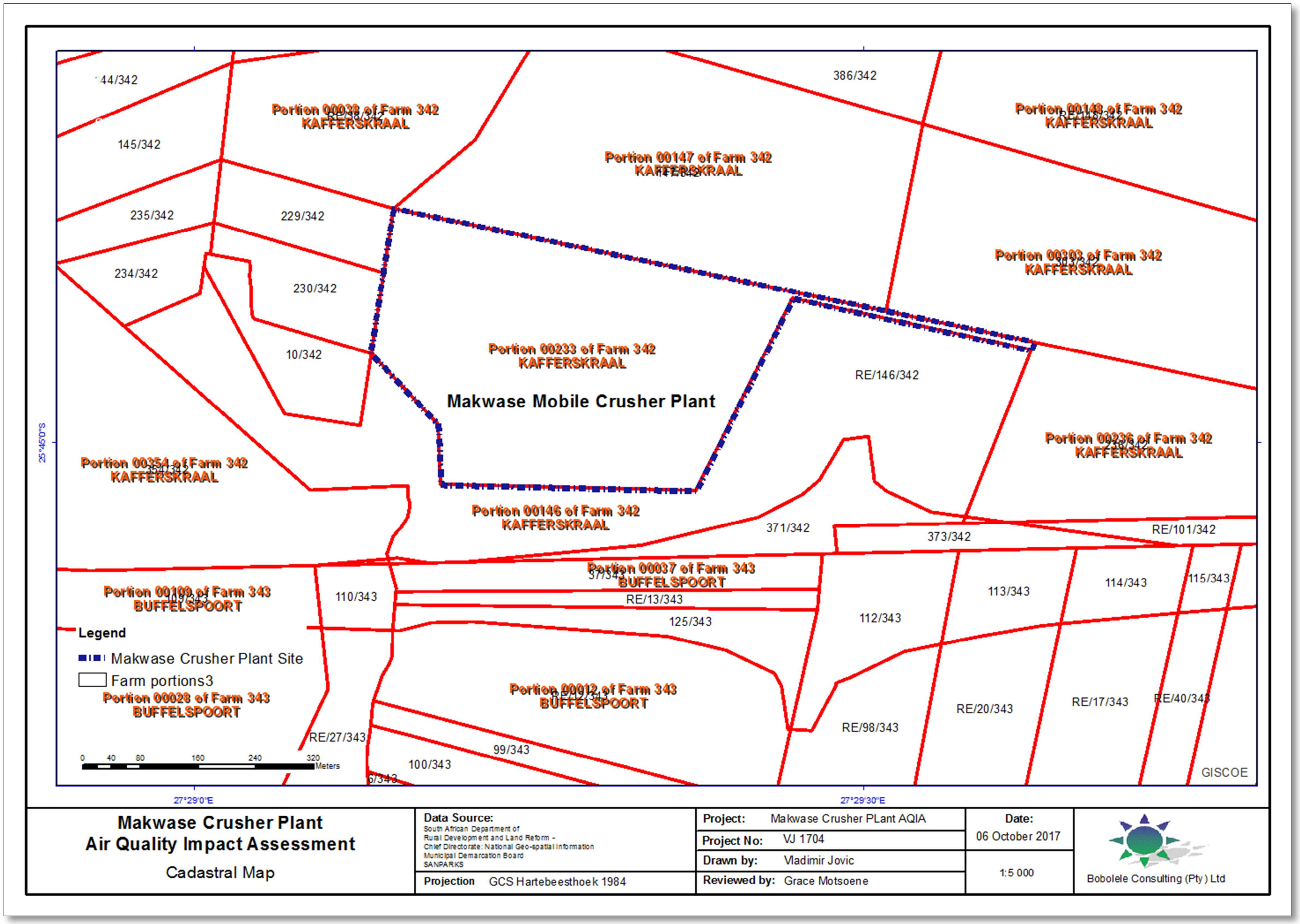

Figure 5: Cadastral map of immediate vicinity of proposed Makwase Crusher Plant (farm portions and parcels).

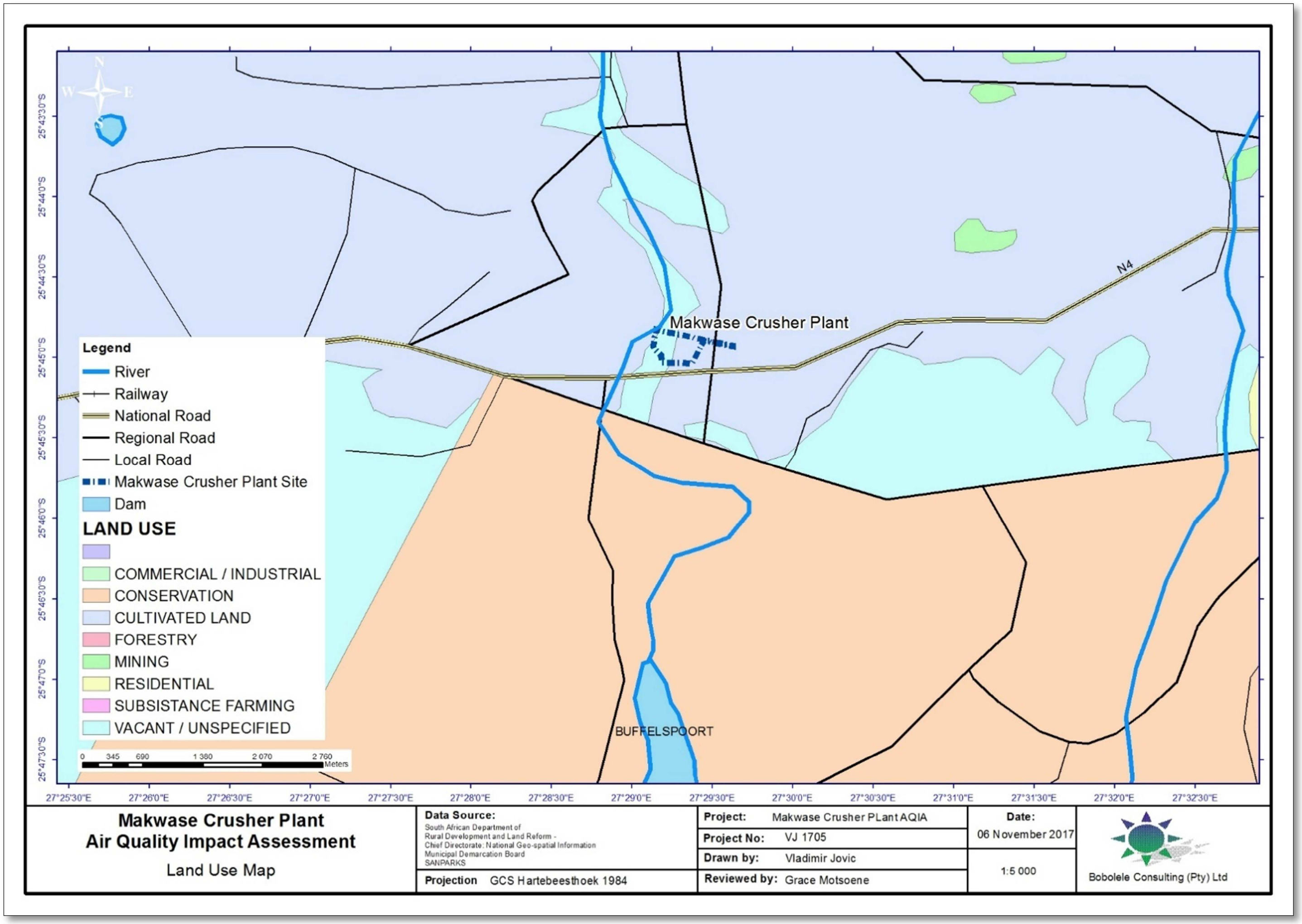

Figure 6: Surrounding land-use at the area in the vicinity of the proposed Makwase Crusher Plant.

Figure 7: Identified locations of sensitive receptors relative to proposed Makwase Crusher Plant.

3. AIR QUALITY FRAMEWORKS, LEGISLATION, REGULATIONS AND POLICIES

This section summarises the policy, legal, and administrative framework within which the AQIA will be carried out. This includes a summary of relevant South African regulations. In addition, this section introduces the regulatory authorities responsible for reviewing this Report.

3.1 2012 NATIONAL FRAMEWORK FOR AIR QUALITY MANAGEMENT IN THE REPUBLIC OF SOUTH AFRICA

The requirements for a National Framework on Air Quality Management in South Africa (NFAQM) are stipulated in section 7 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), herein after referred to as the AQA. The AQA requires the Minister, by notice in the Gazette, to establish a National Framework for achieving the objectives of the AQA. To this end, the minister published the First National Framework in 2007. As an inaugural framework, the 2007 framework was a less technical document that aimed at unpacking the AQA in some detail to ensure that all South Africans understand the intentions of the AQA. The provisions for the review of the National Framework are given in section 7 (5)(b) of the AQA which states that the framework must be reviewed by the Minister at intervals of not more than five years. Thus, the National Framework was reviewed in 2012 which led to the development of 2012 National Framework for Air Quality Management in the Republic of South Africa.

The Air Quality Act of South Africa is pivoted on the Bill of Rights contained in the Constitution of South Africa. The Bill enshrines the rights of all people in the country and affirms the democratic values of human dignity, equality and freedom. The state must respect, protect, promote and fulfil the rights in the Bill of Rights.

Section 24 of the Constitution states that everyone has the right:

- To an environment that is not harmful to their health or well-being; and
- To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –
  - prevent pollution and ecological degradation;
  - Promote conservation; and
  - Secure ecologically sustainable development and the use of natural resources while promoting justifiable economic and social development.

In order to give effect to this right in the context of air quality, it is necessary to ensure that levels of air pollution are not harmful to human health or well-being. It follows that the setting of ambient air quality standards is necessary, as well as mechanisms to ensure that ambient air quality standards are achieved and maintained. Hence, the AQA provides an objectives-based approach to the management of air quality at different governance and operational levels and is the legislative means to ensuring that the rights described above are upheld. Therefore, in implementing the AQA it is necessary to ensure that there is clarity on governance and technical objectives so air quality management measures are implemented in a cohesive, coherent and uniform manner that ensures the most benefit for the least cost through efficient and effective use of resources.

The purpose of the National Framework, is to achieve the objectives of the AQA, and as such the National Framework provides a medium- to long-term plan of the practical implementation of the AQA.

The framework must provide mechanisms, systems and procedures to promote holistic and integrated air quality management through pollution prevention and minimisation at source, and through impact management with respect to the receiving environment from local scale to international issues. Hence, the National Framework provides norms and standards for all technical aspects of air quality management.

Section 7(1) of the AQA requires the National Framework to include the following:

- Mechanisms, systems and procedures to -
  - attain compliance with ambient air quality standards;
  - give effect to the Republic's obligations in terms of international agreements;
- National norms and standards for
  - the control of emissions from point and non-point sources;
  - air quality monitoring;
  - air quality management planning;
  - air quality information management; and
- Any other matter which the Minister considers necessary for achieving the object of the AOA.

Section 7(2) of the AQA requires that the norms and standards established in the National Framework are aimed at ensuring:

- Opportunities for public participation in the protection and enhancement of air quality;
- Public access to air quality information;
- The prevention of air pollution and degradation of air quality;
- The reduction of discharges likely to impair air quality, including the reduction of air pollution at source;
- The promotion of efficient and effective air quality management;
- Effective air quality monitoring;
- Regular reporting on air quality; and
- Compliance with the Republic's obligations in terms of international agreements.

The National Framework, in terms of Section 7(3) of the AQA:

- binds all organs of state in all spheres of government; and
- may assign and delineate responsibilities for the implementation of the AQA amongst:
  - The different spheres of government; and
  - Different organs of state.

3.2 NATIONAL ENVIRONMENT MANAGEMENT: AIR QUALITY ACT

The prevailing legislation in the Republic of South Africa with regards to the Air Quality field is the National Environment Management: Air Quality Act (Act No. 39 of 2004) (NEM: AQA). The

AQA serves to repeal the Atmospheric Pollution Prevention Act (45 of 1965) (APPA) and various other laws dealing with air pollution.

According to the Act, the then Department of Environment Affairs and Tourism (now the Department of Environmental Affairs) (DEA), the provincial environmental departments and local authorities (district and local municipalities) are separately and jointly responsible for the implementation and enforcement of various aspects of AQA. Each of these spheres of government is obliged to appoint an air quality officer and to co-operate with each other and co-ordinate their activities through mechanisms provided for in the National Environment Management Act, 1998 (Act 107 of 1998) (NEMA).

