Environmental Noise Impact Assessment for the Proposed Amendments and Expansions at Kolomela Mine

Project done for **EXM Environmental Advisory (Pty) Ltd**

Report compiled by:
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Rev 0.1	August 2021	Incorporation of client's comments
Rev 0.2	September 2021	Incorporation of client's comments

Glossary and Abbreviations

Airshed	Airshed Planning Professionals (Pty) Ltd
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.
EC	European Commission
EHS	Environmental, Health, and Safety (IFC)
EXM	EXM Environmental Advisory (Pty) Ltd
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_P	Sound pressure level (in dB)
Ltd	Limited
L_W	Sound Power Level (in dB)
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
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
WHO	World Health Organisation
WRF	The Weather Research and Forecasting (WRF) Model
%	Percentage

Executive Summary

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by EXM Environmental Advisory (Pty) Ltd (EXM) to conduct the environmental noise impact assessment study for the proposed expansions and amendment of current activities at Kolomela Mine, which includes the Kapstevel South Project. The assessment is based on the updated life-of-mine plan of 2021 (hereafter referred to as the project).

The main objective of the noise specialist study was to determine the potential impact on the acoustic environment and noise sensitive receptors (NSRs) as a result of the proposed amendments and expansion of operations and to 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 a survey conducted on the 6th to 8th July 2021.
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 IFC noise level guidelines for residential, institutional and educational receptors (55 dBA during the day and 45 dBA during the night) which is also in line with the SANS 10103 rating for urban districts.

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:

- The closest NSR is an individual homestead ~1 km south of Kapstevel mining area.
- The baseline noise levels were between 32.6 and 44.8 dBA during the day and between 34.5 and 39.7 dBA during the night. The baseline noise levels are below the IFC guidelines for residential areas.

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 28 km east-west by 26.2 km north-south. The area was divided into a grid matrix with a 100-m resolution.

The main findings of the impact assessment were as follows:

- The environmental noise impact assessment considered two scenarios that would reflect the maximum noise impacts:
  - Operational year 2022 – maximum noise impacts to the eastern section of Kolomela Mine
  - Operational year 2030 – maximum noise impacts to the western section of Kolomela Mine
- An autonomous 2030 scenario was also assessed. With this scenario, the equipment numbers change slightly from the 2030 scenario for some of the listed primary equipment. Although the 90t trucks are removed from Kapstevel mining area for the autonomous scenario, the additional equipment alterations, and the logarithmic nature of noise results in similar noise impacts at Kapstevel mining area. The impacts due to truck trips (although decrease) are not overall significant in terms of noise. There is therefore no notable noise benefit with the autonomous scenario.
- The noise levels due to the project operations during 2022 and 2030 (including the autonomous 2030 scenario) potentially exceed the IFC guideline for residential areas at the closest NSR16. NSR16 is a farm owned by the Kolomela Mine. If noise levels due to the project exceed the IFC guidelines and become an annoyance at NSR16 after mitigation measures have been implemented, consideration should be given to relocating the residences at this site.
- A general management and mitigation plan, as stipulated in Section 6, are recommended to minimise noise impacts from the project on the surrounding area.
- The impact significance related to the project in terms of noise is medium.

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1 Introduction

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by EXM Environmental Advisory (Pty) Ltd (EXM) to conduct the environmental noise impact assessment study for the proposed expansions at Kolomela Mine, which includes the Kapstevel South Project. The assessment is based on the updated life-of-mine plan of 2021 (hereafter referred to as the project). The location of the project is provided in Figure 1.

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 operations at the project site and to 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:
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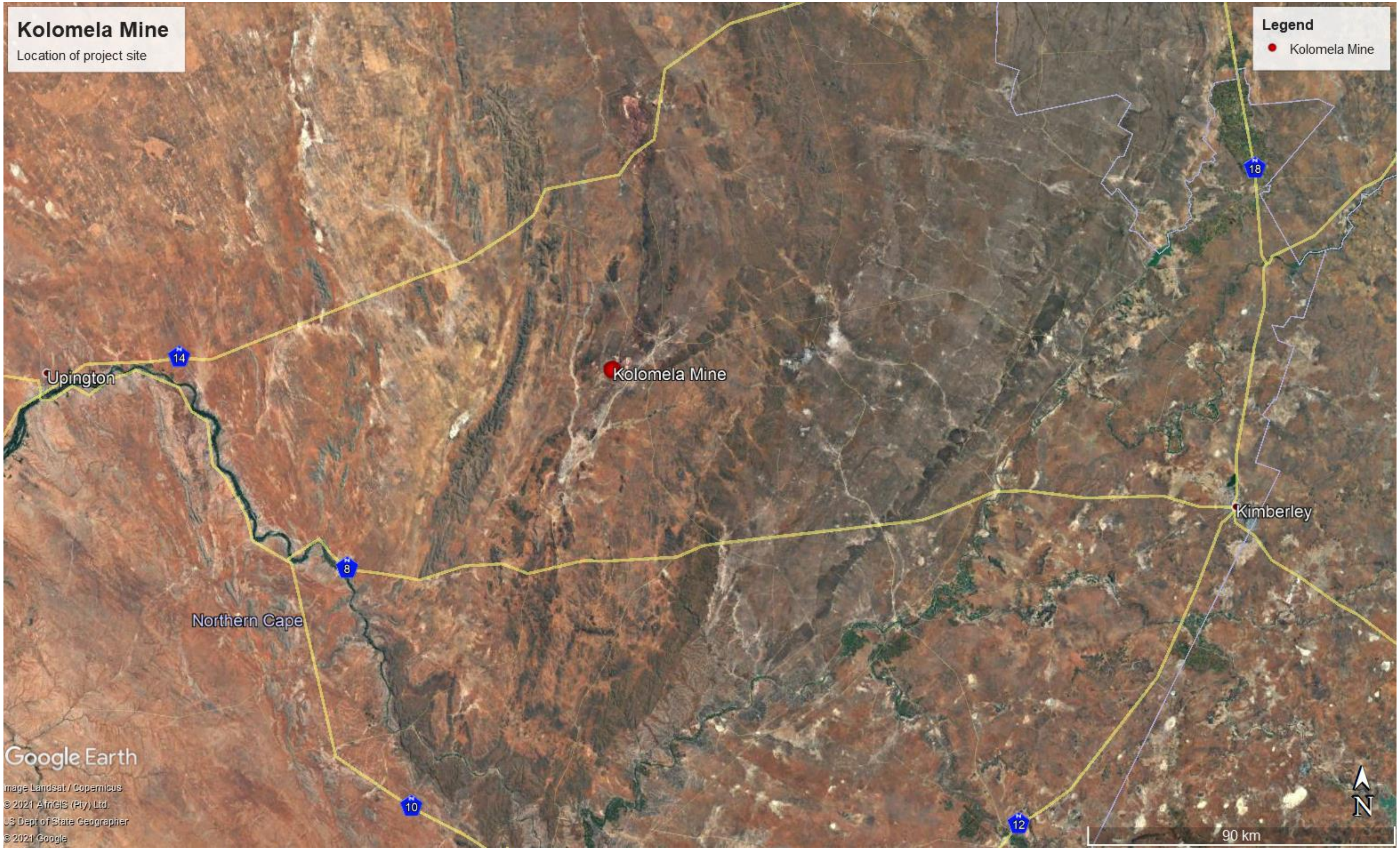


