Noise Specialist Study for the Proposed West Wits Mining Project

Project done for SLR Consulting (South Africa) (Pty) Ltd

Report compiled by:
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Report Details

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Revision Record

Version	Date	Comments
Rev 0	February 2019	For client review
Rev 0.1	April 2019	Incorporation of client comments
Rev 0.2	May 2019	Incorporation of client comments
Rev 0.3	May 2019	Grammatical changes
Rev 0.4	May 2019	Update of management measures

NEMA Regulation (2014), Appendix 6

NEMA Regulations (2014) (as amended) - Appendix 6	Relevant section in report
Details of the specialist who prepared the report	Section 1.3
The expertise of that person to compile a specialist report including a curriculum vitae	Section 1.3 and Appendix B
A declaration that the person is independent in a form as may be specified by the competent authority	Report details (Executive Summary) and Section 1.3
An indication of the scope of, and the purpose for which, the report was prepared	Section 1.2
An indication of the quality and age of base data used for the specialist report	Section 3.3
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 3.3 and Section 4.2
The duration date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 3.3
A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 1.6
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An identification of any areas to be avoided, including buffers	Not applicable
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 1
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.7
A description of the findings and potential implications of such findings on the impact of the proposed activity or activities	Section 4.2
Any mitigation measures for inclusion in the EMPr	Section 5
Any conditions for inclusion in the environmental authorisation	No comments received.
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 5
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and regarding the acceptability of the proposed activity or activities	Section 7
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 5
A description of any consultation process that was undertaken during the course of preparing the specialist report	Not applicable.
A summary and copies of any comments received during any consultation process and where applicable all responses thereto	Not applicable.
Any other information requested by the competent authority.	Not applicable.

Glossary and Abbreviations

Airshed	Airshed Planning Professionals (Pty) Ltd
ASG	Atmospheric Studies Group
dB	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure.
dBA	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure that has been A-weighted to simulate human hearing.
C_i	Correction for impulsiveness
Ct	Correction for tonality
EAP	Environmental Assessment Practitioner
EC	European Commission
EHS	Environmental, Health, and Safety (IFC)
FMAC	Francois Malherbe Acoustic Consulting cc
Hz	Frequency in Hertz
HV	Heavy vehicle
IEC	International Electro Technical Commission
IFC	International Finance Corporation
ISO	International Standards Organisation
Kn	Noise propagation correction factor
K1	Noise propagation correction for geometrical divergence
K2	Noise propagation correction for atmospheric absorption
K3	Noise propagation correction for the effect of ground surface;
K4	Noise propagation correction for reflection from surfaces
K5	Noise propagation correction for screening by obstacles
kW	Power in kilowatt
L_{Aeq} (T)	The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
L_{AIeq} (T)	The impulse corrected A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
$L_{Req,d}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.
$L_{Req,n}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.
$L_{R,dn}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10dB in order to account for the additional disturbance caused by noise during the night.
L_{A90}	The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels (L_{A90}) (in dBA)
L_{AFmax}	The A-weighted maximum sound pressure level recorded during the measurement period

L_{AFmin}	The A-weighted minimum sound pressure level recorded during the measurement period
L_{me}	Sound power level 25 m from a road, 4 m above ground (in dBA)
L_P	Sound pressure level (in dB)
L_{PA}	A-weighted sound pressure level (in dBA)
L_{PZ}	Un-weighted sound pressure level (in dB)
Ltd	Limited
L_W	Sound Power Level (in dB)
NEMAQA	National Environment Management Air Quality Act
masl	Meters above sea level
m^2	Area in square meters
m/s	Speed in meters per second
NLG	Noise level guideline
NSR	Noise sensitive receptor
p	Pressure in Pa
Pa	Pressure in Pascal
µPa	Pressure in micro-pascal
p_{ref}	Reference pressure, 20 µPa
Pty	Proprietary
rpm	Rotational speed in revolutions per minute
SABS	South African Bureau of Standards
SANS	South African National Standards
SLM	Sound Level Meter
SoW	Scope of Work
STRM	Shuttle Radar Topography Mission
USGS	United States Geological Survey
WG-AEN	Working Group – Assessment of Environmental Noise (EC)
WHO	World Health Organisation
%	Percentage

Executive Summary

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by SLR Consulting (South Africa) (Pty) Ltd to undertake a specialist environmental noise impact study for the Proposed West Wits Mining Project (hereafter referred to as the project).

The main objective of the noise specialist study was to determine the potential impact on the acoustic environment and potential noise sensitive receptors (NSRs) as a result of the development of the proposed project and recommend suitable management and mitigation measures. To meet the above objective, the following tasks were included in the Scope of Work (SoW):

1. A review of available technical project information.
2. A review of the legal requirements and applicable environmental noise guidelines.
3. A study of the receiving (baseline) acoustic environment, including:
    a. The identification of NSRs from available maps and field observations;
    b. A study of environmental noise attenuation potential by referring to available weather records, land use and topography data sources; and
    c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from surveys conducted on 26 and 27 March 2018.
4. An impact assessment, including:
    a. The establishment of a source inventory for proposed activities.
    b. Noise propagation simulations to determine environmental noise levels as a result of the project.
    c. The screening of simulated noise levels against environmental noise criteria.
    d. Assessment of impact significance levels.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. The preparation of a comprehensive specialist noise impact assessment report.

The South African National Standards (SANS) 10103 guidelines, which are in line with those published by the IFC in their *General Environmental Health and Safety (EHS) Guidelines* and World Health Organisation (WHO) *Guidelines for Community Noise*, were considered in the assessment. The Gauteng Province also has Noise Control Regulations that were taken into consideration with the assessment of the project noise impacts.

The baseline acoustic environment was described in terms of the location of NSRs, the ability of the environment to attenuate noise over long distances, as well as existing background and baseline noise levels. The following was found (see Figure 1):

- NSRs:
    - Includes places of residence and areas where members of the public may be affected by noise generated by proposed activities.
    - NSRs in the vicinity of the proposed operations and the West Wits mining right application area include numerous residential areas, including schools, hospitals and clinics.

- On average, noise impacts are expected to be slightly more notable to the south of the project activities. Terrain may affect noise propagation between sources and NSRs by acting as noise barriers.
- The acoustic climate at NSRs is currently affected by road traffic, community activities, air traffic, domesticated animals as well as natural noises such as birds and insects.
- Recorded $L_{Req,d}$ at all sampling locations during the daytime survey are similar to those given in the SANS 10103 as typical for suburban and urban districts. The LReq,n at sampling locations 2 and 3 are typical for suburban and urban districts at night-time as described by SANS 10103, the recorded LAReq,n at sampling location 1 more closely resembles that of a central business district as described by SANS 10103 due to heavy traffic on the R41 road. Due to safety considerations no night time measurements were conducted at locations 4, 5 and 6. SANS 10103 typical night time outdoor rating levels are assumed based on daytime levels.

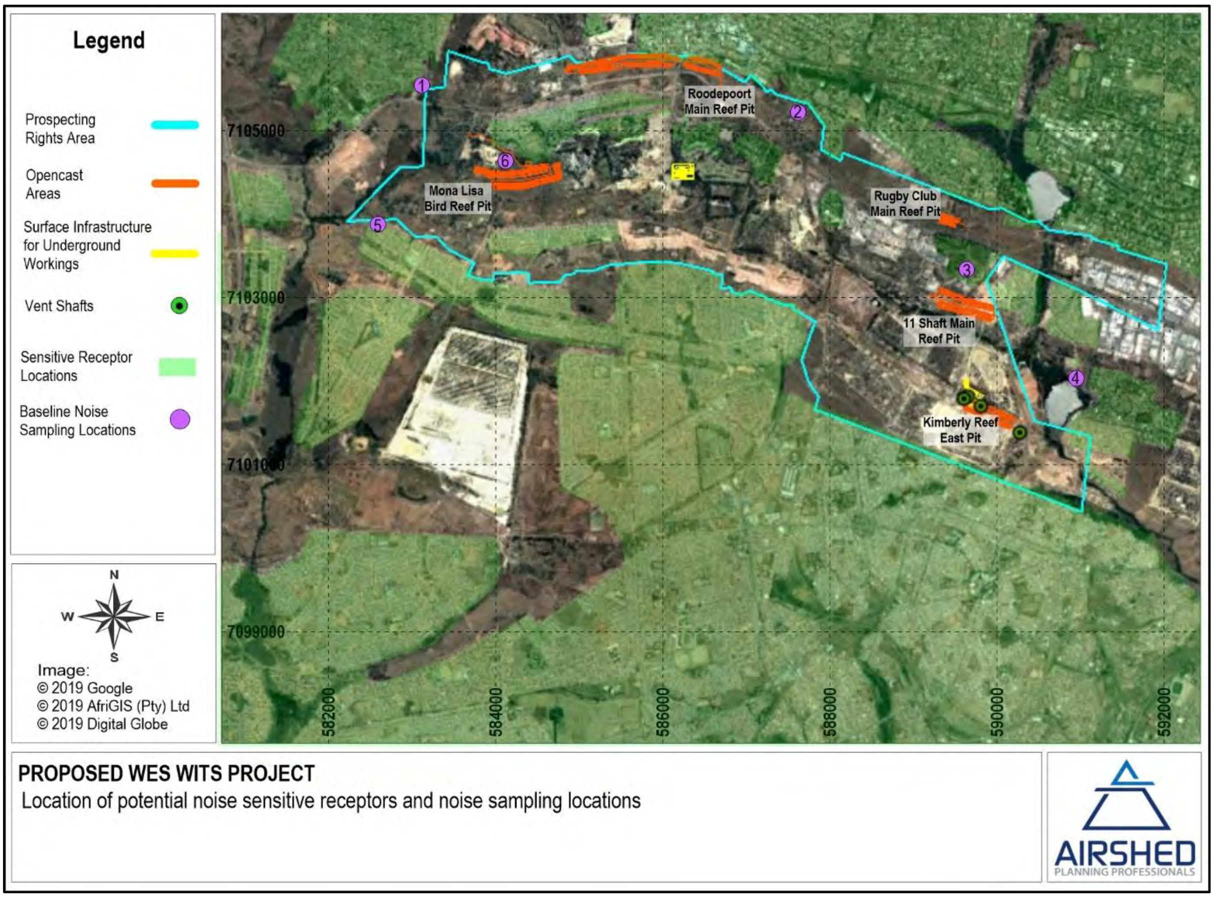

Figure 1: Proposed location for the proposed project components with the location of potential sensitive receptors and noise sampling locations

Noise emissions from diesel powered mobile equipment were estimated using L_W predictions for industrial machinery (Bruce & Moritz, 1998), where L_W estimates are a function of the power rating of the equipment engine. General materials handling L_W's were obtained from the database of François Malherbe Acoustic Consulting cc (FMAC) for similar operations. Values from the database are based on source measurements. Estimates of road traffic were made given mining and production rates, truck capacities, assumed vehicle speeds and road conditions.

The source inventory, local meteorological conditions and information on local land use were used to populate the noise propagation model (CadnaA, ISO 9613). The propagation of noise was calculated over an area of 9.5 km east-west by 6.8 km north-south. The area was divided into a grid matrix with a 50-m resolution.

The main findings of the impact assessment are:

- The simulated noise levels from the proposed project operations exceed the selected noise criteria at the closest NSRs surrounding the project sites.
- A management and mitigation plan are recommended to minimise noise impacts from the project on the surrounding area.
- Construction and closure phase impacts are expected to me similar or slightly lower than simulated noise impacts of the operational phase.
- The significance of the noise impacts due to proposed project activities were found to be *medium* at all unmitigated opencast mining operations with the exception of operations at the Kimberly Reef East Pit which was *low*. Assuming the adoption of good practice noise mitigation and management measures as recommended, the significance of project noise impacts may be reduced in frequency and severity and reduces to *low significance*. For underground mining activities, the significance was *low* for unmitigated and mitigated operations.

The following key recommendations should be included in the project environmental management programme:

- A monitoring programme as per the requirements of the International Finance Corporation (IFC) and SANS 10103:
  - Once-off during the operational phase of each opencast mining area at the closest NSR;
  - Annually during the operational phase of underground mining activities at the closest NSR; and
  - In response to complaints received.

Based on the findings of the assessment and the close proximity of NSRs to the project, it is recommended good engineering practice mitigation and where possible additional screening measures are in place during the operational phase of the project.

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1 Introduction

West Wits MLI (Proprietary) Limited (West Wits) is applying for a mining rightfor an area located south of Roodepoort and to the north of Soweto in the City of Johannesburg Metropolitan Municipality, Gauteng. The proposed mining operation (the project) would involve the development of five open pit mining areas (referred to as the Mona Lisa Bird Reef Pit, Roodepoort Main Reef Pit, Rugby Club Main Reef Pit, 11 Shaft Main Reef Pit and Kimberley Reef East Pit) and refurbishment of two existing infrastructure complexes (referred to as the Bird Reef Central Infrastructure Complex and Kimberley Reef East Infrastructure Complex) to access the existing underground mine workings.

The proposed project would also include the establishment of run of mine (ROM) ore stockpiles, topsoil stockpiles and waste rock dumps as well as supporting infrastructure including material storage and handling facilities (for fuel, lubricants, general and hazardous substances), general and hazardous waste management facilities, sewage management facilities, water management infrastructure, communication and lighting facilities, centralised and satellite offices, workshops, washbays, stores, change houses, lamprooms, vent fans and security facilities.

Primary mineral processing is proposed take place on site, where ore would be crushed prior to transportation offsite. All run-of mine material would be transported to an existing processing plant off-site for concentrating of minerals.

The expected life of mine for the open pit operations (inclusive of rehabilitation) is three (3) to five (5) years and 20 years and 10 years for the Kimberly East underground operations and the Bird Reef Central underground workings respectively. The pits would be mined in a phased approach with each pit taking between six and 16 months to be mined and rehabilitated.

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by SLR Consulting (South Africa) (Pty) Ltd to undertake a specialist environmental noise impact study for the West Wits Mining Project (hereafter referred to as the project).

1.1 Study Objective

The main objective of the noise specialist study was to determine the potential impact on the acoustic environment and potential noise sensitive receptors (NSRs) as a result of the operations at the project and recommend suitable management and mitigation measures. The location of the project site is provided in Figure 1.