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

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

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

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

A fundamental aspect of the new approach to the air quality regulation, as reflected in the AQA, is the establishment of National Ambient Air Quality Standards (NAAQS). These standards provide the goals for air quality management plans and also provide the benchmark by which the effectiveness of these management plans is measured. The AQA provides for the identification of priority pollutants and the setting of ambient standards with respect to these pollutants.

The Act ensures that air quality planning is integrated with existing activities. The implications of this are that plans that are required in terms of the NEMA must incorporate consideration of air quality. In addition, Integrated Development Plans (IDP's) developed by local and district municipalities, also have to take air quality into account.

The Act describes various regulatory tools that should be developed to ensure the implementation and enforcement of air quality management plans. These include:

- Priority Areas, which are air pollution 'hot spots';
- Listed Activities and Minimum Emission Standards1, under Section 21 of the AQA which are 'problem' processes that require an Atmospheric Emission Licence (AEL) in order to operate;
- Controlled Emitters, which includes the setting of emission standards for 'classes' of emitters, such as motor vehicles, incinerators, etc., as well as controlled fuels;
- Control of Dust;

[1] Minimum Emission Standards are the highest emission standards at which a Listed Activity will be allowed to operate under normal working conditions. If a definition of the process operated on the plant is matching the process description under established Listed Activities, the plant operates a Listed Activity and it must then be in possession of an Atmospheric Emission Licence indicating the specific Listed Activity(s) operated on the facility. Not only must the plant be in possession of an Atmospheric Emission Licence, it must also comply with the conditions within the licence to comply with AQA.

- Control of Noise; and
- Control of Odours.

In order to facilitate implementation of and compliance with the AQA, the Act provides for government to turn down AEL Licence applications from applicants who have a problematic record of air quality management practices. It also provides for government to demand that 'problem' industries appoint qualified air quality practitioners.

The Act also deals with South Africa's international obligations in terms of air quality management. Provision is made for the control of processes impacting on South Africa's neighbours and the global atmosphere in general, as well as trans-boundary air pollution.

The Act further regulates the establishment of the National Framework for Air Quality Management (NFAQM). The Framework was published in September 2007 and under its provisions was amended in 2012 and published in 2013.

The Act as a whole is defined by the adoption of a comprehensive approach to the management of offences and penalties, which includes the provision of transitional arrangements. The Act provides for flexibility and proactive approach, so that permissible emission limits can be amended on a progressive basis in order to achieve set air quality standards. As a consequence, the AQA came into full effect only on 1 April 2010. Certain sections of the Act came into force on 11 September 2005, but the Minister excluded other sections until such time as local authorities had the capacity and skills to deal with the implementation of the legislation. Significantly, many of the excluded sections related to listed activities and licensing of listed activities. The excluded sections were brought into effect on the 31 March 2010, and the old Atmospheric Pollution Prevention Act (APPA) of 1965 was fully repealed on the same date.

The Act also required the Minister or the Member of Executive Council (MEC) to identify and publish activities which result in atmospheric emissions that require an AEL before they can operate. 1 April 2010 also marked the date when the new list of activities requiring AEL to operate was promulgated and, with this, the levelling of the atmospheric emission "playing field" through the setting of minimum emissions standards for all these listed activities was implemented.

Government Notice 248 (GN248:2010) established and identified activities which result in atmospheric emissions for which an AEL must be obtained before operation can take place. The Minister amended the list of activities in November 2013.

The amended list of activities was published in terms of Section 21(1)(b) of AQA as a 'list of activities which result in atmospheric emissions which have or may have a significant detrimental effect on the environment, including health, social conditions, economic conditions or cultural heritage' (GN893:2013, GG37054, 22 November 2013).

GN893:2013 lists the ten main categories, each with its associated subcategories (more detailed description of the exact activities and minimum emission standards), for which an AEL needs to be obtained. The main categories include:

- Combustion Installations;
- Petroleum Industry, the production of gaseous ad liquid fuels as well as petrochemicals from crude oil, coal, gas or biomass;
- Carbonization and Platinum Gasification;
- Metallurgical Industry;
- Mineral Processing, Storage and Handling;
- Organic Chemicals Industry;

- Inorganic Chemicals Industry;
- Thermal Treatment of Hazardous and General Waste;
- Pulp and Paper Manufacturing Activities, including By-Products Recovery;
- Animal Matter Processing.

The Notice further stated that the minimum emission standards will be applicable to both permanently operating plants and for experimental (pilot) plants with a design capacity equivalent to the one of a listed activity. Minimum standards are applicable under normal working conditions, and any normal start-ups, maintenance, upset and shut-down conditions that exceed a period of 48 hours will be subject to Section 30 of the AQA, which deals with control of emergency accidents. Upset conditions means that any temporary failure of air pollution control equipment or failure of a process to operate in a normal or usual manner that leads to an emission standard being exceeded.

Any existing plant must comply with the minimum emission standards for existing plant as contained in Part 3 of the Notice (which gives detailed account of minimum emission standards) by 01 April 2015 unless where specified. Any existing plant must comply with the minimum emission standards for new plant as contained in Part 3 of the Notice (which gives detailed account of minimum emission standards) by 01 April 2020, unless where specified.

The listed activities are published in terms of Section 21(1)(b) of AQA as a 'list of activities which result in atmospheric emissions which have or may have a significant detrimental effect on the environment, including health, social conditions, economic conditions or cultural heritage' (GN37054, 22 November 2013), updated in 2015.

3.3 RELATION TO THE EIA PROCESS

Through impact assessment the safety, health and environmental impacts of developments and activities are scrutinised. This process encourages participation by all stakeholders and provides decision-makers with detailed information to determine whether an activity may proceed or not, and in the case of an approval provides information on the mitigation measures that must be introduced to ensure that safety, health and environmental impacts are kept to acceptable levels.

Furthermore, environmental impact management has been rolled out nationally and provincially in the form of the environmental impact assessment (EIA) process. This participatory process provides government with the detailed information required for it to make an informed decision on whether a development may go ahead or not and, in the case of a go-ahead, exactly what measures must be taken to ensure that safety, health and environmental impacts are kept to acceptable levels.

The use and importance of the EIA tool is fully acknowledged by the AQA and, as such, the use of EIAs is inextricably linked to the AQA's atmospheric emission licensing process.

The requirements of the AQA interface with the EIA process in a number of ways that are addressed below. First, the process of granting an AEL is related to the issuing of an Environmental Authorisation (EA) for an EIA application as discussed in Paragraph 5.5.2 of NFAQM. Secondly, the AQA has introduced some fundamental changes to air quality legislation in South Africa that shape and inform the specialist Air Quality Impact Assessment reports, which generally form part of an EIA process. These latter aspects are considered below.

3.4 SPECIALIST AIR QUALITY IMPACT ASSESSMENT REPORT

In general, all development applications involving listed activities will be required to undergo an EIA and will require a specialist Air Quality Impact Assessment study. Through its various requirements, the AQA prescribes and informs the scope and content of such specialist Air Quality Impact Assessment studies. The key elements of the AQA that are relevant to the EIA process are summarised, followed by the establishment of norms for a specialist AQIA report based on these requirements.

Key requirements of the AQA are as follows:

Human health impacts

One of the objectives of the AQA is to give effect to our constitutional right to an environment that is not harmful to the health and well-being of people. The emphasis on human health requires that the specialist AQIA for a proposed listed activity includes an assessment of potential health impacts. The level of detail required is dependent on the nature and extent of atmospheric emissions and could range from a simple comparative assessment of predicted ambient air quality levels with ambient air quality standards through to a full health risk assessment.

Ambient air quality standards

The AQA is effects-based legislation, with the result that activities that result in atmospheric emissions are to be determined with the objective of achieving health-based ambient air quality standards. Each new development proposal with potential impacts on air quality must be assessed not only in terms of its individual contribution, but in terms of its additive contribution to baseline ambient air quality i.e. cumulative effects must be considered.

Point source emission standards

The AQA may also prescribe minimum standards for certain point source emissions and these must be taken into account in the specialist study.

Mitigation measures

Related to the above, the AQA states that the Best Practicable Environmental Option (BPEO) that would prevent, control, abate or mitigate pollution, must be used.

Atmospheric Emission Licence (AEL) requirements

Notwithstanding the procedural linkages between an EIA and an AEL, the AQA prescribes factors that need to be taken into account by licensing authority when considering an application for an AEL (Section 39 of the AQA) and also stipulates the contents of AELs (Section 43 of the AQA).

3.5 AMBIENT AIR QUALITY STANDARDS

The NEM:AQA 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'. National ambient air quality standards, including allowable frequencies of exceedance and compliance timeframes, were issued by the Minister of Water and Environmental Affairs on 24 December 2009 (**Table 3)**. National standards for $PM_{2.5}$ were established by the Minister of Water and Environmental Affairs on 29 June 2012.

More stringent standards can be established at the provincial and local levels. Even though the NEM:AQA does not make provision for air quality standards on a local scale, local authorities are still allowed to define local specific air quality guidelines as internal objectives or targets to assist the municipality in meeting their air quality obligations.

Table 3: National Ambient Air Quality Standards as of 24 December 2009.

National Ambient Air Quality Standards for Particulate Matter (PM_{10})

AVERAGING PERIOD	LIMIT VALUE (µg/m³)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE
24 hours	120	4	Immediate – 31 December 2014
24 hours	75	4	1 January 2015
1 year	50	0	Immediate – 31 December 2014
1 year	40	0	1 January 2015

The reference method for the determination of the PM_{10} fraction of suspended particulate matter shall be EN 12341.

The DEA has established National Ambient Air Quality Standards for particulate matter of aerodynamic diameter less than 2.5 micron metres in June 2012 (GN486: 2012) as set out in **Table 4**.

Table 4: Established National Ambient Air Quality Standards for Particulate Matter ($PM_{2.5}$).

National Ambient Air Quality Standards for Particulate Matter ($PM_{2.5}$)

AVERAGING PERIOD	LIMIT VALUE (µg/m³)	FREQUENCY OF EXCEEDANCE	COMPLIANCE DATE
24 hours	65	0	Immediate – 31 December 2015
24 hours	40	0	1 January 2016 – 31 December 2029
24 hours	25	0	01 January 2030
1 year	25	0	Immediate – 31 December 2015
1 year	20	0	1 January 2016 – 31 December 2029
1 year	15	0	01 January 2030

The reference method for the determination of PM2.5 fraction of suspended particulate matter shall be EN 14907.

On 01 November 2013, the legislated standards for dust fallout were promulgated in the form of the NEM:AQA National Dust Control Regulations (NDCR) (GNR 827). The purpose of the regulations is to prescribe general measures for the control of dust in all areas. A standard for the acceptable dust fallout rate is set out in **Table 5** for residential and non-residential areas and is used to assess compliance.

The method to be used for measuring dust fallout rate and the guideline for locating sampling points shall be ASTM D1739:1970, or equivalent method approved by any internationally recognised body.

Table 5: Acceptable dust fallout rates as per the National Dust Control Regulations (2013).

RESTRICTION AREAS	DUST FALLOUT RATE (D) (mg/m²/day) 30 DAY AVERAGE	PERMITTED FREQUENCY OF EXCEEDING DUST FALLOUT RATE	REFERENCE METHOD
Residential Area	D < 600	Two within a year, not sequential months	ASTM D1739

Non-Residential Area	600 < D < 1200	Two within a year, not sequential months	ASTM D1739

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

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

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

4. AIR POLLUTION AND HUMAN HEALTH IMPACTS

In rural environment, emissions associated with rocks and stones crushing will act as a significant source of air pollutants, including, but not limited to fine particulates in the form of PM_{10}, $PM_{2.5}$ and TSP.

4.1 FINE PARTICULATES

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

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

Studies suggest that short-term exposure to particulate matter leads to adverse health effects, even at low concentrations of exposure (below 100 $\mu g/m^3$). Morbidity effects associated with short-term exposure to particulates include increases in lower respiratory symptoms, medication use and small reductions in lung function. Long-term exposure to low concentrations (~10 $\mu g/m^3$) of particulates is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function (WHO, 2000). Those most at risk include the elderly, individuals with pre-existing heart or lung disease, asthmatics and children. Some identified short and long-term health effects associated with exposure to particulate matter are presented in **Table 6**.

Table 6: Short-term and long-term health effects associated with exposure to PM (after WHO, 2004).