Figure 1: The location of the project site

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, and strategic air pollution impact assessment and management services and policy support to assist clients in addressing a wide variety of air pollution and environmental noise related assessments.

She has experience on the various components of environmental noise assessments from 2015 to present. Her project experience range over various countries in Africa, providing her with an inclusive knowledge base of international legislation and requirements pertaining to noise impacts.

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

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;
- 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). Taking into consideration the above in addition to the location of potential NSRs in relation to operational areas, two operational scenarios were considered.

Although not assessed as part of this study, the character of noise generated by blasting is mentioned. Blasting can cause noise and vibration, which can have an impact upon neighbouring noise receptors. Blasting usually results in both ground and airborne vibration. The latter includes both audible noise and vibration known as airblast, which can cause objects to rattle and make noise. Annoyance and discomfort from blasting can occur when noise startles individuals or when airblast or ground vibration causes vibration of building elements such as windows. The degree of annoyance is influenced by the level of airblast and vibration as well as factors such as the time of day, the frequency of occurrence and the sensitivity of individuals. The generation and transmission of airblast and ground vibration is affected by a number of factors including blast design, meteorology (particularly wind speed and direction and temperature inversions), topography, geology and soil water content (Earth Resources | Victoria State Government, 2015). Whereas the audible part of the airblast (acoustic) is characterized by frequencies ranging from 20 to 20 000 Hz the non-audible part, consist of sound energy below 20 Hz and is referred to as an 'over pressure' when the air blast pressure exceeds atmospheric pressure. Airblast over pressure exerts a force on structures and may in turn cause secondary and audible rattles within structures such as windows (Aloui, 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. 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 2. Here, the linear scale with its large numbers is converted into a manageable scale from 0 dB at the threshold of hearing (20 micro-pascals (µPa)) to 130 dB at the threshold of pain (~100 Pa) (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

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

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

Where:

***L_p** is the sound pressure level in dB;*

***p** is the actual sound pressure in Pa; and*

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

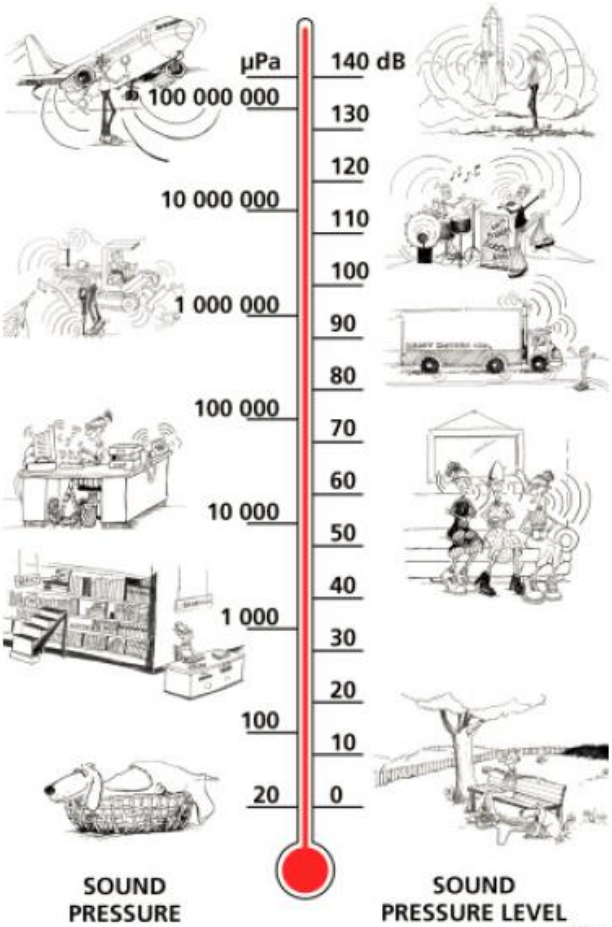


Figure 2: The decibel scale and typical noise levels (Brüel & Kjær Sound & Vibration Measurement A/S, 2000)

1.5.1 Perception of Sound

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

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

1.5.2 Frequency Weighting

Since human hearing is not equally sensitive to all frequencies, a 'filter' has been developed to simulate human hearing. The 'A-weighting' filter simulates the human hearing characteristic, which is less sensitive to sounds at low frequencies than at high frequencies (Figure 3). "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) and have been A-weighted.