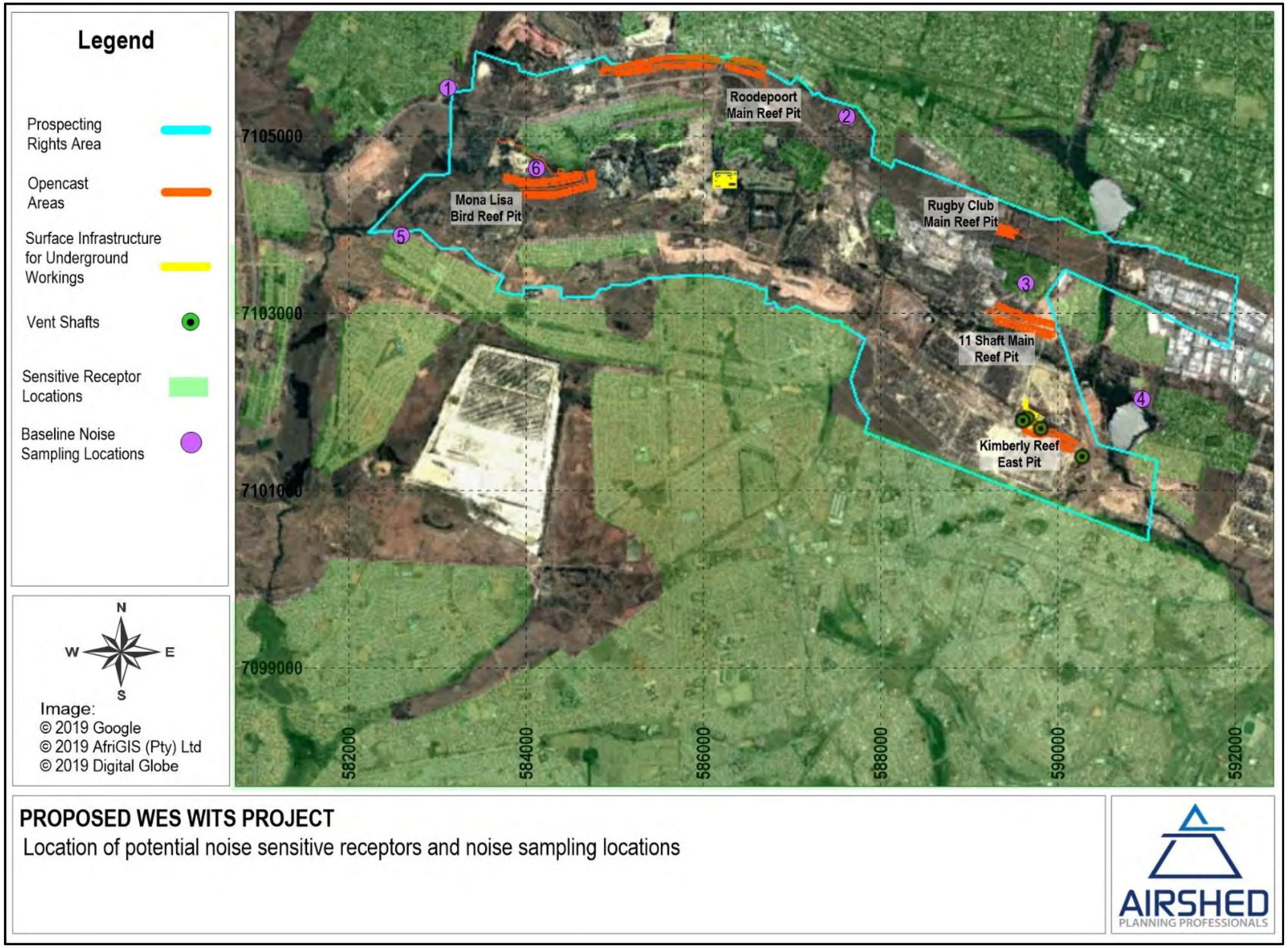


Figure 2: Proposed location for the proposed project components with the location of potential sensitive receptors and noise sampling locations

1.2 Scope of Work

To meet the above objective, the following tasks were included in the Scope of Work (SoW):

1. A review of available technical project information.
2. A review of the legal requirements and applicable environmental noise guidelines.
3. A study of the receiving (baseline) acoustic environment, including:
   a. The identification of NSRs from available maps and field observations;
   b. A study of environmental noise attenuation potential by referring to available weather records, land use and topography data sources; and
   c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from surveys conducted on 26 and 27 March 2018.
4. An impact assessment, including:
   a. The establishment of a source inventory for proposed activities.
   b. Noise propagation simulations to determine environmental noise levels as a result of the project.
   c. The screening of simulated noise levels against environmental noise criteria.
   d. Assessment of impact significance levels.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. The preparation of a comprehensive specialist noise impact assessment report.

1.3 Specialist Details

Airshed is an independent consulting firm with no interest in the project other than to fulfil the contract between the client and the consultant for delivery of specialised services as stipulated in the terms of reference.

Reneé von Gruenewaldt is a Registered Professional Natural Scientist (Registration Number 400304/07) with the South African Council for Natural Scientific Professions (SACNASP) and a member of the National Association for Clean Air (NACA).

Following the completion of her bachelor's degree in atmospheric sciences in 2000 and honours degree (with distinction) with specialisation in Environmental Analysis and Management in 2001 at the University of Pretoria, her experience in air pollution started when she joined Environmental Management Services (now Airshed Planning Professionals) in 2002. Reneé von Gruenewaldt later completed her Master's Degree (with distinction) in Meteorology at the University of Pretoria in 2009.

Reneé von Gruenewaldt became partner of Airshed Planning Professionals in September 2006. Airshed Planning Professionals is a technical and scientific consultancy providing scientific, engineering and strategic air pollution impact assessment and management services and policy support to assist clients in addressing a wide variety of air pollution related risks and air quality management challenges.

She has extensive experience on the various components of air quality management including emissions quantification for a range of source types, simulations using a range of dispersion models, impacts assessment and health risk screening assessments. Reneé has been the principal air quality specialist and manager on several Air Quality Impact Assessment between 2006 to present and Noise Assessment projects between 2015 and present and her project experience ranges over various countries in Africa, providing her with an inclusive knowledge base of international legislation and requirements pertaining to air quality and noise impacts.

A comprehensive curriculum vitae of Reneé von Gruenewaldt is provided in Appendix B.

1.4 Description of Activities from a Noise Perspective

Construction phase activities will include bulk earthworks (for the establishment of open pits, stockpiles, waste rock dumps and haul routes).

Access to site will be via main access roads. Opencast mining will include excavation and transport of ore and waste. Ore will be transported by truck via dedicated haul roads. The main source of noise for underground mining activities will include the ventilation shafts.

During decommissioning, bulk earthworks are expected. Very little information regarding the decommissioning phase was available for consideration. From a noise perspective it is, however, likely to be similar in character and impact to the construction phase.

Noise generating sources are very similar for the construction and mining phase of surface mining operations. Noise is emitted by construction equipment used for activities such as land clearing, site preparation, excavation, clean-up, and landscaping. The same types of equipment (diesel mobile equipment) will be used for the liberation, excavation, handling and transport of mined ore and waste rock.

Construction and diesel mobile mining equipment can be described or divided into distinct categories. These are earthmoving equipment, materials handling equipment, stationary equipment, impact equipment, and other types of equipment. The first three categories include machines that are powered by internal combustion engines. Machines in the latter two categories are powered pneumatically, hydraulically, or electrically. Additionally, exhaust noise tends to account for most of the noise emitted by machines in the first three categories (those that use internal combustion engines) whereas engine-related noise is usually secondary to the noise produced by the impact between impact equipment and the material on which it acts (Bugliarello, Alexandre, Barnes, & Wakstein, 1976).

Construction and diesel mobile mining equipment generally produce noise in the lower end of the frequency spectrum. Reverse or moving beeper alarms emit at higher frequency ranges and are often heard over long distances.

Noise generated during mine construction and surface mining activities is highly variably since it is characterised by variations in the power expended by equipment. Besides having daily variations in activities, major construction and mining projects are accomplished in several different phases where each phase has a specific equipment mix depending on the work to be accomplished during that phase.

Although not assessed as part of this study, the character of noise generated by blasting is mentioned. Blasting can cause noise and vibration, which can have an impact upon neighbouring noise receptors. Blasting usually results in both ground and airborne vibration. The latter includes both audible noise and vibration known as airblast, which can cause objects to rattle and make noise. Annoyance and discomfort from blasting can occur when noise startles individuals or when airblast or ground vibration causes vibration of building elements such as windows. The degree of annoyance is influenced by the level of airblast and vibration as well as factors such as the time of day, the frequency of occurrence and the sensitivity of individuals. The generation and transmission of airblast and ground vibration is affected by a number of factors including blast design, meteorology (particularly wind speed and direction and temperature inversions), topography, geology and soil water content (Earth Resources | Victoria State Government, 2015). Whereas the audible part of the airblast (acoustic) is characterized by frequencies ranging from 20 to 20 000 Hz the non-audible part, consist of sound energy below 20 Hz and is referred to as an ‘over pressure’ when the air blast pressure exceeds atmospheric pressure. Airblast over pressure exerts a force on structures and may in turn cause secondary and audible rattles within structures such as windows (Aloui, Bleuzen, Essefi, & Abbes, 2016).

1.5 Background to Environmental Noise and the Assessment Thereof

Before more details regarding the approach and methodology adopted in the assessment is given, the reader is provided with some background, definitions and conventions used in the measurement, calculation and assessment of environmental noise.

Noise is generally defined as unwanted sound transmitted through a compressible medium such as air. Sound in turn, is defined as any pressure variation that the ear can detect. Human response to noise is complex and highly variable as it is subjective rather than objective (that not all response to noise is the same).

A direct application of linear scales (in pascal (Pa)) to the measurement and calculation of sound pressure leads to large and unwieldy numbers. And, as the ear responds logarithmically rather than linearly to stimuli, it is more practical to express acoustic parameters as a logarithmic ratio of the measured value to a reference value. This logarithmic ratio is called a decibel or dB. The advantage of using dB can be clearly seen in Figure 3. Here, the linear scale with its large numbers is converted into a manageable scale from 0 dB at the threshold of hearing (20 micro-pascals (μPa)) to 130 dB at the threshold of pain (~100 Pa) (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

As explained, noise is reported in dB. “dB” is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure. The relationship between sound pressure and sound pressure level is illustrated in this equation.

$$L_p = 20 \cdot \log_{10}\left(\frac{p}{p_{ref}}\right)$$

Where:

L_p is the sound pressure level in dB;

p is the actual sound pressure in Pa; and

p_{ref} is the reference sound pressure (p_{ref} in air is 20 μPa).

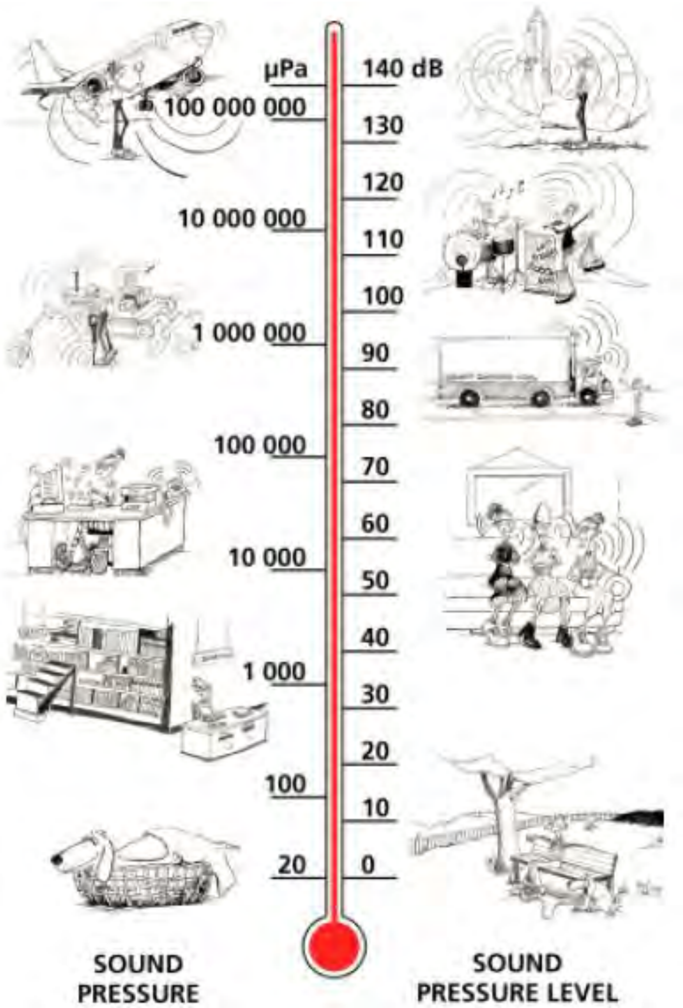


Figure 3: The decibel scale and typical noise levels (Brüel & Kjær Sound & Vibration Measurement A/S, 2000)

1.5.1 Perception of Sound

Sound has already been defined as any pressure variation that can be detected by the human ear. The number of pressure variations per second is referred to as the frequency of sound and is measured in hertz (Hz). The hearing frequency of a young, healthy person ranges between 20 Hz and 20 000 Hz.

In terms of L_P, audible sound ranges from the threshold of hearing at 0 dB to the pain threshold of 130 dB and above. Even though an increase in sound pressure level of 6 dB represents a doubling in sound pressure, an increase of 8 to 10 dB is required before the sound subjectively appears to be significantly louder. Similarly, the smallest perceptible change is about 1 dB (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

1.5.2 Frequency Weighting

Since human hearing is not equally sensitive to all frequencies, a 'filter' has been developed to simulate human hearing. The 'A-weighting' filter simulates the human hearing characteristic, which is less sensitive to sounds at low frequencies than at high frequencies (Figure 4). "dBA" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities, that have the same units (in this case sound pressure) have been A-weighted.

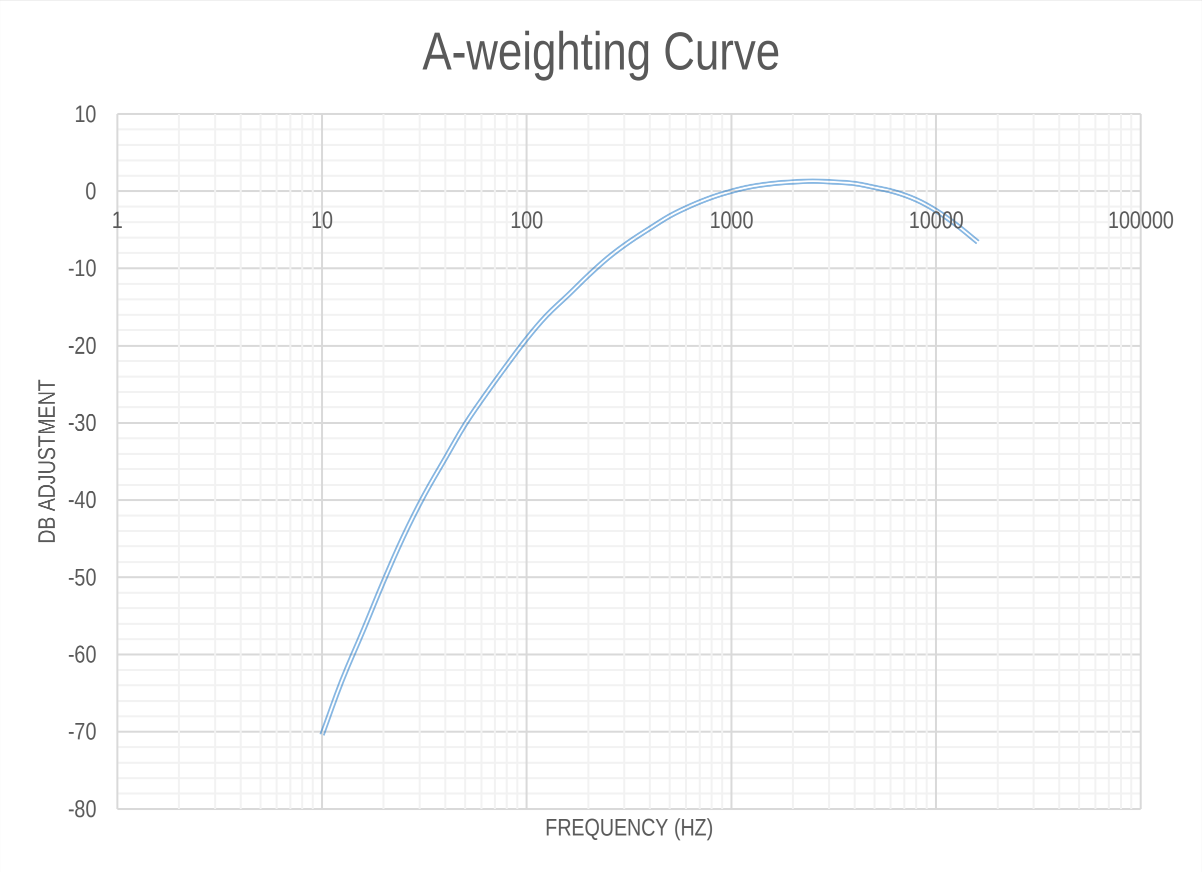


Figure 4: A-weighting curve

1.5.3 Adding Sound Pressure Levels

Since sound pressure levels are logarithmic values, the sound pressure levels as a result of two or more sources cannot simply be added together. To obtain the combined sound pressure level of a combination of sources such as those at an industrial plant, individual sound pressure levels must be converted to their linear values and added using:

$$L_{p\_combined} = 10 \cdot \log\left(10^{\frac{L_{p1}}{10}} + 10^{\frac{L_{p2}}{10}} + 10^{\frac{L_{p3}}{10}} + \cdots 10^{\frac{L_{pi}}{10}}\right)$$

This implies that if the difference between the sound pressure levels of two sources is nil the combined sound pressure level is 3 dB more than the sound pressure level of one source alone. Similarly, if the difference between the sound pressure levels of two sources is more than 10 dB, the contribution of the quietest source can be disregarded (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

1.5.4 Environmental Noise Propagation

Many factors affect the propagation of noise from source to receiver. The most important of these are:

- The type of source and its sound power (L_W);
- The distance between the source and the receiver;
- Atmospheric conditions (wind speed and direction, temperature and temperature gradient, humidity etc.);
- Obstacles such as barriers or buildings between the source and receiver;
- Ground absorption; and
- Reflections.

