



Environmental Noise Impact Assessment for the Proposed Kokoseb Gold Mine, Namibia

Project done for Environmental Compliance Consultancy

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Revision Record

Version	Date	Comments
Rev 0	August 2025	For internal review
Rev 1	August 2025	For client review
Rev 2	September 2025	Incorporation of clients comments
Rev 3	September 2025	Inclusion of impacts at all receptors onsite

Glossary and Abbreviations

BSI	British Standards Institution
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.
ECC	Environmental Compliance Consultancy
EHS	Environmental, Health, and Safety (IFC)
EPL	Exclusive prospecting licence
Ha	Hectare
Hz	Frequency in Hertz
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
ISO	International Standards Organisation
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
km	Kilometre
km/hr	Speed in kilometres per hour
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_{Aleq} (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_{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
LoM	Life of mine
L_p	Sound pressure level (in dB)
L_w	Sound power level (in dB)
m	Metres
m/s	Speed in metres per second
NACA	National Association for Clean Air

NSR	Noise sensitive receptor
oz	Ounce
p	Pressure in Pa
Pa	Pressure in Pascal
μPa	Pressure in micro-pascal
p_{ref}	Reference pressure, 20 μPa
SABS	South African Bureau of Standards
SACNASP	South African Council for Natural Scientific Professions
SANS	South African National Standards
SLM	Sound level meter
SRTM	Shuttle Radar Topography Mission
WRF	Weather Research and Forecasting
°C	Degrees Celsius

Executive Summary

Damaran Exploration Namibia (Pty) Ltd (Damaran Exploration) is seeking to develop the Kokoseb Gold Mine (hereafter referred to as the project) within the Erongo Region in Namibia. The project is expected to produce 1,367,000 oz of gold with a life of mine (LoM) of a minimum of 11 years. The project will be undertaken in the exclusive prospecting licence (EPL) 4818 area, where the gold resource is located and covering an area of 33,667 ha. Airshed Planning Professionals (Pty) Ltd was commissioned by Environmental Compliance Consultancy (ECC) to undertake an Environmental Noise Impact Assessment for the proposed project.

The main objective of the noise specialist study was to determine the significance of impacts on the acoustic environment and noise receptors (NSRs) given noise generated by operational activities proposed for the project.

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

1. A review of technical information for the project.
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;
 - b. Analysis of sampled baseline noise levels.
4. An impact assessment, including:
 - a. A source inventory for project operations.
 - b. Noise propagation simulations to determine environmental noise levels over the selected study area and at NSRs as a result of the project operations.
 - c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable noise management measures and monitoring requirements.
6. The preparation of a comprehensive specialist environmental noise impact assessment report.

In the assessment of sampled and simulated noise levels, reference was made to the International Finance Corporation (IFC) noise level guidelines for residential, institutional and educational receptors (55 dBA during the day and 45 dBA during the night) since these are applicable to nearby NSRs. Annoyance was assessed according to the South African National Standard (SANS) 10103 (2008) scale.

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 assumed baseline noise levels. The following was found:

- The closest potential sensitive receptors to the proposed project include individual dwellings within the project boundary.
- The wind flow is primarily from the southwest during the day and from the east during the night.
- The measured noise levels within the study area were between 26 dBA and 38 dBA during the day-time and between 28 dBA and 31 dBA during the night-time.

A source inventory was developed for the project operations. A detailed list of equipment for operations was provided. Noise levels for the equipment were calculated using predictive equations for industrial machinery as per

the Handbook of Acoustics, Chapter 69, by Bruce and Moritz (1998). Numerous noise source L_w 's for operations at the project plant was obtained from a database for similar operations. Values from the database are based on source measurements carried out in accordance with the procedures specified in SANS 10103.

The source inventory and information on local land use were used to populate the noise attenuation model (CadnaA, ISO 9613). The propagation of noise was calculated over an area of 25 km east-west by 20 km north-south. The area was divided into a grid matrix with a 50 m resolution.

The main findings of the impact assessment were as follows:

- Noise levels due to project operations exceed the IFC noise guidelines at NSRs within the operational boundary.
- Expected community reaction due to project activities, based on measured baseline noise levels, were as follows:
 - R1:
 - Day-time: 'strong' to 'very strong' reaction with threats of community action.
 - Night-time: 'strong' to 'very strong' reaction with threats of community action.
 - R2:
 - Day-time: 'strong' to 'very strong' reaction with threats of community action.
 - Night-time: 'strong' to 'very strong' reaction with threats of community action.
 - R3:
 - Day-time: 'medium' reaction with widespread complaints.
 - Night-time: 'strong' to 'very strong' reaction with threats of community action.
 - R4:
 - Night-time: 'little' reaction with sporadic complaints.

The noise impacts due to the project are predicted to exceed IFC noise guidelines for residential areas at onsite residential dwellings within the project boundary (i.e. R1, R2 and R3). Given the proximity of these NSRs to the project operations, it is unlikely that mitigation measures will be able to reduce the noise levels at these sites to within the IFC noise guidelines. It is thus recommended that these NSRs be relocated to outside the project boundary once operations commence. In addition, a complaints register must be kept throughout the life of the operations.

It is the specialist opinion that, from an environmental noise perspective, the project may be authorised, if NSRs R1, R2 and R3 are relocated to outside of the project boundary prior to project operations and IFC noise guidelines for residential areas are met at all surrounding NSRs.

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Environmental Noise Impact Assessment for the Proposed Kokoseb Gold Mine, Namibia

Airshed Planning Professionals (Pty) Ltd was commissioned by Environmental Compliance Consultancy (ECC) to undertake an Environmental Noise Impact Assessment for the proposed project. The layout of the project and identified noise sensitive receptors in the study area is provided in Figure 1-2.

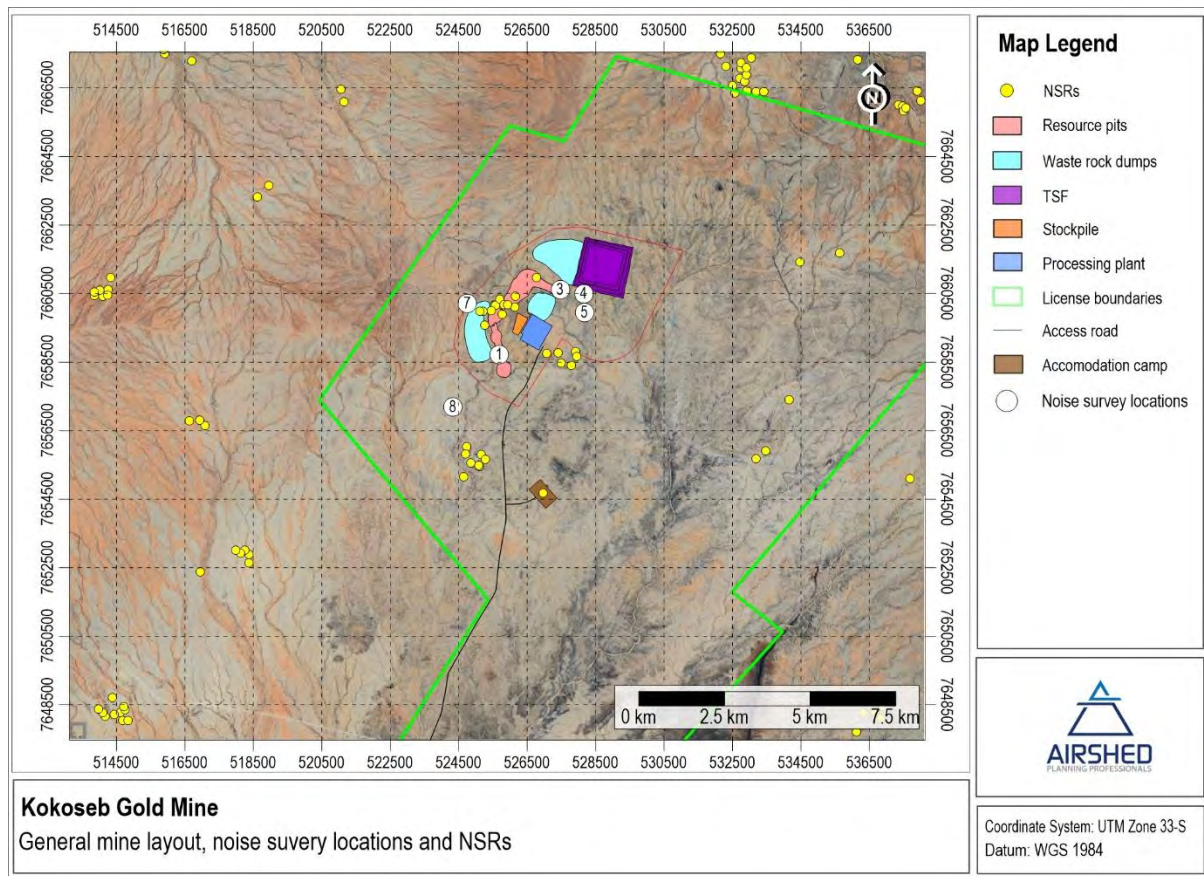


Figure 1-2: The proposed project layout, location of noise survey locations and potential noise sensitive receptors (NSRs) in the study area

1.1 Study Objective

The main objective of the noise specialist study was to determine the significance of impacts on the acoustic environment and potential noise sensitive receptors (NSRs) given noise generated by activities proposed as part of the project.

1.2 Scope of Work

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

1. A review of technical information for the project.
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;
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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 a partner of Airshed Planning Professionals in September 2006. Airshed Planning Professionals is a technical and scientific consultancy providing scientific, engineering, strategic impact assessments, management services and policy support to assist clients in addressing a wide variety of air pollution and environmental noise related projects. 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 and environmental noise impacts.

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

1.4 Description of Activities from a Noise Perspective

As is typical of opencast mining and ore processing facilities, sources of noise at the project site will include the following:

- Drilling
- Blasting;
- Ore and waste handling (loading, unloading, dozing) in open pits, on waste dumps, crusher/plant area, tailings storage facility;
- Crushing and screening of ore;
- Haul truck traffic;
- Diesel mobile equipment use (including reverse warnings); and,
- Ore processing activities such as crushing, screening and milling.

Whereas ore processing activities generate noise fairly constantly; drilling, blasting, ore and waste handling, transport activities and operating diesel mobile equipment generate noise that is intermittent and highly variable spatially.

The biggest determinant of noise impacts from operations will be the spatial distribution of noise sources and to a lesser extent mining rates and fleet size due to the non-linear cumulative nature of sound pressure levels (see Section 1.5.3).

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

1.5 Background to Environmental Noise and the Assessment Thereof

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

Noise is generally defined as unwanted sound transmitted through a compressible medium such as air. Sound in turn, is defined as any pressure variation that the ear can detect. Human response to noise is complex and highly variable as it is subjective rather than objective.

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 1-3. Here, the linear scale with its large numbers is converted into a manageable scale from 0 dB at the threshold of hearing (20 micro-pascals (μPa)) to 130 dB at the threshold of pain (~100 Pa) (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

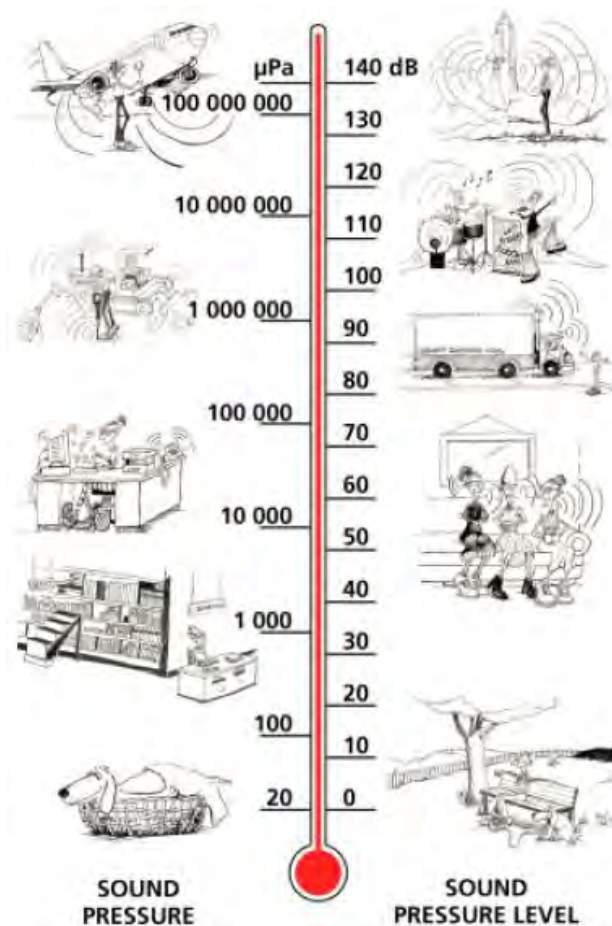


Figure 1-3: The decibel scale and typical noise levels (Brüel & Kjær Sound & Vibration Measurement A/S, 2000)

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 μ Pa).