POLLUTANT	SHORT-TERM EXPOSURE	LONG-TERM EXPOSURE
Particulate matter	• Lung inflammatory reactions • Respiratory symptoms • Adverse effects on the cardiovascular system • Increase in medication usage • Increase in hospital admissions • Increase in mortality	• Increase in lower respiratory symptoms • Reduction in lung function in children • Increase in chronic obstructive pulmonary disease • Reduction in lung function in adults • Reduction in life expectancy • Reduction in lung function development

5. BASELINE ASSESSMENT

5.1 METEOROLOGICAL OVERVIEW

The general climate experienced in the interior of southern Africa is controlled predominantly by subtropical high pressure, with temporary disruptions by low pressure cells or fronts. This high-pressure zone, centred approximately along 30°S latitude, is associated with divergence at the surface and convergence in the upper atmosphere. **Figure 8** below shows the predominant macroscale atmospheric circulations over the subcontinent. Easterly waves and lows tend to be summer phenomena, while westerly waves and lows tend to be autumn to spring phenomena. Fronts associated with westerly lows tend to have greater influence over southern Africa in winter.

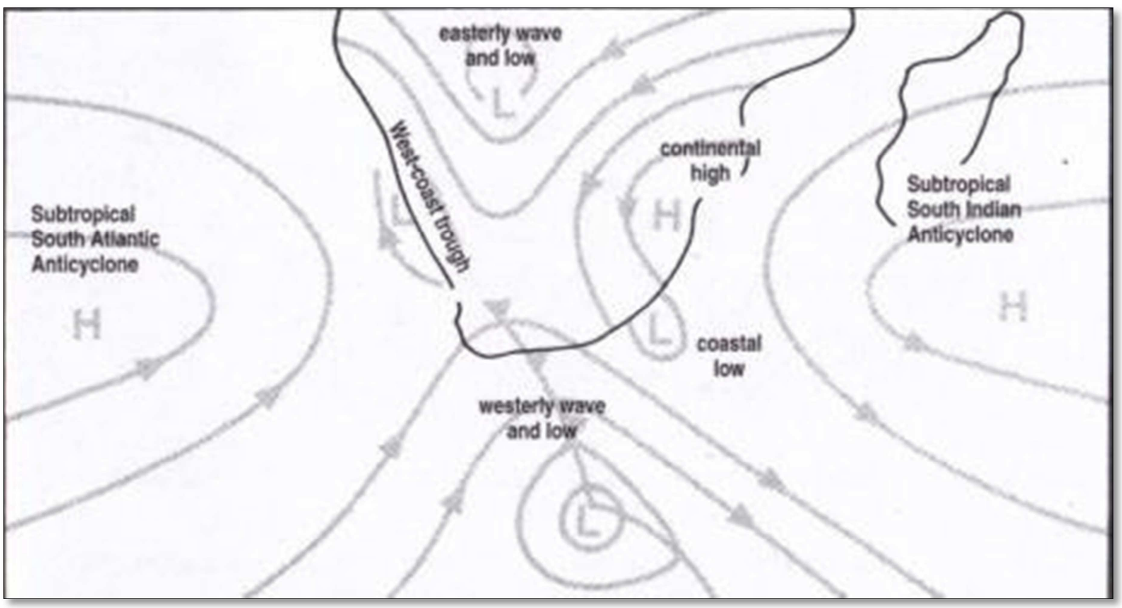

Figure 8: Some important features of the surface atmospheric circulation over Southern Africa (Preston-Whyte and Tyson, 1988).

This section of the report has reference to the "Air Quality Impact Assessment for a Chrome Sand Drying Plant, Changes to the Tailings Dam Design and Other Operational and Surface Infrastructure Changes at Tharisa Minerals", Report No.: APP/12/SLR04 that was prepared by Airshed Planning Professionals for SLR Consulting (Africa) (Pty) Ltd.

The development of a local meteorological dataset for local wind field analysis is described in the methodology section (Section 7). The following description of local meteorology is based on the Unified Model and Klipfontein Weather Station that belongs to Anglo Platinum.

5.2 LOCAL WIND FIELD

As per the Regulations Regarding Air Dispersion Modelling (DEA, 2014), representativeness of the meteorological data is influenced by the following four factors:

- Proximity of the meteorological site to the area being modelled;
- Complexity of the terrain;
- Exposure of the meteorological measurement site;

- Time period of data collection.

Dispersion comprises vertical and horizontal components of motion. The wind field largely determines the horizontal dispersion of pollution in the atmospheric boundary layer. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. The wind direction and the variability in wind direction, determine the general path pollutants will follow, and the extent of cross-wind spreading (Shaw and Munn, 1971; Pasquill and Smith, 1983; Oke, 1990).

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

In characterising the dispersion potential of the site, reference was made to hourly average meteorological data modelled by SAWS (Unified Model) for the period January 2009 to December 2011.

The data was generated by the model at a coordinate set within the Tharisa Minerals boundary.

Meteorological data recorded at Anglo Platinum's Klipfontein meteorological station for the period January to December 2008 are also included in this report. This weather station is situated approximately 12.1 km to the west northwest of the proposed Crusher plant. Parameters that need to be taken into account in the characterisation of meso-scale ventilation potentials include wind speed, wind direction, extent of atmospheric turbulence, ambient air temperature and mixing depth.

5.2.1 KLIPFONTEIN METEOROLOGICAL STATION

Wind roses comprise 16 spokes, which represent the directions from which winds blew during the period. The colours used in the wind roses below, reflect the different categories of wind speeds; the light blue area, for example, representing winds of 1 m/s to 2 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. For the current wind roses, each dotted circle represents a 3% frequency of occurrence. The value given in the centre of the circle described the frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s.

Klipfontein ambient monitoring station is regarded as representative of the local meteorology. Period average, day-time, night-time and seasonal wind roses (January 2008 to December 2008) measured at Klipfontein are depicted in **Figure 9**. The spatial and diurnal variability in the wind field is clearly evident in this figure. The dominant wind direction is south-south-westerly (~9% frequency of occurrence) to a southerly (~8% frequency of occurrence). Frequent air flow also occurs from the east (~7%) and east-southeast (~6% of the time). However, this dominant wind field consists of relatively low wind speeds of approximately 1 - 2 m/s not effectively dispersing pollutants. Wind speeds in excess of 4 m/s are evident from the southerly and south-south-easterly sector occurring infrequently (< 5% of the total period). Calm conditions (wind speeds < 1 m/s) occur for 32% of the time at the Klipfontein station.

Airflow for the Rustenburg region is characterised mainly by a variation in north-westerly and south-westerly winds, with more frequent southerly to easterly winds in the Brits area. The

Lonmin area indicates predominantly north-westerly and east-south-easterly winds (Liebenberg-Enslin & Burger, 2003).

Diurnal airflow for the region is characterised mainly by a variation in north-westerly and easterly winds, with the strongest winds recorded from the south North-easterly and north-westerly wind flow dominates day-time conditions with north-north-westerly winds occurring for 10% of the time and northerly winds for 9% of the time. Infrequent but strong southerly winds are evident with calm conditions occurring for 27% of the time. During night-time there is dramatic decrease in frequency of occurrence of the wind from the northerly sector with a strong increase of winds from the south to southwest (for 28% of the time combined) and east-southeast (17% of the time). As is typical from night-time conditions, an increase in the number of calms to 36% of the time is evident. The seasonal variation in wind flow at Klipfontein is considerable, with strong southerly winds dominant throughout the year. During the summer months, the strongest winds are from the easterly to east-south-easterly sector. In autumn the general wind speed decreases with more frequent winds from the south and south-southwest. A similar wind flow pattern is evident during the winter months with an increase in frequent winds from the south-southwest, northwest and east-southeast. During spring-time the wind flow shifts to reflect similar patterns than during the summer months with prevailing winds from the easterly sector and from the northwest.

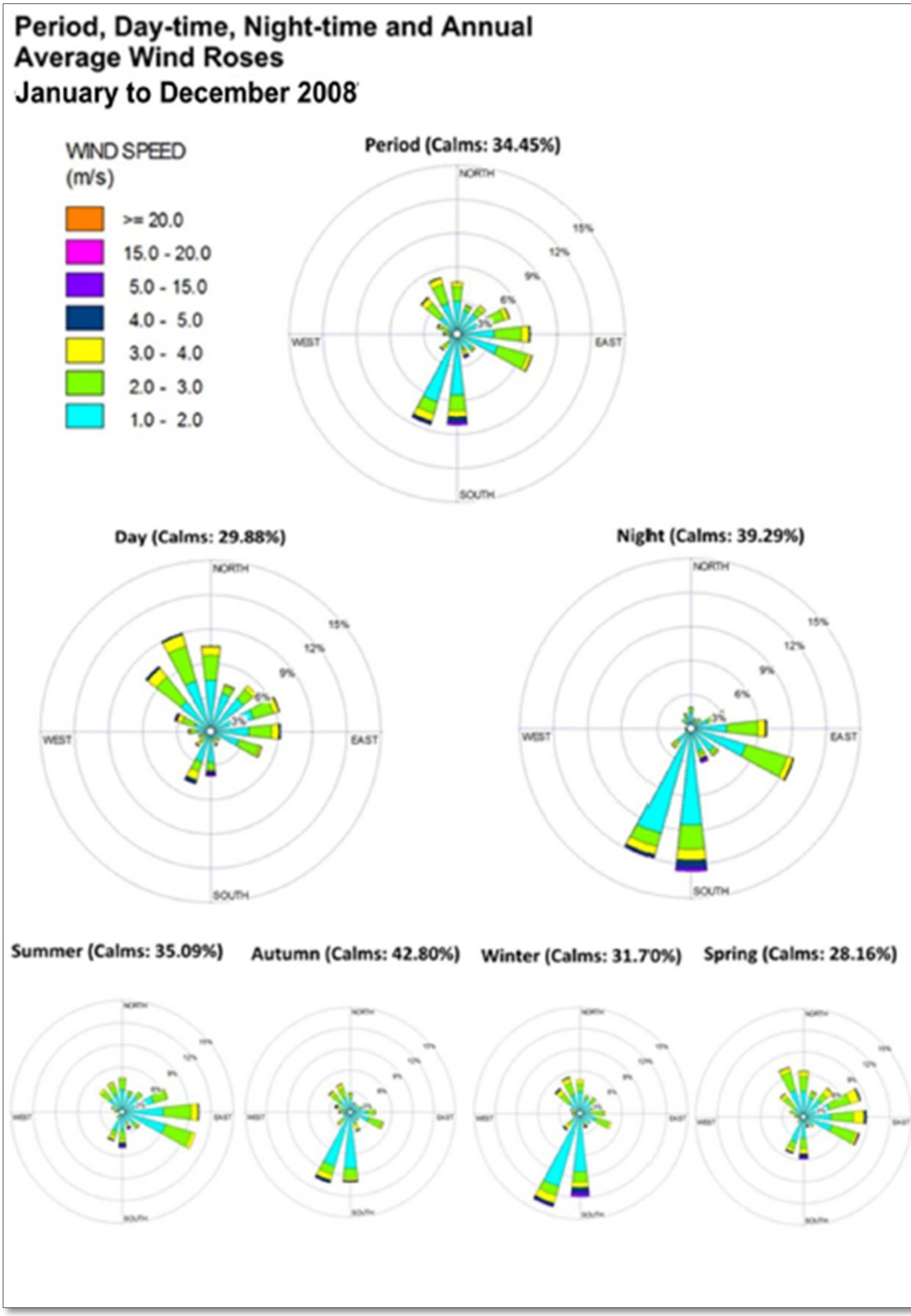

Figure 9 : Period, day and night time and seasonal wind roses for the Klipfontein station for the period Jan to Dec 2008.

5.2.2 SAWS UNIFIED MODEL

The unified model generated wind data is illustrated in the figures below. **Figure 10** presents the periodic, daytime, night-time and annual wind roses for Unified Model data for a point located within the property shows the periodic, day-time, night-time and annual wind roses for the period January 2009 to December 2011. It is clear from the periodical wind rose that the dominant wind direction modelled by the Unified model is North West. Winds from the south west sector are the least common. Wind speeds hardly reach speeds higher than 5 m/s. day-time and night-time wind roses differ significantly with day-times dominated by winds from the north-west and north north-west whereas night times are dominated by winds from the opposite direction and the south. Annual wind roses resemble the periodic wind rose.

Figure 11 depicts seasonal wind roses. Summer, spring and autumn winds are dominantly from the north-west, while winter winds are prevailingly from the south. The highest wind speeds are associated with spring time.

5.2.3 AGREEMENT BETWEEN KLIPFONTEIN AND UNIFIED MODEL

There is a sufficient agreement between the measured Klipfontein and Unified Model modelled data and therefore use was made of the more recent modelled data that was available for a longer period. The modelled data was therefore decided to be valid for model input.

It is important to note that there exists a discrepancy between the calm conditions for the measured data at the Klipfontein station (which averages around 30%) and the modelled data with an average of around 8%. As the measured Klipfontein meteorological data was only available for a period of one year, this means that a third of the one-year data would be disregarded by the model.