To arrive at a representative result from either measurement or calculation, all these factors must be taken into account (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

1.5.5 Environmental Noise Indices

In assessing environmental noise either by measurement or calculation, reference is generally made to the following indices:

- L_{Aeq} (T) – The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured). The International Finance Corporation (IFC) provides guidance with respect to L_{Aeq} (1 hour), the A-weighted equivalent sound pressure level, averaged over 1 hour.
- L_{AIeq} (T) – The impulse corrected A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured). In the South African Bureau of Standards' (SABS) South African National Standard (SANS) 10103 of 2008 for 'The measurement and rating of environmental noise with respect to annoyance and to speech communication' prescribes the sampling of L_{AIeq} (T).
- $L_{Req,d}$ – The L_{Aeq} rated for impulsive sound (L_{AIeq}) and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.
- $L_{Req,n}$ – The L_{Aeq} rated for impulsive sound (L_{AIeq}) and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.
- $L_{R,dn}$ – The L_{Aeq} rated for impulsive sound (L_{AIeq}) and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10 dB in order to account for the additional disturbance caused by noise during the night.
- L_{A90} – The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels.

- L_{AFmax} – The maximum A-weighted noise level measured with the fast time weighting. It's the highest level of noise that occurred during a sampling period.

1.6 Approach and Methodology

The assessment included a study of the legal requirements pertaining to environmental noise impacts, a study of the physical environment of the area surrounding the project and the analyses of existing noise levels in the area. The impact assessment focused on the estimation of sound power levels (L_W's) (noise 'emissions') and sound pressure levels (L_P's) (noise impacts) associated with the operational phase. The findings of the assessment components informed recommendations of management measures, including mitigation and monitoring. Individual aspects of the noise impact assessment methodology are discussed in more detail below.

1.6.1 Information Review

An information requirements list was submitted to the EAP at the onset of the project. In response to the request, the following information was supplied:

- Project and site layout maps;
- Mining schedule;
- Material throughputs;
- List of stationary and mobile equipment; and,
- A basic process description.

A site visit was conducted on the 8 May 2018 to the existing Solplaatjies open pit mining operations site to verify the list of equipment used for operations. As the equipment from this site will move over to the opencast mining operations, it was used for the current assessment.

1.6.2 Review of Assessment Criteria

In South Africa, provision is made for the regulation of noise under the National Environmental Management Air Quality Act (NEMAQA) (Act. 39 of 2004) but environmental noise limits have yet to be set. It is believed that when published, national criteria will make extensive reference to SANS 10103 of 2008 '*The measurement and rating of environmental noise with respect to annoyance and to speech communication*'. This standard has been widely applied in South Africa and is frequently used by local authorities when investigating noise complaints. These guidelines, which are in line with those published by the IFC in their *General Environmental Health and Safety (EHS) Guidelines* and World Health Organisation (WHO) *Guidelines for Community Noise*, were considered in the assessment. The Gauteng Province also has Noise Control Regulations that were taken into consideration with the assessment of the project noise impacts.

1.6.3 Study of the Receiving Environment

NSRs generally include residences, community buildings such as schools, hospitals and any publicly accessible areas outside an industrial facility's property.

The ability of the environment to attenuate noise as it travels through the air was studied by considering local meteorology, land use and terrain. Atmospheric attenuation potential was described based on WRF[1] meteorological data for the period 2015 to 2017.

Readily available terrain data was obtained from the United States Geological Survey (USGS) web site (https://earthexplorer.usgs.gov/). A study was made of Shuttle Radar Topography Mission (STRM) 1 arc-sec data.

1.6.4 Noise Survey

The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in an area. Higher ambient noise levels will result in less noticeable noise impacts and a smaller impact area. The opposite also holds true. Increases in noise will be more noticeable in areas with low ambient noise levels. The data from a baseline noise survey conducted on 26 and 27 March 2018 was studied to determine current noise levels within the area.

The survey methodology, which closely followed guidance provided by the SANS 10103 (2008) and IFC (2007), is summarised below:

- The survey was designed and conducted by a trained specialist.
- Sampling was carried out using a Type 1 sound level meter (SLM) that meet all appropriate International Electrotechnical Commission (IEC) standards and is subject to calibration by an accredited laboratory (Appendix A). Equipment details are included in Table 1.
- The acoustic sensitivity of the SLM was tested with a portable acoustic calibrator before and after each sampling session.
- A sample, 20 minutes in duration for day-time and 10 minute in duration for night-time, representative and sufficient for statistical analysis were taken with the use of the portable SLM capable of logging data continuously over the sampling time period. SANS 10103 defines day-time as between 06:00 and 22:00 and night-time between 22:00 and 06:00 (SANS 10103, 2008).
- L_{Aleq} (T), L_{Aeq} (T); L_{AFmax}; L_{AFmin}; L_{90} and 3rd octave frequency spectra were recorded.
- The SLM was located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- SANS 10103 states that one must ensure (as far as possible) that the measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer.
- A detailed log and record was kept. Records included site details, weather conditions during sampling and observations made regarding the acoustic environment of each site.

[1] The Weather Research and Forecasting (WRF) Model is a next-generation mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting applications.

Table 1: Sound level meter details

Equipment	Serial Number	Purpose	Last Calibration Date
Brüel & Kjær Type 2250 Lite SLM	S/N 2731851	Attended 20-minute sampling.	10 May 2017
Brüel & Kjær Type 4950 ½" Pre-polarized microphone	S/N 2709293	Attended 20-minute sampling.	10 May 2017
SVANTEK SV33 Class 1 Acoustic Calibrator	S/N 57649	Testing of the acoustic sensitivity before and after each daily sampling session.	10 May 2017
Kestrel 4000 Pocket Weather Tracker	S/N 559432	Determining wind speed, temperature and humidity during sampling.	Not Applicable

SANS 10103 (2008) prescribes the method for the calculation of the equivalent continuous rating level ($L_{Req,T}$) from measurement data. $L_{Req,T}$ is the equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$) during a specified time interval, plus specified adjustments for tonal character, impulsiveness of the sound and the time of day; and derived from the applicable equation:

$$L_{Req,T} = L_{Aeq,T} + C_i + C_t + K_n$$

Where

- $L_{Req,T}$ is the equivalent continuous rating level;
- $L_{Aeq,T}$ is the equivalent continuous A-weighted sound pressure level, in decibels;
- C_i is the impulse correction;
- C_t is the correction for tonal character; and
- K_n is the adjustment for the time of day (or night), 0 dB for daytime and +10 dB for night-time.

Instrumentation used in this survey are capable of integrating while using the I-time (impulse) weighting and $L_{AIeq,T}$ directly measured. When using $L_{AIeq,T}$, only the tonal character correction and time of day adjustment need to be applied to derive $L_{Req,T}$.

If audible tones such as whines, whistles, hums, and music are present as determined by the procedure given hereafter (e.g. if the noise contains discernible pitch), then C_t = +5 dBA may be used. If audible tones are not present, then C_t = 0 should be used. Note however that the method described in SANS 10103 is only recommended if there is uncertainty as to the presence of pitch and is considered a recommendation, not a requirement. The correction is predominantly the result of the subjective opinion of the specialist.

The presence of tones can be determined as follows (SANS 10103, 2008): Using a one-third octave band filter, which complies with the requirements of IEC 61260, the time average sound pressure level in the one-third octave band that contains the tone to be investigated as well as the time average one-third octave band sound pressure level in the adjacent bands to the one that contains the tone frequency should be measured. The difference between the time average sound pressure levels in the two adjacent one-third octave bands should be determined with the time average sound pressure level of the one-third octave band that contains the tone frequency. A level difference between the one-third octave band that contains the tone frequency and the two adjacent one-third octave bands should exceed the limits given in Table 2 to indicate the presence of a tonal component.

NOTE: the adjustment for tonality was only applied if the tone was clearly identifiable as being generated by human activities and not birds or insects.

Table 2: Level differences for the presence of a tonal component

Centre frequencies of 3rd octave bands (Hz)	Minimum 3rd octave band L_P difference (dB)
25 to 125	15
160 to 400	8
500 to 10 000	5

The equivalent continuous day/night rating level can be calculated using the following equation:

$$L_{R,dn} = \left[\left(\frac{d}{24}\right)10^{L_{Req,d}/10} + \left(\frac{24-d}{24}\right)10^{\left(L_{Req,n}+k_n\right)/10}\right]$$

Where

- $L_{R,dn}$ is the equivalent continuous day/night rating level;
- D is the duration of the day-time reference time period (06:00 to 22:00);
- $L_{Req,d}$ is the equivalent continuous rating level determined for the day-time reference time period (06:00 to 22:00);
- $L_{Req,n}$ is the equivalent continuous rating level determined for the night-time reference time period (22:00 to 06:00); and
- K_n is the adjustment 10 dB that should be added to the night-time equivalent continuous rating level.

NOTE: If no tonal correction is made, L_{Aleq} is equivalent to $L_{Req,T}$.

1.6.5 Source Inventory

Noise emissions from diesel powered mobile equipment were estimated using L_W predictions for industrial machinery (Bruce & Moritz, 1998), where L_W estimates are a function of the power rating of the equipment engine.

General materials handling L_W's were obtained from the database of François Malherbe Acoustic Consulting cc (FMAC) for similar operations. Values from the database are based on source measurements.

The rock breaker L_W's were calculated based on source measurements as obtained from the site visit undertaken at Solplaatjies on 8 May 2018.

Estimates of road traffic were made given mining rates and assumed vehicle speeds and road conditions.

1.6.6 Noise Propagation Simulations

The propagation of noise from proposed activities was simulated with the DataKustic CadnaA software. Use was made of the International Organisation for Standardization's (ISO) 9613 module for outdoor noise propagation from industrial noise sources.

ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level under meteorological conditions favourable to propagation from sources of known sound emission. These conditions are for downwind propagation or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night.

The method also predicts an average A-weighted sound pressure level. The average A-weighted sound pressure level encompasses levels for a wide variety of meteorological conditions. The method specified in ISO 9613 consists specifically of octave-band algorithms (with nominal midband frequencies from 63 Hz to 8 kHz) for calculating the attenuation of sound which originates from a point sound source, or an assembly of point sources. The source (or sources) may be moving or stationary. Specific terms are provided in the algorithms for the following physical effects; geometrical divergence, atmospheric absorption, ground surface effects, reflection and obstacles. A basic representation of the model is given in the equation below:

$$L_P = L_W - \sum [K_1, K_2, K_3, K_4, K_5, K_6]$$

Where;

L_P is the sound pressure level at the receiver;
L_W is the sound power level of the source;
K_1 is the correction for geometrical divergence;
K_2 is the correction for atmospheric absorption;
K_3 is the correction for the effect of ground surface;
K_4 is the correction for reflection from surfaces; and
K_5 is the correction for screening by obstacles.

This method is applicable in practice to a great variety of noise sources and environments. It is applicable, directly or indirectly, to most situations concerning road or rail traffic, industrial noise sources, construction activities, and many other ground-based noise sources.

To apply the method of ISO 9613, several parameters need to be known with respect to the geometry of the source and of the environment, the ground surface characteristics, and the source strength in terms of octave-band sound power levels for directions relevant to the propagation.

1.6.6.1 Simulation Domain

If the dimensions of a noise source are small compared with the distance to the listener, it is called a point source. All sources were quantified as point sources or areas/lines represented by point sources. The sound energy from a point source spreads out spherically, so that the sound pressure level is the same for all points at the same distance from the source and decreases by 6 dB per doubling of distance. This holds true until ground and air attenuation noticeably affect the level. The impact of an intruding industrial noise on the environment will therefore rarely extend over more than 5 km from the source and is therefore always considered "local" in extent.

The propagation of noise was calculated over an area of 9.5 km east-west by 6.8 km north-south and encompasses the project area. The area was divided into a grid matrix with a 50 m resolution. The model was set to calculate L_P's at each grid and discrete receptor point at a height of 1.5 m above ground level.

1.6.7 Presentation of Results

Noise impacts were calculated in terms of:

- The day-time noise level (L_{Aeq});
- The night-time noise level (L_{Aeq}) for underground mining operations only; and,
- The equivalent day/night noise level (L_{Aeq}).

As opencast mining operations will only take place during the day (06:00 to 18:00) the night-time noise level (L_{Aeq}) impacts were not calculated for this scenario.

Results are presented in isopleth form. An isopleth is a line on a map connecting points at which a given variable (in this case sound pressure, L_P) has a specified constant value. This is analogous to contour lines on a map showing terrain elevation. In the assessment of environmental noise, isopleths present lines of constant noise level as a function of distance.

Simulated noise levels were assessed according to guidelines published in SANS 10103 and by the IFC. To assess annoyance at nearby places of residence, the increase in noise levels above the baseline at NSRs were calculated and compared to guidelines published in SANS 10103.

1.6.8 Recommendations of Management and Mitigation

The findings of the noise specialist study informed the recommendation of suitable noise management and mitigation measures.

1.6.9 Impact Significance Assessment

The significance of environmental noise impacts was assessed according to the methodology adopted by SLR Consulting (South Africa) (Pty) Ltd and considered both an unmitigated and mitigated scenario. Refer to Appendix D of this report for the methodology.