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 1-4). "dBA" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities, that have the same units (in this case sound pressure) that has been A-weighted.

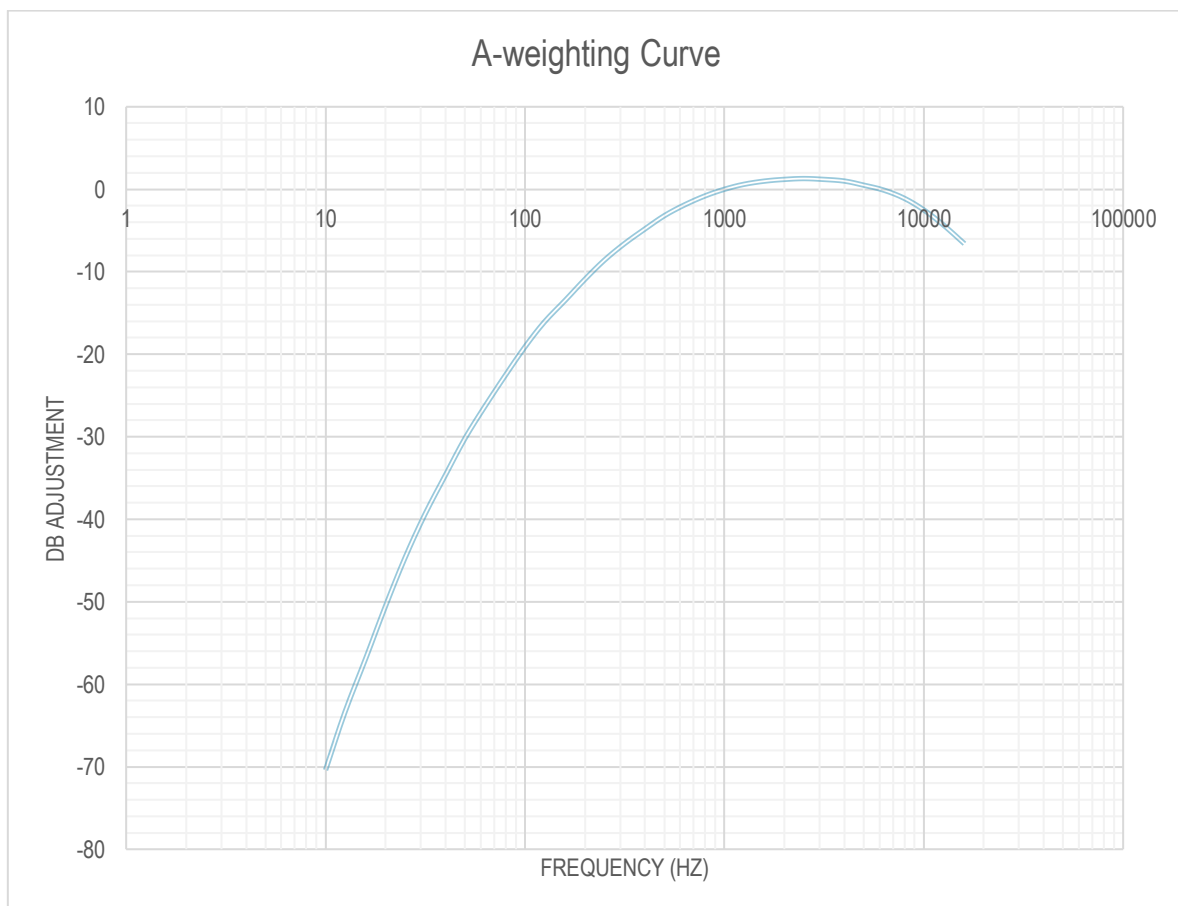


Figure 1-4: A-weighting curve

1.5.3 Adding Sound Pressure Levels

Since sound pressure levels are logarithmic values, the sound pressure levels as a result of two or more sources cannot 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:

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

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 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).
- $L_{A1eq}(T)$ – 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 $L_{A1eq}(T)$.
- 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 is the highest level of noise that occurred during a sampling period.
- L_{AFmin} – The minimum A-weighted noise level measured with the fast time weighting. It is the lowest 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 L_W 's (noise 'emissions') and L_P 's (noise impacts) associated with the project 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

The following information was supplied for inclusion in the study:

- Layout maps;
- Process description for project operations;
- Mining throughput;
- List of equipment for project operations; and,
- Baseline noise measurements.

1.6.2 Review of Assessment Criteria

In the absence of local guidelines and standards, this study refers to noise level guidelines published by the International Finance Corporation (IFC) in their '*General Environmental, Health, and Safety (EHS) Guidelines*' (IFC, 2007).

In addition to the above reference is also made to very useful indicators of likely community response to an intruding industrial noise as set out by the South African Bureau of Standards' (SABS) South African National Standard (SANS) 10103 of 2008 (SANS 10103, 2008).

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. Residential areas 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 land use and terrain.

Readily available terrain data was obtained from the United States Geological Survey (USGS) web site (<https://earthexplorer.usgs.gov/>) accessed in August 2025. A study was made of Shuttle Radar Topography Mission (STRM) 1 arc-sec data.

1.6.4 Noise Survey

The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in an area. Higher ambient noise levels will result in less noticeable noise impacts and a smaller impact area. The opposite also holds true. Increases in noise will be more noticeable in areas with low ambient noise levels. The data from a baseline noise survey conducted on the 1st and 2nd of August 2024 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 conducted by ECC.
- 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.
- Samples 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.
- $L_{Aeq}(T)$, $L_{Aeq}(T)$; L_{AFmax} ; L_{AFmin} ; L_{A90} and 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, general weather conditions during sampling and observations made regarding the acoustic environment of each site.

1.6.5 Source Inventory

To determine the change in noise impacts associated with the project, a source inventory had to be developed. A list of mobile and stationary equipment was made available for the study. L_w 's for these were calculated using predictive equations for industrial machinery as per the Handbook of Acoustics, Chapter 69, by Bruce and Moritz (1998).

Numerous noise source L_w 's for operations at the project plant was obtained from a database for similar operations. Values from the database are based on source measurements carried out in accordance with the procedures specified in SANS 10103.

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

1.6.6 Noise Propagation Simulations

1.6.6.1 ISO 9613

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

ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation 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 mid-band 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:

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

Where;

L_P is the sound pressure level at the receiver;

L_W is the sound power level of the source;

K₁ is the correction for geometrical divergence;

K₂ is the correction for atmospheric absorption;

K₃ is the correction for the effect of ground surface;

K₄ is the correction for reflection from surfaces; and

K₅ 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 over an area of 25 km east-west by 20 km north-south and encompasses the project. The area was divided into a grid matrix with a 50 m resolution. NSRs and survey locations were included as discrete receptors. The model was set to calculate L_P 's at each grid and discrete receptor point at a height of 1.5 m above ground level.

1.6.7 *Presentation of Results*

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 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.

1.7 Management of Uncertainties

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 of 40 km/hr and 60 km/hr were assumed on the haul road and the access road respectively.
- The mitigating effect of pit walls, buildings, and infrastructure acting as acoustic barriers were not taken into account providing a conservative assessment of the noise impacts off-site.
- The quantification of sources of noise was limited to the operational phase of the project. Construction and closure phase activities are expected to be similar or less significant. Noise impacts will cease post-closure.
- All activities were assumed to be 24 hours per day, 7 days per week, apart from specific plant operations where the operating hours were provided as follows:
 - Carbon Regeneration Kiln operating 20 hrs/day; and,
 - Smelting Furnace operating 5 hrs/day.
- Although other existing sources of noise within the area were identified, such sources were not quantified but were taken into account during the baseline survey.
- Blast vibration and noise did not form part of the scope of work of this assessment.
- The baseline noise levels as surveyed in August 2024 were assumed to be representative of current baseline noise levels.
- The environmental noise assessment focuses on the evaluation of impacts for humans.

2 Legal Requirements and Noise Level Guidelines

The IFC best practice guidelines were adopted in the absence of Namibian legislation.

2.1 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 2-1**, 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. $\Delta = 3$ 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 2-1: 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

2.2 SANS 10103 Guidance on Estimating Community Response

SANS 10103 (2008) 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;
- $0 \text{ dB} < \Delta \leq 10 \text{ dB}$: There will be 'little' reaction with 'sporadic complaints';
- $5 \text{ dB} < \Delta \leq 15 \text{ dB}$: There will be a 'medium' reaction with 'widespread complaints'. $\Delta = 10$ dB is subjectively perceived as a doubling in the loudness of the noise;
- $10 \text{ dB} < \Delta \leq 20 \text{ dB}$: There will be a 'strong' reaction with 'threats of community action'; and,
- $15 \text{ dB} < \Delta$: 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.

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. Potential noise sensitive receptors within the study area include individual dwellings and small communities (Figure 1-2). The proposed accommodation camp has also been included as NSRs. It should be noted that there are a number of NSRs in close proximity to the project that will be relocated. These have been excluded from the impact assessment.

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 of 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.

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.

Data from the calculated WRF¹ data for the period 2022 to 2024 was used for the assessment (Figure 3-1). The modelled data set indicates wind flow primarily from the southwestern sector during the day and from the east during the night. On average, noise impacts are expected to be slightly more notable to the northeast during the day and to the west during the night.

Temperature gradients in the atmosphere create effects that are uniform in all directions from a source. On a sunny day with no wind, temperature decreases with altitude and creates a 'shadowing' effect for sounds. On a clear

¹ The Weather Research and Forecasting (WRF) Model is a state-of-the-art mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting applications.

night, temperatures may increase with altitude thereby ‘focusing’ sound on the ground surface. Noise impacts are, therefore, generally more notable during the night (Figure 3-2).