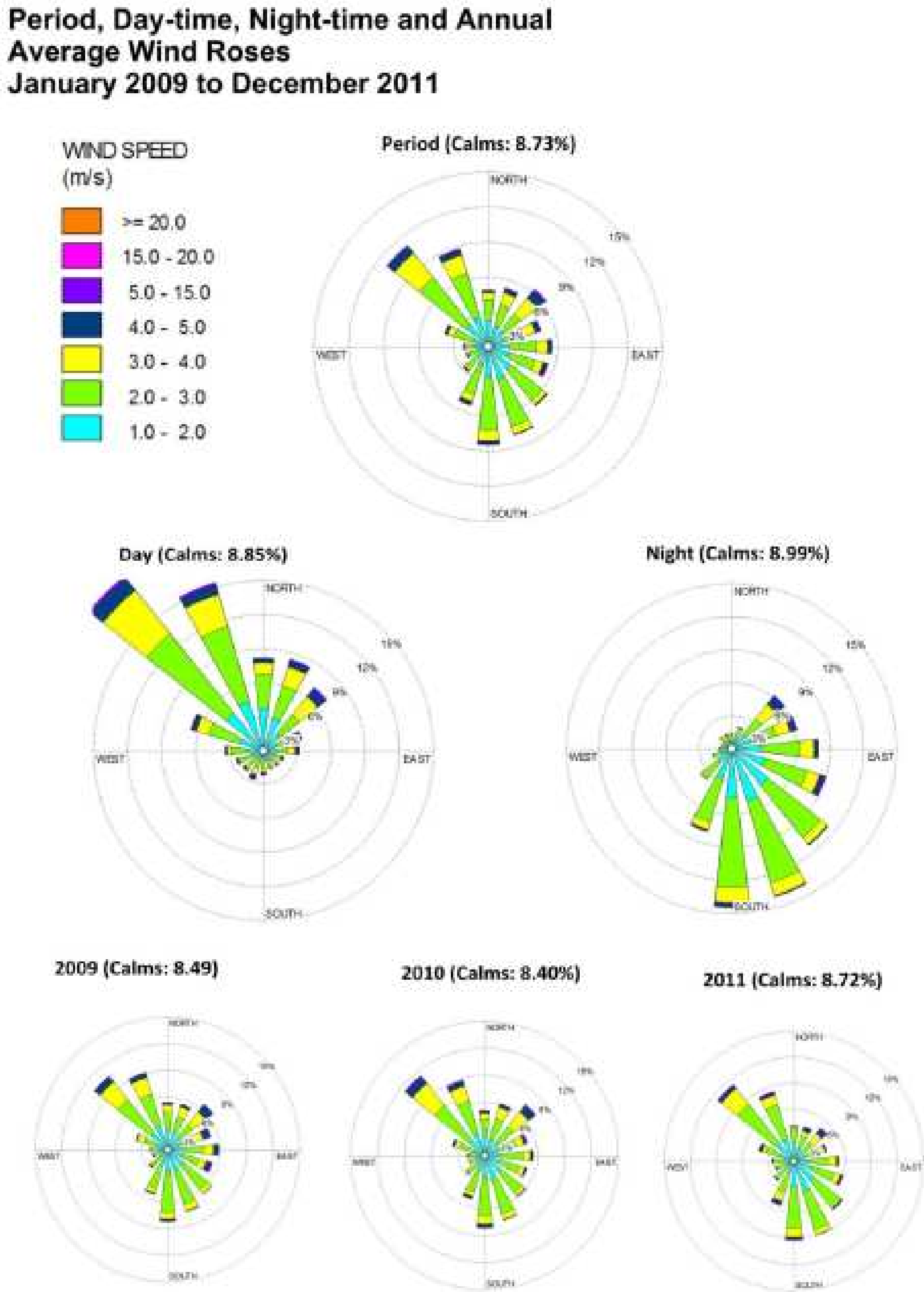

Figure 10: Periodic, daytime, night-time and annual wind roses for Unified Model data for a point located within the property (Jan 2009 to Dec 2011).

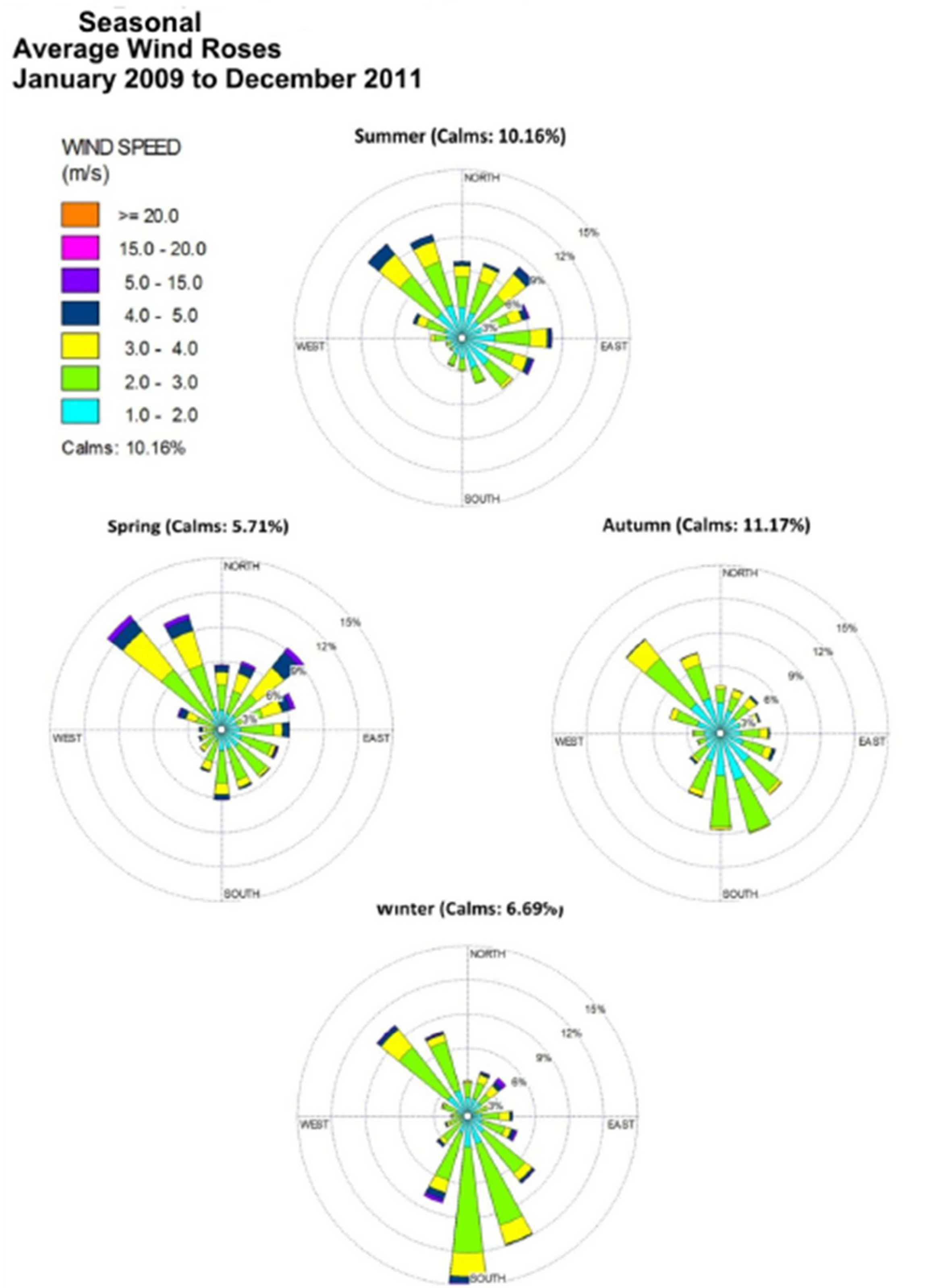

Figure 11: Seasonal wind roses for Unified Model data for a point located within the property (Jan 2009 to Dec 2011).

5.3 TEMPERATURE

5.3.1 KLIPFONTEIN METEOROLOGICAL STATION

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers. Monthly trends for the year 2008 in ambient temperature recorded at the Klipfontein station is illustrated in **Figure 12**.

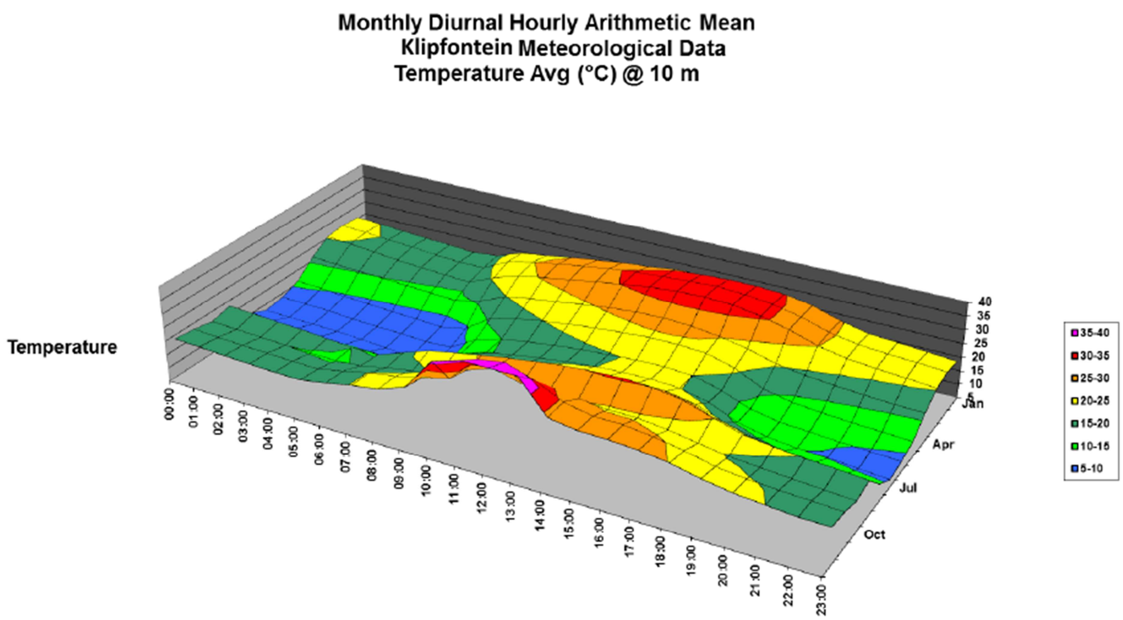

Figure 12: Monthly diurnal temperature profile for Klipfontein (2008).

5.3.2 SAWS UNIFIED MODEL

A temperature profile of the unified model temperature data is shown in **Figure 13**. From the figure it can be seen that December is the warmest month with temperatures reaching values of around 28°C at noon. June and July are the coldest months with minimum temperatures of around 2.5°C before sunrise.

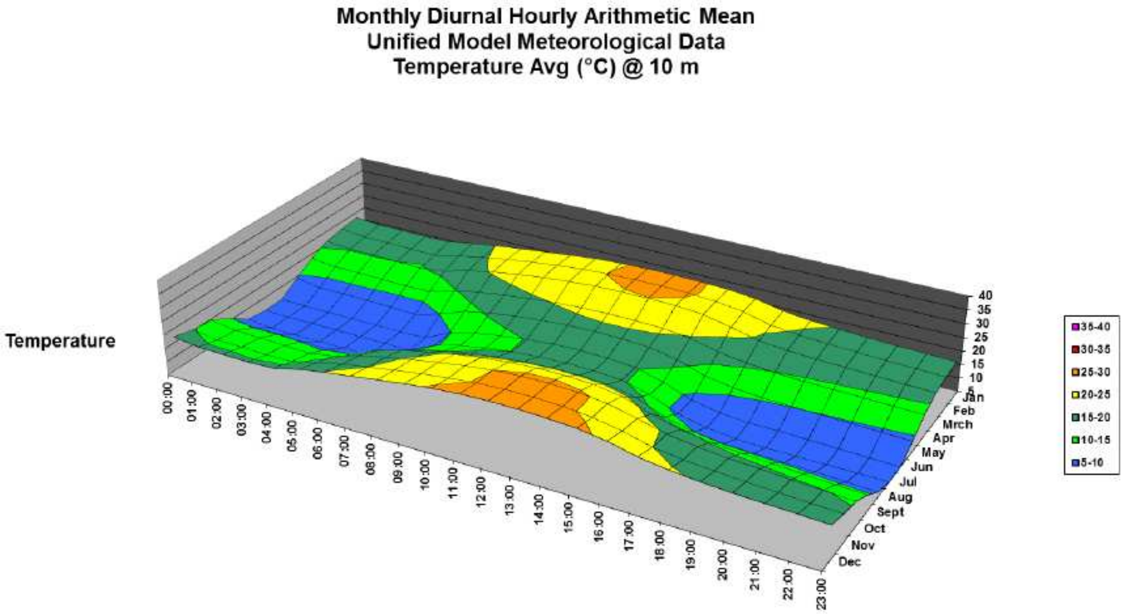

Figure 13: Unified Model temperature profile (2009 - 2011).