1.7 Limitations and Assumptions

The following limitations and assumptions should be noted:

- Estimates of road traffic were made with the provided material throughputs and haul truck capacities. The vehicle speeds and road conditions were assumed. Trucks were assumed to travel at 40 km/h on site.
- The mitigating effect of pit walls acting as acoustic barriers was not taken into account, providing a conservative assessment of the noise impacts off-site.
- The quantification of sources of noise was limited to the operational phase of the project. Construction and closure phase activities are expected to be similar or less significant and its impacts only assessed qualitatively. Noise impacts will cease post-closure.
- Although other existing sources of noise within the area were identified, such sources were not quantified but were taken into account during the survey.

2 Legal Requirements and Noise Level Guidelines

2.1 National Standards

In South Africa, provision is made for the regulation of noise under the National Environmental Management Air Quality Act (NEMAQA) (Act. 39 of 2004) but legally enforceable environmental noise limits have yet to be set. It is believed that when published, national criteria will make extensive reference to the South African Bureau of Standards (SABS) standard South African National Standard (SANS) 10103 (2008) ‘The measurement and rating of environmental noise with respect to annoyance and to speech communication’. This standard has been widely applied in South Africa and is frequently used by local authorities when investigating noise complaints.

2.2 Gauteng Noise Control Regulations

The 1992 Noise Control Regulations (The Republic of South Africa, 1992) published in terms of Section 25 of the Environment Conservation Act (Act no. 73 of 1989) defines a “disturbing noise” as “a noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dBA or more.

In Gauteng, the 1992 Noise Control Regulations were replaced by the Gauteng Noise Control Regulations in 1999 (The Gauteng Provincial Government, 1999). Of importance to the current survey are the Gauteng Noise Control Regulations definitions’ for the following:

(a) A “controlled area” is a piece of land designated by a local authority where, in case of industrial noise in the vicinity of an industry:
    i. the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter was in operation, exceeds 60 dBA; or
    ii. the calculated outdoor equivalent continuous "A"-weighted” sound pressure level at a height of at least 1.2 metres, but not more than 1.4 metres, above the ground for a period of 24 hours, exceeds 60 dBA.

(b) A “disturbing noise" means a noise level that causes the ambient noise level to rise above the designated zone level, or if no zone level has been designated, the typical rating levels for ambient noise in districts, as per SANS 10103 (2008) (Table 3).

2.3 SANS 10103 (2008)

SANS 10103 (2008) addresses the manner in which environmental noise measurements are to be taken and assessed in South Africa, and is fully aligned with the WHO guidelines for Community Noise (WHO, 1999). It should be noted that the values given in Table 3 are typical rating levels that it is recommended should not be exceeded outdoors in the different districts specified.

Table 3: Typical rating levels for outdoor noise

Type of district	Equivalent Continuous Rating Level ($L_{Req,T}$) for Outdoor Noise		
	Day/night $L_{R,dn}$[(c)] (dBA)	Day-time $L_{Req,d}$[(a)] (dBA)	Night-time $L_{Req,n}$[(b)] (dBA)
Rural districts	45	45	35
Suburban districts with little road traffic	50	50	40
Urban districts	55	55	45
Urban districts with one or more of the following; business premises; and main roads.	60	60	50
Central business districts	65	65	55
Industrial districts	70	70	60

Notes

(a) $L_{Req,d}$ =The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.

(b) $L_{Req,n}$ =The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.

(c) $L_{R,dn}$ =The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10dB in order to account for the additional disturbance caused by noise during the night.

SANS 10103 also provides a guideline for estimating community response to an increase in the general ambient noise level caused by intruding noise. If Δ is the increase in noise level, the following criteria are of relevance:

- "$\Delta \leq 0$ dB: There will be no community reaction;
- 0 dB < $\Delta \leq$ 10 dB: There will be 'little' reaction with 'sporadic complaints';
- 5 dB < $\Delta \leq$ 15 dB: There will be a 'medium' reaction with 'widespread complaints'. Δ = 10 dB is subjectively perceived as a doubling in the loudness of the noise;
- 10 dB < $\Delta \leq$ 20 dB: There will be a 'strong' reaction with 'threats of community action'; and
- 15 dB < Δ: There will be a 'very strong' reaction with 'vigorous community action'.

The categories of community response overlap because the response of a community does not occur as a stepwise function, but rather as a gradual change.

2.4 International Finance Corporation Guidelines on Environmental Noise

The IFC General Environmental Health and Safety Guidelines on noise address impacts of noise beyond the property boundary of the facility under consideration and provides noise level guidelines.

The IFC states that noise impacts should not exceed the levels presented in Table 4, or result in a maximum increase above background levels of 3 dBA at the nearest receptor location off-site (IFC, 2007). For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. Δ = 3 dBA is, therefore, a useful significance indicator for a noise impact.

It is further important to note that the IFC noise level guidelines for residential, institutional and educational receptors correspond with the SANS 10103 guidelines for urban districts.

Table 4: IFC noise level guidelines

Area	One Hour L_{Aeq} (dBA) 07:00 to 22:00	One Hour L_{Aeq} (dBA) 22:00 to 07:00
Industrial receptors	70	70
Residential, institutional and educational receptors	55	45

3 Description of the Receiving Environment

This section provides details of the receiving acoustic environment which is described in terms of:

- Local NSRs;
- The local environmental noise propagation and attenuation potential; and
- Current noise levels and the existing acoustic climate.

3.1 Potential Noise Sensitive Receptors

Potential noise sensitive receptors generally include places of residence and areas where members of the public may be affected by noise generated by mining and transport activities.

Potential noise sensitive receptors within the study area include residential developments surrounding the project site including schools, hospitals and clinics (Figure 1).

3.2 Environmental Noise Propagation and Attenuation potential

3.2.1 Atmospheric Absorption and Meteorology

Atmospheric absorption and meteorological conditions have already been mentioned with regards to their role in the propagation on noise from a source to receiver (Section 1.5.4). The main meteorological parameters affecting the propagation of noise include wind speed, wind direction and temperature. These along with other parameters such as relative humidity, air pressure, solar radiation and cloud cover affect the stability of the atmosphere and the ability of the atmosphere to absorb sound energy. Use is made of WRF data for the period 2015 to 2017.

Wind speed increases with altitude. This results in the ‘bending’ of the path of sound to ‘focus’ it on the downwind side and creating a ‘shadow’ on the upwind side of the source. Depending on the wind speed, the downwind level may increase by a few dB but the upwind level can drop by more than 20 dB (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). It should be noted that at wind speeds of more than 5 m/s, ambient noise levels are mostly dominated by wind generated noise.

The diurnal wind field is presented in Figure 5. Wind roses represent wind frequencies for 12 cardinal wind directions. Frequencies are indicated by the length of the shaft when compared to the circles drawn to represent a frequency of occurrence. Wind speed classes are assigned to illustrate the frequencies with high and low winds occurring for each wind vector. The frequencies of calms, defined as periods for which wind speeds are below 1 m/s, are also indicated.

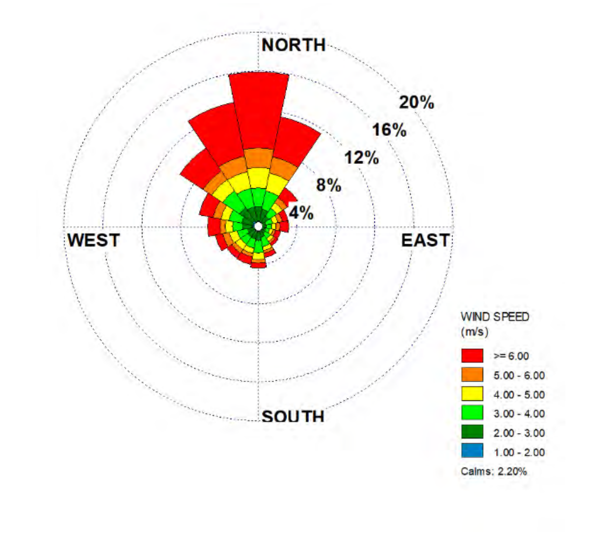
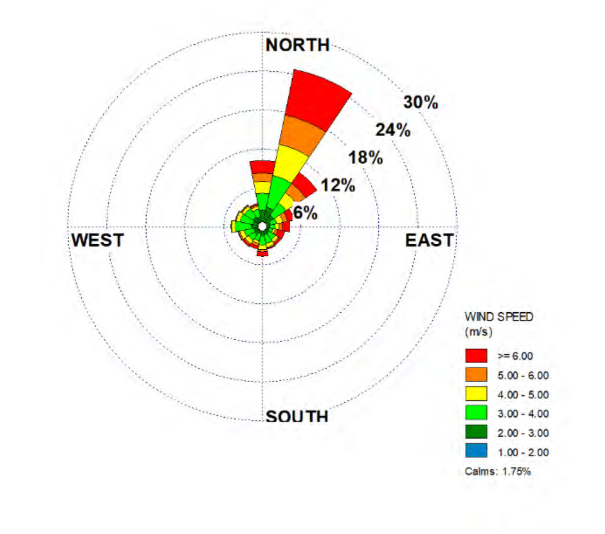
Day-time wind field (06:00 to 22:00)	Night-time wind field (22:00 to 06:00)
	

Figure 5: Day- and night-time wind field (WRF data: 2015 to 2017)

On average, noise impacts are expected to be more notable to the south during the day and to the south-southwest during the night.

Temperature gradients in the atmosphere create effects that are uniform in all directions from a source. On a sunny day with no wind, temperature decreases with altitude and creates a 'shadowing' effect for sounds. On a clear night, temperatures may increase with altitude thereby 'focusing' sound on the ground surface. Noise impacts are therefore generally more notable during the night. CadnaA allows the input of the average temperature and relative humidity. Use was made of 17°C average temperature and 51% average relative humidity in simulations, as obtained from the WRF data set.

3.2.2 Terrain, Ground Absorption and Reflection

Noise reduction caused by a barrier (i.e. natural terrain, installed acoustic barrier, building) feature depends on two factors namely the path difference of a sound wave as it travels over the barrier compared with direct transmission to the receiver and the frequency content of the noise (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). Topography was included in the simulations (Figure 5). Readily available terrain data was obtained from the United States Geological Survey (USGS) web site (https://earthexplorer.usgs.gov/). A study was made of Shuttle Radar Topography Mission (STRM) 1 arc-sec data.

Sound reflected by the ground interferes with the directly propagated sound. The effect of the ground is different for acoustically hard (e.g., concrete or water), soft (e.g., grass, trees or vegetation) and mixed surfaces. Ground attenuation is often calculated in frequency bands to take into account the frequency content of the noise source and the type of ground between the source and the receiver (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). Based on observations made during the visit to site, ground cover was found to be acoustically mixed, that is, only somewhat conducive to noise attenuation.

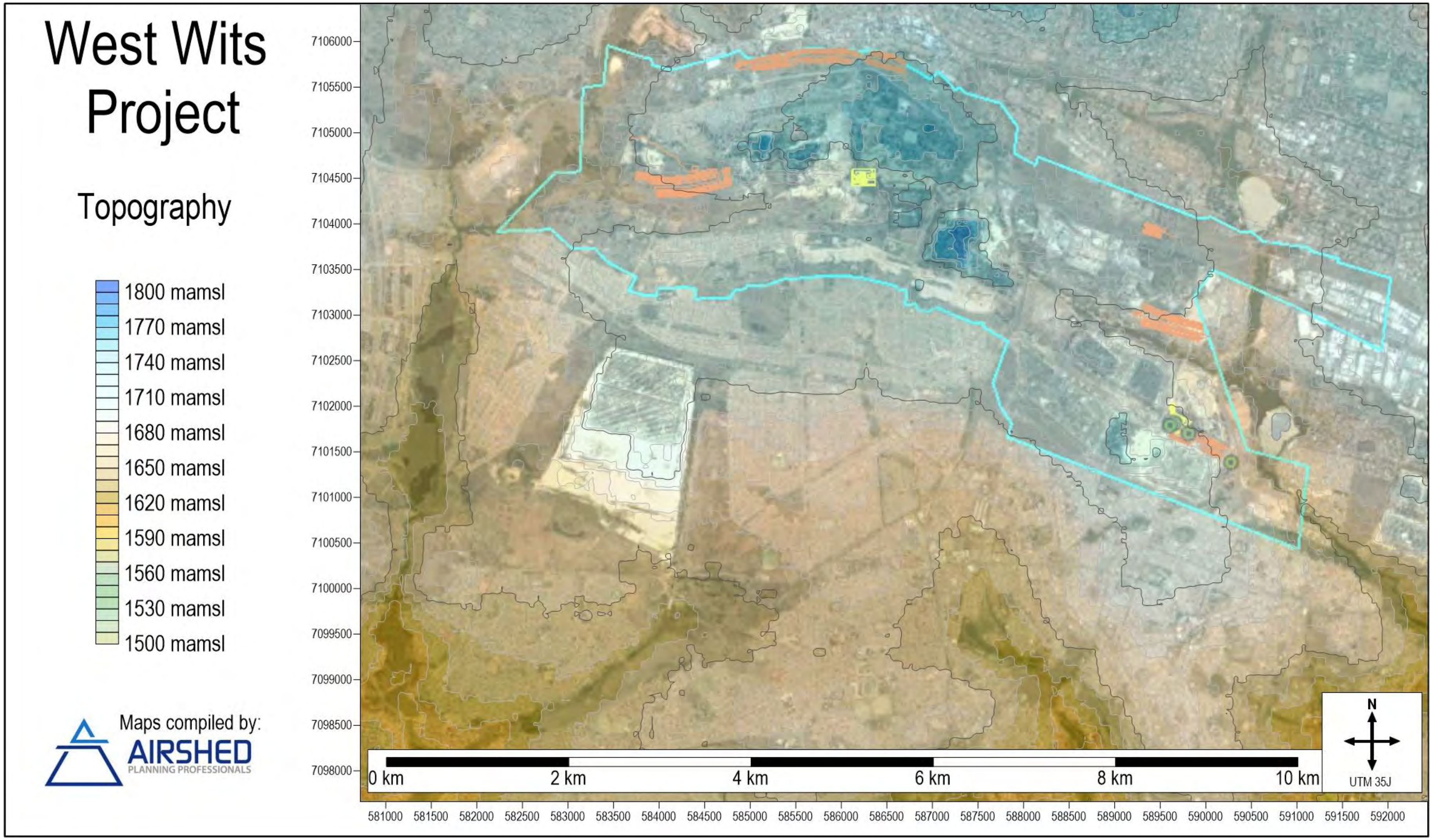


Figure 6: Topography for the study area

3.3 Baseline Noise Survey and Results

Day- and night-time noise measurements were conducted on 26 and 27 March 2018 at the six sampling locations shown in Figure 1. Survey sites were selected taking into consideration existing and proposed activities, NSRs, accessibility and safety. Due to safety considerations no night time measurements were conducted at locations 4, 5 and 6.

During the day-time survey, temperatures ranged between 24.6°C and 29.5°C, with approximately 5% cloud cover. Winds were between 0.3 m/s and 1.7 m/s and from a north-westerly direction. Humidity was between 30.6% and 36.8%. At night, temperatures ranged between 16.4°C and 20.0°C, mostly with clear skies and calm wind conditions.

Acoustic observations made during the survey are summarised in Table 5 and Table 6. The acoustic climate at NSRs is currently mostly affected by vehicle traffic and community activities, with a smaller contribution from domesticated animals, natural noises such as birds and insects as well as air traffic.