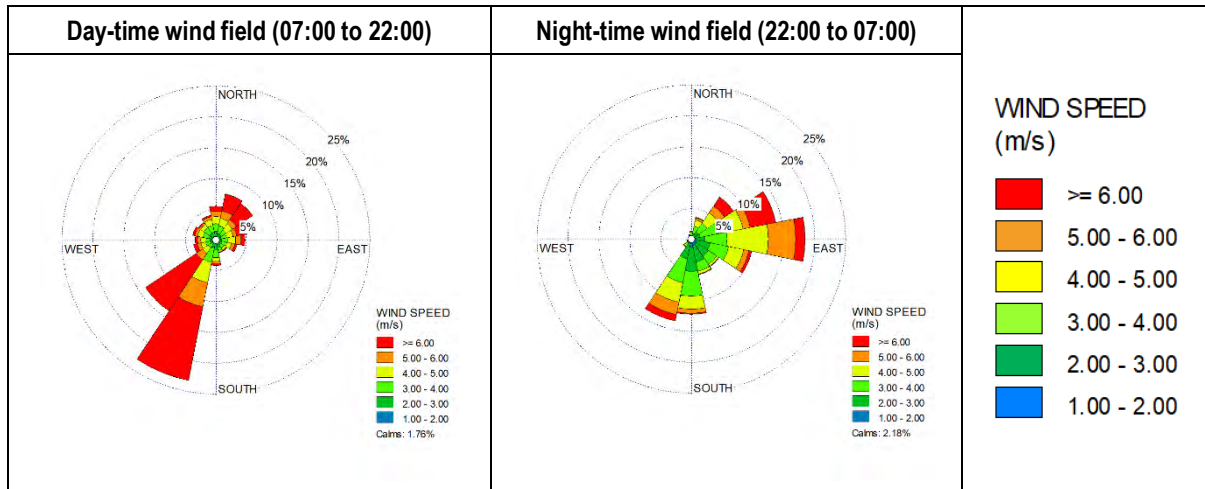


Figure 3-1: Wind rose for the study area (as obtained from WRF data) for the period 2022 to 2024

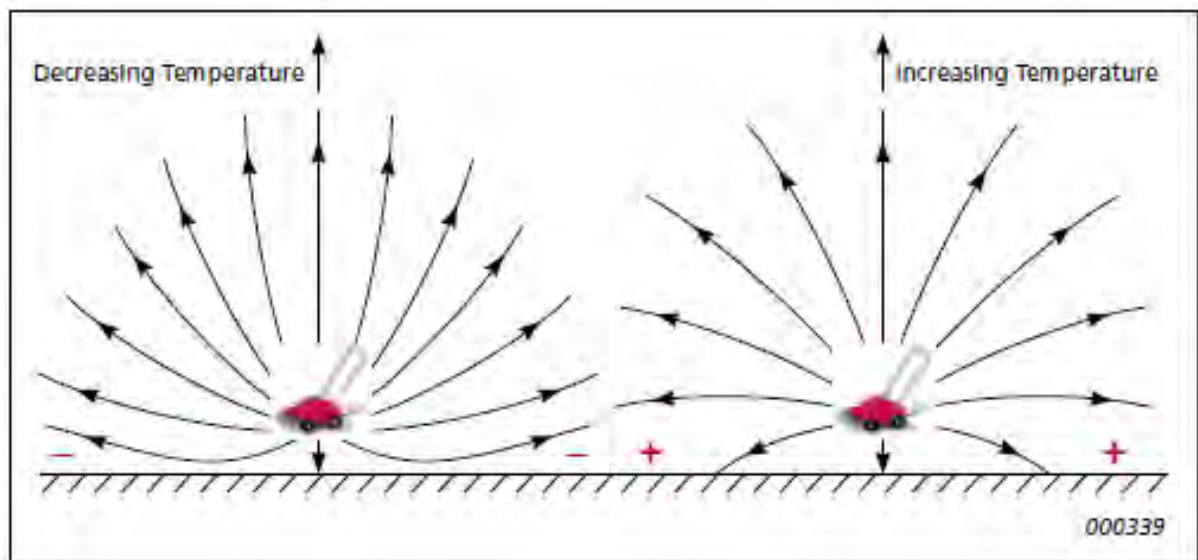


Figure 3-2: Bending the path of sound during typical day time conditions (image provided on the left) and night-time conditions (image provided on the right)

3.2.2 Terrain, Ground Absorption and Reflection

Noise reduction caused by a barrier (i.e., natural terrain, installed acoustic barrier, building) feature depends on two factors namely the path difference of a sound wave as it travels over the barrier compared with direct transmission to the receiver and the frequency content of the noise (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). The topography² for the study area is provided in Figure 3-3.

² SRTM1 from the United States Geological Survey at <https://earthexplorer.usgs.gov>

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, ground cover was found to be acoustically mixed.

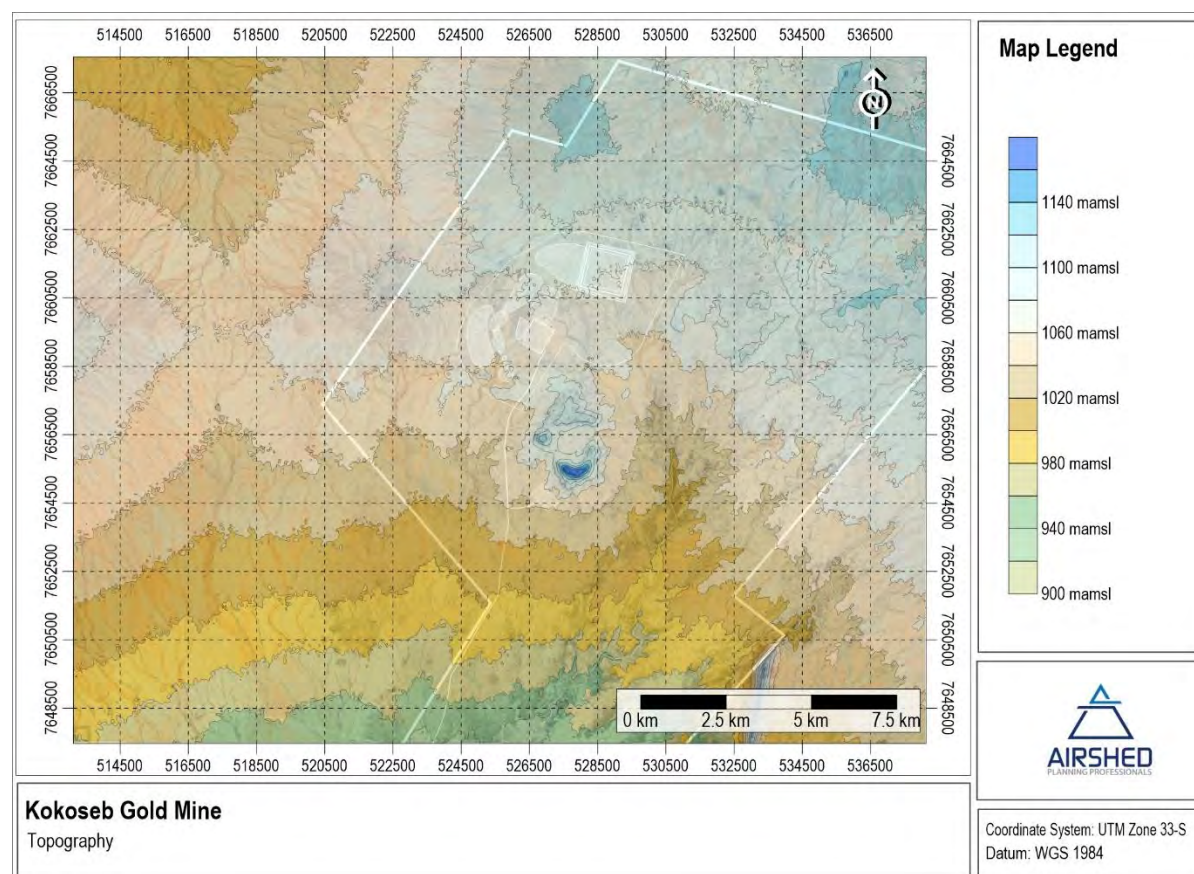


Figure 3-3: Topography for the study area

3.3 Noise Survey and Results

The noise survey campaign at six locations was undertaken on the 1st and 2nd of August 2024 to gather noise baseline conditions. The survey results are summarised in Table 3-1. For comparison purposes, the measured noise levels (L_{Aeq}) are presented in Figure 3-4 to Figure 3-5 (day-time results) and Figure 3-6 to Figure 3-7 (night-time results). The IFC noise guidelines for residential areas (55 dBA for day-time and 45 dBA for night-time) were not exceeded at any of the noise survey sites. The measured day-time noise levels ranged from 26 dBA to 38 dBA and night-time noise levels ranged from 28 dBA to 38 dBA.

For detailed time-series, frequency spectra and statistical results, the reader is referred to Appendix C.

Table 3-1: Project baseline environmental noise survey results summary

Sampling point	Visual and acoustic observations	General weather conditions	Time of day	Start date and time	Duration	L _{AFmax} (dBA)	L _{AFmin} (dBA)	L _{Aeq} (dBA)	L _{Aleq} (dBA)	L _{A90} (dBA)	IFC noise guidelines for residential areas
Site 1	Survey site is located ~1.5 km south of small community with a main road to the north and another road ~30 m to the east. Noise sources include dogs, drilling activities and vehicle road traffic.	28°C; no cloud cover	Day	2024/08/02 12:32	00:22:31	60.5	24.8	30.9	29.4	26.7	55
		9°C; no cloud cover	Night	2024/08/01 23:51	00:23:03	54.1	19.2	27.8	41.9	21.0	45
Site 3	Survey site is located ~20 m from exploration tanks. Noise sources include insects, road traffic and distant drilling activities.	17°C; no cloud cover	Day	2024/08/02 10:41	00:22:22	56.2	20.7	29.6	33.6	22.9	55
		8°C; no cloud cover	Night	2024/08/02 02:08	00:23:16	59.3	19.3	30.8	44.5	20.8	45
Site 4	Survey site is located north of a main road. Noise sources include insects, birds, drilling activities and distant road traffic.	27°C; no cloud cover	Day	2024/08/02 11:53	00:23:34	58.9	20.4	27.6	29.6	22.3	55
		8°C; no cloud cover	Night	2024/08/02 01:05	00:23:17	55.3	20.1	27.7	40.0	21.6	45
Site 5	Survey site is located near	27°C; no cloud cover	Day	2024/08/02 11:16	00:23:39	56.6	23.4	30.7	39.3	26.3	55

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Sampling point	Visual and acoustic observations	General weather conditions	Time of day	Start date and time	Duration	L _{AFmax} (dBA)	L _{AFmin} (dBA)	L _{Aeq} (dBA)	L _{Aleq} (dBA)	L _{A90} (dBA)	IFC noise guidelines for residential areas
	drilling activities and south of a main road. Noise sources include insects, birds and drilling activities.	8°C; no cloud cover	Night	2024/08/02 00:31	00:23:23	54.4	21.5	28.4	41.3	22.6	45
Site 7	Survey site is located ~700 m west of a small community. Noise sources include birds, insects, dogs, community activity, and drilling activities.	16°C; no cloud cover	Day	2024/08/02 09:58	00:23:36	60.0	32.3	38.4	38.6	35.4	55
		10°C; no cloud cover	Night	2024/08/01 23:12	00:21:27	53.7	25.6	28.9	25.6	26.9	45
Site 8	Survey site located south of project. Noise sources include birds, dogs and drilling activities.	16°C; 20% cloud cover	Day	2024/08/02 09:20	00:23:05	54.5	19.2	26.4	23.0	21.4	55
		11°C; no cloud cover	Night	2024/08/01 22:21	00:22:21	59.6	18.8	27.7	24.5	20.3	45

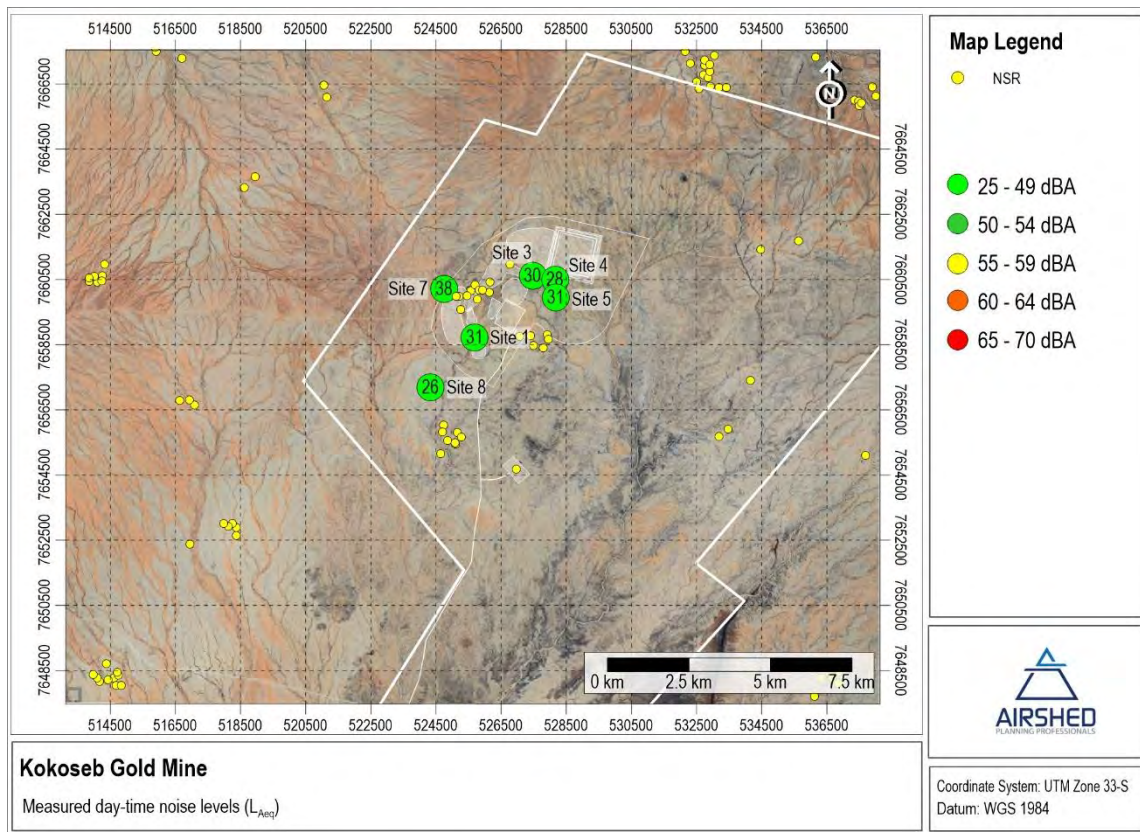


Figure 3-4: Spatial representation of the measured day-time baseline noise levels (L_{Aeq})