5.4 RAINFALL AND PRECIPITATION

5.4.1 KLIPFONTEIN METEOROLOGICAL STATION

Precipitation is important to air pollution studies since it represents an effective removal mechanism of atmospheric pollutants. Long-term monthly average rainfall figures for various stations within the Rustenburg-Brits region are given in **Table 7** and depicted in **Figure 14**. Long-term average total annual rainfall is in the range of 630 mm to 740 mm. The study area falls within a summer rainfall region, with over 70% of the annual rainfall occurring during the October to February period.

Table 7: Long-term monthly rainfall figures (mm) for the Rustenburg-Brits region.

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Ann
Donkerhoek (1914 - 1975)	138	107	99	48	19	10	8	9	16	54	97	132	738
Rustenburg (1928 - 1989)	120	92	85	51	16	10	5	8	19	49	91	114	659
Kroondal (1949 - 1992)	126	92	77	56	15	10	4	6	20	56	90	109	660
Waterkloof (1917 - 2000)	125	102	94	47	19	7	5	8	21	54	115	140	737
Klipfontein (1928 - 2001)	116	91	78	45	17	8	4	5	16	53	82	115	631
Brits (1951-1984)	121	82	62	52	19	5	4	5	14	59	101	97	621

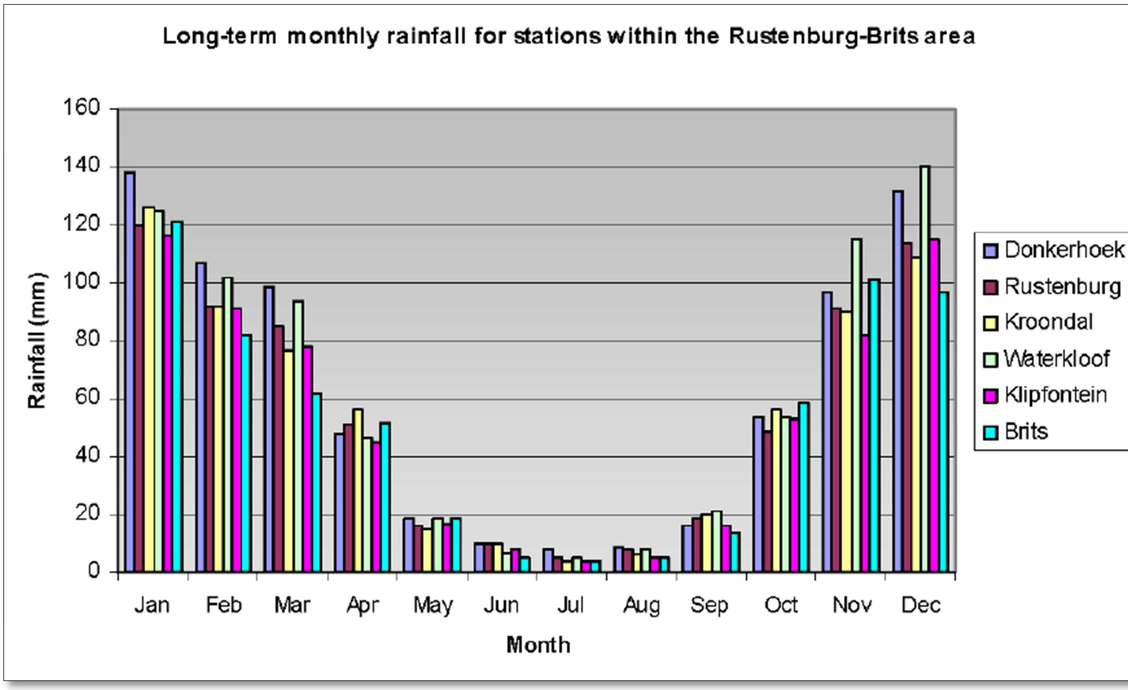

Figure 14: Long-term monthly rainfall for stations within the Rustenburg-Brits region.

5.4.2 SAWS UNIFIED MODEL

Rainfall data generated by the Unified model was not available.

5.5 MIXING HEIGHT AND ATMOSPHERIC STABILITY

The vertical component of dispersion is a function of the extent of thermal turbulence and the depth of the surface mixing layer. Unfortunately, the mixing layer is not easily measured, and must therefore often be estimated using prognostic models that derive the depth from some of the other parameters that are routinely measured, e.g. solar radiation and temperature. During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the mixing layer to the lowest elevated inversion. Radiative flux divergence during the night usually results in the establishment of ground based inversions and the erosion of the mixing layer. Day-time mixing heights were calculated with the prognostic equations of Batchvarova and Gryning (1990), while night-time boundary layer heights were calculated from various diagnostic approaches for stable and neutral conditions. The mixing layer at the proposed sites ranges in depth from 0 metres (i.e. only a stable or neutral layer exists) during night-times to the base of the lowest level elevated inversion during unstable, day-time conditions.

Atmospheric stability is frequently categorised into one of six stability classes. These are briefly described in **Table 8**. The hourly standard deviation of wind direction, wind speed and solar radiation were used to determine hourly-average stability classes (STAR method).

The atmospheric boundary layer is normally unstable during the day as a result of the turbulence due to the sun's heating effect on the earth's surface. The thickness of this mixing layer depends predominantly on the extent of solar radiation, growing gradually from sunrise to reach a maximum at about 5-6 hours after sunrise. This situation is more pronounced during the winter months due to strong night-time inversions and a slower developing mixing layer. During the night a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral.

For elevated releases, the highest ground level concentrations would occur during unstable, daytime conditions. The wind speed resulting in the highest ground level concentration depends on the plume buoyancy. If the plume is considerably buoyant (high exit gas velocity and temperature) together with a low wind, the plume will reach the ground relatively far downwind. With stronger wind speeds, on the other hand, the plume may reach the ground closer, but due to the increased ventilation, it would be more diluted. A wind speed between these extremes would therefore be responsible for the highest ground level concentrations. The highest concentrations for low level releases would occur during weak wind speeds and stable (night-time) atmospheric conditions. Air pollution episodes are characterised by calm winds and stable conditions.

Table 8: Atmospheric Stability Classes.

CLASS	DEFINITION	DESCRIPTION
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

6. EXISTING AMBIENT AIR QUALITY

The Rustenburg Local Municipality developed an Air Quality Management Plan for the municipal area in 2005. According to the main findings from the plan, major air pollution sources within Rustenburg-Brits area include emissions from manufacturing and mining industries, townships and informal settlements and vehicular activity. Primary atmospheric emissions released from these sources include sulphur dioxide (SO_2) nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter ($PM_{2.5}$ and PM_{10}) and Volatile Organic Compounds (VOCs). Secondary pollutants such as ozone (O_3) are formed in the atmosphere through the chemical transformation of precursors such as VOCs and NO_x. Heavy metals such as lead (Pb), chromium (Cr) and nickel (Ni) occur in the Rustenburg area due to mining and smelting activities.

6.1 IDENTIFICATION OF EXISTING SOURCES OF EMISSION WITHIN THE RUSTENBURG-BRITS AREA

The contribution of various sources of emission to ambient particulate and gaseous concentrations within the Rustenburg region is of interest given the elevated concentrations having been recorded. The most significant sources located within the Rustenburg-Brits region include:

- Stack, vent and fugitive emissions from industrial operations - industrial emissions include various criteria pollutants (as SO_2, NO_x, CO and particulates), greenhouse gases (CO_2 and CH_4), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), various heavy metals and other toxins such as dioxins and furans. Industries in the region include three platinum smelter operations, viz.: Anglo Platinum Smelter Operation (Waterval Smelter), Impala Platinum and Lonmin (Western Platinum). Sources of emission at these operations typically include stack emissions, including main stack releases which comprise furnace and converter off-gases, acid plant stack emissions and releases from flash dryer stacks. The furnace and converter operations are also associated with significant fugitive emissions. Aside from the two ferro-chrome industries situated in the region, viz. the Xstrata (Rustenburg)and Xstrata (Wonderkop) operations, Merafe Ferrochrome is situated to the north west of Rustenburg and IFM ~30 km east of Rustenburg. Furnace stack emissions, furnace fugitives and baghouse stack releases represent the main sources at these operations. The induction furnaces at Joerg Foundry (Trek Engineering) represent a smaller source of industry-related emissions.
- Stack emissions from boiler operations - boiler stack emissions include particulates, NO_x, SO_2, CO, VOCs and CO_2. In addition to various smelter plants, boiler operations are also undertaken at Rainbow Chickens, Rustenburg Abattoir, MKTV Tobacco Limited, Rustenburg Provincial Hospital, British American Tobacco Products, Mageu Number One and Anglo Platinum Base Metals Refinery (BMR).
- Stack emissions from incineration operations - emissions include criteria gases (SO_2, NOx, CO, lead and particulates), acid gases (hydrogen chloride, hydrogen bromide, hydrogen fluoride), metal gases (chromium, arsenic, cadmium, mercury, manganese, etc.) and dioxins and furans. Incineration operations are undertaken at Anglo Platinum Precious Metals Refinery (PMR), with medical waste incineration occurring at Ferncrest Hospital.
- Fugitive emissions from quarrying and mining operations - comprising mainly dust releases, with small amounts of NO_x, CO, SO_2, methane, CO_2 being released during blasting operations.

- Fugitive dust emissions from tailings impoundments which are associated with Anglo, Impala and Lonmin mineral processing operations. Anglo Platinum tailings dams in the region currently include Phases 1-3 (i.e. Paardekraal tailings), Waterval West, Waterval East, and Klipfontein. Lonmin's tailings include Western Platinum - North, - East, - South and - West, Karee Mine and Eastern Platinum. Impala Platinum has one large tailings dam.
- Vehicle tailpipe emissions - significant primary pollutants emitted by motor vehicles include CO_2, CO, hydrocarbons (HCs), SO_2, NO_x, particulate matter and lead.
- Household fuel combustion (coal, wood) - coal burning emits a large amount of gaseous and particulate pollutants including SO_2, heavy metals, total and respirable particulates including heavy metals and inorganic ash, CO, polycyclic aromatic hydrocarbons (PAHs), NO_2 and various toxins such as benzo(a)pyrene. Pollutants from wood burning include respirable particulates, NO_2, CO, PAHs, particulate benzo(a)pyrene and formaldehyde. Particulate emissions from wood burning have been found to contain about 50% elemental carbon and about 50% condensed hydrocarbons.
- Biomass burning - major pollutants from veld fires are particulates, CO and VOCs. The extent of NOx emissions depends on combustion temperatures, with minor sulphur oxides being released.
- Various miscellaneous fugitive dust sources, including: agricultural activities, wind erosion of open areas, vehicle-entrainment of dust along paved and unpaved roads.
- Ambient air pollutant concentrations within the Rustenburg region occur not only due to local source but also as a result of emissions from various remote sources. Regionally-transported air masses comprising well mixed concentrations of 'aged' (secondary) pollutants are known to represent a significant component of ambient fine particulate concentrations within the South African interior. Such air masses contain pollutants released from various remote sources including elevated releases from distant industrial operations and power generation facilities and large-scale biomass burning in neighbouring countries. Typical pollutants which circulate within such regionally-transported polluted air masses include nitrates, ammonium nitrate and sulphates.

The quantification of background particulate concentration, which is of particular importance given the nature of the proposed development, is complicated due to the large number of sources of this pollutant. Sources of particulates also include a significant proportion of fugitive emissions from diffuse sources (e.g. vehicle-entrained dust from roadways, wind-blown dust from stockpiles and open areas, dust generated by materials handling) which are more difficult to quantify than are emissions from point sources.

6.2 AMBIENT AIR QUALITY DATA

6.2.1 DUST FALLOUT RESULTS

A dust fallout monitoring network was established in April 2009 and data up to February 2011 was included in this report. The various dust fallout monitoring sites are shown in the figures below (**Figure 15** and **Figure 16).**

Figure 15: Dust fallout monitoring stations surrounding Tharisa Minerals.

