Noise Specialist Study - Pure Source Mine Project in the Free State

Project done for **Shango Solutions**

Report compiled by:

Reneé von Gruenewaldt

Nick Grobler

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Address: 480 Smuts Drive, Halfway Gardens | Postal: P O Box 5260, Halfway House, 1685
Tel: +27 (0)11 805 1940 | Fax: +27 (0)11 805 7010
www.airshed.co.za

Report Details

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Prepared by	Renee von Gruenewaldt, (Pr. Sci. Nat.), MSc (University of Pretoria) Nick Grobler, BEng (Chem), BEng (Hons) (Env) (University of Pretoria)
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Revision Record

Version	Date	Comments
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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
Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure inclusive of a site plan identifying site alternative	Section 4
An identification of any areas to be avoided, including buffers	Section 4
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 3.1 and Section 4.2
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
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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	Provided in the EIA
A summary and copies of any comments received during any consultation process and where applicable all responses thereto	Provided in the EIA
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)
EXM	EXM Advisory Services (Pty) Ltd
FMAC	Francois Malherbe Acoustic Consulting cc
Hz	Frequency in Hertz
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

The proposed Pure Source Mine Project will involve opencast mining with trucks and shovels, of sand, gravel and possibly diamonds (based on potential established via exploration). Reject material will be backfilled into mined voids and topsoil stockpiles established for rehabilitation. Mined sand will either be screened in the pit or transported by truck to the washing plant. Once the sand is removed the underlying gravel will be exposed and test pits established to ascertain gravel quality and diamond potential. Where appropriate the gravel will be excavated and crushed in the pit by a mobile crusher and then either loaded onto trucks or transported to the plant to extract diamonds. In the areas where there is no silica sand the topsoil will be stripped and stockpiled to expose the underlying aggregate. Where the presence of high yield diamondiferous gravel is anticipated the silica sand will be stockpiled. The sand from the northern pit is expected to be screened and loaded at the location and will be sold as unprocessed sand directly. The sand from the main and east pit is exclusively identified to be beneficiated and sold as specialised sand. The processes, as described above, will hereafter be referred to as the project.

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by Shango Solutions, the independent Environmental Assessment Practitioner (EAP) to undertake an environmental noise impact study as part of the application for environmental authorisation. The main objective of the noise specialist study was to determine the potential impact on the acoustic environment and 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 28 February and 1 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.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. The preparation of a comprehensive specialist noise impact assessment report.

In the assessment of simulated noise levels, reference was made to the South African National Standard (SANS) 10103 and IFC noise guidelines.

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:

- NSRs:

- Include places of residence and areas where members of the public may be affected by noise generated by proposed activities.
- NSRs within a 2 km radius of the proposed operations include several residences on the both banks of the Vaal River to the west and east of the proposed operations, as well as the residential area of Vaal Oewer to the north of the operations.

- The acoustic climate at NSRs is currently affected by community activities, music, light vehicle and motorcycle traffic, domesticated animals as well as natural noises such as birds, insects and noise created by the Vaal River.
- Recorded $L_{Req,d}$ at all sampling locations during the day-time survey are similar to those given in SANS 10103 as typical for rural districts (45 dBA). Recorded night-time $L_{Req,n}$ at sampling locations 1, 4 and 5 are typical for rural districts at (35 dBA) as described by SANS 10103. Recorded night-time $L_{Req,n}$ at sampling location 2 and 3 are however more akin to those typical for urban districts (45 dBA) as described by SANS 10103. This is due to insect activity which is prevalent during the summer months.

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. Mobile crushing and screening as well as the generator 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 11 km east-west by 8.5 km north-south. The area was divided into a grid matrix with a 50-m. The noise impacts were simulated for the entire Life of Mine (LOM) to determine all potential noise impacts throughout project operations.

The main findings of the impact assessment are:

- A management and mitigation plan are recommended to minimise noise impacts from the project on the surrounding area.
- Day-time and day/night-time noise levels from the project operations exceed the selected noise criteria at NSRs within Vaal Oewer.
- Construction and closure phase impacts are expected to me similar or slightly lower than simulated noise impacts of the operational phase.
- The overall significance for construction and demolition is “low” and for operation is ‘medium’.

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:
  - Annually during the operational phase at five proposed sampling locations; and
  - In response to complaints received.

Based on the findings of the assessment and provided the measures planned and recommended are in place, it is the specialist opinion that the project may be authorised.

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1 Introduction

The proposed Pure Source Mine Project is located on portion 3 of the farm Woodlands 407, the remaining extent of portion 1 of the farm Woodlands 407 and the remaining extent of the farm Woodlands 407, located approximately 20 km north-east of Parys in the Free State Province (Figure 1). The properties are located along a stretch of the Vaal river and covers an area of approximately 875 hectares.

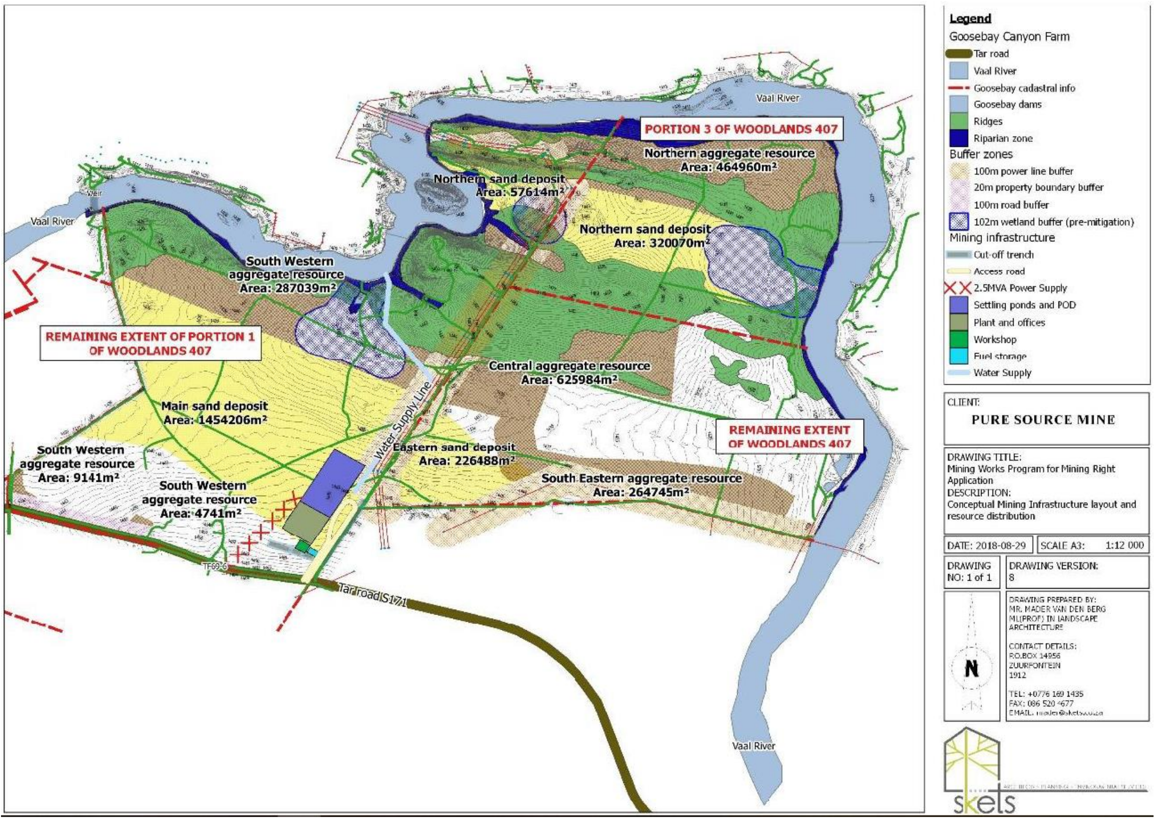

Figure 1: Local setting and mine layout

The proposed Pure Source Mine Project will involve opencast mining with trucks and shovels, of sand, gravel and possibly diamonds (based on potential established via exploration). Reject material will be backfilled into mined voids and topsoil stockpiles established for rehabilitation. Mined sand will either be screened in the pit or transported by truck to the washing plant. Once the sand is removed the underlying gravel will be exposed and test pits established to ascertain gravel quality and diamond potential. Where appropriate the gravel will be excavated and crushed in the pit by a mobile crusher and then either loaded onto trucks or transported to the plant to extract diamonds. In the areas where there is no silica sand the topsoil will be stripped and stockpiled to expose the underlying aggregate. Where the presence of high yield diamondiferous gravel is anticipated the silica sand will be stockpiled. The sand from the northern pit is expected to be screened and loaded at the location and will be sold as unprocessed sand directly. The sand from the main and east pit is exclusively identified to be beneficiated and sold as specialised sand. The processes, as described above, will hereafter be referred to as the project.

The schedule for the sand and gravel mining is provided in Figure 2 and Figure 3 respectively.