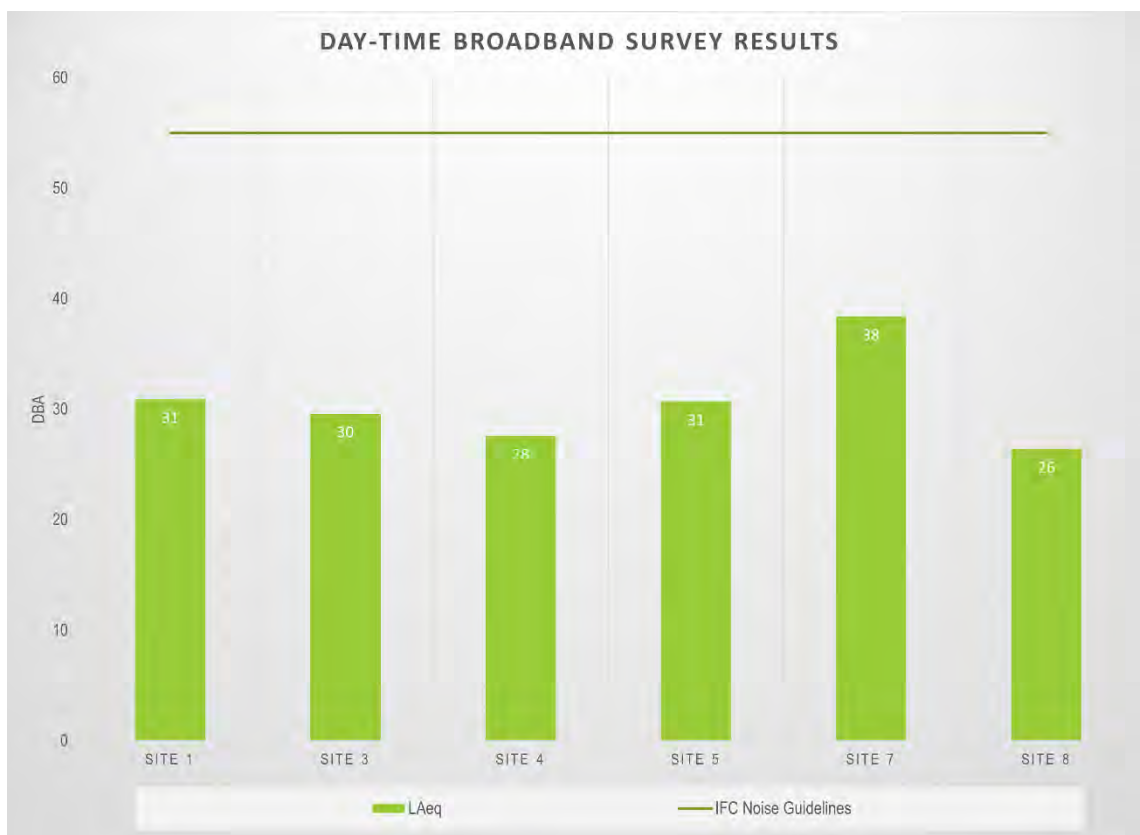


Figure 3-5: The measured day-time baseline noise levels (L_{Aeq})

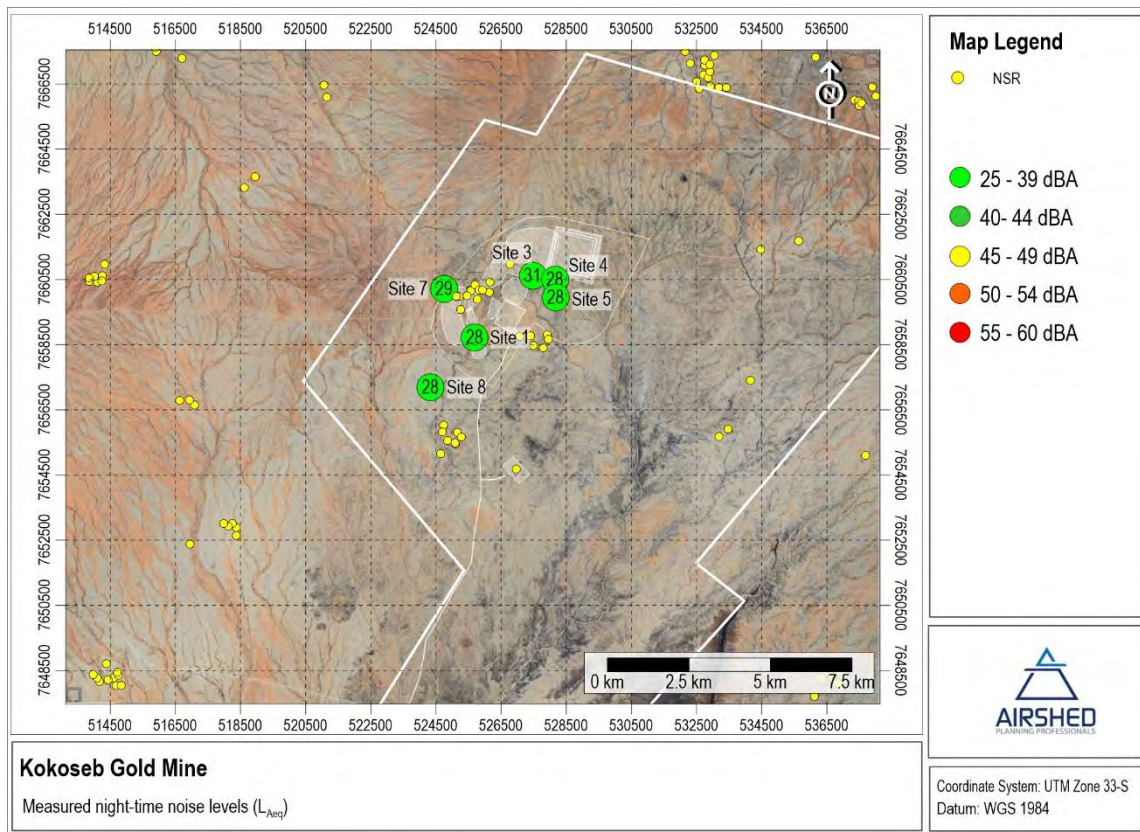


Figure 3-6: Spatial representation of the measured night-time baseline noise levels (L_{Aeq})

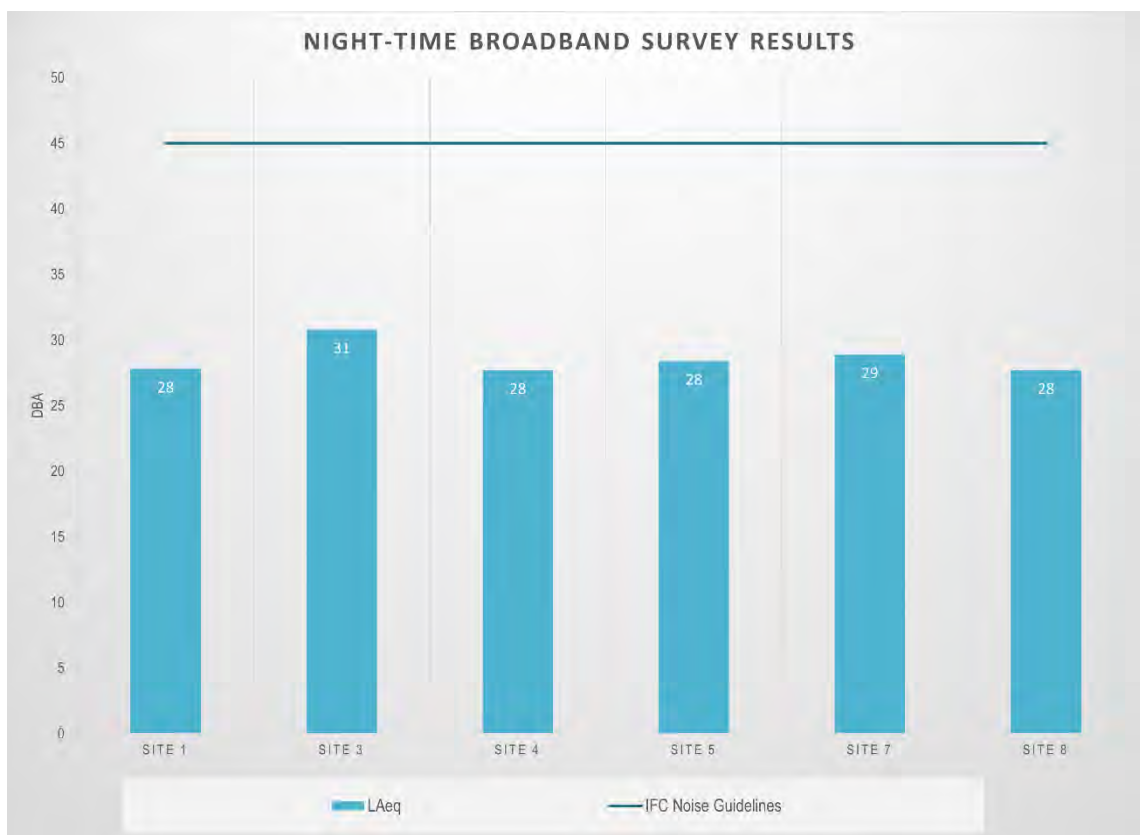


Figure 3-7: The measured night-time baseline noise levels (L_{Aeq})

4 Impact Assessment

The noise source inventory, noise propagation modelling and results for the project are discussed below.

4.1 Noise Sources and Sound Power Levels

A list of equipment for the project was provided and is summarised in Table 4-1 to Table 4-3. Noise sound pressure levels were calculated for all the equipment with the total octave band frequency spectra L_w 's provided in Table 4-4 to Table 4-6.

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).

The parameters for the elevated noise point sources are provided in Table 4-7.

Table 4-1: Plant equipment list for the project

Equipment Description	No. of Units	Specification
Primary Crusher	1	Superior Mk III 42-65
SAG Mill	1	Grate discharge, 10.40 m Ø x 5.24 m EGL
Ball Mill	1	Overflow discharge, 7.60 m Ø x 11.68 m EGL
Cyclone Cluster	1	16 off 500 mm Ø, 10 operating, 6 standby, 2 blanked ports
Cyclone Feed Pumps	2	450 MCU, 3,490 m³/h @ 29 m TDH, SG 1.49
Gravity Feed Pumps	2	14 x 12, 1,381 m³/h @ 21 m TDH, SG 1.49
Gravity Scalping Screen	2	2.44 m wide x 5.49 m long, 2 mm x 11.5 mm aperture (SWF)
Gravity Concentrator	2	KC-QS48 GX10
Inline Leach Reactor	1	Gekko ILR2000BA
Pebble Crusher	1	HP4
Trash Screen	1	3.66 m wide x 8.5 m long, 0.63 mm x 8.8 mm slot SWF, polyurethane deck
Pre-Leach Thickener	1	31 m Ø High Rate
Leach Feed Pumps	2	12 x 10, 1,020 m³/h @ 27 m TDH, SG 1.47
Mill Water Pumps	2	2,112 m³/h @ 55 m TDH, SG 1.0
CIL Tanks	6	3,600 m³
CIL Tank Agitators	6	To suit 3,600 m³ tank
Intertank Screens	6	Mechanically swept intertank screen, 2.4 m Ø x 3.44 m height, 0.833 mm aperture
Acid Wash Column	1	14 t live capacity, 29.8 m³ total volume.
Elution Column	1	14 t live capacity, 29.8 m³ total volume.