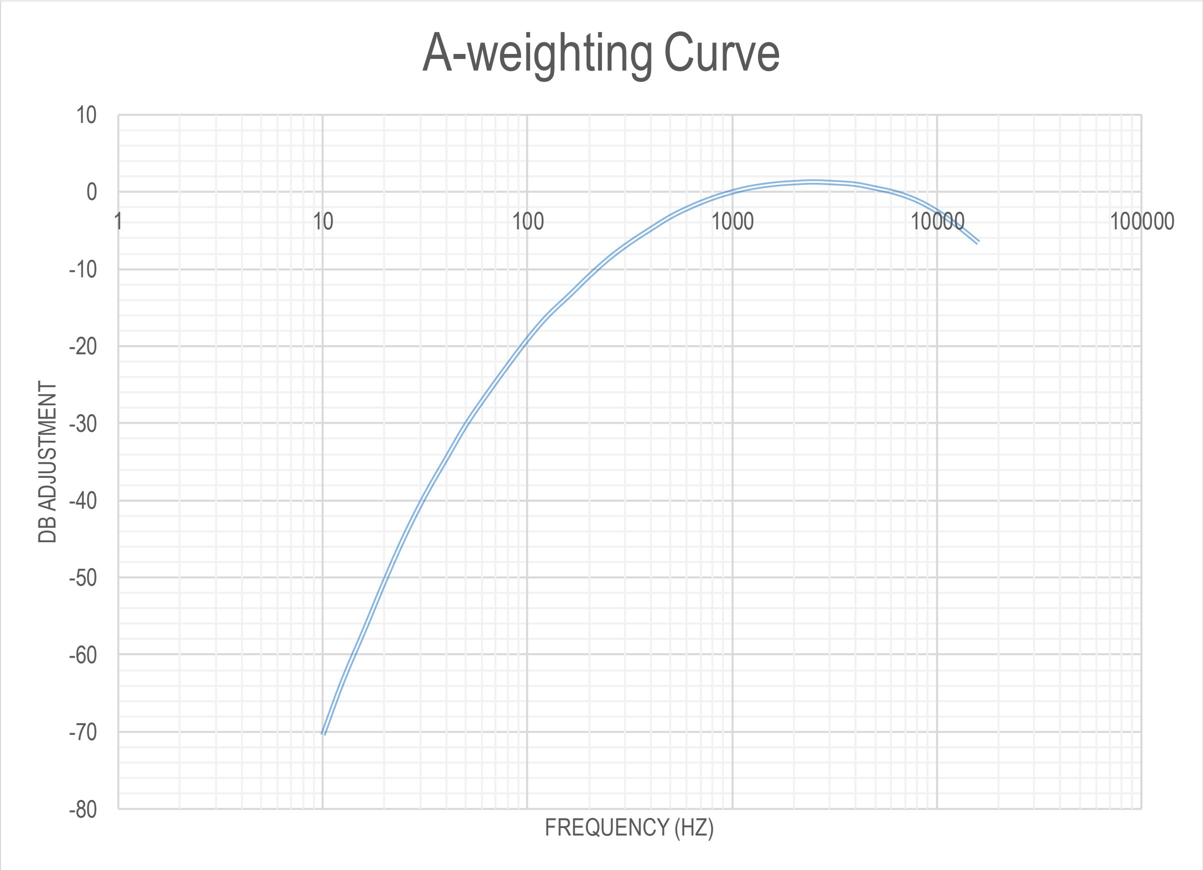


Figure 3: A-weighting curve

1.5.3 Adding Sound Pressure Levels

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

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

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

1.5.4 Environmental Noise Propagation

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

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

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

1.5.5 Environmental Noise Indices

In assessing environmental noise either by measurement or calculation, reference is 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_{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.
- **L_{AFmin}** – The minimum A-weighted noise level measured with the fast time weighting. It's 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 sound power levels (L_W's) (noise 'emissions') and sound pressure levels (L_P's) (noise impacts) associated with the construction and operational phases. 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 sent to EXM at the onset of the project. In response to the request, the following information was supplied:

- Layout maps;
- Mine throughput schedule;
- Vehicle numbers; and
- Measured noise source term.

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* (IFC 2007) and World Health Organisation (WHO) *Guidelines for Community Noise* (WHO 1999), 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.

The ability of the environment to attenuate noise as it travels through the air was studied by considering local meteorology, land use and terrain.

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

1.6.4 Noise Survey

The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in an area. Higher ambient noise levels will result in less noticeable noise impacts and a smaller impact area. The opposite also holds true. Increases in noise will be more noticeable in areas with low ambient noise levels. The data from a baseline noise survey conducted on the 6th to 8th July 2021 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 C). 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 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_{AIeq} (T), L_{Aeq} (T); L_{AFmax}; L_{AFmin}; L_{Zeq} (T), 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	Last Calibration Date
Svantek 977 sound level meter	S/N 36183	Noise sampling.	1,2 March 2021
Svantek 7052E ½" microphone	S/N 78692		
Svantek SV 12L ½" pre-amplifier	S/N 40659		
SVANTEK SV33 Class 1 Acoustic Calibrator	S/N 43170	Testing of the acoustic sensitivity before and after each daily sampling session.	2 March 2021
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.