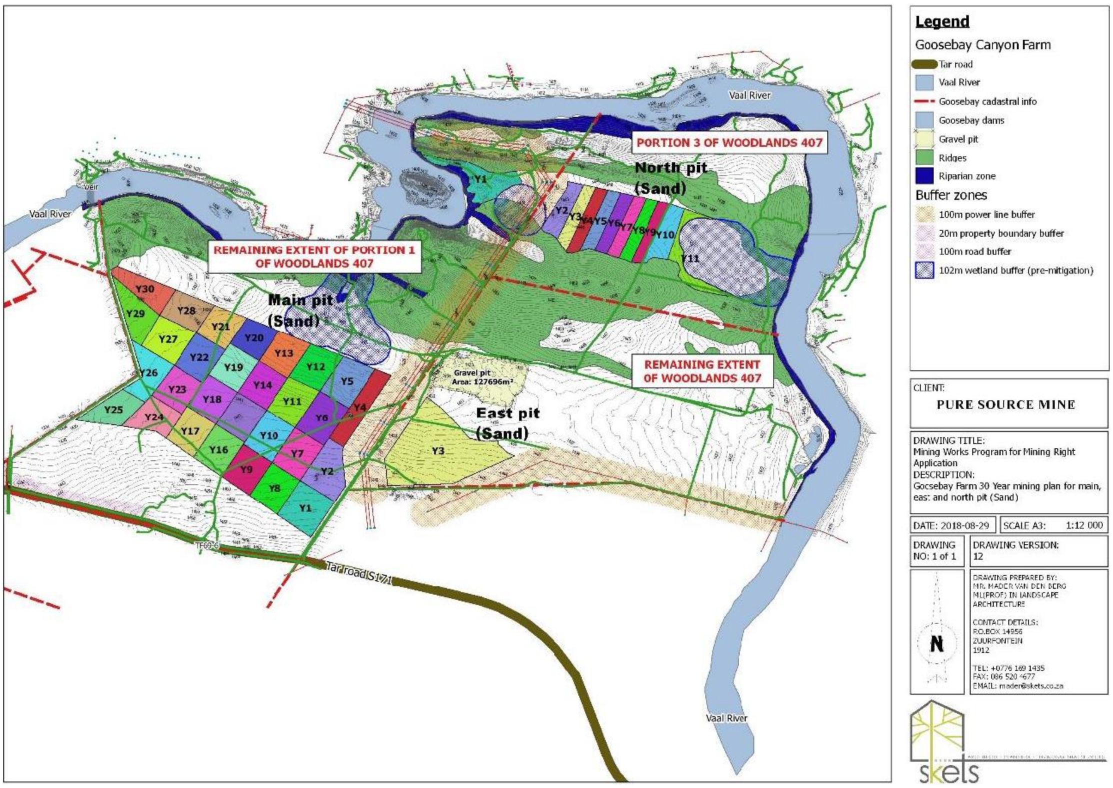

Figure 2: Sand mining schedule

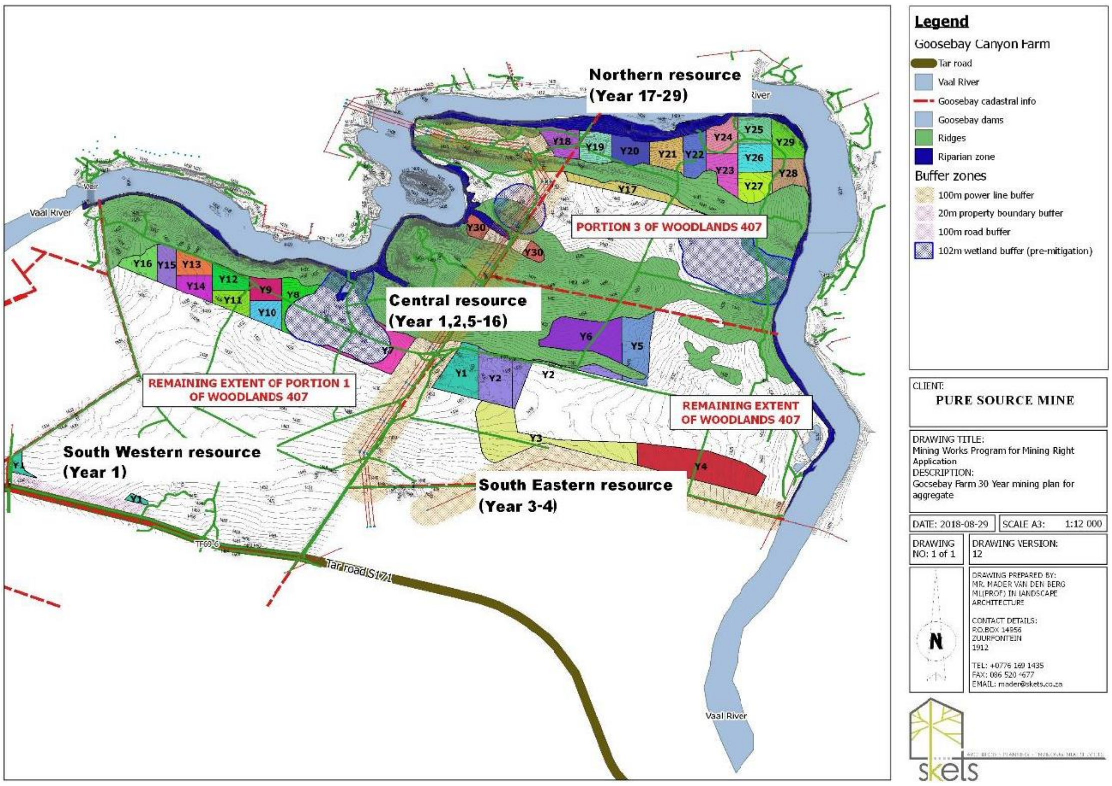

Figure 3: Gravel mining schedule

The proposed open pit surface mining and processing activities will result in noise impacts in the study area. Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by Shango Solutions to undertake an environmental noise specialist study for the project as part of the Environmental Impact Report (EIR) process.

1.1 Study Objective

The main objective of the noise specialist study was to determine the potential impact on the acoustic environment and noise sensitive receptors (NSRs) as a result of the project and recommend suitable management and mitigation measures.

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
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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

1.3.1 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.

1.3.2 Competency Profile of Specialist

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 range over various countries in Africa, providing her with an inclusive knowledge base of international legislation and requirements pertaining to air quality.

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 and haul routes, the processing plant and infrastructure such as offices and workshops), as well as metal and concrete works for the erection of the processing plant and other infrastructure.

Mining will include opencast mining, backfilling, crushing and screening by means of mobile equipment in the gravel mine areas and transport of sand and gravel to the wash plant. The sand and gravel will be transported by truck via dedicated haul roads.

During decommissioning, bulk earthworks and demolishing activities 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 sand and gravel.

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, et al., 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.

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.

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 4. 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).

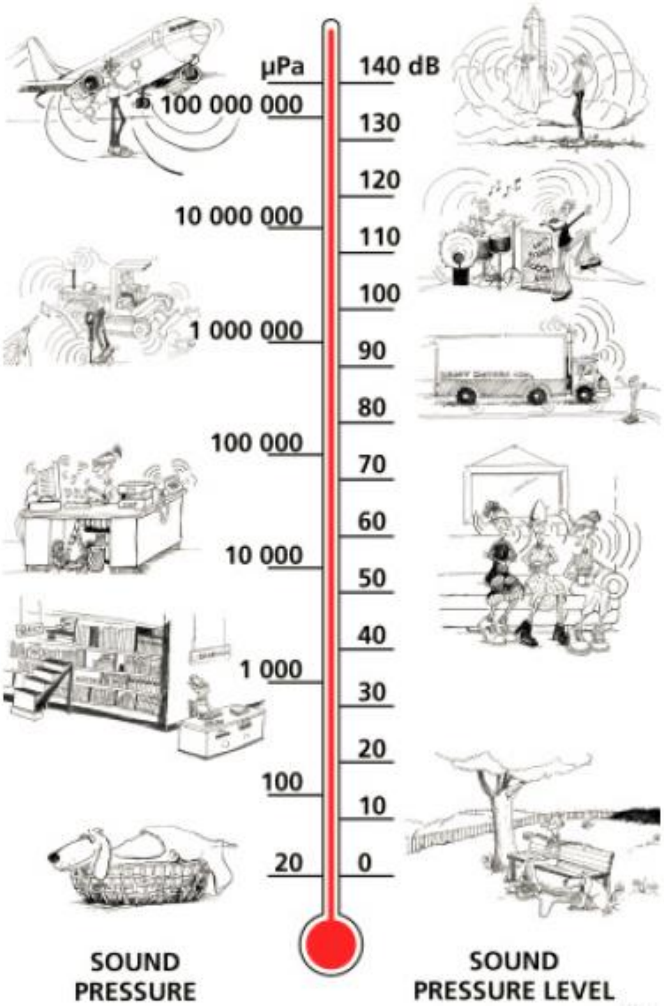

Figure 4: The decibel scale and typical noise levels (Brüel & Kjær Sound & Vibration Measurement A/S, 2000)

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).*

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 5). "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) that has been A-weighted.

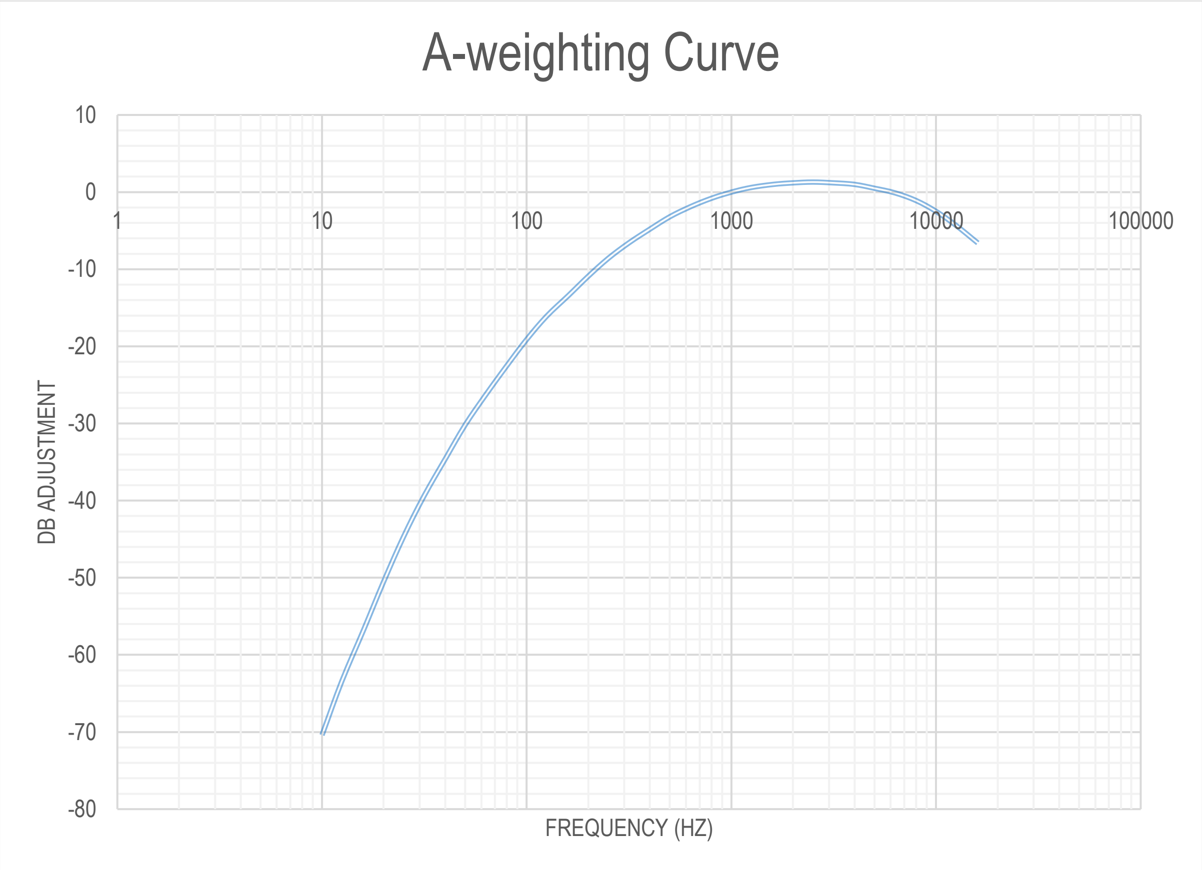

Figure 5: A-weighting curve

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 just 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 Shango Solutions at the onset of the project. In response to the request, the following information was supplied:

- Project and site layout maps;
- A mining schedule;
- A basic process description; and
- A list of equipment.

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 EHS Guidelines* and World Health Organisation (WHO) *Guidelines for Community Noise*, were considered in the assessment.

1.6.3 Study of the Receiving Environment

NSRs generally include private residences, community buildings such as schools, hospitals and any publicly accessible areas outside an industrial facility's property. Homesteads and residential areas which were included in the assessment as NSRs were identified from available maps and satellite imagery.

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 on-site meteorological data for the period 28 February and 1 March 2018.

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 surveys conducted on 28 February and 1 March 2018 was studied to determine current noise levels within the area.

The survey methodology, which closely followed guidance provided by the IFC (2007) and SANS 10103 (2008), 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.
- Samples, 15 to 30 minutes in duration, 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. Samples representative of the day- and night-time acoustic environment were taken. 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 were kept. Records included site details, weather conditions during sampling and observations made regarding the acoustic environment of each site.

Table 1: Sound level meter details

Equipment	Serial Number	Purpose	Calibration Date
Brüel & Kjær Type 2250 Lite SLM	S/N 2731851	Attended 30-minute sampling.	10 May 2017
Brüel & Kjær Type 4950 ½" Pre-polarized microphone	S/N 2709293	Attended 30-minute sampling.	10 May 2017

Equipment	Serial Number	Purpose	Calibration Date
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.

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:

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

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.

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.

Mobile crushing and screening equipment as well as the wash plant 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 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.

1.6.6.1 ISO 9613

ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to 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.

1.6.6.2 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 for an area of 11 km east-west by 8.5 km north-south. 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.

1.6.6.3 Simulation Scenario

The noise impacts were simulated for the entire Life of Mine (LOM) to determine all potential noise impacts throughout project operations.

1.6.7 Presentation of Results

Mining operations will take place on a 5.5-day work week with a two-shift system, operating hours will be from 6:00 to 18:00. Diamond sorting alone will be operating 24 hours per day with a 6-day work week. As the diamond sorting operations would contribute very little to the noise environment, night-time noise levels were not evaluated.

Noise impacts were therefore calculated in terms of:

- The day-time noise level (L_{Aeq}); and
- The equivalent day/night noise level (L_{Aeq}).

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 Shango Solutions 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, buildings, and infrastructure acting as acoustic barriers were not taken into account. The local topography however was included.
- 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 South African National Standards

SANS 10103 (2008) successfully 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. Outdoor ambient noise exceeding these levels will be annoying to the community.

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 useful 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.

2.1 Gauteng Noise Control Regulations

Although the project is not within the Gauteng Province, NSR that may potentially be affected by the project are within Gauteng. Reference has therefore been made to the 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). It defines “controlled” areas as areas where calculations or measurements over 24-hours indicate noise levels in exceedance of 60 dBA. It defines a “disturbing noise" as 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).