Equipment Description	No. of Units	Specification
Carbon Regeneration Kiln	1	Horizontal tube, 720 kg/h
Electrowinning Cells	3	22 cathodes, 3000 amps x 7 volts, SS304
Induction Furnace	1	500 kg brass capacity (70 L)
Cyanide Destruction Tanks	2	596 m ³
Cyanide Destruction Agitators	2	To suit 596 m ³ tank
Tails Thickener	1	31 m Ø High Rate
Tails Thickener Underflow Pumps	2	608 m ³ /h @ 30 m TDH, SG 1.66
Tails Filters	3	Larox FFP3512

Table 4-2: Mobile equipment list for the project

Mining Fleet	Quantity	Type
Excavator	4	Hitachi EX1900
Dump Truck	27	Caterpillar 777G
Front End Loader	1	Caterpillar 990K
Dozer	4	Caterpillar D10
Grader	3	Caterpillar G16
Watercart	3	Caterpillar 777WT
Drill Rigs	9	
Lighting Plant	16	
Light vehicles	11	

Table 4-3: Road logistics list for the project

Road Logistics	Quantity	Unit
Mine Diesel Supply	6	trucks/week
Processing Reagents & Consumables Supply	21	trucks/week
Total	27	trucks/week

Table 4-4: Octave band frequency spectra L_w 's for the plant

Equipment	Type	Lw octave band frequency spectra (dB)								Lw (dB)	LWA (dBA)	Source
		63	125	250	500	1000	2000	4000	8000			
Primary Crusher	Lw	123	123	121	111	106	105	100		127.4	115.8	Lw database
SAG Mill	Lw	118	117	118	114	111	108	100		123.5	116.5	Lw database
Ball Mill	Lw	107	108	109	107	106	101	97		114.9	110.0	Lw database
Cyclone feed pumps	Lw	92.6	93.6	95.6	95.6	98.6	95.6	91.6	85.6	103.8	102.1	Lw predictions (Bruce & Moritz, 1998)
Gravity feed pumps	Lw	86.0	87.0	89.0	89.0	92.0	89.0	85.0	79.0	97.2	95.5	Lw predictions (Bruce & Moritz, 1998)
Gravity Scalping Screen	Lw	113.3	109.0	108.4	108.4	108.2	105.8	102.4		117.4	112.6	Lw database
Pebble Crusher	Lw	123	123	121	111	106	105	100		127.4	115.8	Lw database
Trash Screen	Lw	113.3	109.0	108.4	108.4	108.2	105.8	102.4		117.4	112.6	Lw database
Leach Feed Pumps	Lw	86.0	87.0	89.0	89.0	92.0	89.0	85.0	79.0	97.2	95.5	Lw predictions (Bruce & Moritz, 1998)
Mill Water Pumps	Lw	88.3	89.3	91.3	91.3	94.3	91.3	87.3	81.3	99.5	97.8	Lw predictions (Bruce & Moritz, 1998)
Intertank Screens	Lw	113.3	109.0	108.4	108.4	108.2	105.8	102.4		117.4	112.6	Lw database
Tails Thickener Underflow Pumps	Lw	84.5	85.5	87.5	87.5	90.5	87.5	83.5	77.5	95.7	94.0	Lw predictions (Bruce & Moritz, 1998)
Carbon Regeneration Kiln	Lw	112.1	112.8	113.9	110.1	107.9	104.6	98.6		119.0	112.9	Lw database
Smelting Furnace	Lw	109.3	111.2	109.1	106.5	102.6	101.6	98.7		115.8	109.2	Lw database
Incinerator	Lw	83.6	93.7	101.2	106.6	109.8	111.0	110.8	108.7	119.3	116.7	Incinerator measurements (Arifianto, et al., 2018)

Table 4-5: Octave band frequency spectra L_w 's for the mobile equipment

Equipment	Type	Lw octave band frequency spectra (dB)								Lw (dB)	LWA (dBA)	Source
		63	125	250	500	1000	2000	4000	8000			
Excavator	Lw	116.6	121.6	124.6	119.6	117.6	114.6	108.6	102.6	128.2	122.8	Lw Predictions (Bruce & Moritz, 1998)
Dump Truck	Lw	116.5	121.5	124.5	119.5	117.5	114.5	108.5	102.5	128.1	122.7	Lw Predictions (Bruce & Moritz, 1998)
Front End Loader	Lw	115.2	120.2	123.2	118.2	116.2	113.2	107.2	101.2	126.8	121.4	Lw Predictions (Bruce & Moritz, 1998)
Dozer	Lw	115.2	120.2	123.2	118.2	116.2	113.2	107.2	101.2	126.8	121.4	Lw Predictions (Bruce & Moritz, 1998)
Grader	Lw	112.0	117.0	120.0	115.0	113.0	110.0	104.0	98.0	123.6	118.2	Lw Predictions (Bruce & Moritz, 1998)
Watercart	Lw	116.1	121.1	124.1	119.1	117.1	114.1	108.1	102.1	127.8	122.4	Lw Predictions (Bruce & Moritz, 1998)
Drill Rigs	Lw	111.5	116.5	119.5	114.5	112.5	109.5	103.5	97.5	123.1	117.8	Lw Predictions (Bruce & Moritz, 1998)

Equipment	Type	L _w octave band frequency spectra (dB)								L _w (dB)	L _{WA} (dBA)	Source
		63	125	250	500	1000	2000	4000	8000			
Lighting Plant	L _w	101.6	106.6	109.6	104.6	102.6	99.6	93.6	87.6	113.2	107.9	L _w Predictions (Bruce & Moritz, 1998)
Light Vehicles	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)

Table 4-6: Octave band frequency spectra L_w's for the road logistics

Equipment	Type	L _w octave band frequency spectra (dB)								L _w (dB)	L _{WA} (dBA)	Source
		63	125	250	500	1000	2000	4000	8000			
Mine Diesel Supply	L _w	118.7	121.7	116.7	114.7	111.7	105.7	99.7	119.7	126.1	120.7	L _w Predictions (Bruce & Moritz, 1998)
Processing Reagents & Consumables Supply	L _w	115.3	118.3	113.3	111.3	108.3	102.3	96.3	116.3	122.7	117.3	L _w Predictions (Bruce & Moritz, 1998)

Table 4-7: Elevated noise point source parameters

Parameter	Units	Smelting Furnace Stack (Gold Furnace)	Carbon Regeneration Kiln (Diesel Exhaust Stack)	Incinerator
Stack Height	m	11.0	20.0	4.0
Stack Diameter at Release	m	0.15	0.30	0.20
Dry Gas Velocity	m/s	4.20	4.00	1.60
Gas Temperature (°C)	°C	600	40	1150

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.

Table 4-8 provides a summary of simulated noise levels for the project at NSRs within the study area. Simulated noise levels due to project only are also presented in the form of isopleth plots (Figure 4-1 and Figure 4-2).

Noise levels due to project operations exceed IFC noise guidelines for residential areas at NSRs R1, R2 and R3 (Table 4-8).

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); the predicted increase in noise levels from the baseline due to project operations only is expected to result in the following community reaction (Table 4-8):

- R1:
 - Day-time: 'strong' to 'very strong' reaction with threats of community action.
 - Night-time: 'strong' to 'very strong' reaction with threats of community action.
- R2:
 - Day-time: 'strong' to 'very strong' reaction with threats of community action.
 - Night-time: 'strong' to 'very strong' reaction with threats of community action.
- R3:
 - Day-time: 'medium' reaction with widespread complaints.
 - Night-time: 'strong' to 'very strong' reaction with threats of community action.
- R4:
 - Night-time: 'little' reaction with sporadic complaints.

Table 4-8: Summary of simulated noise levels (provided as dBA) due to the proposed project activities at the closest NSRs (excluding NSRs to be relocated)

Noise Sensitive Receptor	IFC noise guideline for residential areas		Project operations ^(a)		Baseline ^(b)		Increase Above Baseline ^(c)	
	Day-time	Night-time	Day	Night	Day	Night	Day	Night
R1	55	45	73.7	73.7	29.6	30.8	44.1	42.9
R2	55	45	69.6	69.6	38.4	28.9	31.2	40.7
R3	55	45	52	51	32.7	28.7	19.3	22.3
R4	55	45	34.6	34.7	32.7	28.7	4.0	7.0
R5	55	45	32.1	31.4	55.0	45.0	0.0	0.2

Notes:

- (a) Exceedance of the IFC noise guideline is provided in bold.
- (b) Baseline noise levels at R3 and R4 based on an average of the measured baseline noise levels for the site and assumed to be representative of the background noise levels at these NSRs. The baseline noise levels for the proposed accommodation camp were assumed to be IFC noise guidelines for residential areas.
- (c) Likely community response in accordance with the SANS 10103:

< 3 dBA	< 5 dBA	< 10 dBA	< 15 dBA	< 20 dBA
Change imperceptible	No reaction	'Little' reaction with sporadic complaints	'Medium' reaction with widespread complaints	'Strong' to 'very strong' reaction with threats of community action or vigorous community action.

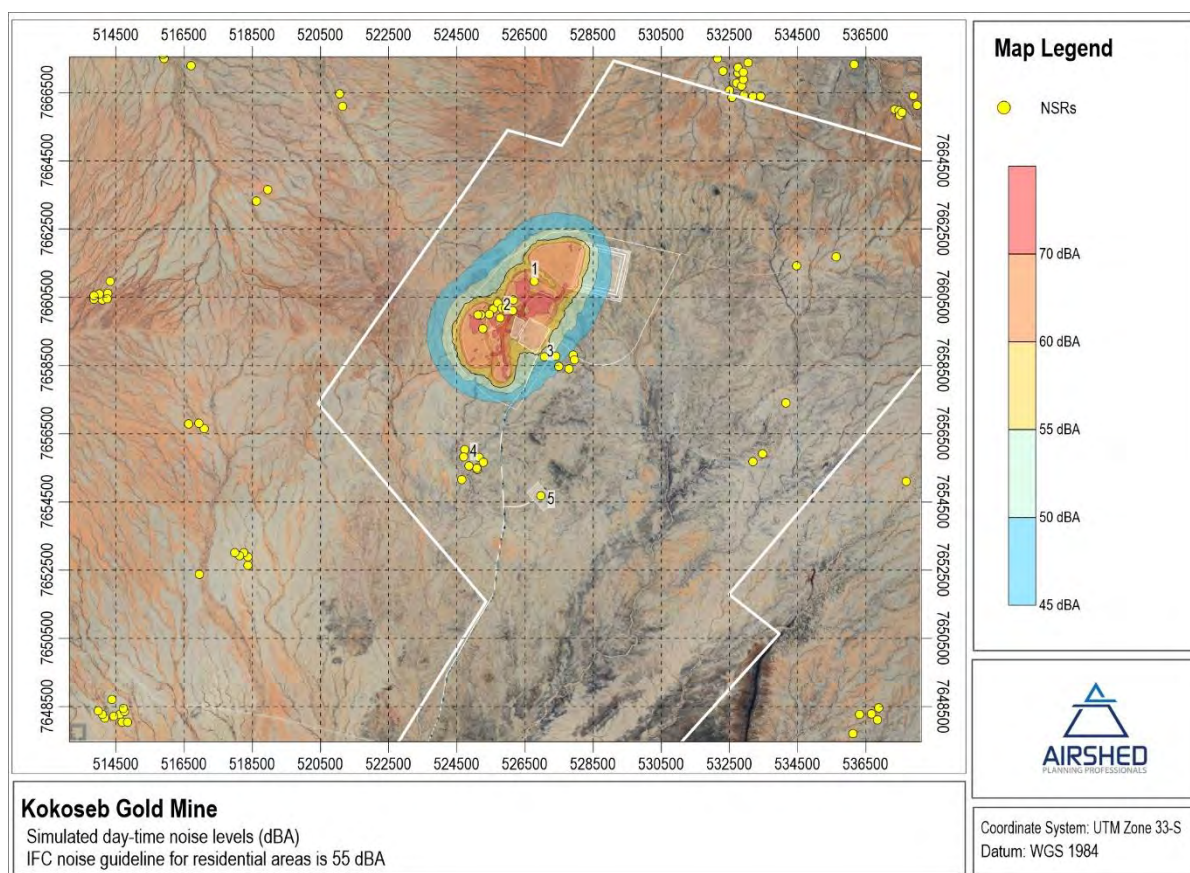


Figure 4-1: Simulated day-time noise levels due to normal project operations only