1.6.5 Source Inventory

Noise source emissions for diesel powered mobile equipment, plant and workshop equipment were obtained from source measurements provided by the proponent.

Noise emissions from diesel powered mobile equipment, where source measurements were not available, 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.

Conveyor, conveyor transfer and general materials handling L_W's were obtained from a database 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:

(a) The International Organisation for Standardization's (ISO) 9613 module for outdoor noise propagation from industrial noise sources; and

(b) The German "Richtlinien für den Lamschutz an Straben" or RLS90 traffic noise module (for the access road).

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:

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

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 RLS90

The RLS90 road traffic noise module included in CadnaA requires average hourly traffic flow, separated into heavy and light vehicles, the average speed for each group, the dimension, geometry and type of the road and of any natural and artificial obstacles. As with ISO 9613, the module also takes also into account the main features which influence the propagation of noise namely obstacles, vegetation, air absorption, reflections and diffraction.

1.6.6.3 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 28 km east-west by 26.2 km north-south and encompasses the Kolomela Mine. The area was divided into a grid matrix with a 100 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 tabular and 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 provided by EXM. Refer to Appendix F of this report for the methodology.

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 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 providing a conservative assessment of the noise impacts off-site.
- The quantification of sources of noise was limited to the operational phase of the Kolomela Mine. 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.
- The railway noise due to moving trains was not taken into account as detailed train information was not available for the assessment. This is a limitation to the study as moving trains will add to the increased noise levels in the area with potential notable noise increases at NSR24 and Beeshoek.
- All activities were assumed to be 24 hours per day, 7 days per week.

- Although other existing sources of noise within the area were identified, such sources were not quantified but were taken into account during the survey.
- Blast vibration and noise did not form part of the scope of work of this assessment.
- The environmental noise assessment focuses on the evaluation of impacts for humans.

2 Legal Requirements and Noise Level Guidelines

2.1 National 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.

2.2 South African National Standards

In South Africa, provision is made for the regulation of noise under the National Environmental Management Air Quality Act (NEMAQA) (Act. 39 of 2004) but legally enforceable environmental noise limits have yet to be set. It is believed that when published, national criteria will make extensive reference to the South African Bureau of Standards (SABS) standard SANS 10103 (2008) *'The measurement and rating of environmental noise with respect to annoyance and to speech communication'.* This standard has been widely applied in South Africa and is frequently used by local authorities when investigating noise complaints. The standard is also fully aligned with the WHO guidelines for Community Noise (WHO, 1999). It should be noted that the values given in Table 2 are typical rating levels for different districts specified.

Table 2: 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.

2.3 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 3**, 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 3: 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

2.4 Summary of Assessment Criteria

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.

2.5 Regulations Regarding Report Writing

This report complies with the requirements of the National Environmental Management Act, 1998 (NEMA, No 107 of 1998) and the Environmental Impact Assessment (EIA) regulations (EIA Regulations, 2014 (GN R 982, as amended in 2016, 2017, 2018 and 2020)). The table below provides a summary of the requirements, with cross references to the report sections where these requirements have been addressed.

Table 4: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014), as amended in 2017

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 (as amended in 2017) must contain:	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 1.3.2 Appendix A
A declaration that the person is independent in a form as may be specified by the competent authority	Section 1.3.1 Appendix B
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 3.2 Section 3.3
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 4
The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 3.3 Section 4
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 3.1
An identification of any areas to be avoided, including buffers	Section 3.1 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 4
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
Any mitigation measures for inclusion in the EMPr	Section 6
Any conditions for inclusion in the environmental authorisation	Section 6
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 6
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 7
Regarding the acceptability of the proposed activity or activities; and	Section 4
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 4 Section 6 Section 7
A description of any consultation process that was undertaken during the course of carrying out the study	Not applicable

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 (as amended in 2017) must contain:	Relevant section in report
A summary and copies if any comments that were received during any consultation process	None received
Any other information requested by the competent authority.	None received

2.6 Procedures for the Assessment

This report complies with protocols for the assessment and minimum report content in terms of sections 24(5)(a), (h) and 44 of the National Environmental Management Act, 1998 (NEMA, No 107 of 1998) (Government Gazette No. 43110) published on 20 March 2020. The table below provides a summary of the requirements, with cross references to the report sections where these requirements have been addressed.

Table 5: Specialist assessment requirements in terms of Government Gazette No. 43110 (2020)