2.2 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

2.3 Criteria Applied in This Assessment

Reference is made to the IFC guidelines for residential areas and the increase in noise levels of 3 dBA above background levels. Due to the location of potential NSRs, reference is also made to the Gauteng Noise Control Regulations.

3 Description of the Receiving Environment

This chapter 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 Noise Sensitive Receptors

NSRs generally include places of residence and areas where members of the public may be affected by noise generated by proposed activities. Only those within a 2 km radius of activities are likely to be affected.

NSRs within a 2 km radius of the project (Figure 6) include several residences on the both banks of the Vaal river to the west and east of the proposed operations, as well as the village of Vaal Oewer to the north of the operations.

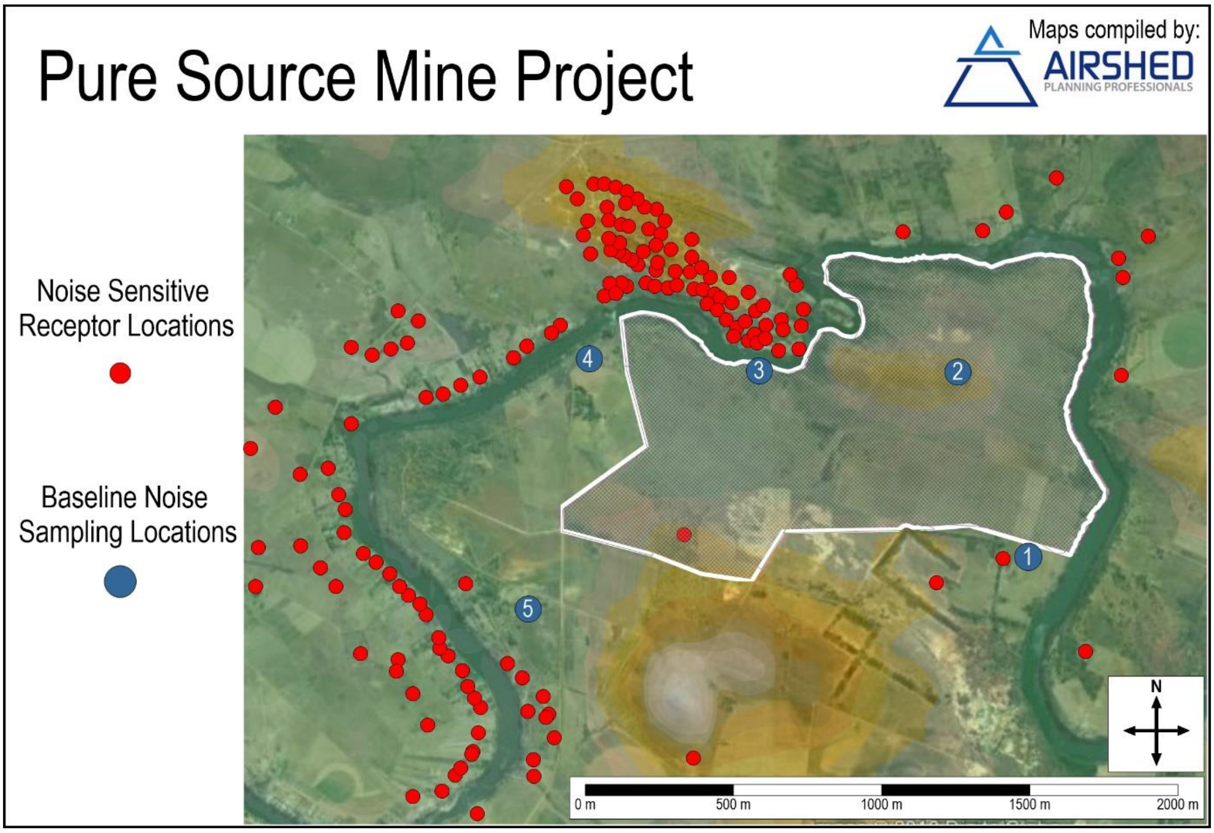

Figure 6: Environmental noise impact study area, NRs, and baseline noise measurement sites

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 MM5 data for the period 2014 to 2016.

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 for the area is presented in Figure 7. Wind roses represent wind frequencies for 16 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.

(a) Day-time wind field (07:00 to 22:00)	(b) Night-time wind field (22:00 to 07:00)

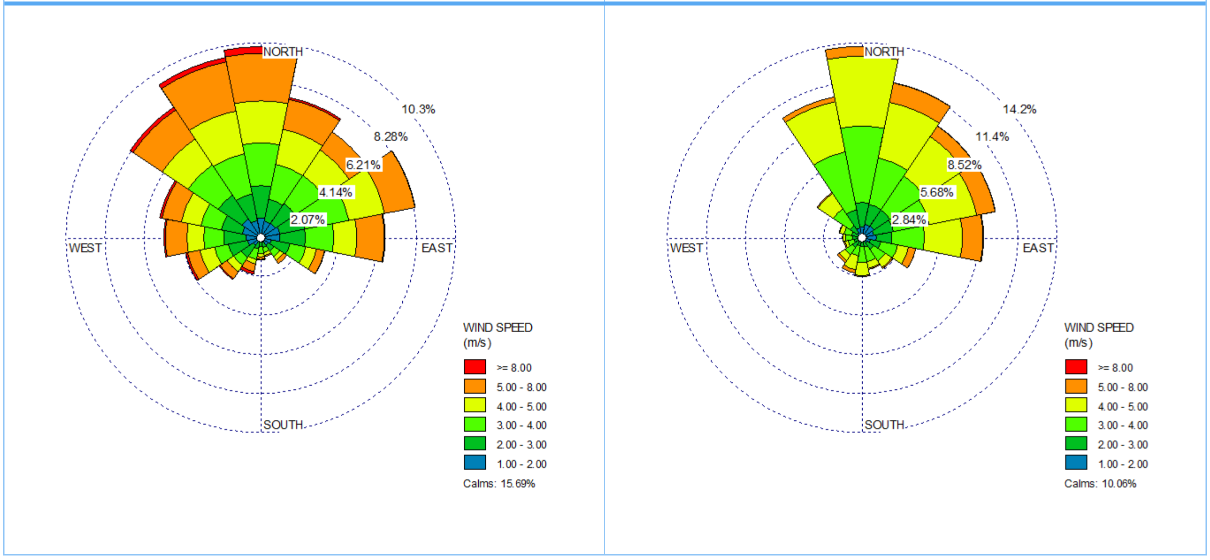

Figure 7: Day- and night-time wind field showing dominant northerly winds (MM5, 2014 to 2016)

MM5 data for the study area indicates a wind field dominated by winds from the northern sector during the day- and night (Figure 7), with very little wind from the south. Day- and night-time average wind speeds are 3.2 m/s and 3.3 m/s respectively. Calm conditions occur 15.7% of time during the day 10.0% during the night. The average temperature in the study area over the three-year period was 17.2°C and the average humidity 62%. Noise impacts are expected to be slightly more notable to the south of the project activities.

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.

3.2.2 Terrain, Ground Absorption and Reflection

Noise reduction caused by a barrier (i.e. natural terrain, installed acoustic barrier, building) 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). The terrain of the study area is shown in Figure 8. The noise impact study area is located between 1400 and 1500 meters above sea level (masl).

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.

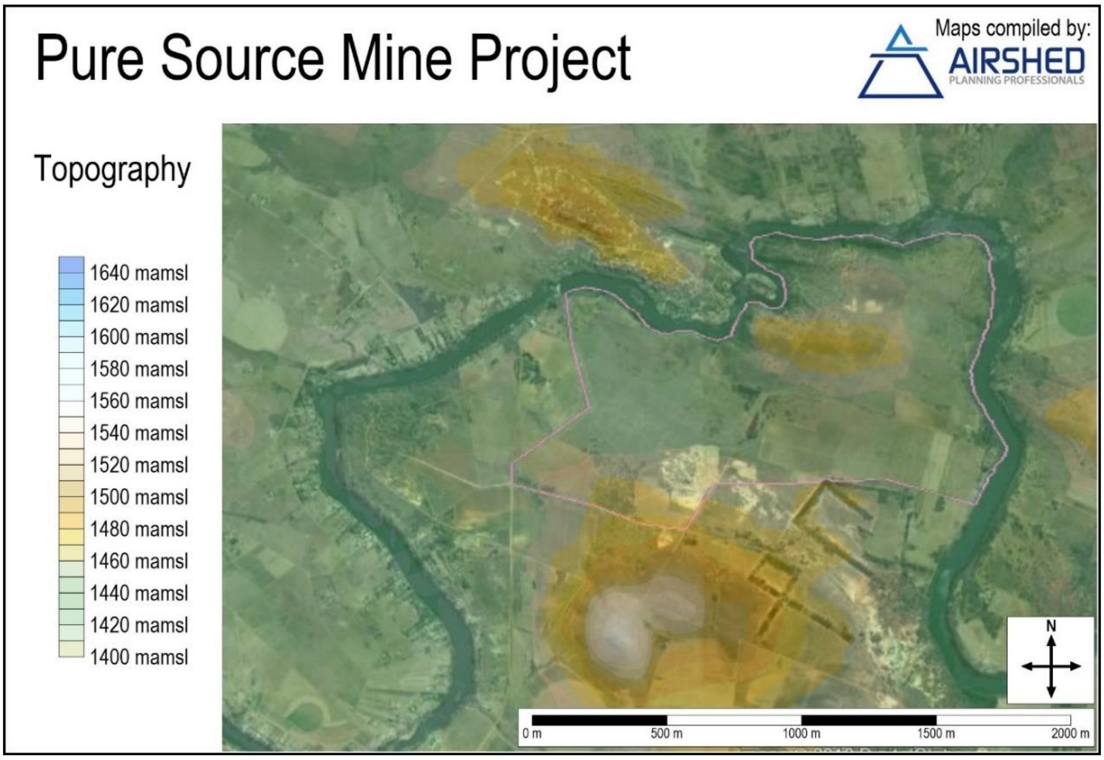

Figure 8: Topography of the local study area

3.3 Baseline Noise Survey and Results

Day- and night-time noise measurements were conducted on 28 February and 1 March 2018 at five locations shown in Figure 4. Survey sites were selected taking into consideration existing and proposed activities, NSRs, accessibility and safety. Fieldwork log sheets, photographs of the sampling sites and microphone placement are included in Appendix C.

During the day-time survey, temperatures ranged between 27.3°C and 31.0°C, with 5% to 70% cloud cover. Winds were between 0 m/s and 1.7 m/s and from a north-north-easterly and south-south-easterly direction. Humidity was between 32.5% and 49.6%. At night, temperatures ranged between 15.1°C and 18.4°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 affected by community activities, vehicle traffic, domesticated animals as well as natural noises such as birds, insects and the Vaal River. Additionally, a mining operation to the west of the project location contributes to baseline noise levels on the west of the study area.

$L_{Req,d}$ at all sampling locations during the daytime survey are similar to those given in SANS 10103 as typical for rural districts (45 dBA). The $L_{Req,n}$ at sampling locations 1, 4 and 5 are typical for rural districts at night-time (35 dBA) as described by SANS 10103. Night-time $L_{Req,n}$ at sampling location 2 and 3 are however more akin to those typical for urban districts (45 dBA). According to the account of the SLM operator, birds and insects (possibly disturbed by the SLM operator), as well as the Vaal river to the north, were the main source of audible noise at sampling location 2 during the night-time survey. The main sources of audible noise at sampling location 3 during the night-time survey were birds, insects, barking dogs in the Vaal Oewer residential area, as well as splashes and water noise from the Vaal River. An analysis of the frequency spectra (Figure 11 and Figure 12) for each sampling location shows a very high contribution in the high frequency (12.5 and 16kHz) bands at sampling location 2 and 3 during the night, indicative of insect noise.

Logged broadband results are shown in Figure 9 for the daytime survey and in Figure 10 for the night-time survey.