Recorded $L_{Req,d}$ at all sampling locations during the daytime survey are similar to those given in SANS 10103 as typical for suburban and urban districts. The $L_{Req,n}$ at sampling locations 2 and 3 are typical for suburban and urban districts at night-time as described by SANS 10103, the recorded $LAR_{eq,n}$ at sampling location 1 more closely resembles that of a central business district as described by SANS 10103 due to heavy traffic on the R41 road. Due to safety considerations no night time measurements were conducted at locations 4, 5 and 6, SANS 10103 typical night time outdoor rating levels are assumed based on daytime levels.

Logged broadband results are shown in Figure 7 for the daytime survey and in Figure 8 for the night-time survey.

Table 5: Baseline noise measurement survey results – Comparison to SANS 10103

Site	Day-time $L_{Req,d}$ (dBA)	Night-time $L_{Req,n}$ (dBA)	Day/night $L_{R,dn}$ (dBA)
1	59.9	54.7	62.1
2	45.5	44.7	50.9
3	47.1	47.5	53.5
4	54.7	45.0[(a)]	54.8
5	51.7	45.0[(a)]	53.1
6	48.2	40.0[(a)]	48.9

(a) No night-time measurements conducted due to security considerations. SANS 10103 typical night time outdoor rating levels are assumed based on daytime measurements.

Table 6: Baseline noise measurement survey details and broadband results

Site	Description	Coordinates	Local Start Time	Duration	Noise Climate	L_{AFmax} (dBA)	L_{Aleq} (dBA)	L_{A90} (dBA)
Day-time								
Site 1	Corner Corlett & Reyger	26,16569 S 27,83223 E	11:09	20 min	Heavy road traffic, birds, insects, air traffic	78.2	59.9	39.0
Site 2	Tornado Street	26,16876 S 27,87690 E	11:58	20 min	Road traffic, birds, insects, dogs, trains	57.7	45.5	36.3
Site 3	Maxim offices, Club terrace rd	26,18808 S 27,89838 E	12:58	20 min	Heavy road traffic, industrial activity, air traffic, birds, insects, dogs	64.2	47.1	41.4
Site 4	Winze dr, close to fleurhof Primary School	26,19778 S 27,91987 E	14:01	20 min	Road traffic, school noise, birds, insects, air traffic	77.9	54.7	41.9
Site 5	Edge of town	26,18209 S 27,82797 E	14:52	20 min	Road traffic, dogs, community noise, birds, insects	73.1	51.7	37.9
Site 6	Close to Goudrand	26,17505 S 27,84173 E	16:08	20 min	Road traffic, mining activities, birds, insects, dogs, community noise, air traffic	69.1	48.2	32.5
Night-time								
Site 1	Corner Corlett & Reyger	26,16569 S 27,83223 E	22:03	10 min	Road traffic, birds, insects, dogs, community noise, air traffic	68.1	54.7	39.9
Site 2	Tornado Street	26,16876 S 27,87690 E	11:58	10 min	Road traffic, birds, insects, dogs, air traffic	56.3	44.7	36.8
Site 3	Maxim offices, Club terrace rd	26,18808 S 27,89838 E	12:58	10 min	Road traffic, birds, insects, community noise, air traffic, frogs	58.5	47.5	41.9
Site 4	Winze dr, close to fleurhof Primary School	26,19778 S 27,91987 E	No night-time measurements conducted due to safety considerations					
Site 5	Edge of town	26,18209 S 27,82797 E	No night-time measurements conducted due to safety considerations					
Site 6	Close to Goudrand	26,17505 S 27,84173 E	No night-time measurements conducted due to safety considerations					

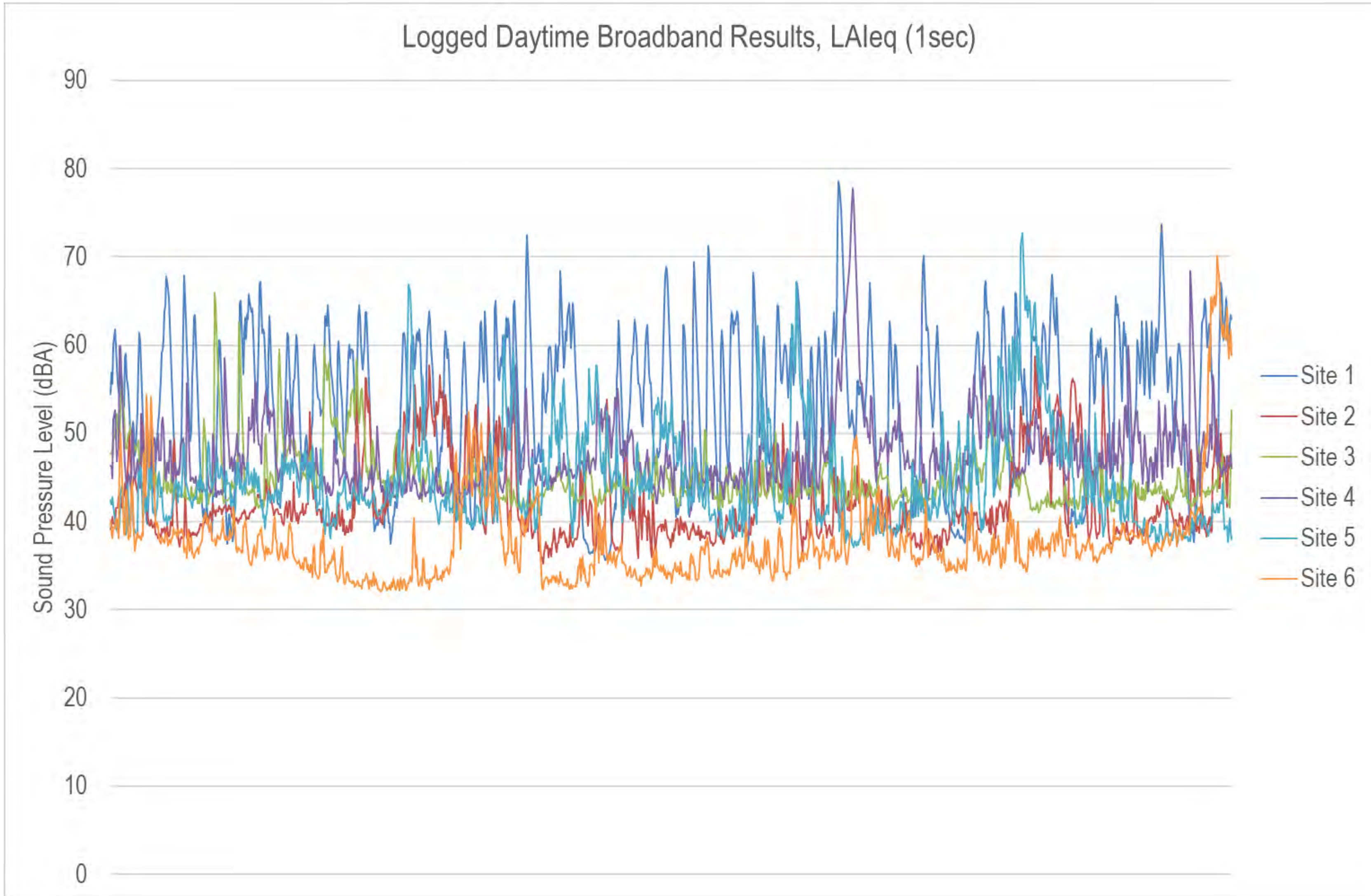


Figure 7: Logged Daytime Broadband Results

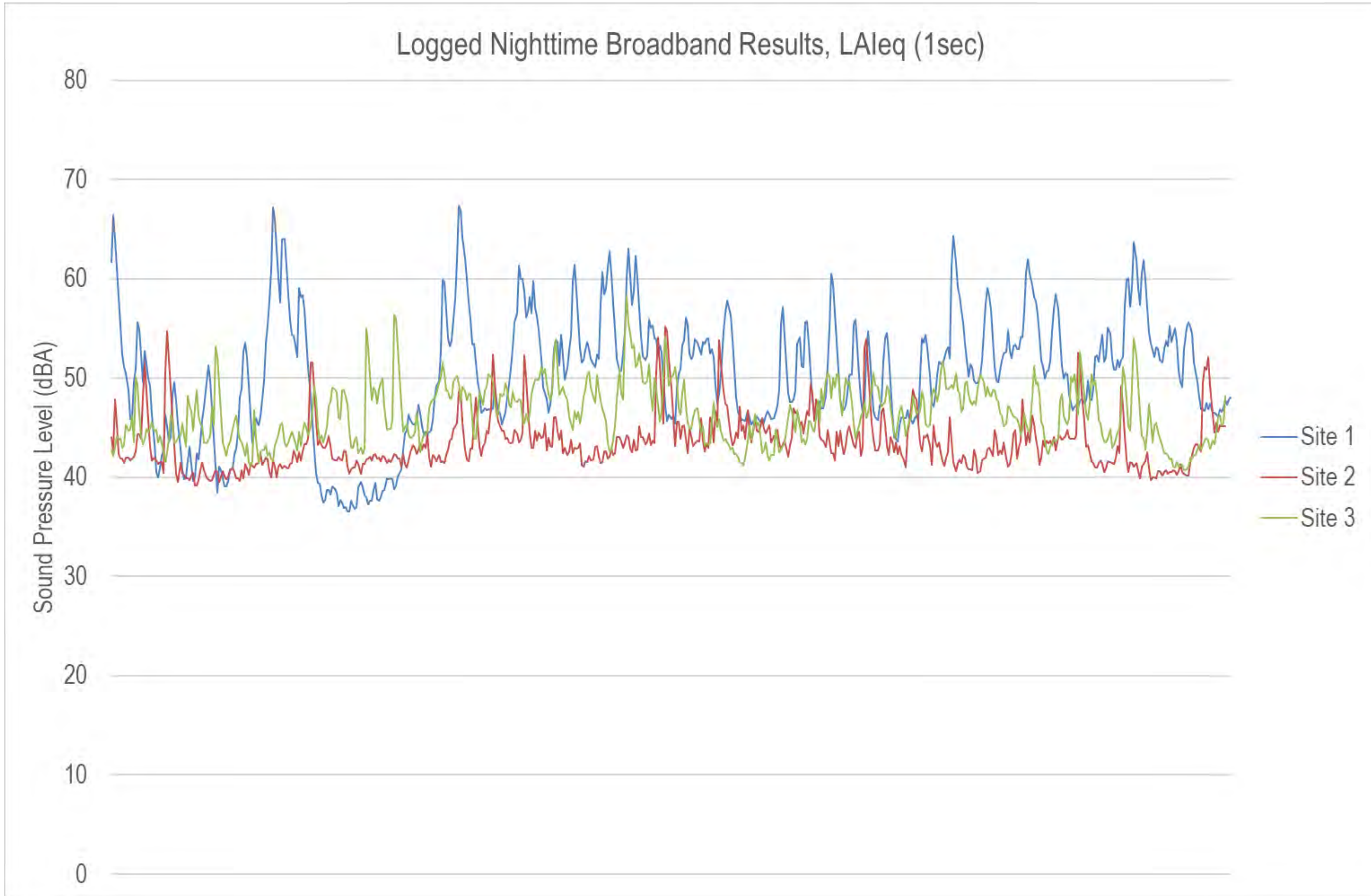


Figure 8: Logged Night-time Broadband Results

4 Impact Assessment

The noise source inventory, noise propagation modelling and results are discussed in Section 4.1 and Section 4.2 respectively.

4.1 Noise Sources and Sound Power Levels

The complete source inventory for the project is included in Table 7. Octave band frequency spectra L_W's are included in Table 8.

Table 7: Noise source inventory for the project

Source Name	Source type	Equipment ID	Qty.	Vehicles per hour	Speed (km/h)	Operating time, day and night-time hours		L_W (dB)
Komatsu D375A	Area	BULLDOZER1	1	0	0	12	0	126.2
CAT D6	Area	BULLDOZER2	1	0	0	12	0	119.8
Hyundai HX520L	Area	EXCAVATOR1	2	0	0	12	0	124.8
Hitachi EX400	Area	EXCAVATOR2	1	0	0	12	0	123.1
Hitachi ZX470LCH	Area	EXCAVATOR3	1	0	0	12	0	123.8
Volvo EC480E	Area	EXCAVATOR4	1	0	0	12	0	124.1
Volvo EC330BLC	Area	EXCAVATOR5	2	0	0	12	0	121.3
Bell B30 ADT	Moving point source	ADT1		19	40	12	0	123.5
BR 380JG	Point source	CRUSHER	1	0	0	12	0	121.1
FEL	Area	FEL	2	0	0	12	0	120.6
Water Bowser	Area	BOWSER	2	0	0	12	0	120.4
Handling	Area	HANDLING	4	0	0	12	0	106.4
Rock breaker	Area	RBREAKER	1	0	0	12	0	118.6
Ventilation shaft	Point source	VENT	4	0	0	16	8	131.0

The reader is reminded of the non-linearity in the addition of L_W's. If the difference between the sound power levels of two sources is nil the combined sound power level is 3 dB more than the sound pressure level of one source alone. Similarly, if the difference between the sound power levels of two sources is more than 10 dB, the contribution of the quietest source can be disregarded (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). Therefore, although some sources of noise could not be quantified (e.g. light vehicle movements), the incremental contributions of such sources are expected to be minimal given that the majority of sources are considered in the source inventory.

Table 8: Octave band frequency spectra L_W's

Equipment ID	Equipment details	Type	L_W octave band frequency spectra (dB)									L_W (dB)	L_{WA} (dBA)	Source
			31.5	63	125	250	500	1000	2000	4000	8000			
BULLDOZER1	Komatsu D375A	L_W		114.6	119.6	122.6	117.6	115.6	112.6	106.6	100.6	126.2	120.8	L_W Predictions (Bruce & Moritz, 1998)
BULLDOZER2	CAT D6	L_W		108.2	113.2	116.2	111.2	109.2	106.2	100.2	94.2	119.8	114.4	L_W Predictions (Bruce & Moritz, 1998)
EXCAVATOR1	Hyundai HX520L	L_W		113.2	118.2	121.2	116.2	114.2	111.2	105.2	99.2	124.8	119.5	L_W Predictions (Bruce & Moritz, 1998)
EXCAVATOR2	Hitachi EX400	L_W		111.5	116.5	119.5	114.5	112.5	109.5	103.5	97.5	123.1	117.8	L_W Predictions (Bruce & Moritz, 1998)
EXCAVATOR3	Hitachi ZX470LCH	L_W		112.1	117.1	120.1	115.1	113.1	110.1	104.1	98.1	123.8	118.4	L_W Predictions (Bruce & Moritz, 1998)
EXCAVATOR4	Volvo EC480E	L_W		112.4	117.4	120.4	115.4	113.4	110.4	104.4	98.4	124.1	118.7	L_W Predictions (Bruce & Moritz, 1998)
EXCAVATOR5	Volvo EC330BLC	L_W		109.7	114.7	117.7	112.7	110.7	107.7	101.7	95.7	121.3	116.0	L_W Predictions (Bruce & Moritz, 1998)
ADT1	Bell B30 ADT	L_W		111.9	116.9	119.9	114.9	112.9	109.9	103.9	97.9	123.5	118.2	L_W Predictions (Bruce & Moritz, 1998)
ADT2	Bell B25 ADT	L_W		111.1	116.1	119.1	114.1	112.1	109.1	103.1	97.1	122.7	117.4	L_W Predictions (Bruce & Moritz, 1998)
CRUSHER	BR 380JG	L_W		109.5	114.5	117.5	112.5	110.5	107.5	101.5	95.5	121.1	115.7	L_W Predictions (Bruce & Moritz, 1998)
FEL	FEL	L_W		109.0	114.0	117.0	112.0	110.0	107.0	101.0	95.0	120.6	115.3	L_W Predictions (Bruce & Moritz, 1998)
BOWSER	Water Bowser	L_W		108.8	113.8	116.8	111.8	109.8	106.8	100.8	94.8	120.4	115.1	L_W Predictions (Bruce & Moritz, 1998)
HANDLING	Handling	L_W		80	90	98.8	97.6	100.7	101.4	95.4		106.4	105.8	L_W FMAC Database
RBREAKER	Rock breaker	L_W	106.3	114.0	113.0	109.4	107.5	107.2	104.2	99.8	93.8	118.6	111.6	L_W based on L_P measurements at Solplaatjies
VENT	Ventilation shaft	L_W	120.6	121.6	122.6	123.6	123.6	123.6	121.6	117.6	116.6	131.0	128.3	L_W Predictions (Bruce & Moritz, 1998)

Haul truck traffic noise was included. Traffic parameters as determined from either mining rates and truck capacities; or assumptions made are summarised in Table 7. It should be noted that haul truck equipment was provided for two equipment types. The haul truck with the higher L_w was assumed for the assessment.