Assessment and Reporting on Noise Impacts	Section in Report
The assessment must be undertaken by a noise specialist	Section 1.3 and Appendix A
The assessment must be undertaken based on a site inspection as well as applying the noise standards and methodologies stipulated in SANS 10103:2008 and SANS 10328:2008 (or latest versions) for residential and non -residential areas as defined in these standards.	Section 2, Section 3.3 and Section 4
A baseline description must be provided of the potential receptors and existing ambient noise levels. The receptors could include places of residence or tranquillity that have amenity value associated with low noise levels. As a minimum, this description must include the following:	
• current ambient sound levels recorded at relevant locations (e.g. receptors and proposed new noise sources) over a minimum of two nights and that provide a representative measurement of the ambient noise climate, with each sample being a minimum of ten minutes and taken at two different times of the night (such as early evening and late at night) on each night, in order to record typical ambient sound levels at these different times of night;	Section 3.3
• records of the approximate wind speed at the time of the measurement;	Section 3.3
• mapped distance of the receiver from the proposed development that is the noise source; and	Section 3.1
• discussion on temporal aspects of baseline ambient conditions.	Section 3.3
Assessment of impacts done in accordance to SANS 10103:2008 and SANS 10328:2008 (or latest versions) must include the following aspects which must be considered as a minimum in the predicted impact of the proposed development:	
• characterisation and determination of noise emissions from the noise source, where characterization could include types of noise, frequency, content, vibration and temporal aspects;	Section 4
• projected total noise levels and changes in noise levels as a result of the construction, commissioning and operation of the proposed development for the nearest receptors using industry accepted models and forecasts; and,	Section 4
• desired noise levels for the area.	Section 4 and Section 5
The findings of the Noise Specialist Assessment must be written up in a Noise Specialist Report that must contain as a minimum the following information:	
• details and relevant qualifications and experience of the noise specialist preparing the assessment including a curriculum vitae;	Section 1.3 and Appendix A

Assessment and Reporting on Noise Impacts	Section in Report
• a signed statement of independence by the specialist;	Appendix B
• the duration and date of the site inspection and the relevance of the season and weather conditions to the outcome of the assessment;	Section 3.2 and Section 3.3
• a description of the methodology used to undertake the on-site assessment inclusive of the equipment and models used, as relevant, together with results of the noise assessment;	Section 1.6.4, Section 1.6.6 and Section 4
• a map showing the proposed development footprint (including supporting infrastructure) with a 50m buffered development envelope;	Figure 1 and Figure 2
• confirmation from the specialist that all reasonable measures have been considered, or not, in the micro- siting of the proposed development to minimise disturbance of receptors;	Section 4 and Section 6
• a substantiated statement from the specialist on the acceptability, or not, of the proposed development and a recommendation on the approval, or not, of the proposed development;	Section 7
• any conditions to which this statement is subjected;	Section 6 and Section 7
• the assessment must identify alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification and which were not considered;	Section 4. No alternative development footprints were provided for the assessment.
• a motivation must be provided if there were development footprints identified as per paragraph 2.5.9. above that were identified as having a "low" noise sensitivity and that were not considered appropriate;	Not applicable
• where identified, proposed impact management outcomes, mitigation measures for noise emissions during the construction and commissioning phases that may be of relative short duration, or any monitoring requirements for inclusion in the Environmental Management Programme (EMPr); and,	Section 6
• a description of the assumptions made and any uncertainties or gaps in knowledge or data.	Section 1.7

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

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

As mentioned in Section 1.5.4, the impact of an intruding industrial/mining noise on the environment rarely extends over more than 5 km from the source. Potential noise sensitive receptors within the project area (indicated in Figure 4), include the residential areas of Beeshoek, Boichoko, Newtown and Postmasburg. Individual homesteads also surround the project area. The closest NSR likely to be affected by the proposed amended layout include NSR7, NSR8 and NSR9 which lies east of the Leeuwfontein mining area and NSR16 which lies south of the Kapstevel mining area.