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

Site	Day/night	Day-time	Night-time
	$L_{R,dn}$ (dBA)	$L_{Req,d}$ (dBA)	$L_{Req,n}$ (dBA)
1	43.7	39.8	36.3
2	52.2	39.4	45.8
3	53.3	41.0	47.0
4	42.3	39.3	34.6
5	43.4	39.8	35.9

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	SE	26° 45.296'S 27° 37.596'E	13:15	30 min	Birds, insects, air traffic, agricultural vehicles	52.3	39.8	24.2
Site 2	NE	26° 44.575'S 27° 37.280'E	14:45	30 min	Birds, insects, road vehicles (north of river)	56.9	39.4	24.0
Site 3	N	26° 44.527'S 27° 36.100'E	16:00	30 min	Birds, insects, community noise, dogs, road traffic	57.0	41.0	31.1
Site 4	NW	26° 44.512'S 27° 35.320'E	11:48	30 min	Birds, insects, dogs, mining, electrical equipment	84.0	39.3	29.9
Site 5	SW	26° 45.701'S 27° 34.985'E	12:43	30 min	Birds, insects, air traffic	51.9	39.8	28.5
Night-time								
Site 1	SE	26° 45.296'S 27° 37.596'E	1:27	15 min	Birds, insects, river	51.8	36.3	31.1
Site 2	NE	26° 44.575'S 27° 37.280'E	2:00	15 min	Birds, insects, road traffic, alarms, dogs, animals	56.3	45.8	31.5
Site 3	N	26° 44.527'S 27° 36.100'E	2:41	15 min	Birds, insects, dogs, river	78.8	47.0	33.2
Site 4	NW	26° 44.512'S 27° 35.320'E	3:28	15 min	Birds, insects, river, electrical equipment	43.9	34.6	30.6
Site 5	SW	26° 45.701'S 27° 34.985'E	3:56	15 min	Birds, insects, dogs, river	56.1	35.9	23.7