4.2 Noise Propagation and Simulated Noise Levels

The propagation of noise generated during the operational phase was calculated with CadnaA in accordance with ISO 9613. Meteorological and site specific acoustic parameters as discussed in Section 3.2 along with source data discussed in 4.1, were applied in the model.

Results are presented in isopleth form (Figure 9 to Figure 13). The simulated equivalent continuous day-time rating level ($L_{Req,n}$) and day/night time rating level ($L_{Req,dn}$) of 55 dBA (guideline level) extends over NSRs during the operation of all opencast mining operations with the exception of Kimberly Reef East Pit. The simulated equivalent continuous day/night time rating level ($L_{Req,dn}$) of 60 dBA (Gauteng Noise Control Regulation level) extends ~230 m from the operational area still extending over NSRs during the operation of all opencast mining operations with the exception of Kimberly Reef East Pit. For underground mining operations, the simulated equivalent continuous day-time rating level ($L_{Req,n}$) of 55 dBA (guideline level) does not extend over NSRs during the operation of vents. Simulated equivalent continuous night-time rating level ($L_{Req,n}$) of 45 dBA (guideline level) extends over NSRs during the operation of vents with continuous day/night time rating level ($L_{Req,dn}$) of 55 dBA (guideline level) extending over NSRs. The continuous day/night time rating level of 60 dBA (Gauteng Noise Control Regulation level) does not extend over NSRs.

Based on the simulated increase in noise levels above the baseline (Figure 14 to Figure 18) and according to the SANS 10103 (2008), the community reaction due to day-time noise levels from the project operations are expected to result in varying reactions and complaints based on distance from the project. A summary of the community reaction is provided in Table 9. It should be noted that the expected community reaction will overlap as not all individuals are equally sensitive to noise. Change of 10 dB is subjectively perceived as a doubling in the loudness of the noise.

Table 9: Expected community reaction and distance from mining operations due to day-, night- and day/night time noise level increases from the baseline [(a)]

Mining area	Distance to closest potential sensitive receptor	Increase in noise levels above the baseline			
		0 dB < Δ ≤ 10 dB	5 dB < Δ ≤ 15 dB	10 dB < Δ ≤ 20 dB	15 dB < Δ
		Expected Community reaction according to the SANS 10103			
		'Little' reaction with 'sporadic complaints'	'Medium' reaction with 'widespread complaints'	'Strong' reaction with 'threats of community action'	'Very strong' reaction with 'vigorous community action'
Day-time					
Kimberly Reef East Pit (mining duration: 5 months)	~590m	Up to ~130m	From ~40m to ~260m	Up to ~130m	Up to ~40m
11 Shaft Main Reef Pit (mining duration: 8 months)	~100m	Up to ~180m	From ~100m to ~450m	From ~40m to ~180m	Up to ~100m
Rugby Club Main Reef Pit (mining duration: 3 months)	~120m	Up to ~400m	From ~200m to ~780m	From ~130m to ~400m	Up to ~200m
Mona Lisa Bird Reef Pit (mining duration: 3 months)	~60m	Up to ~300m	From ~100m to ~560m	From ~40m to ~300m	Up to ~100m
Roodepoort Main Reef Pit (mining duration: 12 months)	~20m	Up to ~400m	From ~160m to ~950m	From ~50m to ~400m	Up to ~160m
Vent Shafts (mining duration: 25 years)	~550m	Up to ~220m	From ~150m to ~520m	From ~100m to ~220m	Up to ~150m
Night-time					
Kimberly Reef East Pit (mining duration: 5 months)	~590m	NA	NA	NA	NA
11 Shaft Main Reef Pit (mining duration: 8 months)	~100m	NA	NA	NA	NA
Rugby Club Main Reef Pit (mining duration: 3 months)	~120m	NA	NA	NA	NA
Mona Lisa Bird Reef Pit (mining duration: 3 months)	~60m	NA	NA	NA	NA
Roodepoort Main Reef Pit (mining duration: 12 months)	~20m	NA	NA	NA	NA

Mining area	Distance to closest potential sensitive receptor	Increase in noise levels above the baseline			
		0 dB < Δ ≤ 10 dB	5 dB < Δ ≤ 15 dB	10 dB < Δ ≤ 20 dB	15 dB < Δ
		Expected Community reaction according to the SANS 10103			
		'Little' reaction with 'sporadic complaints'	'Medium' reaction with 'widespread complaints'	'Strong' reaction with 'threats of community action'	'Very strong' reaction with 'vigorous community action'
Vent Shafts (mining duration: 25 years)	~550m	Up to ~620m	From ~400m to ~880m	From ~190m to ~620m	Up to ~400m
Day/Night time					
Kimberly Reef East Pit (mining duration: 5 months)	~590m	Up to ~80m	From ~30m to ~250m	Up to ~80m	Up to ~30m
11 Shaft Main Reef Pit (mining duration: 8 months)	~100m	Up to ~60m	Up to ~180m	Up to ~60m	0 m
Rugby Club Main Reef Pit (mining duration: 3 months)	~120m	Up to ~180m	From ~100m to ~350m	From ~40m to ~180m	Up to ~100m
Mona Lisa Bird Reef Pit (mining duration: 3 months)	~60m	Up to ~200m	From ~60m to ~450m	From ~20m to ~200m	Up to ~60m
Roodepoort Main Reef Pit (mining duration: 12 months)	~20m	Up to ~210m	From ~110m to ~400m	From ~50m to ~210m	Up to ~110m
Vent Shafts (mining duration: 25 years)	~550m	Up to ~440m	From ~260m to ~700m	From ~120m to ~440m	Up to ~260m

(a) Values have been bolded where potential noise sensitive receptors within the study area are affected

Figure 9: Simulated equivalent continuous day-time rating level ($L_{Req,d}$) for opencast mining project activities

Figure 10: Simulated equivalent continuous day/night time rating level ($L_{Req,dn}$) for opencast mining project activities

Figure 11: Simulated equivalent continuous day-time rating level ($L_{Req,d}$) for underground mining project activities

Figure 12: Simulated equivalent continuous night-time rating level ($L_{Req,n}$) for underground mining project activities

Figure 13: Simulated equivalent continuous day/night time rating level ($L_{Req,dn}$) for underground mining project activities

Figure 14: Simulated change in day-time noise levels due to opencast mining project activities

Figure 15: Simulated change in day/night time noise levels due to opencast mining project activities

Figure 16: Simulated change in day-time noise levels due to underground mining project activities

Figure 17: Simulated change in night-time noise levels due to underground mining project activities

Figure 18: Simulated change in day/night time noise levels due to underground mining project activities

5 Impact Significance Rating

The significance of environmental noise impacts was assessed according to the methodology adopted by SLR Consulting (South Africa) (Pty) Ltd refer to Appendix D of this report for the methodology.

The significance of the noise impacts was based on the Gauteng Noise Control Regulation level of 60 dBA at NSRs for continuous day/night time noise levels. Proposed project activities were found to be *medium* at all unmitigated opencast mining operations with the exception of operations at the Kimberly Reef East Pit which was *low* (Table 10). Assuming the adoption of good practice noise mitigation and management measures as recommended, the significance of project noise impacts may be reduced in frequency and severity and reduces to *low significance* (Table 10). For underground mining activities, the significance was *low* for unmitigated and mitigated operations. The size of the communities that would be exposed to levels over 60 dBA can be obtained from the impact figures provided in Section 4.2.

No noise impacts are expected post-closure.

Table 10: Significance rating for noise impacts due to project activities

Noise		Project Activity	Consequence				Probability	Significance Rating
Impact Classification	Construction, Operational, Decommissioning & Post-Closure		Severity	Duration	Spatial Scale	Conse-quence		
Resulting Impact from Project Activity	Noise impacts generated may impact on the social environment, especially residential areas adjacent to the mining area (assessment criteria: 60 dBA continuous day/night limit (Gauteng Noise Control Regulation))	Kimberly Reef East Pit (mining duration: 5 months)	Without Mitigation					
			L	L	L	L	L	Low
			With Mitigation					
			L	L	L	L	L	Low
		11 Shaft Main Reef Pit (mining duration: 8 months)	Without Mitigation					
			M	L	M	M	M	Medium
			With Mitigation					
			L	L	L	L	L	Low
		Rugby Club Main Reef Pit (mining duration: 3 months)	Without Mitigation					
			M	L	M	M	M	Medium
			With Mitigation					
			L	L	L	L	L	Low
		Mona Lisa Bird Reef Pit (mining duration: 3 months)	Without Mitigation					
			M	L	M	M	M	Medium
			With Mitigation					
			L	L	L	L	L	Low
		Roodepoort Main Reef Pit (mining duration: 12 months)	Without Mitigation					
			M	L	M	M	M	Medium
			With Mitigation					
			L	L	L	L	L	Low
		Vent Shafts	Without Mitigation					

Noise		Project Activity	Consequence				Probability	Significance Rating
Impact Classification	Construction, Operational, Decommissioning & Post-Closure		Severity	Duration	Spatial Scale	Conse-quence		
		(mining duration: 25 years)	L	M	L	L	L	Low
			With Mitigation					
			L	M	L	L	L	Low

6 Management Measures

In the quantification of noise emissions and simulation of noise levels as a result of the proposed project, it was calculated that ambient noise evaluation criteria for human receptors will be exceeded at NSRs (see Section 4.2 for reference of which NSRs would be affected for which mining operations).

Due to the close proximity of NSRs to the project, it is recommended that mitigation measures be implemented to ensure minimal impacts on the surrounding environment.

It should be noted that the waste rock dumps would provide a noise barrier for NSRs from the pit operations but would also be a source of noise due to activities on the dump.

6.1 Controlling Noise at the Source

6.1.1 Engineering and Operational Practices

For general activities, the following good engineering practice should be applied to all project phases:

- All diesel-powered equipment and plant vehicles should be kept at a high level of maintenance. This should particularly include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment should serve as trigger for withdrawing it for maintenance.
- For any new equipment, specifications with lower sound power levels must be selected. Vendors should be required to guarantee optimised equipment design noise levels.
- In managing noise specifically related to truck and vehicle traffic, efforts should be directed at:
    - Minimising individual vehicle engine, transmission, and body noise/vibration. This is achieved through the implementation of an equipment maintenance program.
    - Maintain road surface regularly to avoid corrugations, potholes etc.
    - Avoid unnecessary idling times.
    - Alternatives to the traditional reverse 'beeper' alarm such as a 'self-adjusting' or 'smart' alarm could be considered. These alarms include a mechanism to detect the local noise level and automatically adjust the output of the alarm so that it is 5 to 10 dB above the noise level near the moving equipment. The promotional material for some smart alarms does state that the ability to adjust the level of the alarm is of advantage to those sites 'with low ambient noise level' (Burgess & McCarty, 2009).
    - Limiting traffic to hours of between 06:00 and 18:00.
- Where possible, other non-routine noisy activities such as construction, decommissioning, start-up and maintenance, should be limited to day-time hours.
- A noise complaints register must be kept.

Additional points that should be considered:

- Good public relations are essential at all stages of the project. Surrounding receptors should be informed about the sound generated by proposed project operations. The information presented to stakeholders should be factual and should not set unrealistic expectations. Potential annoyance levels have been linked to visibility and audibility. Audibility is distinct from the sound level, because it depends on both the ambient sound level and character (spectral, tones and impulsivity) of noises generated at the mine. Psychoacoustics is even more complex, but it has been found that a negative attitude towards a development does influence the possibility of noise complaints.
- Community involvement needs to continue throughout the project. Annoyance is a complicated psychological phenomenon; as with many industrial operations, expressed annoyance with sound can reflect an overall annoyance with the project, rather than a rational reaction to the sound itself. Mining projects offer an economic benefit to the greater population. A positive community attitude throughout the greater area should be fostered, particularly with those residents near the project.
- The developer must implement a line of communication (i.e. a help line where complaints could be lodged). All potential sensitive receptors should be made aware of these contact numbers. The mine should maintain a commitment to the local community and respond to concerns in an expedient fashion. Sporadic and legitimate noise complaints could develop. For example, sudden and sharp increases in sound levels could result from mechanical malfunctions or problems developing. Problems of this nature can be corrected quickly, and it is in the mine's interest to do so.

6.1.1 Specifications and Equipment Design

As the site or activity is in close proximity to NSRs, equipment and methods to be employed should be reviewed to ensure the quietest available technology is used. Equipment with lower sound power levels must be selected in such instances and vendors/contractors should be required to guarantee optimised equipment design noise levels.

6.1.2 Enclosures

As far as is practically possible, source of significant noise should be enclosed. The extent of enclosure will depend on the nature of the machine and their ventilation requirements.

It should be noted that the effectiveness of partial enclosures can be reduced if used incorrectly, e.g. noise should be directed into a partial enclosure and not out of it, there should not be any reflecting surfaces such as parked vehicles opposite the open end of a noise enclosure.

It is recommended that equipment and/or machinery which radiate noise levels between 85.0dBA and 90.0dBA to be acoustically screened off.

6.1.3 Use of Equipment

Some considerations to take into account:

a) Machines used intermittently should be shut down between work periods or throttled down to a minimum and not left running unnecessarily. This will reduce noise and conserve energy.
b) Plants or equipment from which noise generated is known to be particularly directional, should be orientated so that the noise is directed away from NSRs.
c) Construction materials such as beams should be lowered and not dropped.

It is recommended that the ventilation shaft outlet face away from any residential area.

6.1.4 Maintenance

Regular and effective maintenance of equipment and plants are essential to noise control. Increases in equipment noise are often indicative of eminent mechanical failure. Also, sound reducing equipment/materials can lose effectiveness before failure and can be identified by visual inspection.

6.2 Controlling the Spread of Noise

Naturally, if noise activities can be minimised or avoided, the amount of noise reaching NSRs will be reduced. Alternatively, noise reduction berms can be installed to reduce noise at NSRs.

Earth berms can be built to provide screening for large scale earth moving operations and can be landscaped to become permanent features once construction is completed. Care should be taken when constructing earth berms since it may become a significant source of dust.

The waste rock dumps would be developed in such a manner as to limit noise from the dumping of waste rock on top of the berm.