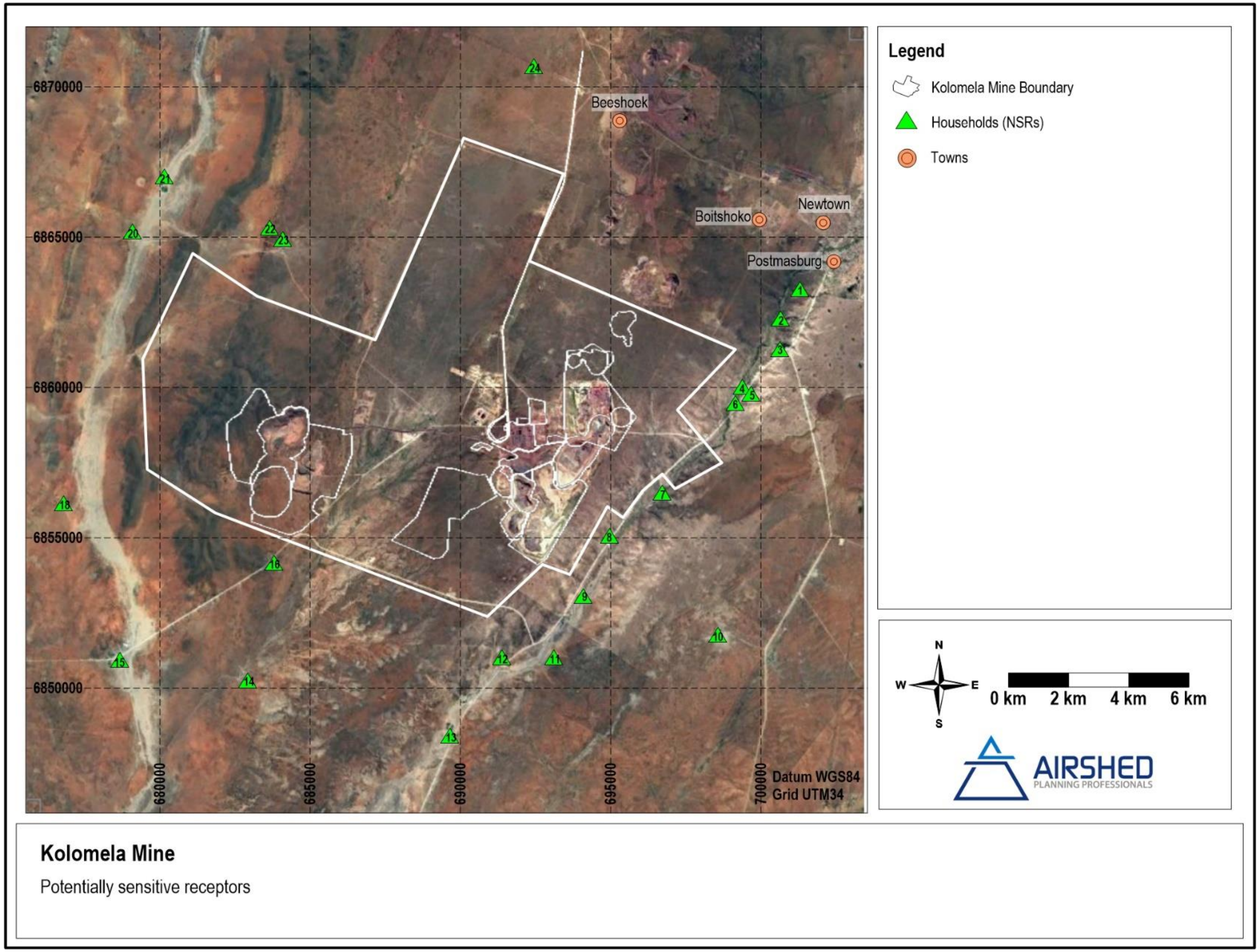


Figure 4: Sensitive receptors within the study area

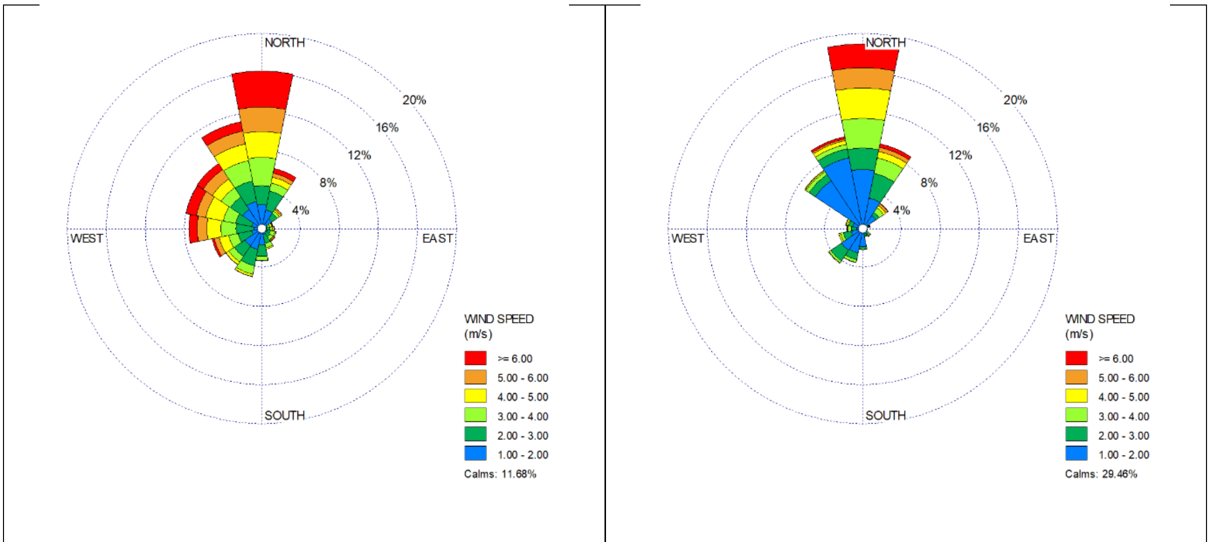
3.2 Environmental Noise Propagation and Attenuation potential

3.2.1 Atmospheric Absorption and Meteorology

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, resulting 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.

On-site meteorological data for the period 2020 was used to generate wind roses for the site. During the day (06:00 – 22:00) and night (22:00 – 06:00), the predominant wind direction is from the north. On average, noise impacts are expected to be more notable south of the project activities.



- Day-time wind rose (06:00 – 22:00)

(b) Night-time wind rose (22:00 – 06:00)

Figure 5: Wind rose for on-site data (2020)

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 (Figure 6).