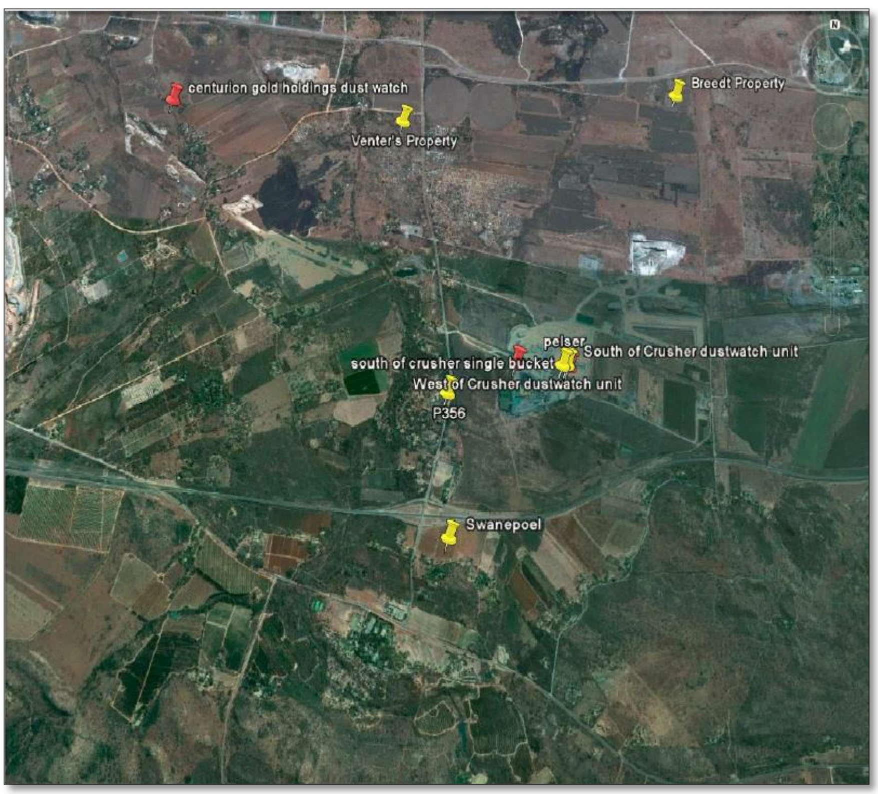

Figure 16: Dust fallout monitoring stations surrounding Tharisa Minerals.

Dust deposition rates were evaluated based on the NDCRs (**Table 5**), providing a residential limit of 600 mg/m²/day and a non-residential limit of 1 200 mg/m²/day, not to be exceeded for more than two times within a year or two sequential months.

The sites used in the monitoring study were either residential or non-residential sites. The table below (**Table 9**) lists the monitoring station locations and their site classifications.

SITE	SITE CLASSIFICATION
P356	Non-Residential
Venter's Property	Residential
Swanepoel	Residential
Breedt Property	Residential
South of Crusher	Residential
Pelser	Non-Residential
Centurion Gold	Non-Residential
South of Crusher	Non-Residential
West of Crusher	Non-Residential

Table 9: Site classification of some dustfall monitor station locations.

The following tables (**Table 10**, **Table 11**, **Table 12**, **Table 13** and **Table 14**) summarise the dust fallout monitoring results. Those sites that are within the various limits are shown in green, with the ones exceeding the NDCR residential threshold level highlighted in orange and the sites exceeding the non-residential threshold level highlighted in red.

Table 10: Dust fallout monitoring results for the period April 2009 to May 2009.

DATE	IGLOO HOUSES	ESKOM WIRES	H. VAN RENSBURG	FLAT ROOF HOUSE	MOUNTAIN RESERVOIR	MARIKANA CHROME	SILVER WORKSHOP	QUARRY	DE BEERS	GRAVEL ROAD
09-Apr	303	ND	142	48	104	ND	135	241	305	168
09-May	25	ND	95	100	93	ND	61	ND	72	201

DATE	PIT OUTCROP EAST	P356	VENTERS PROPERTY	SWANEPOEL	GELDENHUYS GUEST HOUSE	BREEDT PROPERTY	SILVER WORKSHOP	CENTURION HOLDINGS	SPRUITFONTEIN
09-Jun	ND	62	55	26	77	42	51	140	146
09-Jul	87	61	104	60	92	107	97	81	209
09-Aug	60	51	92	188	52	192	ND	81	ND

Table 11: Dust fallout monitoring results for the period June 2009 to August 2009.

DATE	PIT OUTCROP EAST	P356	VENTERS PROPERTY	SWANEPOEL	BREEDT PROPERTY	SILVER WORKSHOP	EAST OF CRUSHER	CENTURION HOLDINGS	SOUTH OF CRUSHER
09-Sep	ND	282	242	258	320	458	341	822	827
09-Oct	383	304	337	282	529	NA	378	2117	1080
09-Nov	352	169	228	333	86	381	312	1060	1416

Table 12: Dust fallout monitoring results for the period September 2009 to November 2009.

DATE	IGLOO HOUSES	ESKOM WIRES	H. VAN RENSBURG	FLAT ROOF HOUSE	MOUNTAIN RESERVOIR	MARIKANA CHROME	CENTURION HOLDINGS	SOUTH OF CRUSHER	WEST OF CRUSHER
09-Dec	ND	122	55	62	42	876	195	2762	380
10-Jan	ND	86	42	22	28	756	103	ND	353

Table 13: Dust fallout monitoring results for the period December 2009 to January 2010.

DATE	PIT OUTCROP EAST	P356	VENTERS PROPERTY	SWANEPOEL	BREEDT PROPERTY	EAST OF CRUSHER	CENTURION HOLDINGS	SOUTH OF CRUSHER	WEST OF CRUSHER
10-Feb	ND	79	103	90	75	123	50	859	159
10-Mar	ND	50	196	104	25	2709	ND	2281	1875
10-Apr	ND	16	26	26	103	475	ND	509	87
10-May	ND	14	24	5	21	3391	ND	136	71
10-Jun	ND	62	56	147	62	ND	ND	8509	140
10-Jul	ND	94	105	26	46	ND	ND	2392	140
10-Aug	ND	ND	202	180	43	ND	ND	1609	339
10-Sep	ND	216	212	187	188	ND	ND	652	348
10-Oct	ND	188	387	203	370	ND	ND	1070	807

Table 14: Dust fallout monitoring results for the period February 2010 to February 2011.

7. IMPACT ASSESSMENT

The methodology employed for this study is discussed below in the following sections. Of primary focus were the activities which have the potential to emit dust to the atmosphere, and the effects of these were contextualised within the framework of the dispersion potential of the area.

Dispersion models compute ambient concentrations and deposition levels as a function of source configuration, emission strengths and meteorological characteristics, thus providing useful tools to ascertain the spatial and temporal patterns in the ground level concentrations and deposition arising from the emissions of various sources.

7.1 EMISSION INVENTORY

Various methods exist to calculate emission inventories, with each approach depending on the availability of data. Methods include continuous monitoring at source, data extrapolation from short term source emissions testing, and the combination of published emission factors and equations with known activity levels.

For this assessment, international emission factors and equations have been sourced from either the United States Environmental Protection Agency (US EPA) AP42 (US EPA, 1995) or the Australian Government National Pollutant Inventory (NPI, 2012) database to develop an emissions inventory.

An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant (US EPA, 1995). A factor could be expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g. kilograms of particulate matter emitted per tonne of ore transferred on a conveyor). In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category (i.e. a population average). The US EPA AP42 (US EPA, 1995) lists one of the primary uses of emission factors as developing inputs for ambient dispersion modelling.

Various activities are associated with the proposed development of the Makwase Crushing Plant. However, potential impacts associated with the operational phase have only been assessed as detailed information for the establishment phase was not available at the time of this assessment. In addition, impacts associated with the establishment phase are temporary in nature and for a definable period, and as such, any impacts associated with the site preparation are anticipated to be minimal.

The main activities associated with the mobile crushing plant include:

- Material Handling Activities; and
- Secondary and Tertiary Crushing

The emissions inventory described below is a preliminary emissions inventory for the proposed Makwase Crushing Plant based on information available at the time of the study. A constant throughput of 780 000 t/annum was assumed for each source, although in reality, throughputs would vary for each respective source. As such, estimated emissions (and as such, predicted concentrations) are higher than would be observed in reality.

Ambient TSP, PM_{10} and $PM_{2.5}$ emissions have been estimated below for all proposed activities.

It is important to note that dispersion modelling done for this study represents the predicted impacts from the Makwase Crushing Plant only. There was not enough information available to do a cumulative assessment of air quality in the area. As the area in which Makwase Crushing Plant is situated is an area where many mines are found (it falls under the Waterberg-Bojanala Priority Area), air quality is already potentially poor and therefore the impacts predicted in this study will most probably be higher than predicted in this report.

7.1.1 MATERIALS HANDLING OPERATIONS

Materials handling operations associated with activities at Makwase Crushing Plant by means of tipping, loading and offloading. 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).

Materials handling operations which will generate fugitive dust emissions at Makwase Crushing Plant were identified to be:

- Loading;
- Offloading;
- Tipping into Secondary and Tertiary Crushers.

Particulate emissions from these sources have been quantified using equation outlined by the US EPA AP42 (US EPA, 1995).

$$E = k(0.0016) \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \quad kg/Mg$$

Where:

k is the particle size multiplier as detailed in **Table 15** together with the mean wind speed (U) and the material moisture content (M). A mean wind speed of 3.21 m/s was used as per the modelled met data for a project in the vicinity of the proposed Crusher site (LanXess Rustenburg Chrome Mine). The meteorological data cover the period 01 January 2011 - 31 December 2013 (Ngara, 2015). A moisture content of 2.2% was used, as per the recommended range from 0.25 – 4.8% stipulated in the US EPA AP42 (US EPA, 1995) for material handling activities.

Table 15: Emission parameters for material handling activities.

CONSTANT	SYMBOL	UNIT	VALUE		
			PM2.5	PM10	TSP
Particle Size Multiplier	k	-	0.053	0.35	0.74
Mean Wind Speed	U	m/s	3.1	3.1	3.1
Material Moisture Content	M	%	2.2	2.2	2.2

Emission rates for material handling activities are presented in **Table 16**. Control efficiencies of 50% or 90% for water sprays were applied to the various material handling activities (NPI, 2012).

Table 16: Calculated emission rates for material handling activities.

ACTIVITY	UNCONTROLLED VALUE			CONTROLLED VALUE		
	$PM_{2.5}$ Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	TSP Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	TSP Emission Rate (g/s)
Loading[c]	0.0012	0.0077	0.0162	0.0012	0.00770	0.0162
Offloading[c]	0.0012	0.0077	0.0162	0.0006[a]	0.0039[a]	0.0106[a]
Tipping into Secondary Crusher[c]	0.0012	0.0077	0.0162	0.0012[b]	0.0008[b]	0.0016[b]
Tipping into Tertiary Crusher[c]	0.0012	0.0077	0.0162	0.0012[b]	0.0008[b]	0.0016[b]
Total Emissions	**0.0048**	**0.0308**	**0.0648**	**0.0042**	**0.0132**	**0.0300**

a) Controlled emission rates are presented using a 50% control efficiency for water sprays, in line with the Australian Government NPI (NPI, 2012).

b) Controlled emission rates are presented using a 90% control efficiency for water sprays, in line with the Australian Government NPI (NPI, 2012)

c) An area of 9 m^2 has been assumed for all material handling activities.

7.1.2 CRUSHING OPERATIONS

Crushing takes place via a primary, secondary and tertiary crusher at various stages of the process. The emission factors (both uncontrolled and controlled) for $PM_{2.5}$, PM_{10} and TSP crushing have been applied in accordance with the US EPA AP42 (US EPA, 1995). The emission factors and calculated emission rates are shown in **Table 17** and **Table 18**.

Table 17: Emission parameters for primary, secondary and tertiary crushing activities.

ACTIVITY	UNIT	VALUE		
		$PM_{2.5}$	PM_{10}	TSP
Secondary Crushing (uncontrolled)	kg/tonne	-	0.0012	0.0027
Tertiary Crushing (uncontrolled)	kg/tonne	-	0.0012	0.0027
Secondary Crushing (controlled)	kg/tonne	-	0.0003	0.0006
Tertiary Crushing (controlled)	kg/tonne	0.00005	0.0003	0.0006

Table 18: Calculated emission rates for crushing activities.

ACTIVITY	UNCONTROLLED VALUE	CONTROLLED VALUE

	$PM_{2.5}$ Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	TSP Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	TSP Emission Rate (g/s)
Secondary Crushing	-	0.02968	0.06678	-	0.0066	0.0148
Tertiary Crushing	-	0.02968	0.06678	0.0012	0.0066	0.0148
Total Emissions	**-**	**0.05936**	**0.13356**	**0.0012**	**0.0132**	**0.0296**

a) Controlled emission rates are presented using a 50% control efficiency for water sprays, in line with the Australian Government NPI (NPI, 2012).

b) An area of 108 m^2 was used as a best approximation via satellite imagery.