6.3 Summary of Mitigation Techniques

Table 11 provides a summary of the general effectiveness of various mitigation techniques.

Table 11: A summary of general effectiveness of various mitigation techniques

Mitigation Technique	General Effectiveness	Monetary Costs	Conditions where feasible
Vehicle components	Fair	N/A	N/A
Operational factors	Fair	Low	Local roads/site
Engineering considerations	Good/excellent	Medium	New construction
Earth Berms	Excellent (5-15 dBA reduction)	Low	Wide corridors
Sound Insulation	Average	Medium	Case by case

6.4 Monitoring

An environmental noise monitoring campaign should be conducted once off during each operation phase for each opencast mining pit, at the closest NSR. For underground mining operations, an environmental noise monitoring campaign should be conducted annually at the closest NSRs to vent shafts.

Also, In the event that noise related complaints are received short term (24-hour) ambient noise measurements should be conducted as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions.

The following procedure should be adopted for all noise surveys:

- Any surveys should be designed and conducted by a trained specialist.
- Sampling should be carried out using a Type 1 SLM that meets all appropriate IEC standards and is subject to annual calibration by an accredited laboratory.
- The acoustic sensitivity of the SLM should be tested with a portable acoustic calibrator before and after each sampling session.
- Samples of at least 10 min to 24 hours in duration and sufficient for statistical analysis should be taken with the use of portable SLM's capable of logging data continuously over the time period. Samples representative of the day- and night-time acoustic environment should be taken.
- The following acoustic indices should be recoded and reported: L_{Aeq} (T), L_{AIeq} (T), statistical noise level $L_{A90,}$ L_{AFmin} and $L_{AFmax,}$ octave band or 3rd octave band frequency spectra.
- The SLM should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- Efforts should be made to ensure that measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer. It is good practice to avoid conducting measurements when the wind speed is more than 5 m/s, while it is raining or when the ground is wet.
- A detailed log and record should be kept. Records should include site details, weather conditions during sampling and observations made regarding the acoustic environment of each site.

The investigation of complaints should include an investigation into equipment or machinery that likely result or resulted in noise levels annoying to the community. This could be achieved with source noise measurements.

7 Conclusion

Based on the findings of the assessment and the close proximity of NSRs to the project, it is recommended good engineering practice mitigation and where possible additional screening measures are in place during the operational phase of the project.

Monitoring measures of noise for each phase of the project are also recommended at the closest NSRs to the respective operations in order to ensure that Gauteng Noise Control Regulation levels are met.

8 References

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Appendix A – Sound Level Meter Calibration Certificates

nmisa
National Metrology Institute of South Africa

Certificate of Conformance

Private Bag X34, Lynnwood Ridge, Pretoria, 0040
CSIR Campus, Meiring Naude Road, Brummeria, 0184
Calibration office: +27 12 841 4623
Reception: +27 12 841 4152
Fax: +27 12 841 4458
E-mail enquiries: info@nmisa.org

Calibration of:	SOUND LEVEL METER, OCTAVE BAND FILTER, THIRD OCTAVE BAND FILTER & MICROPHONE
Manufacturer:	BRÜEL & KJÆR
Model number:	2250-L, 4950
Serial number:	2731851, 2709293
Calibrated for:	AIRSHED PLANNING PROFESSIONALS (PTY) LTD Midrand
Calibration procedure:	AV\AS-0007 AV\AS-0010
Period of calibration:	10 – 11 May 2017

1 PROCEDURE

The sound level meter was electrically calibrated according to the relevant clauses of SANS 656 and 658 specifications. The microphone with the sound level meter was acoustically calibrated according to the relevant clauses of SANS 656 specifications. The instrument complete with filters was electrically calibrated according to IEC 61260 specification.

The results of the measurements are traceable to the national measurement standards.

The following equipment was used:

Brüel & Kjær 4226 Multi-function calibrator	(AS-52)
Inline Capacitor	(AS-98)
Madgetech PRHTemp 2000	(AS-106)
Brüel & Kjær 3630 Calibration platform	(AS-109)

Calibrated by	Checked by	For Chief Executive Officer
R Nel **Metrologist (Technical Signatory)**	**H Potgieter** **Metrologist**	
Date of Issue **11 May 2017**	**Page 1 of 3**	Certificate number **AV\AS-4634**

Your measure of excellence

2 RESULTS

2.1 The following parameters of the sound level meter were calibrated and conformed to the SANS 656 and SANS 658 specifications, type 1:

Indication under reference conditions (SANS 656 clause 11.2)			*U* = 0,20 dB
Electrical self generated noise			
	A-weighted	(12,9 dB)	*U* = 0,30 dB
	C-weighted	(13,7 dB)	*U* = 0,30 dB
	Linear	(19,2 dB)	*U* = 0,30 dB
Linearity range (primary indicator range) (SANS clause 9.9, table 11)			
	1 kHz		*U* = 0,12 dB
	4 kHz		*U* = 0,12 dB
	8 kHz		*U* = 0,12 dB
Frequency Weightings (SANS 656 clauses 8.1, 11.2, tables 4 & 5)			
	A-weighting	(25 Hz – 16 kHz)	*U* = 0,12 dB
	C-weighting	(25 Hz – 16 kHz)	*U* = 0,12 dB
	Linear	(25 Hz – 16 kHz)	*U* = 0,12 dB
Time weightings (SANS 656 clauses 9.2, 9.3, 9.5, 11.4, table 9, 7 & 10)			
	Slow and Fast		*U* = 0,11 dB
	Impulse		*U* = 0,11 dB
	Peak		*U* = 0,09 dB
Time averaging, L_{Aeq} (SANS 658 clause 11.3.3, table 4)			*U* = 0,12 dB
Impulse weighted time averaging, L_{AIeq} (SANS 658 Annex C, table C1)			*U* = 0,12 dB
Overload indication (SANS 656 clause 11.3)			*U* = 0,31 dB

2.2 The following parameter of the microphone with the sound level meter were calibrated and conformed to the SANS 656 specifications, type 1:

Frequency response (SANS 656 clauses 8.1, tables 4 & 5)		
	31,5 Hz – 12,5 kHz	*U* = 0,20 dB @ 1 kHz

Calibrated by	Checked by	For Chief Executive Officer
R Nel **Metrologist (Technical Signatory)**	**H Potgieter** **Metrologist**	
Date of Issue **11 May 2017**	**Page 2 of 3**	Certificate number **AV\AS-4634**

2.3 The following parameter of the octave band filter was calibrated and conformed to the IEC 61260 specification, class 0 base 2:

Relative attenuation (IEC 61260 clause 4.4, 5.3) 16 Hz - 8 kHz — U = 0,10 dB @ f_m

2.4 The following parameter of the third octave band filter was calibrated and conformed to the IEC 61260 specification, class 0 base 2:

Relative attenuation (IEC 61260 clause 4.4, 5.3) 12,5 Hz - 16 kHz — U = 0,10 dB @ f_m

3 REMARKS

3.1 The reported uncertainties of measurement were calculated and expressed in accordance with the BIPM, IEC, ISO, IUPAP, OIML document entitled "A Guide to the Expression of Uncertainty in Measurement" (International Organisation for Standardisation, Geneva, Switzerland, 1993).

3.2 The reported expanded uncertainty of measurement, U, is stated as the standard uncertainty of measurement multiplied by a coverage factor of k = 2, which for a normal distribution approximates a level of confidence of 95,45 %. The reported expanded uncertainty of measurements is at the reference points.

3.3 Certain of the NMISA certificates are consistent with the capabilities that are included in appendix C of the MRA (Mutual Recognition Arrangement) drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities and ranges and measurement uncertainties specified in Appendix C. For details see http://www.bipm.org.

3.4 The calibrations were carried out at an ambient temperature of 23 °C ± 2 °C and a relative humidity of 50 %RH ± 20 %RH.

3.5 Only parameters given in 2.1, 2.2, 2.3 and 2.4 were calibrated.

3.6 The above statement of conformance is based on the measurement value(s) obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limit(s).

3.7 The firmware versions of the sound measuring device at the time of calibration were: BZ7130 V4.4; BZ7131 V4.4; BZ7132 V4.4.

------------------ *end of certificate* ------------------

Calibrated by R Nel **Metrologist (Technical Signatory)**	Checked by **H Potgieter** **Metrologist**	For Chief Executive Officer
Date of Issue **11 May 2017**	**Page 3 of 3**	Certificate number **AV\AS-4634**

Appendix B – Specialist Curriculum Vitae

FULL CURRICULUM VITAE

Name of Firm	Airshed Planning Professionals (Pty) Ltd
Name of Staff	René von Gruenewaldt (*nee* Thomas)
Profession	Air Quality Scientist
Date of Birth	13 May 1978
Years with Firm	More than 15 years
Nationalities	South African

MEMBERSHIP OF PROFESSIONAL SOCIETIES

- Registered Professional Natural Scientist (Registration Number 400304/07) with the South African Council for Natural Scientific Professions (SACNASP)
- Member of the National Association for Clean Air (NACA)

KEY QUALIFICATIONS

René von Gruenewaldt (Air Quality Scientist): René joined Airshed Planning Professionals (Pty) Ltd (previously known as Environmental Management Services cc) in 2002. She has, as a Specialist, attained over fifteen (15) years of experience in the Earth and Natural Sciences sector in the field of Air Quality and three (3) years of experience in the field of noise assessments. As an environmental practitioner, she has provided solutions to both large-scale and smaller projects within the mining, minerals, and process industries.

She has developed technical and specialist skills in various modelling packages including the AMS/EPA Regulatory Models (AERMOD and AERMET), UK Gaussian plume model (ADMS), EPA Regulatory puff based model (CALPUFF and CALMET), puff based HAWK model and line based models. Her experience with emission models includes Tanks 4.0 (for the quantification of tank emissions), WATER9 (for the quantification of waste water treatment works) and GasSim (for the quantification of landfill emissions). Noise propagation modelling proficiency includes CONCAWE, South African National Standards (SANS 10210) for calculating and predicting road traffic noise.

Having worked on projects throughout Africa (i.e. South Africa, Mozambique, Malawi, Kenya, Angola, Democratic Republic of Congo, Namibia, Madagascar and Egypt) René has developed a broad experience base. She has a good understanding of the laws and regulations associated with ambient air quality and emission limits in South Africa and various other African countries, as well as the World Bank Guidelines, European Community Limits and World Health Organisation.

RELEVANT EXPERIENCE

Mining and Ore Handling

René has undertaken numerous air quality impact assessments and management plans for coal, platinum, uranium, copper, cobalt, chromium, fluorspar, bauxite, manganese and mineral sands mines. These include: compilation of emissions databases for Landau and New Vaal coal collieries (SA), impact assessments and management plans for numerous mines over Mpumalanga (viz. Schoonoord, Belfast, Goedgevonden, Mbila, Evander South, Driefontein, Hartogshoop, Belfast, New Largo, Geluk, etc.), Mmamabula Coal Colliery (Botswana), Moatize Coal Colliery (Mozambique), Revuboe Coal Colliery (Mozambique), Toliera Sands Heavy Minerals Mine and Processing (Madagascar), Corridor Sands Heavy Minerals Mine monitoring assessment, El Burullus Heavy Minerals Mine and processing (Egypt), Namakwa Sands Heavy Minerals Mine (SA), Tenke Copper Mine and Processing Plant (DRC), Rössing Uranium (Namibia), Lonmin platinum mines including operations at Marikana, Baobab, Dwaalkop and Doornvlei (SA), Impala Platinum (SA), Pilannesburg Platinum (SA), Aquarius Platinum, Hoogland Platinum Mine (SA), Tamboti PGM Mine (SA), Sari Gunay Gold Mine (Iran), chrome mines in the Steelpoort Valley (SA), Mecklenburg Chrome Mine (SA), Naboom Chrome Mine (SA), Kinsenda Copper Mine (DRC), Kassinga Mine (Angola) and Nokeng Flourspar Mine (SA), etc.

Mining monitoring reviews have also been undertaken for Optimum Colliery's operations near Hendrina Power Station and Impunzi Coal Colliery with a detailed management plan undertaken for Morupule (Botswana) and Glencor (previously known as Xstrata Coal South Africa).

Air quality assessments have also been undertaken for mechanical appliances including the Durban Coal Terminal and Nacala Port (Mozambique) as well as rail transport assessments including BHP-Billiton Bauxite transport (Suriname), Nacala Rail Corridor (Mozambique and Malawi), Kusile Rail (SA) and WCL Rail (Liberia).

Metal Recovery

Air quality impact assessments have been carried out for Highveld Steel, Scaw Metals, Lonmin's Marikana Smelter operations, Saldanha Steel, Tata Steel, Afro Asia Steel and Exxaro's Manganese Pilot Plant Smelter (Pretoria).

Chemical Industry

Comprehensive air quality impact assessments have been completed for NCP (including Chloorkop Expansion Project, Contaminated soils recovery, C3 Project and the 200T Receiver Project), Revertex Chemicals (Durban), Stoppani Chromium Chemicals, Foskor (Richards Bay), Straits Chemicals (Coega), Tenke Acid Plant (DRC), and Omnia (Sasolburg).

Petrochemical Industry

Numerous air quality impact assessments have been completed for Sasol (including the postponement/exemption application for Synfuels, Infrachem, Natref, MIBK2 Project, Wax Project, GTL Project, re-commissioning of boilers at Sasol Sasolburg and Ekandustria), Engen Emission Inventory Functional Specification (Durban), Sapref refinery (Durban), Sasol (at Elrode) and Island View (in Durban) tanks quantification, Petro SA and Chevron (including the postponement/exemption application).

Pulp and Paper Industry

Air quality studies have been undertaken or the expansion of Mondi Richards Bay, Multi-Boiler Project for Mondi Merebank (Durban), impact assessments for Sappi Stanger, Sappi Enstra (Springs), Sappi Ngodwana (Nelspruit) and Pulp United (Richards Bay).

Power Generation

Air quality impact assessments have been completed for numerous Eskom coal fired power station studies including the ash expansion projects at Kusile, Kendal, Hendrina, Kriel and Arnot; Fabric Filter Plants at Komati, Grootvlei, Tutuka, Lethabo and Kriel Power Stations; the proposed Kusile, Medupi (including the impact assessment for the Flue Gas Desulphurization) and Vaal South Power Stations. René was also involved and the cumulative assessment of the existing and return to service Eskom power stations assessment and the optimization of Eskom's ambient air quality monitoring network over the Highveld.

In addition to Eskom's coal fired power stations, various Eskom nuclear power supply projects have been completed including the air quality assessment of Pebble Bed Modular Reactor and nuclear plants at Duynefontein, Bantamsklip and Thyspunt.

Apart from Eskom projects, power station assessments have also been completed in Kenya (Rabai Power Station) and Namibia (Paratus Power Plant).

Waste Disposal

Air quality impact assessments, including odour and carcinogenic and non-carcinogenic pollutants were undertaken for the Waste Water Treatment Works in Magaliesburg, proposed Waterval Landfill (near Rustenburg), Tutuka Landfill, Mogale General Waste Landfill (adjacent to the Leipardsvlei Landfill), Cape Winelands District Municipality Landfill and the Tsoeneng Landfill (Lesotho). Air quality impact assessments have also been completed for the BCL incinerator (Cape Town), the Ergo Rubber Incinerator and the Ecorevert Pyrolysis Plant.