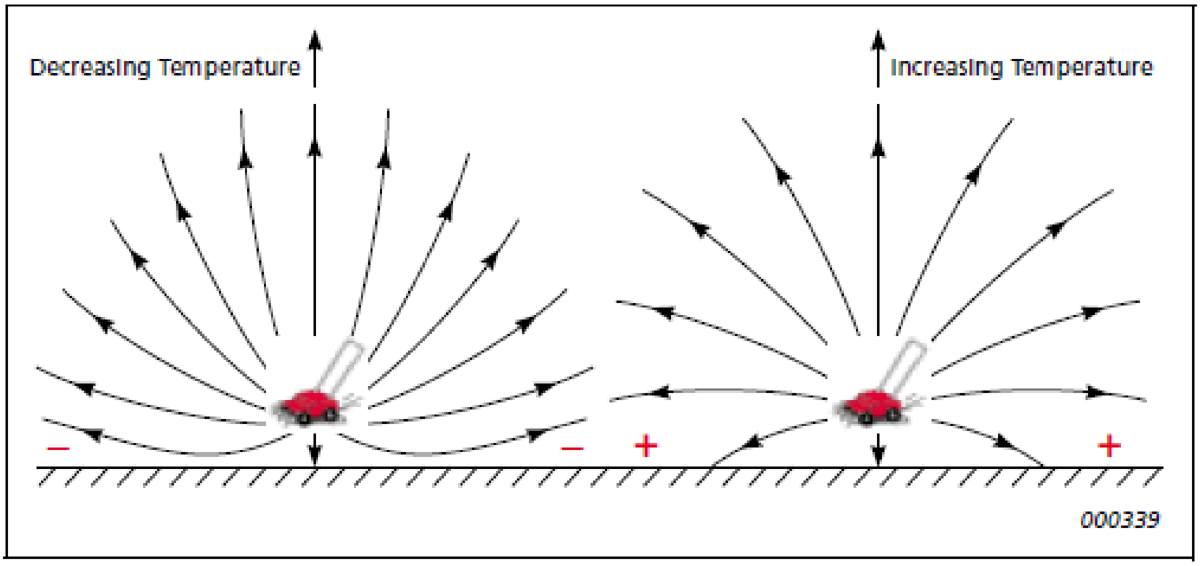


Figure 6: Bending the path of sound during typical day time conditions (image provided on the left) and night-time conditions (image provided on the right)

The average temperature for the site (as obtained from the on-site data for the period 2020) was 19°C.

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 topography for the study area is provided in Figure 7.

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). Ground cover was conservatively assumed to be acoustically hard (not conducive to noise attenuation) due the area's semi-arid nature.

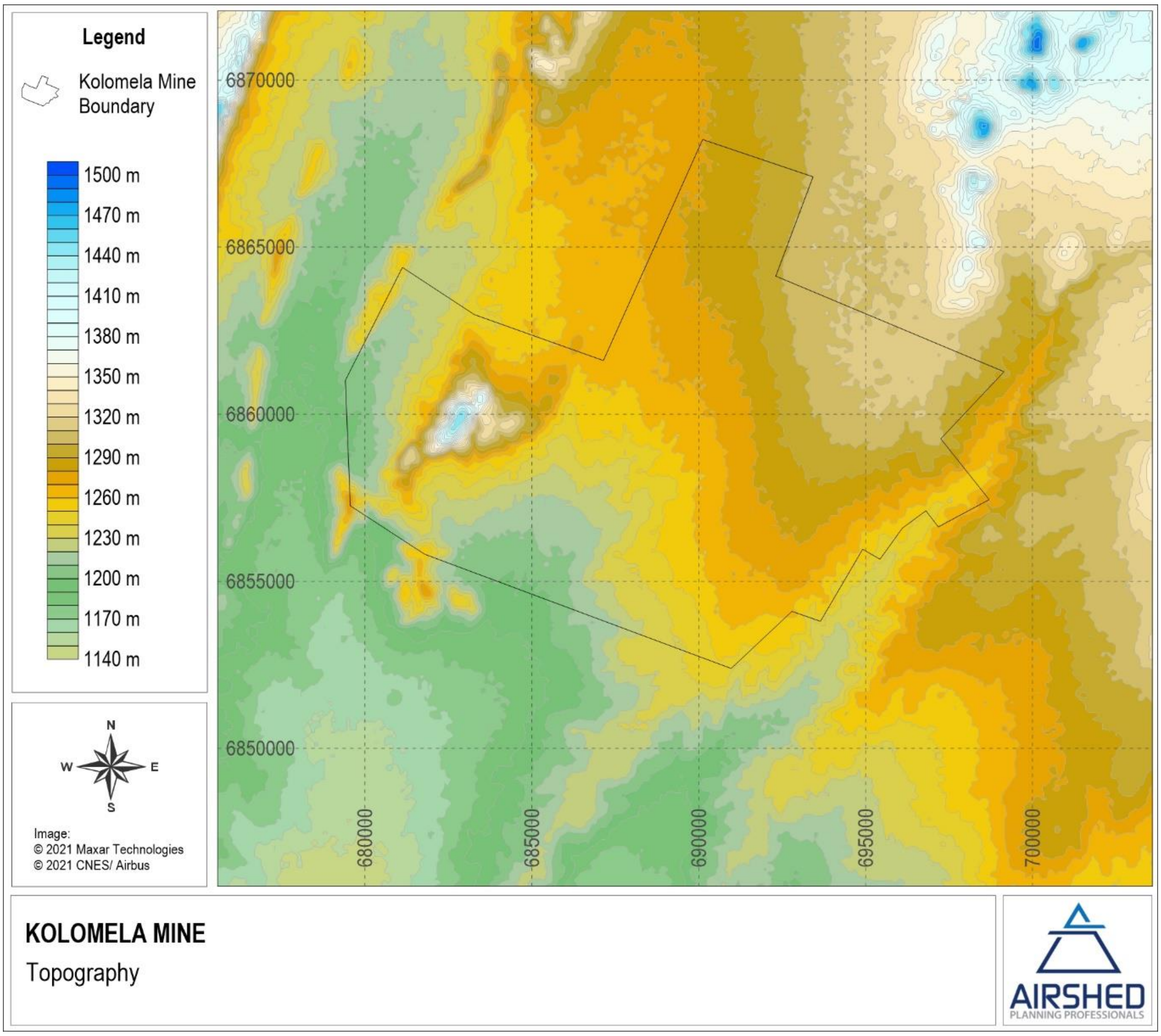


Figure 7: Topography for the study area

3.3 Baseline Noise Survey and Results

The sampling point was selected based on previous noise surveys conducted for the area and accessibility (Figure 8). Survey results for the campaign undertaken on the 6th to 8th July 2021 are summarised in Table 6 and for comparison purposes, visually presented in Figure 9 and Figure 10.

The baseline noise levels at all the sampling locations were below the IFC guidelines for residential areas.