The uncontrolled and controlled emissions for all activities have been summarised and are presented in **Table 19.**

Table 19: Summary of uncontrolled and controlled emissions for model input.

ACTIVITY	UNCONTROLLED		CONTROLLED	
	$PM_{2.5}$ Emission Rate	PM_{10} Emission Rate	$PM_{2.5}$ Emission Rate	PM_{10} Emission Rate
Material handling (g/s)	4.80E-03	3.08E-02	4.2E-03	1.32E-02
Crushing (g/s)	-	5.93E-02	1.2E-03	1.32E-02
Total Emissions ($g/s/m^2$)	5.33E-04	3.97E-03	4.78E-04	1.59E-03

Please note that TSP has been qualitatively quantified, but has not been considered further in this assessment, as SCREEN3 is a Level 1 model and cannot account for dust deposition (dust fallout rate).

7.2 DISPERSION MODELLING

Air pollution dispersion models have been developed to calculate ambient concentrations as a function of source configurations, emission factors and meteorological characteristics. These provide a useful tool to ascertain the spatial and temporal patterns of ground level concentrations arising from the emissions of various point, line, area and volume sources. These outputs are primarily used in environmental and health impact assessments, risk assessments and emission control requirements.

For the purpose of this assessment, a screening level dispersion modelling platform, SCREEN3, was utilised to predict hourly average ground level downwind concentrations of pollutants emitted from the proposed crushing plant at the Makwase Crusher Plant.

SCREEN 3 is a single source Gaussian plume model that provides maximum ground level concentrations for point, area, flare, and volume sources. The SCREEN3 model results can be summed to conservatively estimate the impact from several sources (US EPA, 2012). SCREEN3 examines a full range of meteorological conditions, including standard stability classes and wind speeds, to determine maximum impacts. The full set of meteorological conditions (all stability classes and wind speeds) was used to estimate conditions at various distances from the crusher site.

7.3 MODEL INPUTS

All activities have been modelled as a single area source as a conservative approach. The hourly concentrations of the area source emissions calculated in SCREEN3 were converted to 24-hour and annual concentrations by multiplying the predicted hourly concentrations by 0.4 and 0.08 respectively, as prescribed in the reference document "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources – Revised" (US EPA, 2012). This method is acknowledged to be environmentally conservative and is the Tier 1 model recommended in The Regulations Regarding Air Dispersion Modelling published in Government Notice 533 of 2014 (Government Gazette 37804, page 9, 10).

The following input parameters were utilised for the model:

- Source type (point, area, flare or volume) (as detailed in);
- Dispersion co-efficient (urban or rural);
- Receptor height;
- Emission rates (as detailed in);
- Area parameters (release height, length and width) (as detailed in
- Terrain (simple or complex);
- Meteorology (stability classes and wind speed); and
- Distance of receptors from the source.

Table 20 presents the input parameters for the area sources used in the screening model to predict downwind concentrations of pollutants from the site.

PARAMETER	UNIT	VALUE
Source Release Height	m	3
Receptor Flagpole Height	m	1.5
Dispersion Coefficient	-	rural
Meteorology	-	Full meteorology (All stability classes and wind speeds)
Distance	m	1 to 3000
Terrain	-	Simple terrain, flat option

Table 20 : SCREEN3 input parameters for the proposed crushing plant at the Makwase Crusher Plant.

7.4 SOURCE DATA

The emission rates, source locations, and source parameters for the emission sources used in the model were based on the data presented by the client and calculated accordingly.

7.5 URBAN OR RURAL DISPERSION COEFICIENT

The dispersion coefficient with value "rural" was selected for air modeling purposes.

7.6 TERRAIN

The proposed project was modelled using the Simple Terrain Mode, with Flat option.

7.7 METEOROLOGICAL DATA

The wind speed and stability classes combinations that are considered in SCREEN3 are shown in **Table 21**. It is assumed that the pollutant does not undergo any chemical reactions, and that no other removal processes, such as wet or dry deposition, act on the plume during its transport from the source. SCREEN3 estimates a concentration along the plume centerline directly downwind from the source. The size of the plume and plume rise is determined by the degree of turbulence in the atmosphere which is parameterized according to stability class (A = unstable; B= unstable; C= unstable; D= neutral; E= stable; F = stable) where the unstable regime refers to turbulent conditions and the stable regime refers to stagnate conditions. The stability classes are determined by incorporating wind speed and insolation (e.g., cloud cover) data using empirical methods (Turner, 1970 and USEPA, 1995).

Table 21 : Generic meteorological conditions of wind speed and turbulence stability class combinations considered in SCREEN3.

STABILITY CLASS	WIND SPEED (m/s) AT 10 METERS ABOVE GROUND LEVEL												
	1	1.5	2	2.5	3	3.5	4	4.5	5	8	10	15	20
A - Unstable	*	*	*	*	*								
B - Unstable	*	*	*	*	*	*	*	*	*				
C - Unstable	*	*	*	*	*	*	*	*	*	*	*		
D- Neutral	*	*	*	*	*	*	*	*	*	*	*	*	*
E- Stable	*	*	*	*	*	*	*	*	*				
F- Stable	*	*	*	*	*	*	*						

7.8 MODEL PREDICTIONS

The dispersion modelling results for both uncontrolled and controlled emissions are presented below. Predicted $PM_{2.5}$ and PM_{10} concentrations over a distance between 10 m and 3 km have been assessed. Cumulative concentrations were not determined as no background data was available.

Maximum $PM_{2.5}$ concentrations are predicted to be compliant with the National 24-hour and annual average standards of 40 µg/m^3 and 20 µg/m^3, respectively (**Table 22**). For both scenarios, the highest predicted $PM_{2.5}$ concentrations occur at a distance of 23 m from the facility (**Figure 17** and **Figure 18**). 24-hour average $PM_{2.5}$ concentrations at the closest sensitive receptor of Piet Retief/President van Rensburg school (located 1.5 km away from the facility) are predicted to be 0.17 µg/m^3 and 0.15 µg/m^3 for the uncontrolled and controlled scenarios, respectively. Annual average $PM_{2.5}$ concentrations at Piet Retief/President van Rensburg school are predicted to be 0.03 µg/m^3 and 0.03 µg/m^3 for the uncontrolled and controlled scenarios, respectively (**Table 22**).

Maximum PM_{10} concentrations are predicted to be compliant the National 24-hour and annual average standards of 75 µg/m^3 and 40 µg/m^3, respectively, with the exception of the uncontrolled 24-hour averaging period, which is exceeding the 24-hour average standard (**Table 23**). For both scenarios, the PM_{10} highest predicted concentrations occur at a distance of 23 m from the facility (**Figure 19** and **Figure 20**). Ambient 24-hour average PM_{10}

concentrations at the sensitive receptor of Piet Retief/President van Rensburg school are predicted to be 1.26 µg/m^3 and 0.51 µg/m^3 for the uncontrolled and controlled scenarios, respectively. Annual average PM_{10} concentrations at the Piet Retief/President van Rensburg school are predicted to be 0.25 µg/m^3 and 0.10 µg/m^3 for the uncontrolled and controlled scenarios, respectively (**Table 24**).

As such, concentrations at the closest residential receptor are expected to be low and are compliant with the respective NAAQS for both scenarios.

Table 22: Summary of maximum predicted $PM_{2.5}$ concentrations for the proposed Makwase crusher plant.

ACTIVITY	UNCONTROLLED		CONTROLLED	
	MAXUMUM 24- HOUR CONCENTRATION (µg/m^3)	ANNUAL CONCENTRATION (µg/m^3)	MAXUMUM 24- HOUR CONCENTRATION (µg/m^3)	ANNUAL CONCENTRATION (µg/m^3)
ALL SOURCES	15.92	3.18	14.27	2.85

Table 23: Summary of maximum predicted PM_{10} concentrations for the proposed Makwase crusher plant.

ACTIVITY	UNCONTROLLED		CONTROLLED	
	MAXUMUM 24- HOUR CONCENTRATION (µg/m^3)	ANNUAL CONCENTRATION (µg/m^3)	MAXUMUM 24- HOUR CONCENTRATION (µg/m^3)	ANNUAL CONCENTRATION (µg/m^3)
ALL SOURCES	**118.52**	23.70	47.48	9.50

Table 24: Summary of maximum predicted $PM_{2.5}$ and PM_{10} concentrations at the Piet Retief/President van Rensburg school.

ACTIVITY	UNCONTROLLED		CONTROLLED	
	MAXUMUM 24- HOUR CONCENTRATION (µg/m^3)	ANNUAL CONCENTRATION (µg/m^3)	MAXUMUM 24- HOUR CONCENTRATION (µg/m^3)	ANNUAL CONCENTRATION (µg/m^3)
PM10	1.26	0.25	0.51	0.10
PM2.5	0.17	0.03	0.15	0.03

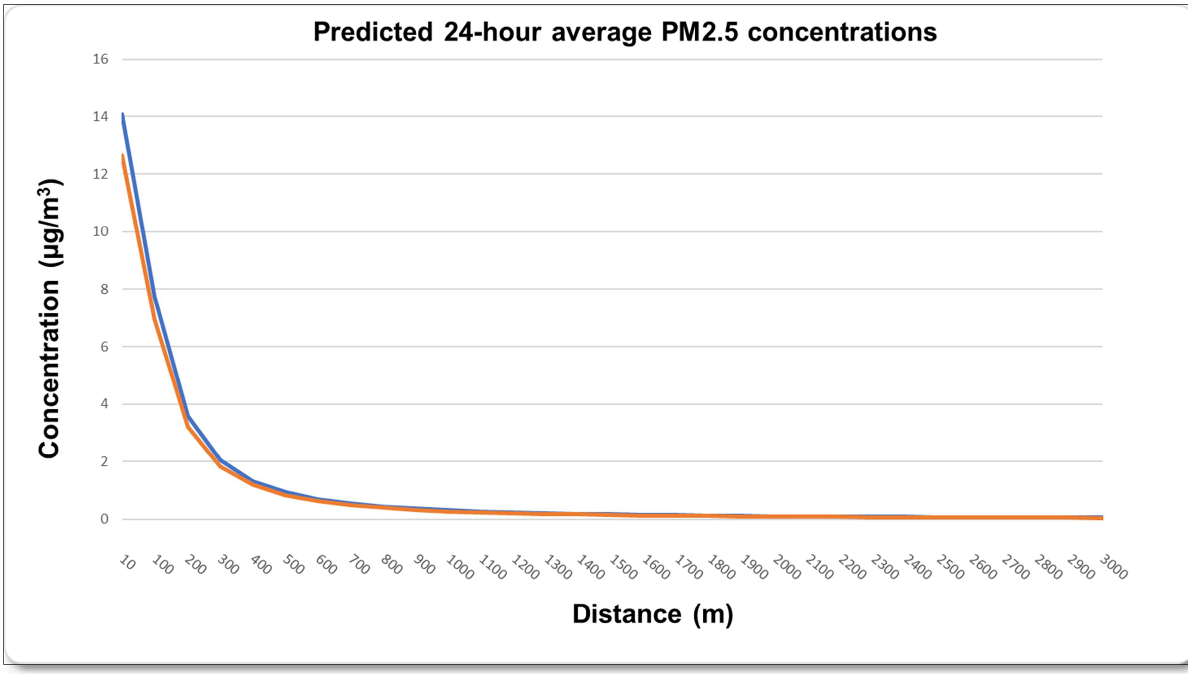

Figure 17: Predicted 24-hour average $PM_{2.5}$ concentrations (Blue line uncontrolled, red line controlled).