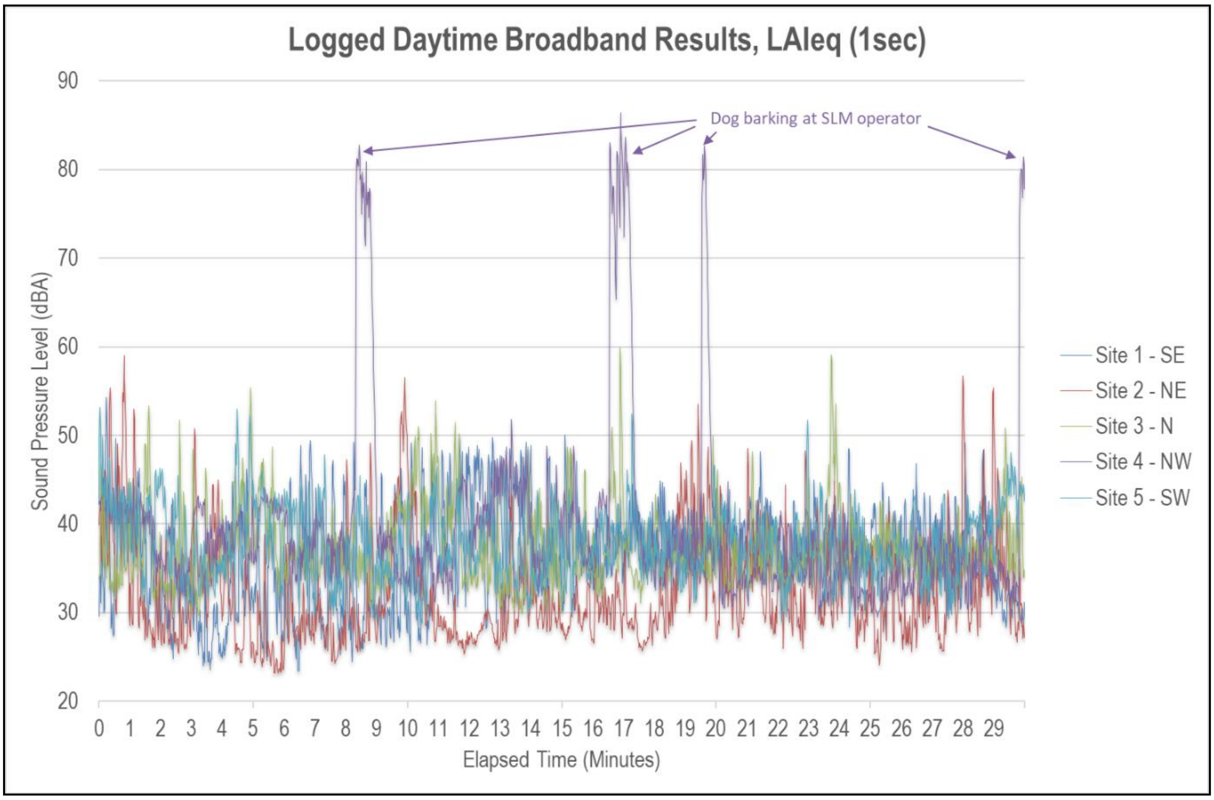

Figure 9: Logged Daytime Broadband Results

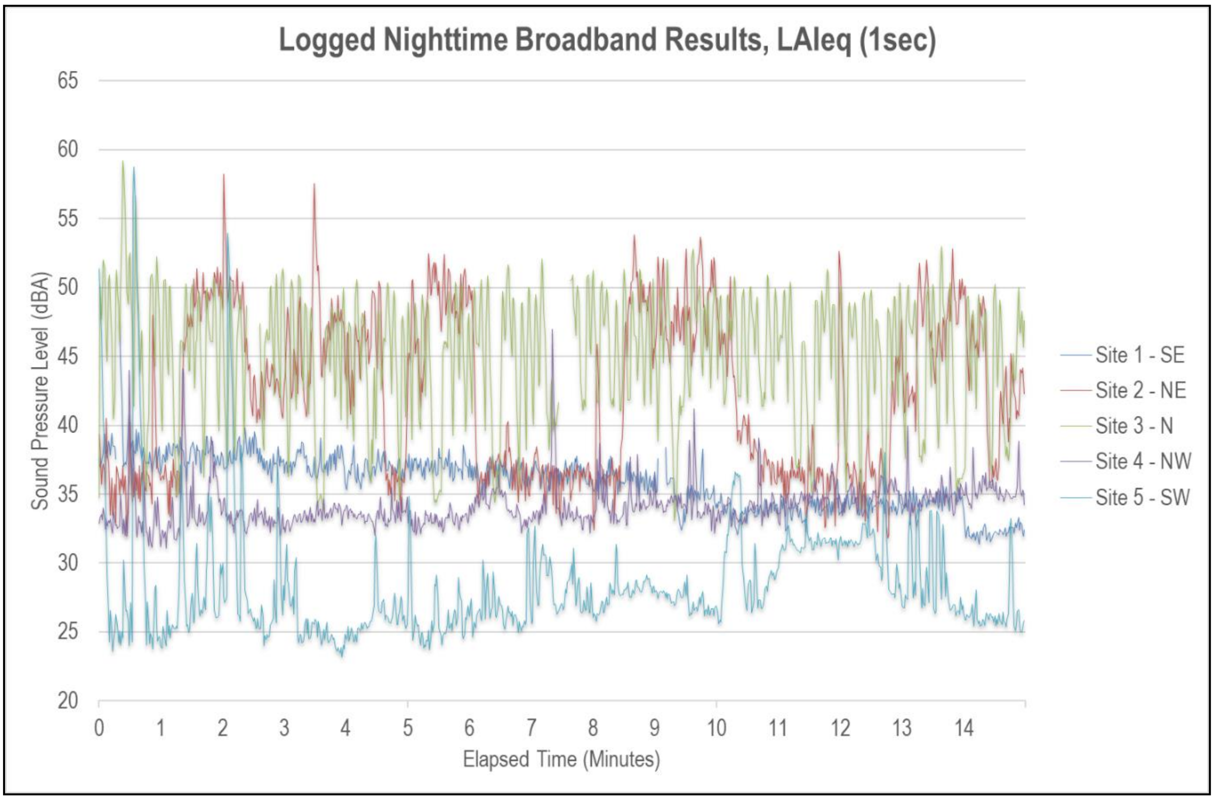

Figure 10: Logged Night-time Broadband Results

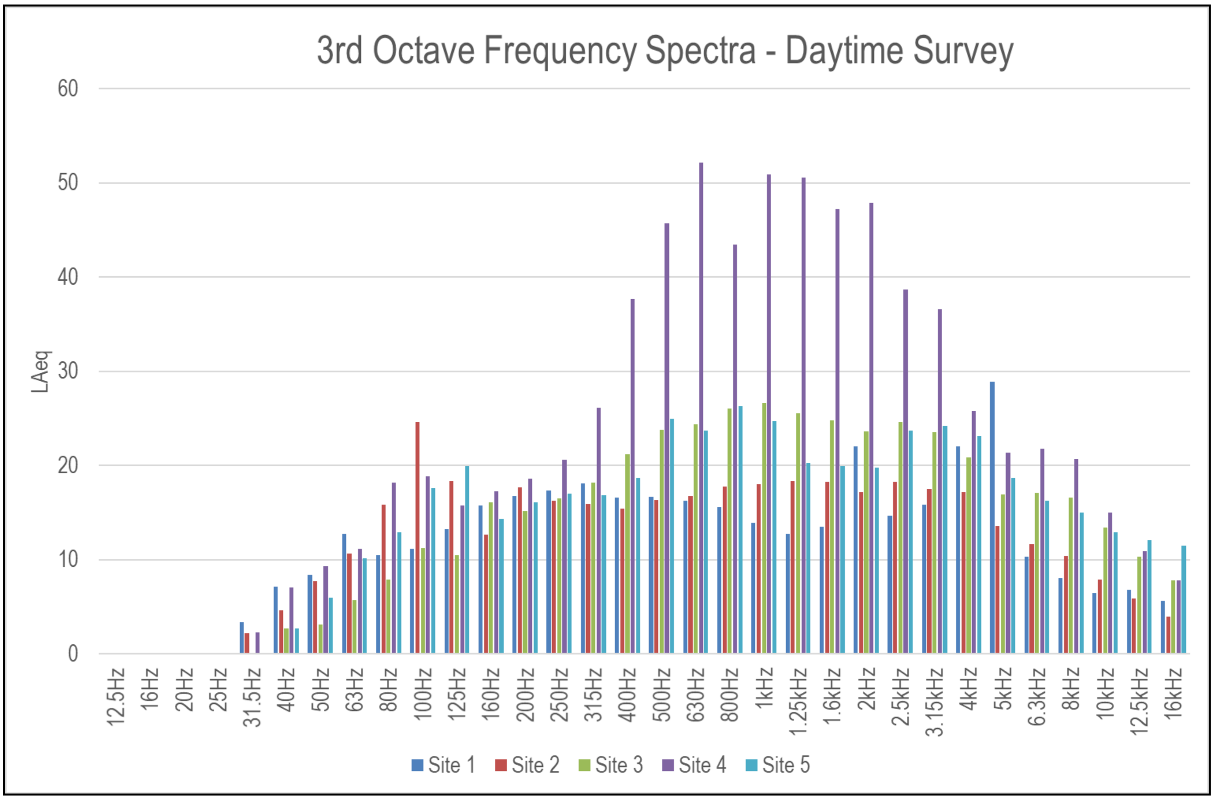

Figure 11: Daytime Frequency Spectra

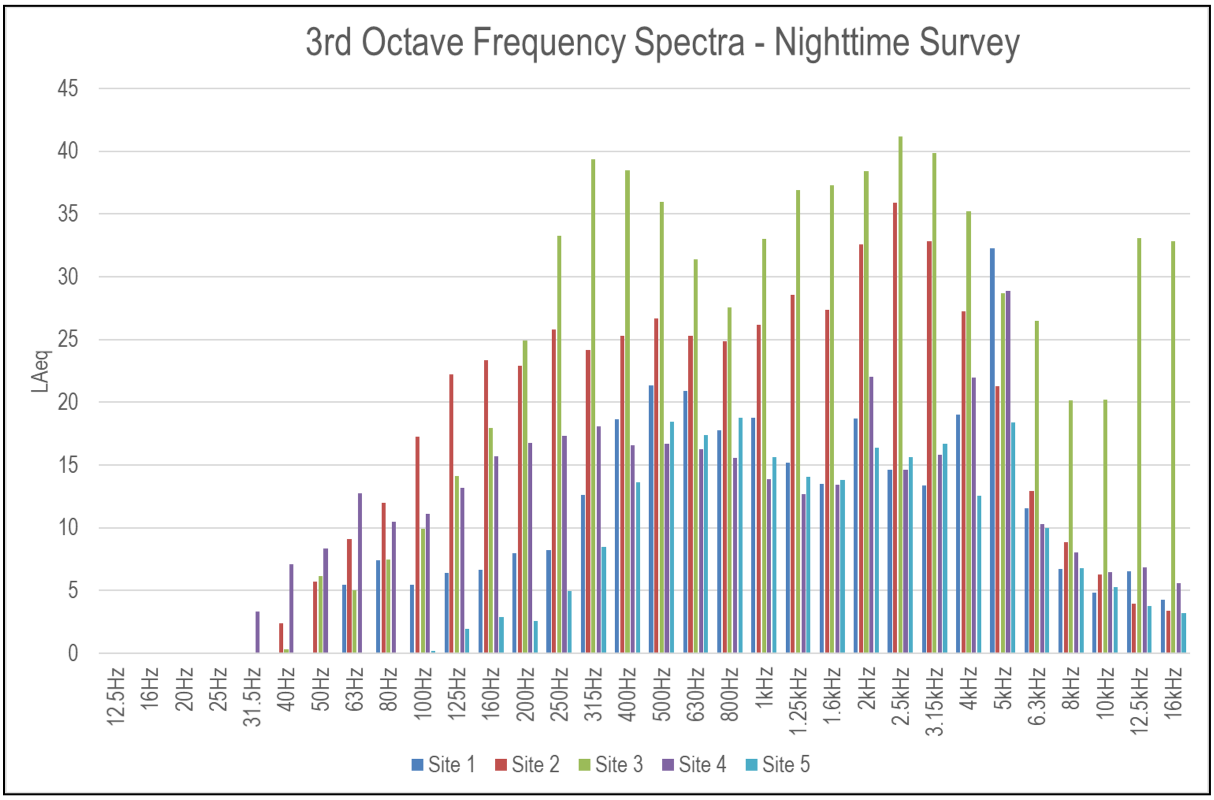

Figure 12: Nighttime Frequency Spectra

For the purpose of this assessment, given the description of the baseline acoustic environment and survey results, it was decided that sampled L_{Aeq} values at site 4 would be more representative of prevailing baseline conditions and provide the specialist with a slightly more conservative estimate of the project's noise impact. In order to illustrate the increase in ambient noise levels as a result of the project, the following representative background noise levels (based on the lowest survey measurements as a conservative approach) were used:

- $L_{Req,d}$ – 39.3 dBA; and
- $L_{R,dn}$ – 42.3 dBA.

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.

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, lighting plants etc.), the incremental contributions of such sources are expected to be minimal given that the majority of sources are considered in the source inventory.

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)
CAT 966	Area	FEL1	10	NA	NA	12	0	120.7
CAT 950	Area	FEL2	7	NA	NA	12	0	119.5
CAT 330	Area	EXCAVATOR	8	NA	NA	12	0	122.1
CAT 730D	Moving point source	ADT	14	10.7	40	12	0	124.1
CAT D4	Area	BULLDOZER	1	NA	NA	12	0	115.2
MG 430	Area	GRADER	1	NA	NA	12	0	120.3
Water bowser	Area	BOWSER	3	NA	NA	12	0	122.1
25t Roller Self Propelled	Area	ROLLER	1	NA	NA	12	0	119.5
LDVs	Area	LDV	4	NA	NA	12	0	121.1
Diesel bowser	Area	DBOWSER	3	NA	NA	12	0	120.4
Diesel tanker truck	Area	DTANKER	1	NA	NA	12	0	120.6
Mobile screening plant	Area	SCREEN	1	NA	NA	12	0	106.4
Mobile crushing plant	Area	CRUSHER	1	NA	NA	12	0	103.5
Generator	Area	GENERATOR	1	NA	NA	12	0	81.0
Wash Plant	Area	WASH	1	NA	NA	12	0	112.8

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
			63	125	250	500	1000	2000	4000	8000			
FEL1	CAT 966	L_W	109.0	114.0	117.0	112.0	110.0	107.0	101.0	95.0	120.7	115.3	L_W Predictions (Bruce & Moritz, 1998)
FEL2	CAT 950	L_W	107.9	112.9	115.9	110.9	108.9	105.9	99.9	93.9	119.5	114.1	L_W Predictions (Bruce & Moritz, 1998)
EXCAVATOR	CAT 330	L_W	110.5	115.5	118.5	113.5	111.5	108.5	102.5	96.5	122.1	116.7	L_W Predictions (Bruce & Moritz, 1998)
ADT	CAT 730D	L_W	112.5	117.5	120.5	115.5	113.5	110.5	104.5	98.5	124.1	118.7	L_W Predictions (Bruce & Moritz, 1998)
BULLDOZER	CAT D4	L_W	103.5	108.5	111.5	106.5	104.5	101.5	95.5	89.5	115.2	109.8	L_W Predictions (Bruce & Moritz, 1998)
GRADER	MG 430	L_W	108.6	113.6	116.6	111.6	109.6	106.6	100.6	94.6	120.3	114.9	L_W Predictions (Bruce & Moritz, 1998)
BOWSER	Water bowser	L_W	110.5	115.5	118.5	113.5	111.5	108.5	102.5	96.5	122.1	116.7	L_W Predictions (Bruce & Moritz, 1998)
ROLLER	25t Roller Self Propelled	L_W	107.8	112.8	115.8	110.8	108.8	105.8	99.8	93.8	119.5	114.1	L_W Predictions (Bruce & Moritz, 1998)
LDV	LDVs	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)
DBOWSER	Diesel 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)
DTANKER	Diesel tanker truck	L_W	108.9	113.9	116.9	111.9	109.9	106.9	100.9	94.9	120.6	115.2	L_W Predictions (Bruce & Moritz, 1998)
SCREEN	Mobile screening plant	L_W	106	95	87	79	80	79	74		106.4	87.1	L_W Database
CRUSHER	Mobile crushing plant	L_W	98	98	97	94	91	88	82	72	103.5	96.4	L_W Database
GENERATOR	Generator	L_W	80	74	57	54	53	48	45	37	81.0	61.4	L_W Database
WASH	Wash Plant	L_W	111.4	102.7	100.5	102	95.6	90.8	86.1		112.8	101.9	L_W Database

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 for LOM are presented in isopleth form (Figure 13 to Figure 16). The simulated equivalent continuous day-time rating level ($L_{Req,d}$) of 55 dBA (IFC noise guideline level) extends ~680 m from the project boundary to the northwest. The simulated equivalent continuous day/night-time rating level ($L_{Req,dn}$) of 55 dBA (IFC noise guideline level) extends ~570 m from the project boundary to the northwest. Both the day- and continuous day/night-time noise levels due to project activities, extends over NSR of Vaal Oewer. The noise impacts due to project activities are predicted to exceed the noise guideline levels for day- and continuous day/night-time at NSR when mining operations extend to the north western region (i.e. Year 1 for sand mining and Year 30 for gravel mining). The Gauteng noise regulations defines "controlled" areas as areas where calculations or measurements over 24-hours indicate noise levels in exceedance of 60 dBA. The simulated continuous day/night time rating level ($L_{Req,dn}$) of 60 dBA was mainly within the mining rights application area and did not extend over any potential NSRs.

An increase above the baseline of 3 dBA (IFC noise guideline) and 7 dBA (Gauteng noise regulations) extends ~1700m and ~1200m respectively to the northwest over potential NSR of Vaal Oewer. For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. According to SANS 10103 (2008); 'little' reaction with 'sporadic complaints' may be expected from the community for increased noise levels up to 10 dBA and 'strong' reaction with 'threats of community action' for increased noise levels of 10 dBA to 20 dBA. With the conservative approach adopted for the assessment (detailed in Section 1.6) the predicted increase in noise levels are expected to be ~15 dBA at potential NSRs at Vaal Oewer. 'Strong' reaction is therefore expected from the community due to the project when mining commences to the northwest.

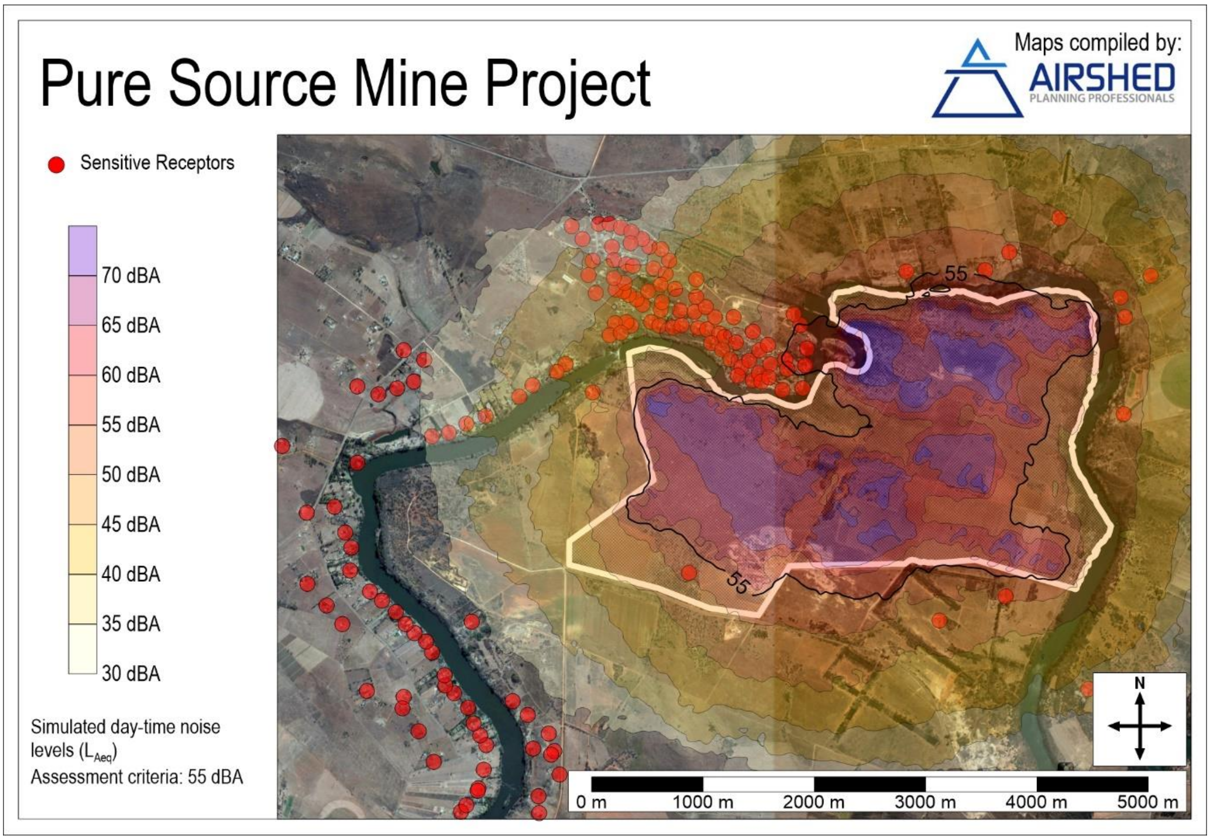

Figure 13: Simulated equivalent continuous day-time rating level ($L_{Req,d}$) for project activities