Cement Manufacturing

Impact assessments for ambient air quality have been completed for the Holcim Alternative Fuels Project (which included the assessment of the cement manufacturing plants at Ulco and Dudfield as well as a proposed blending platform in Roodepoort).

Management Plans

René undertook the quantification of the baseline air quality for the first declared Vaal Triangle Airshed Priority Area. This included the establishment of a comprehensive air pollution emissions inventory, atmospheric dispersion modelling, focusing on impact area "hotspots" and quantifying emission reduction strategies. The management plan was published in 2009 (Government Gazette 32263).

René has also been involved in the Provincial Air Quality Management Plan for the Limpopo Province.

Other Experience (2001)

Research for B.Sc Honours degree was part of the "Highveld Boundary Layer Wind" research group and was based on the identification of faulty data from the Majuba Sodar. The project was THRIP funded and was a joint venture with the University of Pretoria, Eskom and Sasol (2001).

EDUCATION

M.Sc Earth Sciences	University of Pretoria, RSA, Cum Laude (2009) Title: *An Air Quality Baseline Assessment for the Vaal Airshed in South Africa*
B.Sc Hons. Earth Sciences	University of Pretoria, RSA, Cum Laude (2001) Environmental Management and Impact Assessments
B.Sc Earth Sciences	University of Pretoria, RSA, (2000) Atmospheric Sciences: Meteorology

ADDITIONAL COURSES

CALMET/CALPUFF	Presented by the University of Johannesburg, RSA (March 2008)
Air Quality Management	Presented by the University of Johannesburg, RSA (March 2006)
ARCINFO	GIMS, Course: Introduction to ARCINFO 7 (2001)

COUNTRIES OF WORK EXPERIENCE

South Africa, Mozambique, Malawi, Liberia, Kenya, Angola, Democratic Republic of Congo, Lesotho, Namibia, Madagascar, Egypt, Suriname and Iran.

EMPLOYMENT RECORD

January 2002 - Present

Airshed Planning Professionals (Pty) Ltd, (previously known as Environmental Management Services cc until March 2003), Principal Air Quality Scientist, Midrand, South Africa.

2001

University of Pretoria, Demi for the Geography and Geoinformatics department and a research assistant for the Atmospheric Science department, Pretoria, South Africa.

Department of Environmental Affairs and Tourism, assisted in the editing of the Agenda 21 document for the world summit (July 2001), Pretoria, South Africa.

1999 - 2000

The South African Weather Services, vacation work in the research department, Pretoria, South Africa.

CONFERENCE AND WORKSHOP PRESENTATIONS AND PAPERS

- Understanding the Synoptic Systems that lead to Strong Easterly Wind Conditions and High Particulate Matter Concentrations on The West Coast of Namibia, H Liebenberg-Enslin, R von Gruenewaldt, H Rauntenbach and L Burger. National Association for Clean Air (NACA) conference, October 2017.
- Topographical Effects on Predicted Ground Level Concentrations using AERMOD, R.G. von Gruenewaldt. National Association for Clean Air (NACA) conference, October 2011.
- Emission Factor Performance Assessment for Blasting Operations, R.G. von Gruenewaldt. National Association for Clean Air (NACA) conference, October 2009.
- Vaal Triangle Priority Area Air Quality Management Plan – Baseline Characterisation, R.G. Thomas, H Liebenberg-Enslin, N Walton and M van Nierop. National Association for Clean Air (NACA) conference, October 2007.
- A High-Resolution Diagnostic Wind Field Model for Mesoscale Air Pollution Forecasting, R.G. Thomas, L.W. Burger, and H Rautenbach. National Association for Clean Air (NACA) conference, September 2005.
- Emissions Based Management Tool for Mining Operations, R.G. Thomas and L.W. Burger. National Association for Clean Air (NACA) conference, October 2004.
- An Investigation into the Accuracy of the Majuba Sodar Mixing Layer Heights, R.G. Thomas. Highveld Boundary Layer Wind Conference, November 2002.

LANGUAGES

	Speak	Read	Write
English	Excellent	Excellent	Excellent
Afrikaans	Fair	Good	Good

CERTIFICATION

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.

22/11/2017

Signature of staff member

Date (Day / Month / Year)

Full name of staff member: René Georgeinna von Gruenewaldt

Appendix C – Fieldwork Log Sheets and Photos

SITE NUMBER: West Wits 1		SLM DATA RECORD: 180326 001	
Longitude/Easting: 27,8322305 E	Latitude/Northing: - 26,16586946 S		Elevation:
Short Location Description & Notes: Corner Corlett + Reyger			

SETUP	Start Date & Time: 11:09:636 (20min)	End Date & Time: 11:29:23	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.6	~~27.5~~ ESSW	27.3 °C	31.8	5%	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☑ Community	☐ Air Traffic	☑ Road Traffic (~~Reyger~~, Cat)	☐ Constr.	☐ Other

Description: Corlette very busy, long -> short grass, powerline, Lawn mowing in background ± 11:27 Traffic -> Reyger, Corlette, Randfontein Rd. Car count' Randfontein Rd -> Jeffrey

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
11:09:45	Car + Bakkie	11:14	Car x2 + (Car x 3) 4	11:20	Dog	11:26	Truck, Car x 2
	Car		Car (R) + (Car x 2)	11:21	Car, Car	11:27	Car x 3, Car x 2
11:10	Car + Car + Bakkie	11:15	Car x 3		Car x 2, Car R		Car x 5
	Truck		Car, Car x 2		Car x 3, Car x 2		Car x 2, Car (R)
	Car	11:16	Car, Car (R), Car x 2		Car x 2		Car x 2
11:11	Dog		Car x 2, Car	11:22	Car, Car, Car	11:28	Car x 2
	Car	11:17	Car (R), Car, Car x 2		Car x 2, Truck		Car x 4
	Car + Car + Car + Car		Dog, Car x 3	11:23	Car x 4	11:29	Car x ~~3~~ 6, Car
	+ Car + Car + Car	11:18	Gate		Car, Car		Car
11:12	+ Car + Car + Car		Car	11:24	Car x 3		
	+ Car (R) + Car (R)	11:19	Car x 4		Car, Car		
11:13	Car, + Car x 3		Truck	11:25	Car, Truck, Car		
	Car		Car		Car x 2, Car x 2		
	Car x 5 Car x 2	11:20	~~Car~~ Truck, Car Car x 4		Car, x 3, Car (R) x 2		

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SITE NUMBER: West wits 1 Night.		SLM DATA RECORD: 180326007	
Longitude/Easting:	Latitude/Northing:		Elevation:
Short Location Description & Notes:			

SETUP	Start Date & Time: 22:03:38 (10 min.)	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.6	NE	16.4	53.3	0	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects + frogs (wetland)	☑ Dogs	☐ Music	☑ Community	☑ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other

Description: Road Traffic : Corlett, Reygerst. R41 (Randfontein Rd)

C = Corlette R = Reyger

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
10:05	Car x 2 (Corlette)						
10:06	Car x 3 (Corlett)						
10:07	Car (C) Car (R)						
	Car (C)						
10:08	Car (C) x 4						
10:09	Bird.						
10:10	Alarm + dogs (Background)						
10:11	Car (C)						
	Car (R) x 1						
10:12	Car (R) x 1						
10:12	Car (C) x 3						

Page of

SITE NUMBER:	West Wits 2	SLM DATA RECORD:	180326002
Longitude/Easting:	27.8769007	Latitude/Northing: -26.1687591	Elevation:
Short Location Description & Notes:	Tornado street		

SETUP	Start Date & Time: 11:58:30 (20 Min)	End Date & Time: 12:17:39	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.6	NE	26°C	31.7	5%	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☑ Community	☑ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other

Description: Trees. Dogs Traffic: Mile stoker street, R41, Albertina sisulu (↳ closest), Train, Electric fence shorting, ice cream van in BG

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
11:59	Train						
	Dog						
12:03	Helicopter						
12:07	Gate						
12:10	train + dog						
12:12	Gate						
12:14	Gate						
12:14	Bird (Tanfisand)						
12:16	Dog						
12:18	Truck on Albertina Sisulu Rd						
12:19	Plane						

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SITE NUMBER:	West Wits 2 Night	SLM DATA RECORD:	180326008
Longitude/Easting:		Latitude/Northing:	Elevation:
Short Location Description & Notes:	Tornado street.		

SETUP	Start Date & Time: 22:30:10 (10 min.)	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.3	N	18.9	46.6	0	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☐ Community	☑ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other

Description: Shorting electric fence (Continious)
Traffic from Albertina Sisulu Rd (AS), Miles Stoker Rd, R41

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
10:30	Bakkie Door	10:39	Car (AS) x 2				
10:32	Car (AS)	10:40	Car (AS)				
10:33	Bird (Hadeda)						
10:33	Car (AS) x 2						
	Car (AS)						
	Car (AS)						
10:34	Bird (Hadeda)						
10:35	Car (AS) x 2						
	Car (AS)						
10:36	Car (AS)						
10:38	Glass bottle being thrown						
10:38	Car (AS)						
10:39	Car (AS)						

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SITE NUMBER: Wed Wits 3		SLM DATA RECORD: 180326 003	
Longitude/Easting:	Latitude/Northing:		Elevation:
Short Location Description & Notes: Maxim Offices, Club terrace rd.			

SETUP	Start Date & Time: 12:58:49 (20 min)	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.7	NNW	27.87	~~28~~ 37.1	5%	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☑ Community	☑ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other

Description: Some trees. fence. Emty house 5± 30m N. Offices. Lots of industrial activity to the south. Cars entering/leaving at office gate. Air rifle shooting ± 25M NEW Traffic from R41 (very busy) Continious mechanical noise in background from NE.

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
1:00	Bakkie door.	1:14	Truck (Acacia Ave +				
	Air Shot (A)		Helpmekaar Rd)				
1:01	Motor cycle	1:15	Talking				
1:02	~~Car~~ Conversation	1:16	Metal scraping				
	~~Car n engin~~	1:18	Talking				
	Car starting		Sneeze				
1:03	2 Car leaving						
	Car leaving						
1:06	Helicopter						
1:07	Car entering						
1:08	Car leaving						
1:09	Plane						
1:11	Car leaving						
1:12	Car starting engine + leaving						

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SITE NUMBER: West Wits 3 Night		SLM DATA RECORD: 180326 009	
Longitude/Easting:	Latitude/Northing:		Elevation:
Short Location Description & Notes:			

SETUP	Start Date & Time: 10:53 (10 min)	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.3	N	20.2	44.9	0	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects → Frogs	☐ Dogs	☐ Music	☑ Community	☑ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other

Description: Traffic R41, Acacia ave (A), Helpmekaar Rd (H) → very busy

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
10:53	Truck (A)						
10:59	Truck (A) + (L)						

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SITE NUMBER: West Wits 7		SLM DATA RECORD: 180326 004	
Longitude/Easting: 27.910987	Latitude/Northing: -26.197780		Elevation:
Short Location Description & Notes: Winze Dr (close to Fleurhof Primary school			

SETUP	Start Date & Time: 14:01:43 20min	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.8	~~293~~ SSW	29.3	30.6	5%	
Middle 14:12	2-3 m/s	N				
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☐ Dogs	☑ Music	☑ Community	☑ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other

Description: Traffic from Winze Dr. + Smelt Ave. School kids close by & Pumping water into water truck tank (At dam) transformer ±15 m SW

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
14:01	Piece of glass	14:19	Shouting from school				
	Helicopter	14:21	Kids walking past.				
14:02	Car (Winze Dr)						
14:09	People walking past						
	in conversation						
14:10	Helicopter						
14:11	Cars (Winze Dr)						
14:13	Drumming starts						
14:14	Hooting (Utaxi close						
	to school						
	Water truck						
	(Pumping stopped)						
14:16	Hammering (schoolside						
14:17	Cyclist + Plane						

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SITE NUMBER: West Wits 5		SLM DATA RECORD: 180326 005	
Longitude/Easting: 27.827972	Latitude/Northing: -26.182090		Elevation:
Short Location Description & Notes: ~~Edge of~~ Edge of town			

SETUP	Start Date & Time: 14:52:47 20 min	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.4 - 1.5	~~295~~ NW	29.5	30.6	5	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☑ Music	☑ Community	☑ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other

Description: Traffic from R41, Short grass, next to apartment houses.

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
14:54	Dogs						
14:56	Pedestrian						
14:58	Pedestrian + conversation						
	Kids walking past.						
14:59	Conversation						
15:01	More conversation						
15:03	Plane						
15:04	Kids talking						
15:08	Conversation						
	+ shouting						

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SITE NUMBER:	West Wits 6		SLM DATA RECORD:	180326 006	
Longitude/Easting:	27.841731	Latitude/Northing:	-26,175049	Elevation:	
Short Location Description & Notes:	Close to Gaudrand. (±300m)				

SETUP	Start Date & Time:	16:08:50 20min.	End Date & Time:		Sensitivity Before:		Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.5 - 1.5	NW	24.6	36.8	5%	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☑ Community	☑ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other

Description: R41 most prevalent source of traffic noise, trees, long-medium grass, power-lines + substation ± 50-100m crushing + mining ± 500m west (Upward Spiral) on google maps

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
4:09	Waterbottle cracked						
4:12	Phone						
4:15	Plane						
4:25	Phone						
4:28	Plane						

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<table>
<tr><th colspan="2">Site 1</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Facing East</td><td>Facing West</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Facing North</td><td>Facing South</td></tr>
</table>

Site 2	
	
Facing East	Facing West
	
Facing North	Facing South

Site 3	
	
Facing East	Facing West
	
Facing North	Facing South

Site 4	
	
Facing East	Facing West
	
Facing North	Facing South

Site 5	
	
Facing East	Facing West
	
Facing North	Facing South

Site 6	
	
Facing East	Facing West
	
Facing North	Facing South

Appendix D – Significance Rating Methodology

The methodology used for assessing the significance of the impact was obtained from the EAP.

PART A: DEFINITION AND CRITERIA		
Definition of SIGNIFICANCE		Significance = consequence x probability
Definition of CONSEQUENCE		Consequence is a function of severity, spatial extent and duration
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	H	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action. Irreplaceable loss of resources.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints. Noticeable loss of resources.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints. Limited loss of resources.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	L	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	L	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national

PART B: DETERMINING CONSEQUENCE					
			SEVERITY = L		
DURATION	Long term	H	Medium	Medium	Medium
	Medium term	M	Low	Low	Medium
	Short term	L	Low	Low	Medium
			SEVERITY = M		
DURATION	Long term	H	Medium	High	High
	Medium term	M	Medium	Medium	High
	Short term	L	Low	Medium	Medium
			SEVERITY = H		
DURATION	Long term	H	High	High	High
	Medium term	M	Medium	Medium	High
	Short term	L	Medium	Medium	High
			L	M	H
			Localised Within site	Fairly widespread Beyond site	Widespread Far beyond site boundary

			boundary Site	boundary Local	Regional/ national
			SPATIAL SCALE		

PART C: DETERMINING SIGNIFICANCE					
PROBABILITY (of exposure to impacts)	Definite/ Continuous	H	Medium	Medium	High
	Possible/ frequent	M	Medium	Medium	High
	Unlikely/ seldom	L	Low	Low	Medium
			L	M	H
			CONSEQUENCE		

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	Decision guideline
High	It would influence the decision regardless of any possible mitigation.
Medium	It should have an influence on the decision unless it is mitigated.
Low	It will not have an influence on the decision.