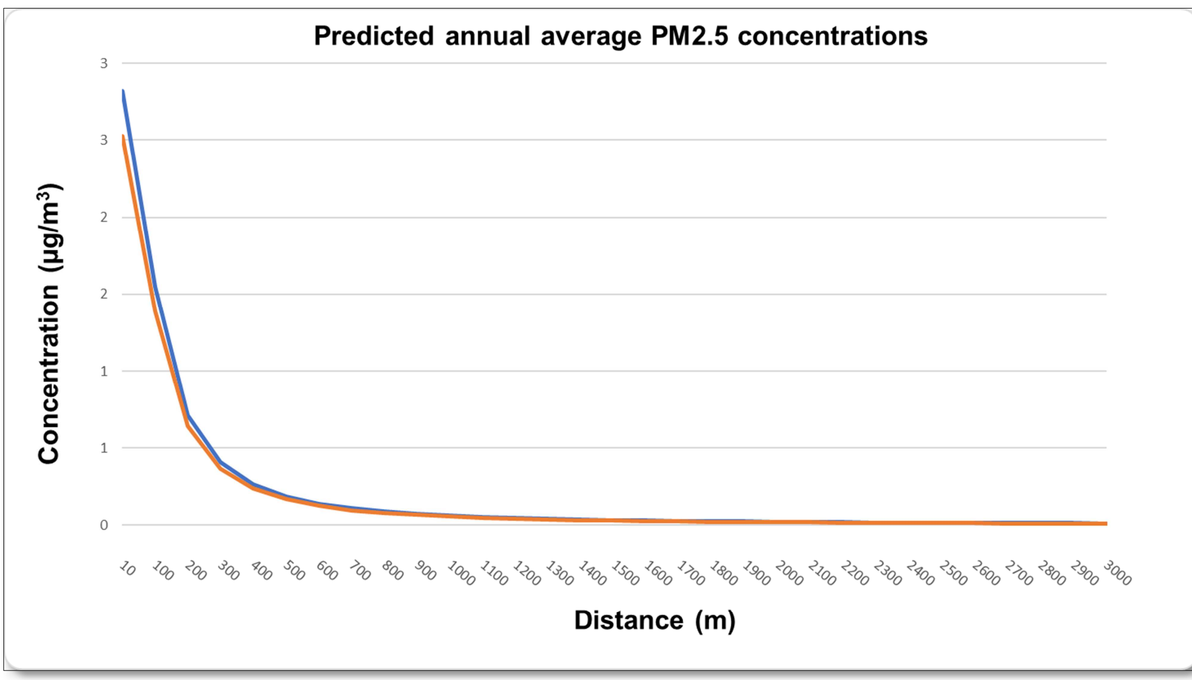

Figure 18: Predicted annual average $PM_{2.5}$ concentrations. (Blue line uncontrolled, red line controlled).

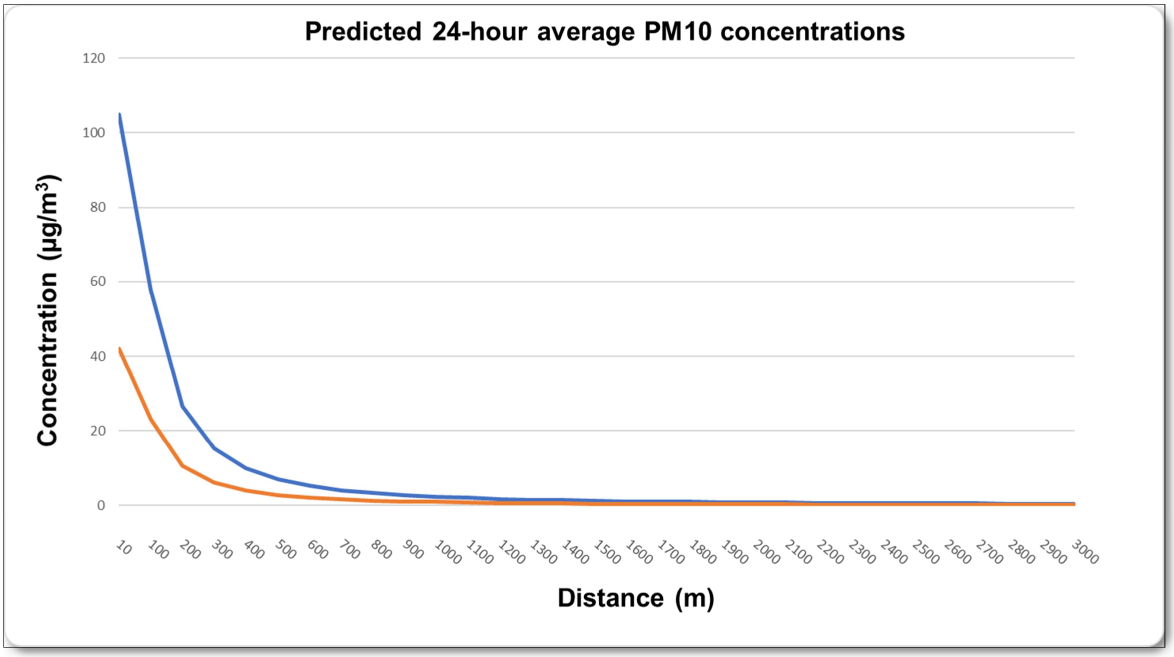

Figure 19: Predicted 24-hour average PM_{10} concentrations. (Blue line uncontrolled, red line controlled).

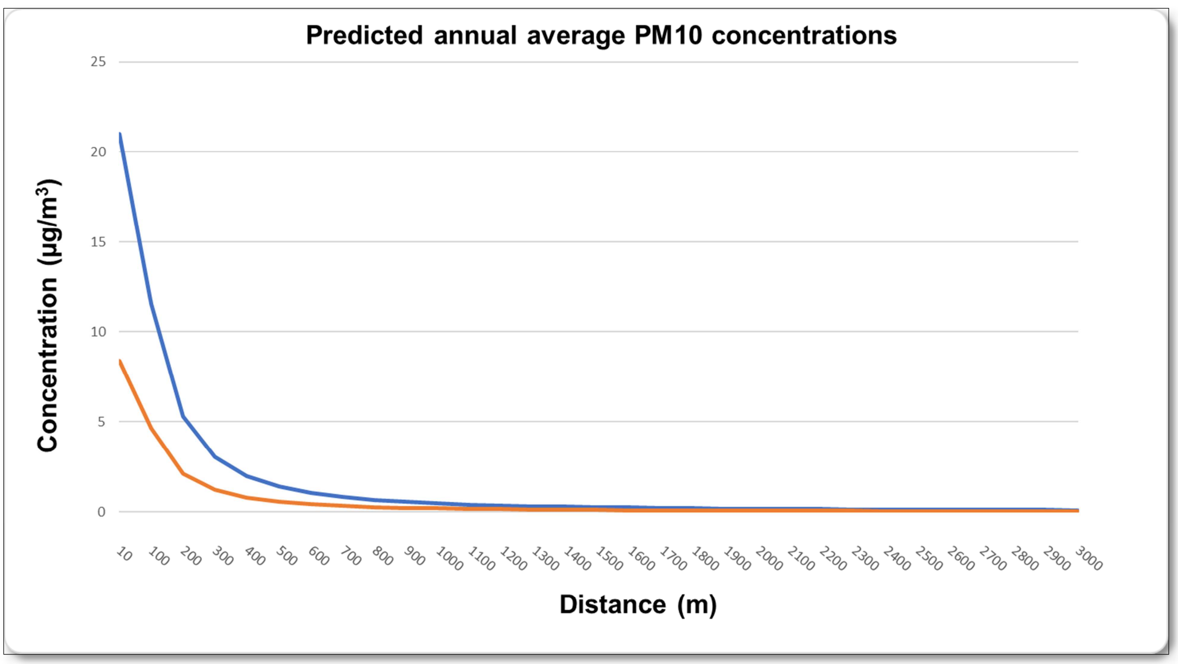

Figure 20: Predicted annual average PM_{10} concentrations. (Blue line uncontrolled, red line controlled).

It is important to note that SCREEN3 model predictions are inherently conservative and reflect the highest possible ground-level concentrations based on worst-case meteorological conditions and in reality, such conditions and concentrations are unlikely to occur. A constant throughput of 780 000 t/annum was also assumed for each source, and in reality, throughputs would vary for each respective source. All sources have also been assumed to be operating continuously.

7.9 CUMULATIVE IMPACTS

Emissions from sources need to be assessed in terms of the cumulative impacts in an area. For the purposes of determining cumulative impacts, the Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa (DEA, 2014), outlines the following for sources influenced by background concentrations e.g. in urban areas and priority areas:

- For annual averages, sum of the highest predicted concentration (C_P) and background concentration (C_B) must be less than the National ambient air quality standards, no exceedances allowed;
- For short-term averages (24 hours or less), sum of the 99th percentile concentrations and background C_B must be less than the National ambient air quality standards. Wherever one year is modelled, the highest concentrations shall be considered.

In determining the cumulative impacts, predicted incremental concentrations should be added to the measured concentrations for the applicable pollutant averaging periods.

No background concentrations were available for this study, but given the low and localised impact this operation will have on surrounding environment, the contribution will be minimal.

7.10 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations of the study were identified:

- Data input into the model has been based on the information provided by the Client. It is assumed that the information provided by the Client is accurate and complete at the time of modelling;
- Where information was not provided by the Client assumptions were made;
- Particulate emission sources for the proposed development at the Makwase Crusher Plant emit 365 days per annum for 8 hours/day (Monday to Sunday);
-
- All sources have been quantified under the assumption that a constant volume of material will be in operation (780 000 tonnes/annum);
- Emission factors as per the US EPA AP42 (US EPA, 1995) have been applied to all material handling and crushing sources;
- All sources have been conservatively modelled as a single area source;
- A release height of 3 m has been assumed for the single area source;
- All emission rates presented in this report are representative of both uncontrolled and controlled emissions;
- TSP has been qualitatively quantified but has further been excluded from this assessment as SCREEN3 is a Level 1 model and cannot account for dust deposition (dust fallout); and
- Cumulative impacts have not been assessed as no background monitoring data is available.

8. CONCLUSIONS

This report investigates the potential air quality impacts associated with the operation of the proposed crushing plant at the Makwase Crusher Plant, near Mooinooi in the North West Province.

An overview of the prevailing meteorological conditions of the surrounding area was undertaken using weather data obtained from the meteorological station at Klipfontein for the period January to December 2008, and UM modelled data from SAWS for the period January 2009 to December 2011.The USEPA and Australian Government NPI emission factors were utilized to estimate $PM_{2.5}$, PM_{10} and TSP emissions from the proposed crushing plant. A Level 1 (screening) dispersion model, SCREEN3, was applied to predict the extent and magnitude of particulate concentrations during the operational phase. SCREEN3 is a Tier 1 model recommended in The Regulations Regarding Air Dispersion Modelling published in Government Notice 533 of 2014 (Government Gazette 37804, page 9, 10) and was considered applicable for this assessment. Comparison of predicted concentrations was made against the relevant NAAQS to determine compliance. It is important to note that TSP was qualitatively quantified, but was not considered further in the assessment as dust deposition cannot be determined using a Level 1 model.

Results from the screening dispersion modelling simulations indicate that:

- Maximum $PM_{2.5}$ concentrations are predicted to be compliant with the National 24-hour and annual average standards of 40 µg/m^3 and 20 µg/m^3, respectively. For both scenarios, the highest predicted $PM_{2.5}$ concentrations occurred at a distance of approximately 23 m from the facility.
- Maximum PM_{10} concentrations are predicted to be compliant the National 24-hour and annual average standards of 75 µg/m^3 and 40 µg/m^3, respectively, with the exception of the uncontrolled 24-hour averaging period, which is exceeding the 24-hour average standard. For both scenarios the highest predicted PM_{10} concentrations occurred at a distance of approximately 23 m from the facility.
- 24-hour average $PM_{2.5}$ concentrations at the closest residential receptor, Piet Retief/President van Rensburg school, which is located 1.5 km away from the facility were predicted to be 0.17 µg/m^3 and 0.15 µg/m^3 for the uncontrolled and controlled scenarios, respectively. Annual average $PM_{2.5}$ concentrations at Piet Retief/President van Rensburg school were predicted to be 0.03 µg/m^3 and 0.03 µg/m^3 for the uncontrolled and controlled scenarios, respectively.
- 24-hour average PM_{10} concentrations at Piet Retief/President van Rensburg school were predicted to be 28.8 µg/m^3 and 10.1 µg/m^3 for the uncontrolled and controlled scenarios, respectively. Annual average PM10 concentrations at Piet Retief/President van Rensburg school were predicted to be 1.26 µg/m^3 and 0.51 µg/m^3 for the uncontrolled and controlled scenarios, respectively.

As such, PM concentrations at the closest residential receptor and beyond are expected to be low and are compliant with their respective NAAQS for both scenarios.

It is important to note that SCREEN3 model predictions are inherently conservative and reflect the highest possible ground-level concentrations based on worst-case meteorological conditions. In reality, such conditions and concentrations are unlikely to occur. In addition, emission estimations were based on a constant throughput of 780 000 tonnes/annum for each scenario, resulting in higher concentration predictions than would likely be the case in reality. As such, it is recommended that more refined emissions calculations and dispersion modelling simulations (Level 2) be undertaken once a detailed design basis becomes available to accurately assess the potential air quality impacts associated with the proposed development of the staged mobile crushing plant at the Makwase Crusher Plant.

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