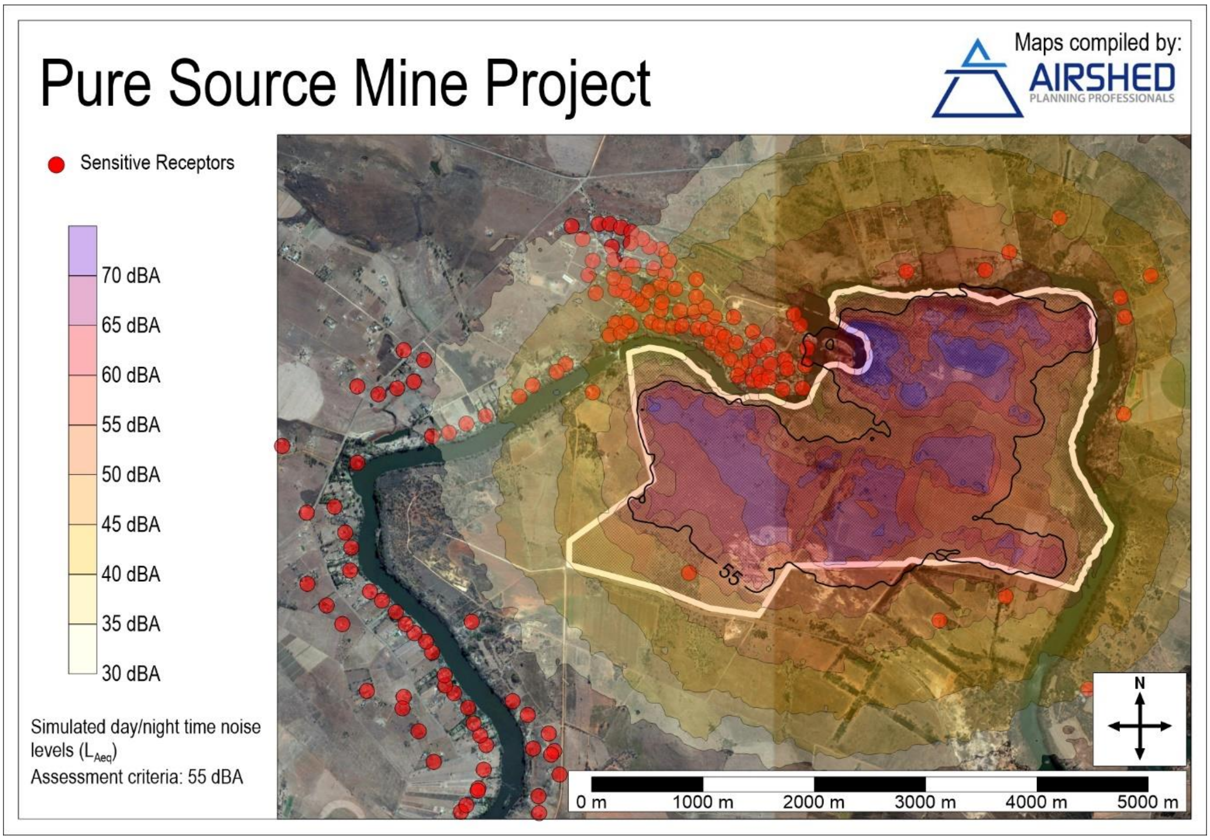

Figure 14: Simulated equivalent continuous day/night-time rating level ($L_{Req,dn}$) for project activities

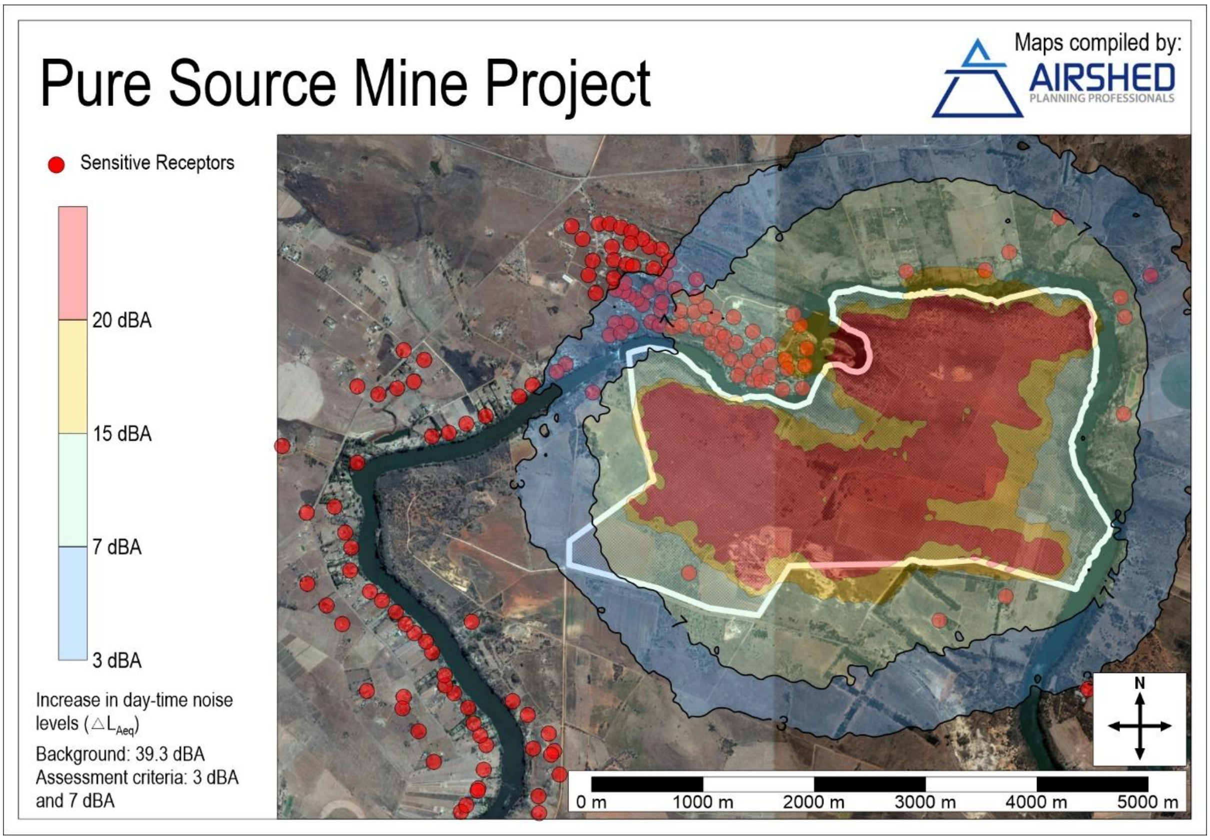

Figure 15: Simulated increase in equivalent continuous day-time rating level ($\Delta L_{Req,d}$) above the baseline

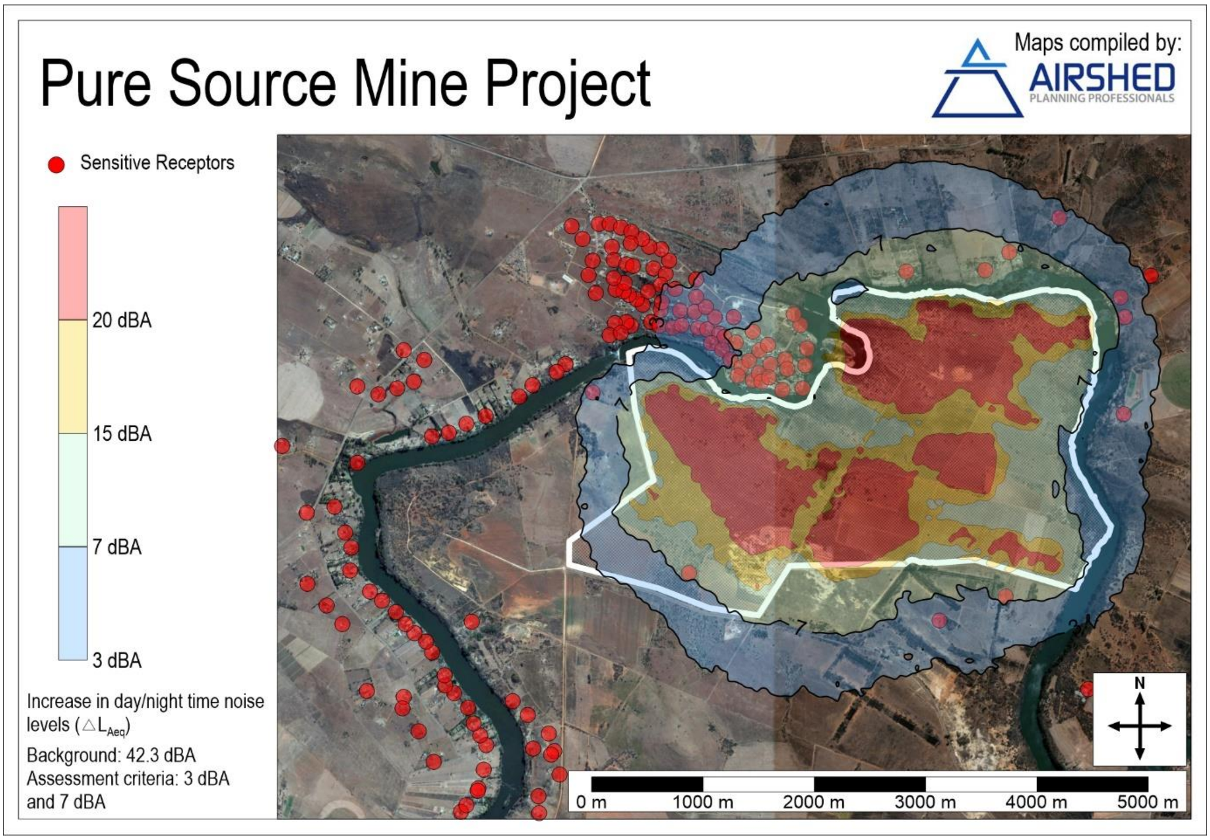

Figure 16: Simulated increase in equivalent continuous day/night-time rating level ($\Delta L_{Req,dn}$) above the baseline

5 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 potential NSRs at Vaal Oewer when mining commences near this residential area. 'Strong' reaction can be expected from members of the community within this impact area.

From a noise perspective, the project may proceed. It is recommended, however, that mitigation measures be implemented to ensure minimal impacts on the surrounding environment.

The mitigation measures should be implemented in a tiered approach where noise is first controlled at the source (Section 5.1). If measured noise levels at the closest NSR is not within acceptable levels, noise levels should be mitigated further by means of controlling the spread of noise (Section 5.2). If noise measurements after these two approached still do not meet acceptable levels, noise can be controlled at the NSR (Section 5.3).

However, even with the best mitigation, it is possible that people may hear the mining operations. Reverse alarms and other impulsive sounds do have a nuisance effect and people may complain. It should be noted that reverse alarms are exempt from an acoustical assessment due to Government Notice R154 of 1992 (Noise Control Regulations) – Clause 7 (1) – "the emission of sound is for the purposes of warning people of a dangerous situation".

5.1 Controlling Noise at the Source

5.1.1 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.
- Equipment 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.
  - Minimising the need for trucks/equipment to reverse. This will reduce the frequency at which disturbing but necessary reverse warnings will occur. 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 is 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). Another alternative to the traditional reverse 'beeper' is the use of white-noise generators. The white-noise generators use a wide range of white-noise frequencies. This enables the listener to instantly locate where and what direction the sound is coming from. The broadband sound also gives workers wearing hearing protection devices (HPDs) and people with hearing difficulties a better chance of hearing the alarm. White-noise reverse alarms create a "ssh-ssh" sound which is gentle on the ear and dissipates quickly, meaning the alarm can only be heard in the danger zone.

    - Limiting traffic to hours to between 06:00 and 18:00. The mining operations for this project is proposing that the operations would be restricted to these hours. This should include other non-routine noisy activities such as construction, decommissioning, start-up and maintenance.

- 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.

5.1.2 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.

5.1.3 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. Generators, pumps and blowers are examples of such equipment.

It should be noted that the effectiveness of partial enclosures and screens 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.

5.1.4 Use and Siting of Equipment

Plant and equipment should be sited as far away from NSRs as possible. Also:

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) Acoustic covers of engines and compressors should be kept closed when in use or idling.
d) Doors to pump houses, and generators should be kept closed at all times.
e) Construction materials such as beams should be lowered and not dropped.

5.1.5 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.

5.2 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 screens, barriers, or berms can be installed to reduce noise at NSRs.