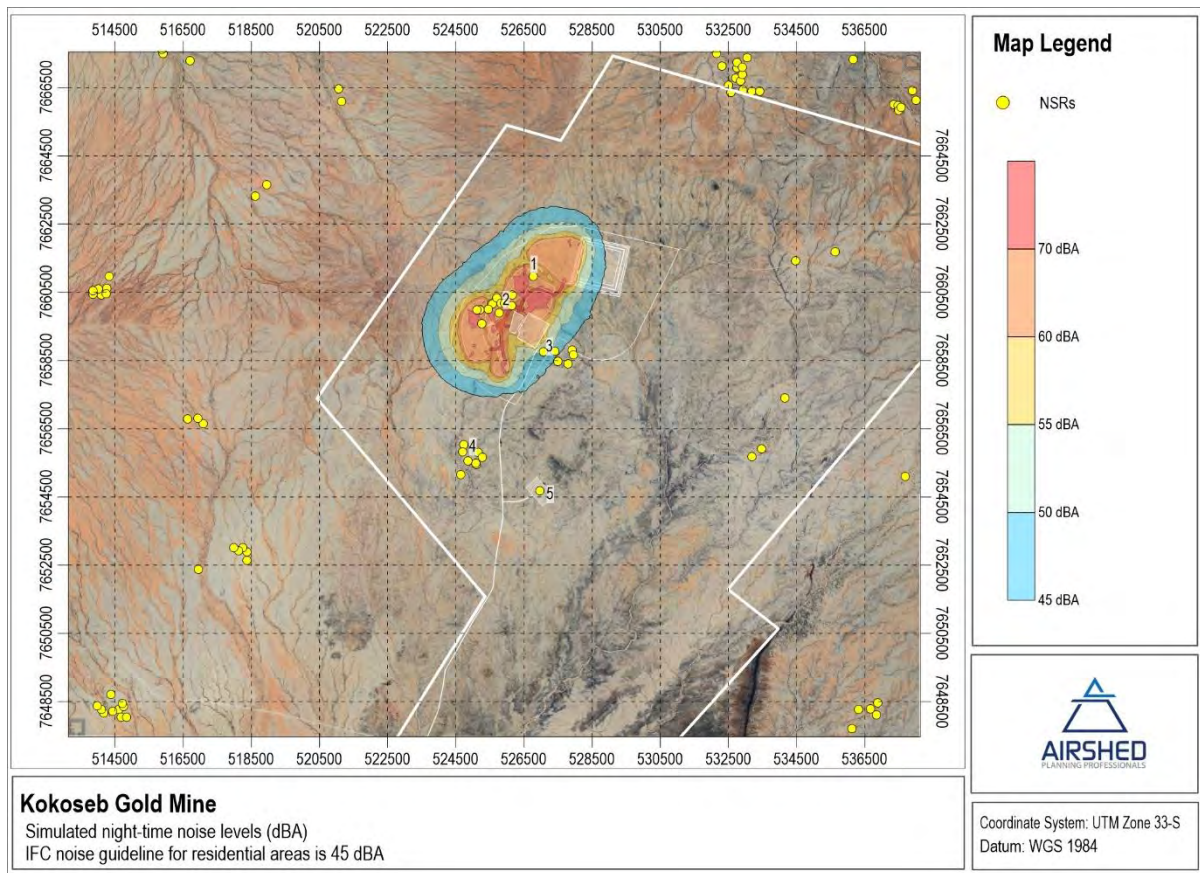


Figure 4-2: Simulated night-time noise levels due to normal project operations only

5 Management Measures

In the quantification of noise emissions and simulation of noise levels as a result of the project, it was found that IFC noise guidelines for residential, educational, and institutional receptors will be exceeded at the closest NSRs due to normal project operations. Noise levels due to project operations can be reduced through effective mitigation and management measures as discussed in this section but are unlikely to bring noise levels at the on-site NSRs (R1, R2 and R3) within IFC guidelines for residential areas given their proximity to the project. It is recommended that the NSRs R1, R2 and R3 be relocated to outside the project boundary once the project operations commence.

The measures discussed in this section are measures typically applicable to industrial sites and are considered good practice by the IFC (2007) and British Standard BSI (2014).

It should be noted that discussion below provides optional mitigations, not all of which will need to be implemented, but consideration can be given should the need for mitigation arise.

5.1 Controlling Noise at the Source

5.1.1 General Good Practice Measures

Good engineering and operational practices will reduce levels of annoyance. 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.
- In managing noise specifically related to 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 surfaces regularly to repair potholes etc.
 - Keep all roads well maintained and avoid steep inclines or declines to reduce acceleration/brake noise.
 - Avoid unnecessary idling at all 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). Also, when reversing, vehicles should travel in a direction away from NSR's if possible.

- Where possible, other non-routine noisy activities such as construction, decommissioning, start-up and maintenance, should be limited to day-time hours.
- A noise complaints register must be kept.
- Provision of general notices to the community in the form of notice boards indicating blast times and dates.

5.1.2 Specifications and Equipment Design

Equipment can be reviewed to ensure the quietest available technology is used. Where equipment with lower sound power levels is selected, vendors/contractors should be required to guarantee optimised equipment design noise levels.

5.1.3 Enclosures

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

Recommendations on use and siting of equipment is as follows:

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

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, the distance between source and receiver must be increased, or noise reduction screens, barriers, or berms must be installed.

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.

It should be noted that increasing the distance between NSRs R1, R2 and R3 and the project will be the only way to bring the noise levels within IFC noise guidelines for residential areas at these receptors.

5.2.2 Screening

If noise control at the source and the use of distance between source and receiver is not possible, screening methods may 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 of dust.

5.3 Monitoring

In the event that noise related complaints are received, short-term 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** Sound Level Meter (SLM) that meets all appropriate International Electrotechnical Commission (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 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 recorded and reported: $L_{Aeq}(T)$, 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.

6 Conclusion

The noise impacts due to the project are predicted to exceed IFC noise guidelines for residential areas at the onsite residential dwellings within the project boundary (i.e. R1, R2 and R3). Given the proximity of these NSRs to the project operations, it is unlikely that mitigation measures will be able to reduce the noise levels at these sites to within the IFC noise guidelines. It is thus recommended that these NSRs be relocated to outside the project boundary once operations commence. In addition, a complaints register must be kept throughout the life of the operations.

It is the specialist opinion that, from an environmental noise perspective, the project may be authorised, if NSRs R1, R2 and R3 are relocated to outside of the project boundary prior to project operations and IFC noise guidelines for residential areas are met at all surrounding NSRs.

7 References

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Appendix A – Specialist Curriculum Vitae

CURRICULUM VITAE

RENEÉ VON GRUENEWALDT

FULL CURRICULUM VITAE

Name of Firm	Airshed Planning Professionals (Pty) Ltd
Name of Staff	Reneé von Gruenewaldt (<i>nee</i> Thomas)
Profession	Air Quality and Environmental Noise Scientist
Position	Principal consultant
Date of Birth	13 May 1978
Years with Firm	Since January 2002
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

Reneé von Gruenewaldt (Air Quality Scientist): Reneé joined Airshed Planning Professionals (Pty) Ltd (previously known as Environmental Management Services cc) in 2002. She has, as a Specialist, attained over twenty (20) years of experience in the Earth and Natural Sciences sector in the field of Air Quality and nine (9) years of experience in the field of environmental 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 air quality 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, Lagrangian GRAL model. Her experience with air emission models includes Tanks 4.0 (for the quantification of tank emissions), WATER9 (for the quantification of wastewater 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 and CadnaA for propagation of industrial, road and rail noise sources.

Having worked on projects throughout Africa (i.e., South Africa, Mozambique, Malawi, Kenya, Angola, Democratic Republic of Congo, Namibia, Madagascar and Egypt for Air Quality Impact Assessments and Mozambique, Namibia, Botswana, Kenya, Ghana, Suriname and Afghanistan for Environmental Noise Impact Assessments) Reneé 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 (AIR QUALITY)

Mining and Ore Handling

Reneé 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 Fluorspar 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 on 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. Reneé was also involved in 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 Duynfontein, 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, the Tsoeneng Landfill (Lesotho) and the FG Landfill (near the Midstream Estate). 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

Reneé 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).

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

RELEVANT EXPERIENCE (GREENHOUSE GAS EMISSION FOOT-PRINTING AND CLIMATE CHANGE IMPACT STATEMENTS)

Mining and Tailings Storage Facilities

Reneé has quantified the direct and indirect (Scope 2 and Scope 3) emissions for numerous mines over the highveld of South Africa and the Democratic Republic of Congo. She has also assessed the climate risks and vulnerabilities of the project and surrounding communities due to increasing ambient temperatures, water scarcity, risk of intense storms.

Gas to Power Plants

Reneé has quantified the direct and indirect (Scope 2 and Scope 3) emissions for gas to power plants proposed for South Africa. She has also assessed the climate risks and vulnerabilities of the project and surrounding communities due to increasing ambient temperatures, water scarcity, risk of intense storms.

RELEVANT EXPERIENCE (NOISE)

Mining

Reneé has undertaken numerous environmental noise assessments for mining operations. These include environmental noise impact assessments including baseline noise surveys for numerous coal, platinum, manganese, tin and zinc mines. Projects include, but are not limited to, Balama (Mozambique), Masama Coal (Botswana), Lodestone (Namibia), Osino (Namibia), Kurmuk (Ethiopia), Gamsberg (SA), Prieska (SA), Kolomela (SA), Heuningkranz (SA), Syferfontein (SA), South 32 (SA), Mamatwan (SA), Alexander (SA) and Marula Platinum Mine (SA), etc.

Power Generation

Environmental noise assessments have been completed for numerous Eskom coal fired power station studies in SA including the Kriel Fabric Filter Plant, Kendal ash facility, Medupi ash facility. Apart from Eskom projects, power plant assessments have also been completed in Botswana (Morupule), Kenya (Or Power geothermal power plants), Suriname (EBS power plant) and SA (Richards Bay combined cycle power plant).

Process Operations

Environmental noise assessments have been undertaken for various process operations including waste disposal facilities (Bon Accord in Gauteng), bottling and drink facilities (Imali and Isanti Project in Gauteng) and Smelter (Gamsberg in Northern Cape).

Transport

An environmental noise assessment was completed for the Obetsebi road expansion and flyover project in Ghana, the Scorpion Zinc Mine transport route in Namibia and the Sisian-Kajaran (North-South Corridor) Road Project in Armenia.

Gas Pipelines

An environmental noise assessment was completed for the Sheberghan gas pipeline in Afghanistan.

Baseline Noise Surveys

Baseline noise surveys have been undertaken for numerous mining and process operation activities (including Raumix quarries, Kolomela and Sibanye Stillwater Platinum Mines (SA)) in support of onsite Environmental Management Programmes.

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: <i>An Air Quality Baseline Assessment for the Vaal Airshed in South Africa</i>
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)

COUNTRIES OF WORK EXPERIENCE

South Africa, Mozambique, Botswana, Ghana, Suriname, Afghanistan, Malawi, Liberia, Kenya, Angola, Democratic Republic of Congo, Ethiopia, Afghanistan, 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 and Environmental Noise 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	Fair	Fair

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

29/07/2024

Date (Day / Month / Year)

Full name of staff member:

Renee Georgeinna von Gruenewaldt

Appendix B – Declaration of Independence

DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner: Renée von Gruenewaldt

Name of Registration Body: South African Council for Natural Scientific Professions

Professional Registration No.: 400304/07

Declaration of independence and accuracy of information provided:

Environmental Noise Impact Assessment for the Proposed Kokoseb Gold Mine, Namibia

I, René von Gruenewaldt, declare that I am independent of the applicant. I have the necessary expertise to conduct the assessments required for the report and will perform the work relating the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. I will disclose to the applicant and the air quality officer all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the air quality officer. The additional information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at Pretoria on this 21st of August 2025.



SIGNATURE

Principal Noise Scientist

CAPACITY OF SIGNATORY

Appendix C – Time-series, Statistical, and Frequency Spectrum Results

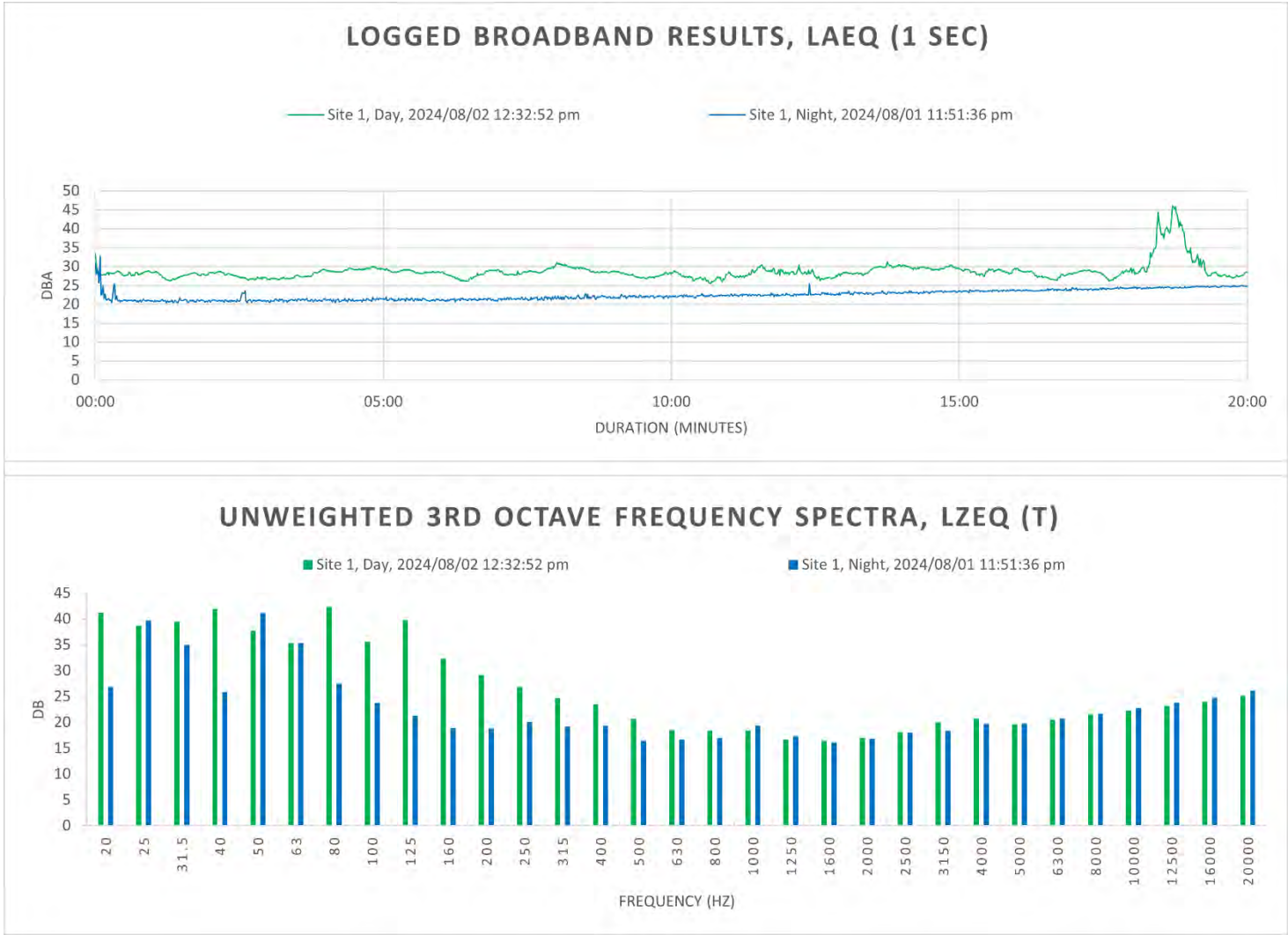


Figure C-1: Detailed day-time survey results for Site 1

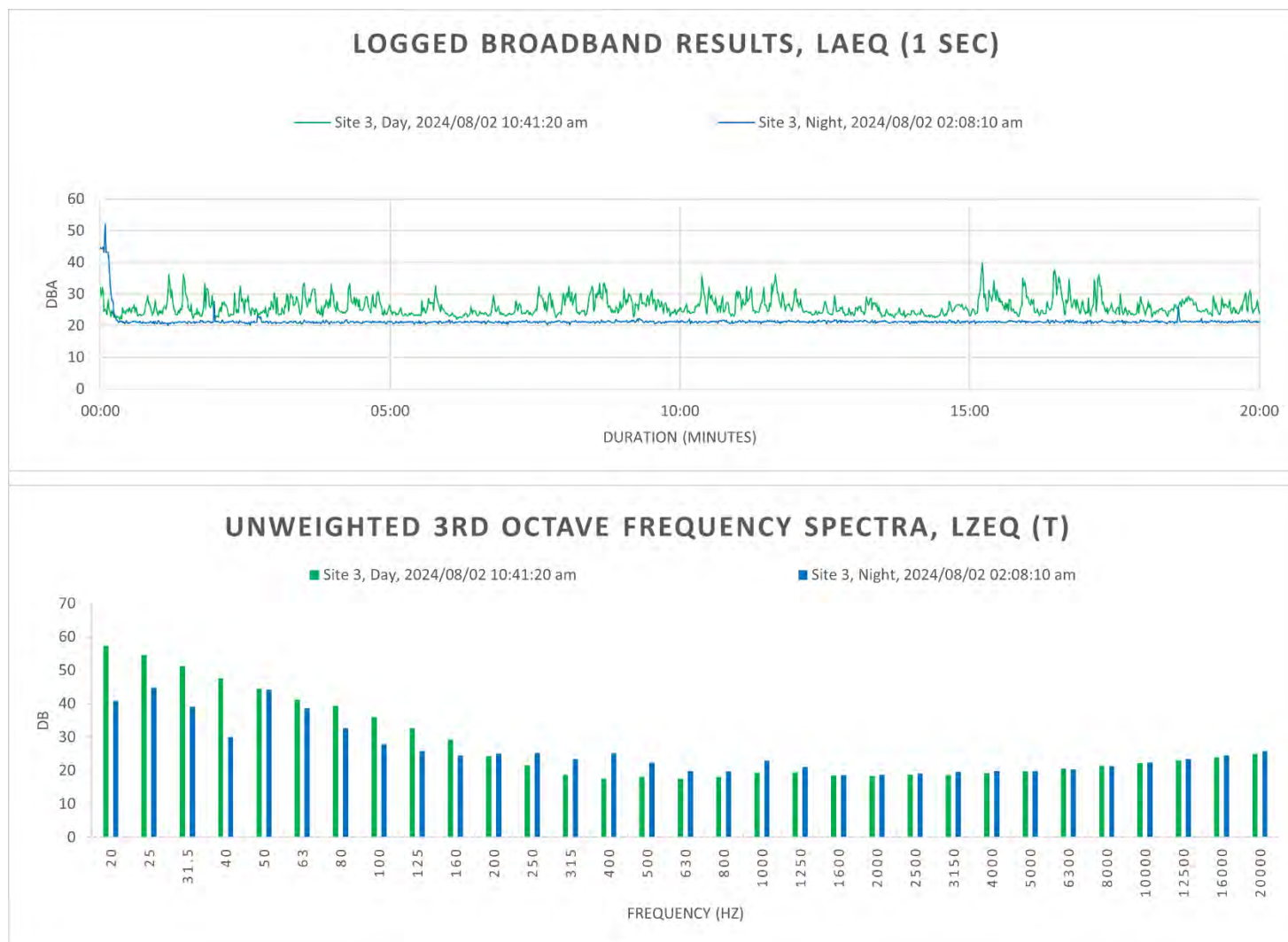


Figure C-2: Detailed day-time survey results for Site 3

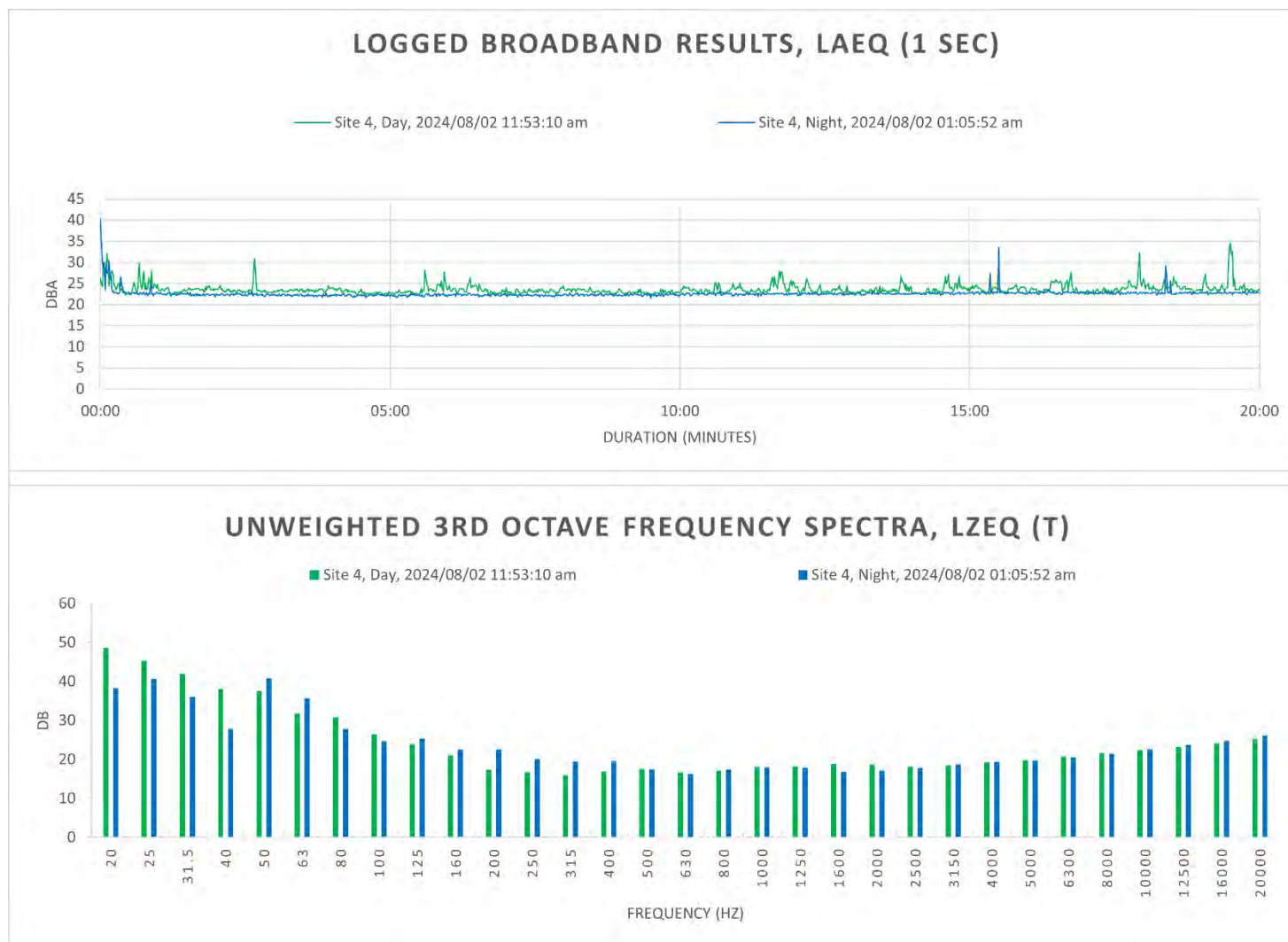


Figure C-3: Detailed day-time survey results for Site 4

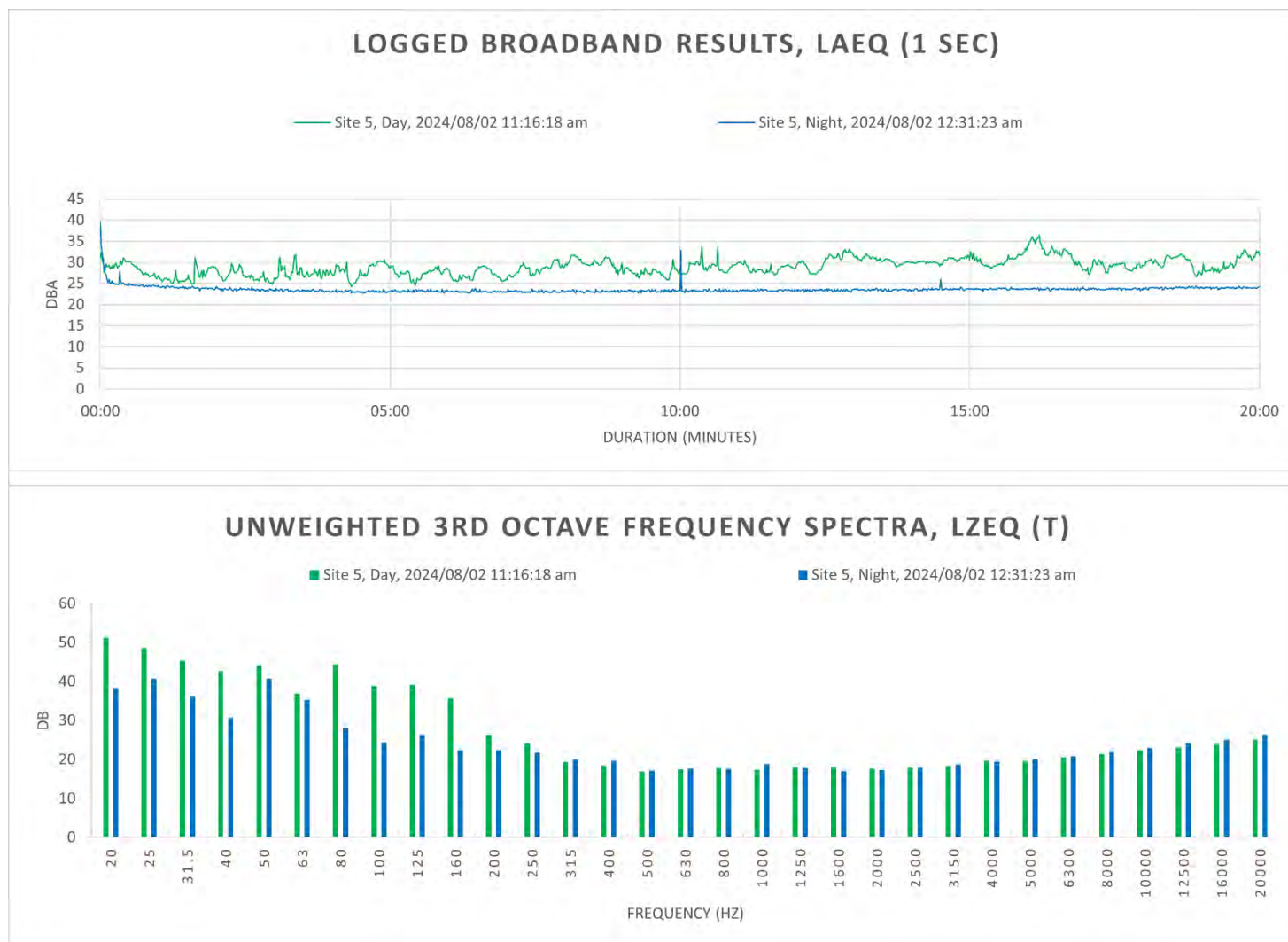


Figure C-4: Detailed day-time survey results for Site 5

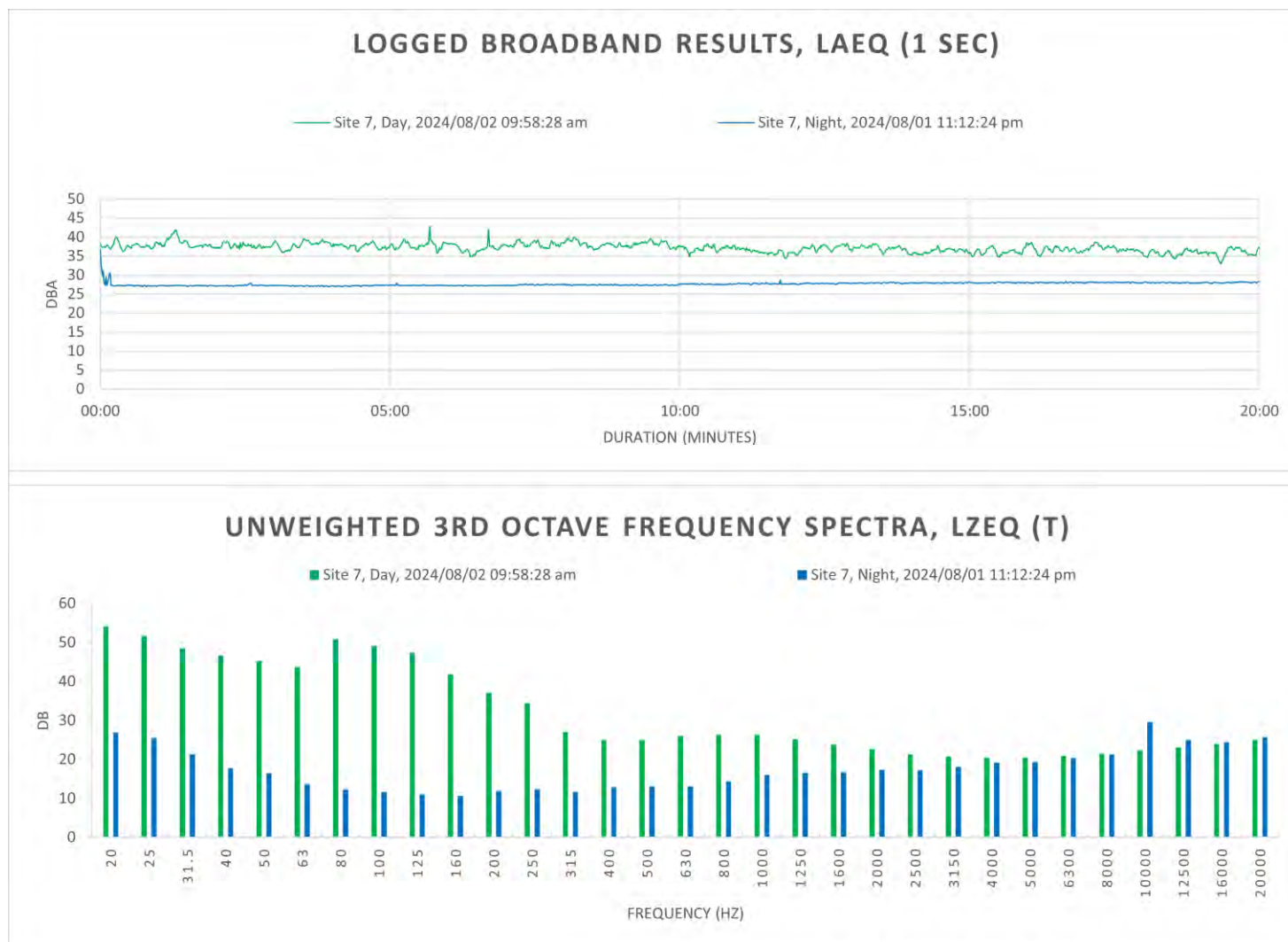


Figure C-5: Detailed day-time survey results for Site 7

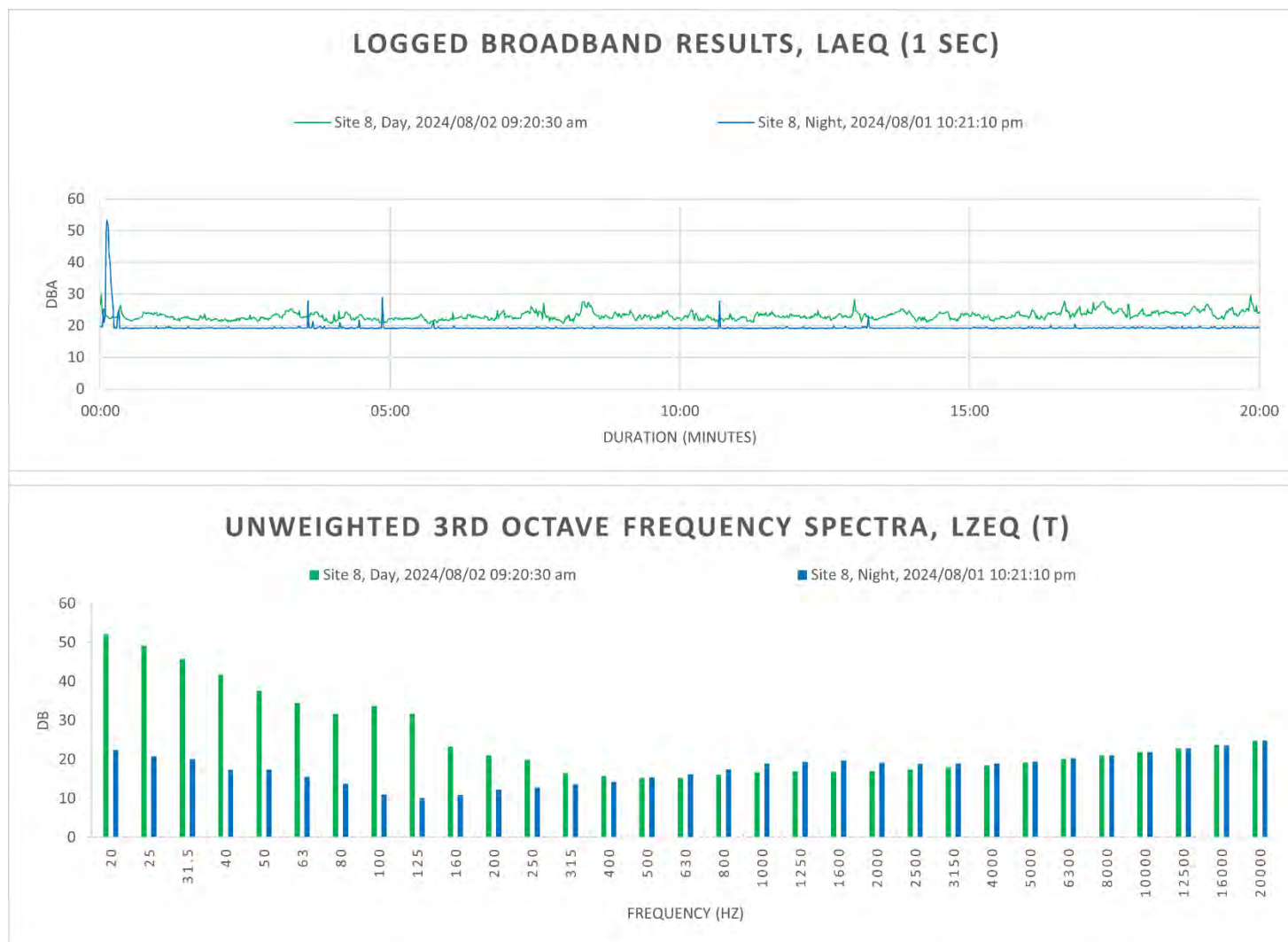


Figure C-6: Detailed day-time survey results for Site 8

Appendix D – Site Photographs

Facing north



Facing east



Facing south



Facing west



Figure D-1: Photographs of environmental noise survey Site 1

Facing north



Facing east



Facing south



Facing west



Figure D-2: Photographs of environmental noise survey Site 3

Facing north



Facing east



Facing south



Facing west



Figure D-3: Photographs of environmental noise survey Site 4

Facing north



Facing east



Facing south



Facing west



Figure D-4: Photographs of environmental noise survey Site 5

Facing north



Facing east



Facing south



Facing west



Figure D-5: Photographs of environmental noise survey Site 7

Facing north



Facing east



Facing south



Facing west



Figure D-6: Photographs of environmental noise survey Site 8