5.2.1 Distance

To increase the distance between source and receiver is often the most effective method of controlling noise since, for a typical point source at ground level, a 6-dB decrease can be achieved with every doubling in distance. It is however conceded that it might not always be possible.

5.2.2 Screening

If noise control at the source and the use of distance between source and receiver is not possible, screening methods must be considered. The effectiveness of a noise barrier is dependent on its length, effective height, and position relative to the source and receiver as well as material of construction. To optimize the effect of screening, screens should be located close to either the source of the noise, or the receiver.

The careful placement of barriers such as screens or berms can significantly reduce noise impacts but may result in additional visual impacts. Although vegetation such as shrubs or trees may improve the visual impact of construction sites, it will not significantly reduce noise impacts and should not be considered as a control measure.

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 dust.

5.3 Controlling Noise at the Receiver

Receiver noise control is mostly achieved through building design. Good hearing conditions are very important in especially institutional, business and educational buildings and adequate airborne sound insulation may necessary in areas of the development likely to be exposed to road and air traffic noise. In any building, there are many possible transmission paths of sound and in most cases part of the sound produced in a room is transmitted indirectly via flanking elements, e.g. side walls, windows, ceiling and floors into adjacent rooms or to the outside.

Since the outside walls of buildings have a relatively low weight in comparison with that of the floor and the ceiling, outside walls can be considered as the main flanking path. Windows are the most important item of flanking paths of outside walls owing to the high sound transmission coefficient of glass panes (Elmallawany, 1983).

Suitable engineering methods for sound insulation of buildings typically include the consideration of single or double glazed of windows for classrooms and acoustically absorbent building materials. The introduction of sealed multiple glazed windows and doorways will necessitate the installation of air conditioning units properly designed, placed and maintained so as to minimize noise associate with such sources.

5.4 Summary of Mitigation Techniques

Table 9 provides a summary of the general effectiveness of various mitigation techniques.

Table 9: 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
Barriers	Excellent (5-15 dBA reduction)	Medium	Almost always
Earth Berms	Excellent (5-15 dBA reduction)	Low	Wide corridors
Buildings and other man-made structures	Good (up to 10 dBA reduction)	N/A	Requires local/site planning

Mitigation Technique	General Effectiveness	Monetary Costs	Conditions where feasible
Vegetative screening	Fair/average	Medium	Almost always
Sound Insulation	Average	Medium	Case by case

5.5 Monitoring

An environmental noise monitoring campaign should be conducted annually during the operational phase, at five potential locations (Figure 17). The locations are selected to coincide with the closest sensitive receptors as well as potential noise impact zones.

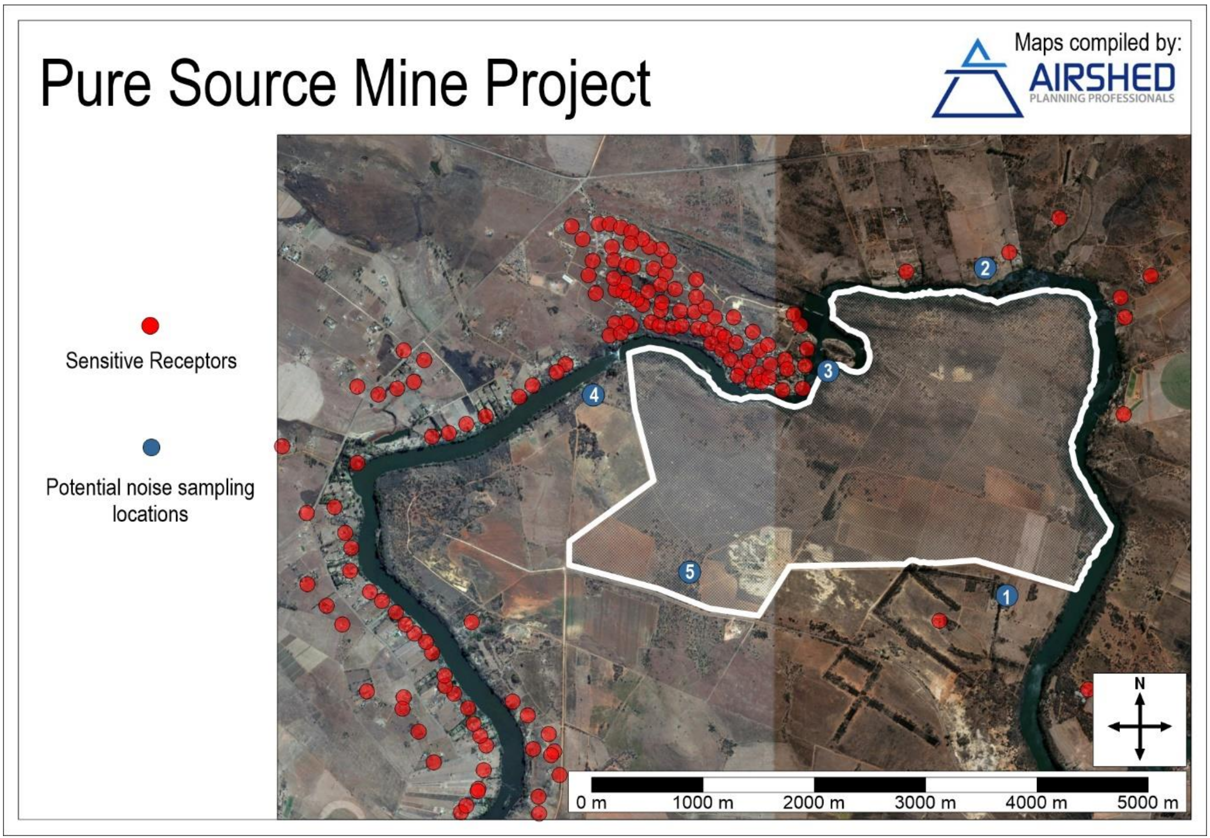

Figure 17: Proposed noise sampling locations

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 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 results or resulted in noise levels annoying to the community. This could be achieved with source noise measurements.

5.6 Summary of Noise Management Plan

The targets for the noise management plan are provided in Table 10 with actions provided in Table 11.

Table 10: Noise Management Plan for the proposed project operations

No.	Mitigation Measures	Phase	Timeframe	Responsible party for implementation	Monitoring Party (frequency)	Target	Performance Indicators (Monitoring Tool)
A	Various management measures may be implemented including: controlling noise at source, controlling spread of noise, controlling noise at receiver. *It is recommend-ed that as a minimum, equipment*	Operational Phase	Duration of operations	Applicant Environmental Manager	Environ-mental Manager (annually or when complaints are received)	IFC residential guidelines (55 dBA for day-time conditions	Sampled noise levels are with IFC residential guidelines at the closest noise sensitive receptors.

No.	Mitigation Measures	Phase	Timeframe	Responsible party for implementation	Monitoring Party (frequency)	Target	Performance Indicators (Monitoring Tool)
	be selected with lowest noise specifica-tions and where possible to enclose noisy equipment. Mining operations should be restricted to day-time hours only.						
Noise Sampling							
B	Noise sampling be conducted at 5 sites annually.	Construction, operation and closure phases	10 to30-minute sample during the day. Sampling should be conducted annually during construction, operations and closure	Applicant Environmental Manager	Environ-mental Manager	Ensure compliance with IFC residential guidelines (55 dBA for day-time conditions	Type 1 SLM
C	Noise sampling be conducted at NSR in the event of a complaint.	Planning phase and proposed operational phase.	24-hour sample	Applicant Environmental Manager	Environ-mental Manager	Ensure compliance with IFC residential guidelines (55 dBA for day-time conditions	Type 1 SLM

Table 11: Action Plan

Phase	Management Action	Timeframe for Implementation	Responsible Party for Implementation	Responsible Party for Monitoring/Audit/Review
Construction Phase	Undertake day-time noise samples at 5 sampling locations or undertake noise sampling at NSRs in the event of a complaint	Annual sampling at 5 locations or when a complaint is received	Consultant	Consultant Environmental Manager (internal review)
Operational Phase	Undertake day-time noise samples at 5 sampling locations or undertake noise sampling at NSRs in the event of a complaint	Annual sampling at 5 locations or when a complaint is received	Consultant	Consultant Environmental Manager (internal review)
	Maintenance on equipment	Throughout operation	Environmental Manager	Environmental Manager (onsite monitoring)

Phase	Management Action	Timeframe for Implementation	Responsible Party for Implementation	Responsible Party for Monitoring/Audit/Review
Closure Phase	Undertake day-time noise samples at 5 sampling locations or undertake noise sampling at NSRs in the event of a complaint	Annual sampling at 5 locations or when a complaint is received	Consultant	Consultant Environmental Manager (internal review)

6 Impact Significance Rating

The significance of environmental noise impacts was assessed according to the methodology adopted by Shango Solutions Refer to Appendix D of this report for the methodology.

The overall significance of construction and decommissioning phase noise impacts on nearby NSRs is considered ***low*** (Table 13).

The significance of the operation phase of the project were found to be ***moderate*** (Table 13). Assuming the adoption of good practice noise mitigation and management measures as recommended, the significance of the project may be reduced to ***low*** (Table 13). The overall significance of the operation phase was found to be ***moderate***.

No noise impacts are expected post-closure.

Table 12: Significance rating for construction, operation and closure phases

Description	Phase		
	Construction	Operation	Closure
Pre-mitigation			
Nature	-1	-1	-1
Extent	3	3	3
Duration	2	4	2
Magnitude	3	3	3
Reversibility	2	2	2
Probability	4	4	4
Pre-mitigation ER	-10	-12	-10
Significance Rating	Medium	Medium	Medium
Post-mitigation			
Nature	-1	-1	-1
Extent	2	2	2
Duration	2	4	2
Magnitude	2	2	2
Reversibility	2	2	2
Probability	2	3	2
Post-mitigation ER	-4	-7.5	-4
Significance Rating	Low	Low	Low
Impact Prioritisation			
Confidence	Medium	High	Medium
Public Response	2	2	2
Cumulative Impact	2	2	2

Description	Phase		
	Construction	Operation	Closure
Irreplaceable Loss	1	1	1
Priority Factor	1.33	1.33	1.33
Final Score	-5.33	-10.00	-5.33
Significance Rating	Low	Medium	Low

7 Conclusion

Based on the findings of the assessment and provided the measures planned and recommended are in place, it is the specialist opinion that the project may be authorised.

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 **R Nel** **Metrologist (Technical Signatory)**	Checked by **H Potgieter** **Metrologist**	For Chief Executive Officer
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 — U = 0,10 dB @ f_m
(IEC 61260 clause 4.4, 5.3)
16 Hz - 8 kHz

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

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.

Signature of staff member

22/11/2017

Date (Day / Month / Year)

Full name of staff member: René Georgeinna von Gruenewaldt

Appendix C – Fieldwork Log Sheets and Photos

SITE NUMBER: GB 1		SLM DATA RECORD: 180228 001
Longitude/Easting: 27° 37.596' E	Latitude/Northing: 26°45.296' S	Elevation: 1435m
Short Location Description & Notes: Most eastern part of farm. Close to log cabins		

SETUP	Start Date & Time: 28/2/18 13:15:28	End Date & Time: 30min	Sensitivity Before: 113.5 dB	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.2	SSE	26.3°C	49.6%	60-70	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☐ Dogs	☐ Music	☐ Community	☑ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other
Description: Between two mielie fields, Powerline south ± 20m									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
13:15	Plane						
13:16 8	Phone Ringtone						
13:22	Sneeze + car window						
13:28	Sneeze						
13:31	Bird stops						
13:37	Tractor (far away)						
	↳ stops 13:42						
13:42	Guinea fowl						
13:44	Tractor						

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14:45:11

GB2

SITE NUMBER:	27° 37.2801 E		SLM DATA RECORD:	180228 002		
Longitude/Easting:		Latitude/Northing:	26° 44.5751 S		Elevation:	1470m
Short Location Description & Notes:	On top of small ridge. South of sand pit.					

SETUP	Start Date & Time: 28/2/18 ~~14:44.28~~ 14:45:11 30 min	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.5	SSE	29.8	37.2	~~37.2~~ 60	
Middle	1.5	SE	29.8	33.3	60	
End	0.7 – 1.7	N	29.4	39.9	60	

NOISE CLIMATE	☑ Birds	☑ Insects	☐ Dogs	☐ Music	☐ Community	☑ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other
Description:	short grass, scattered stones, can hear the river, air traffic, can hear traffic from north (Potchefstroom Rd)(N) and southern road (SR)								

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
14.14	Plane	14:45:	Traffic North road (NR)				
14:22	Truck (rd North)	14:46	Traffic south road (SR)				
14:27	Bird.	14:50	Traffic/Trucks NR				
14:31	Truck (road (N)	14:53	Truck on NR				
	Bird (stops → 14:32)	14:53	Plane				
14:34	Bird.	14:59	Traffic NR				
14:36	Truck (road N)	15:02	Truck NR + sneeze				
14:38	Traffic (road N)	1504	Truck NR				
14:41	Truck (road N)	15:06	Plane				
		15:13	Bird				
		15:14	Knock (fieldworker)				

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SITE NUMBER:	GB3	SLM DATA RECORD:	180228003
Longitude/Easting: 27° 36.100' E	Latitude/Northing: 26° 44.527' S	Elevation:	1436 M
Short Location Description & Notes:	Across river from Vaal oewer		

SETUP	Start Date & Time: 28/2/18	End Date & Time:	Sensitivity Before:	Sensitivity After:

16:00 ~~15:15:58~~ 30 min.

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0 – 1.4	NNE	31.	32.5	50	
Middle						
End	1 – 1.6	NNE	29.8	35.7	50	

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

Description: Lawnmowers, vacuum cleaners, traffic from town medium grass, some trees, alarm ± 10m cliff

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
16:02	Knock fieldworker						
	Dog						
16:13	~~Boat~~ engin Lawnmower						
16:14	Thump (can't ident)						
16:27	Bat						

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SITE NUMBER: GB4		**SLM DATA RECORD:** 18030100C (1424m)	
Longitude/Easting: 27 35.3201' E	**Latitude/Northing:** 26° 44.512' S	**Elevation:**	
Short Location Description & Notes: Next to vaal resort.			

11:48:55 ~~11:4..58~~ 30min

SETUP	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.5 – 1.5	S	27.8	37	5%	
Middle						
End						

→ see video

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

Description: Lots of long trees north, long grass & scrub. Power line transformer ± 25m SW active sand mine to the south ↳ ± 1km wire fence Lawnmowers from across river can be heard

mine entrance at 26° 45.110' S 27° 35.251' E can hear activity ← see photo

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
~~11:..~~							
11:57	Dog						
11:59	Sand Mine						
12:01	Sand mine						
12:02	~~Lawnmower~~						
	Sand mine						
12:05	Dog + bakkie						
12:08	Dog						
12:11	Sandmine						
12:13	Sandmine stops						
12:18	Dog						

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Long: 27° 34.986' E   Lat: 26° 45.698' S

SITE NUMBER: CB5		**SLM DATA RECORD:** 18030l007	
Longitude/Easting: ~~27° 45.698' E~~	**Latitude/Northing:** ~~26~~ ~~45.698~~' ~~S~~ ~~34.986~~'		**Elevation:** 1437 m
Short Location Description & Notes: Next to Deo Volente Youth Camp			

SETUP	**Start Date & Time:** 1/3/18 12:43:32	**End Date & Time:** 30 min	**Sensitivity Before:**	**Sensitivity After:** 113.5 dB

METEOROLOGY	**Wind Speed (m/s)**	**Wind Direction (°)**	**Temperature (°C)**	**Humidity (%)**	**Clouds (%)**	**Remarks:**
Start	0.5 - 1.1	NEN	27.3°C	43.9	5	
Middle						
End						

NOISE CLIMATE	Birds (v)	Insects (v)	Dogs	Music	Community	Air Traffic (v)	Road Traffic (v)	Constr.	Other

Description: short grass, some trees, wirefence, can hear traffic either R500/from Lindequesdrift. Petrol ~~eng~~ engine.

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
12:48	~~Plane~~ Helicopter						
13:02	~~#~~Bird						
13:03	Plane						

Page   of

SITE NUMBER: GBI Night		SLM DATA RECORD: 180301 001	
Longitude/Easting: 27° 37.596' E	Latitude/Northing: 26° 45.296' S		Elevation: 1435m
Short Location Description & Notes:			

SETUP	Start Date & Time: 01:27 15min	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	–	–	16.1	77	10	Misty
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☑ Community	☐ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description: Same as before. Can hear river directly from north									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
1:27	Knock Fieldworker						
1:35	Bakkie fan						
1:36	Sneeze						

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SITE NUMBER:	CB2 Night		SLM DATA RECORD:	180301 002	
Longitude/Easting:	27 37.280' E	Latitude/Northing:	26 44.575' S	Elevation:	1470 m
Short Location Description & Notes:					

SETUP	Start Date & Time: 1/3/18 2:00 15 min	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	1.3	NEE	16.3	77	0	Misty
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☐ Community	☑ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description: Can hear river north. Wildebeest + birds. Same as before									

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
2:01	Plane						
2:04	Birds stop						
2:04	Birds ~~start~~						
2:08	Birds						
2:08	Traffic (Vaal river)						
	(NW)						
2:10	Birds stop						
2:12	Birds						
2:14	Alarm						
	(across river)						

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SITE NUMBER: GB3 Night		SLM DATA RECORD: 180301 003	
Longitude/Easting: 27° 36.100' E	Latitude/Northing: 26 44.527'		Elevation: ~~13~~ 1436 m
Short Location Description & Notes:			

SETUP	Start Date & Time: 1/3/18 2:41:31	End Date & Time: 15 min	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.6	SSE	16.3°C	82.1	0	Misty
Middle						
End						

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

Description: Same as before. night owl intermitted calling Intermitted dog calling. Intermitted splashing in river → fishes jumping

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
2:41	Dog						
2:43	Cough (fieldworker)						
2:47	Dog						
2:49	Cough (fieldworker)						
2:50	Dog						
2:51	Dog						
2:52	Dog						
2:55	Plane.						

Page __ of __

SITE NUMBER: GB4 Night				SLM DATA RECORD: 180301 004	
Longitude/Easting:	27° 35.329'E	Latitude/Northing:	26° 44.512'S	Elevation:	1424 m
Short Location Description & Notes:					

SETUP	Start Date & Time: 1/3/18 3:28:20	End Date & Time: 15 min	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	0.4	NE	13.1	15	77	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☐ Community	☑ Air Traffic	☐ Road Traffic	☐ Constr.	☐ Other
Description:	Powerlines + transformer Can hear river / humming from river's side. Same as before								

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
3:34	Traffic.						
3:36	fieldworker						

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Long: 27° 34.986'E Lat: 26° 45.698'S

SITE NUMBER:	GB 5 Night	SLM DATA RECORD:	180301 005
Longitude/Easting: ~~27° 37.596~~ ~~E5697S~~	Latitude/Northing: ~~27~~	Elevation:	1437 m
Short Location Description & Notes:	Next to Deo Volente Youth Camp		

SETUP	Start Date & Time: 1/3/18 3:56:45 15min	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	—	—	17.4	65.9	0	Misty
Middle						
End						

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

Description: Can hear river SSW. Powerline ± 20m E
Same as before (Day)

EVENTS							
Time	Description	Time	Description	Time	Description	Time	Description
3:57	Field worker						
3:57	Field worker						
4:01	Traffic (N)						
4:04	Birds						
~~4:0~~							
4:06	Bird (Dove)						
4:07	Insect/~~Bird~~ stops ~~at~~ 4:09						

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Site 1	
	
Facing East	Facing West
	
Facing North	Facing South

Site 2	
	
Facing East	Facing West
	
Facing North	Facing South

<table>
<tr><th colspan="2">Site 3</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 4	
	
Facing East	Facing West
	
Facing North	Facing South

Site 5	
	
Facing East	Facing West
	
Facing North	Facing South

Appendix D – Significance Rating Methodology

Method of Assessing Impacts

The impact assessment methodology is guided by the requirements of the NEMA EIA Regulations (2014). The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/likelihood (P) of the impact occurring. This determines the environmental risk. In addition other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

Determination of Environmental Risk

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER).

The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the nature (N), extent (E), duration (D), magnitude (M), and reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$C = \frac{(E+D+M+R)}{4} \times N$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 1.

Table 1: Criteria for determining impact consequence.

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary)
	3	Local (i.e. the area within 5 km of the site)
	4	Regional (i.e. extends between 5 and 50 km from the site)

1

Aspect	Score	Definition
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years)
	3	Medium term (6-15 years)
	4	Long term (the impact will cease after the operational life span of the project)
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction)
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected)
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected)
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way)
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease)
	5	Very high/don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease)
Reversibility	1	Impact is reversible without any time and cost
	2	Impact is reversible without incurring significant time and cost
	3	Impact is reversible only by incurring significant time and cost
	4	Impact is reversible only by incurring prohibitively high time and cost
	5	Irreversible Impact

2

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/scored as per Table 2.

Table 2: Probability scoring.

Probability	1	Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%)
	2	Low probability (there is a possibility that the impact will occur; >25% and <50%)
	3	Medium probability (the impact may occur; >50% and <75%)
	4	High probability (it is most likely that the impact will occur- > 75% probability)
	5	Definite (the impact will occur)

The result is a qualitative representation of relative ER associated with the impact (Table 3). ER is therefore calculated as follows:

ER= C x P

Table 3: Determination of environmental risk.

Consequence	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
	Probability					

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table 4.

Table 4: Significance classes.

Environmental Risk Score	
Value	Description
< 9	Low (i.e. where this impact is unlikely to be a significant environmental risk)

3

≥9 and <17	Medium (i.e. where the impact could have a significant environmental risk)
≥ 17	High (i.e. where the impact will have a significant environmental risk)

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/mitigated.

Impact Prioritisation

In accordance with Appendix 1 of the NEMA 2014 EIA Regulations (GN R.982, as amended), and further to the assessment criteria presented in the Section above it is necessary to assess each potentially significant impact in terms of:

- Cumulative impacts
- The degree to which the impact may cause irreplaceable loss of resources

In addition, it is important that the public opinion and sentiment regarding a prospective development and consequent potential impacts is considered in the decision making process.

In an effort to ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impact ER (post-mitigation). This prioritisation factor does not aim to detract from the risk ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the ER score based on the assumption that relevant suggested management/mitigation impacts are implemented (Table 5).

Table 5: Criteria for determining prioritisation.

Public response (PR)	Low (1)	Issue not raised in public response
	Medium (2)	Issue has received a meaningful and justifiable public response
	High (3)	Issue has received an intense meaningful and justifiable public response
Cumulative impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change
	High (3)	Considering the potential incremental, interactive, sequential,

		and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change
Irreplaceable loss of resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions)

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 5.

The impact priority is therefore determined as follows:

Priority = PR + CI + LR

The result is a priority score which ranges from 3 to 9 and a consequent PF ranging from 1 to 2 (Table 6).

Table 6: Determination of prioritisation factor.

Priority	Ranking	Prioritisation Factor
3	Low	1
4	Medium	1.17
5	Medium	1.33
6	Medium	1.5
7	Medium	1.67
8	Medium	1.83
9	High	2

In order to determine the final impact significance the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is to be able to increase the post mitigation environmental risk rating by a full ranking class, if all the priority attributes are high (i.e. if an impact comes out with a medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential, significant public response, and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance (Table 7).

Table 7: Final environmental significance rating.

Environmental Significance Rating	
Value	Description
< -10	Low Negative (i.e. where this impact would not have a direct influence on the decision to develop in the area)
≥ -10 and < -20	Medium Negative (i.e. where the impact could influence the decision to develop in the area)
≥ -20	High Negative (i.e. where the impact must have an influence on the decision process to develop in the area)
< 10	Low Positive (i.e. where this impact would not have a direct influence on the decision to develop in the area)
≥ 10 and < 20	Medium Positive (i.e. where the impact could influence the decision to develop in the area)
≥ 20	High Positive (i.e. where the impact must have an influence on the decision process to develop in the area)

The significance ratings and additional considerations applied to each impact will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.