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

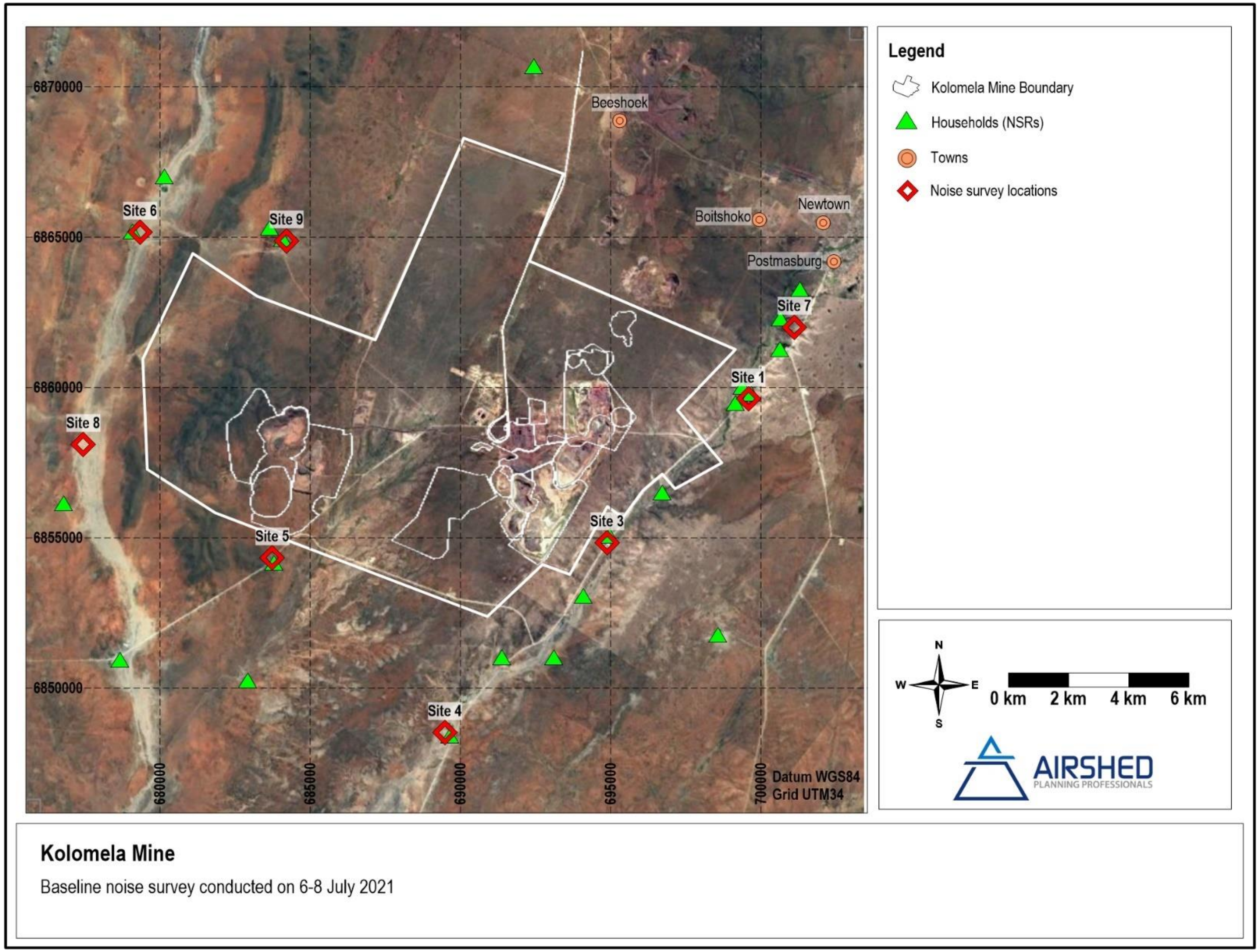


Figure 8: Location of the noise sampling site

Table 6: Summary of project baseline environmental noise survey results

Sampling point	Closest NSR	Time of day	Start date and time	Duration	LAFmax (dBA)	LAFmin (dBA)	LAeq (dBA)	LAIeq (dBA)	LA90 (dBA)	LAeq (dBA) for Comparison to IFC Noise Level Guidelines	IFC Noise Level Guideline (dBA)
Site 1	NSR4, NSR5, NSR6	Day	06/07/2021 09:05	00:10:01	60.4	21.5	40.5	51.2	26.5	40.5	55
		Day	06/07/2021 18:01	00:10:02	57.6	21.6	37.2	49.4	24.3		
		Day	07/07/2021 20:27	00:10:01	71.8	22.8	42.4	50.9	27.8		
		Night	06/06/2021 23:45	00:10:02	60.6	19.6	38.4	49.9	28.5	38.2	45
		Night	07/06/2021 23:48	00:10:03	72.6	21.9	38.0	77.1	24.3		
Site 3	NSR8	Day	06/07/2021 10:57	00:10:01	64.6	21.2	43.2	48.8	23.8	44.8	55
		Day	06/07/2021 18:27	00:10:02	74.8	20.6	43.2	76.9	23.7		
		Day	07/07/2021 20:54	00:10:01	76.5	28.7	46.8	72.7	31.2		
		Night	07/06/2021 00:12	00:10:01	74.4	20.4	41.4	50.3	26.2	39.7	45
		Night	07/06/2021 23:22	00:10:02	56.1	22.8	36.8	52.9	25.6		
Site 4	NSR13	Day	06/07/2021 12:08	00:10:02	61.8	20.1	34.1	48.7	21.5	32.6	55
		Day	06/07/2021 19:04	00:10:01	54.1	20.5	31.6	50.2	22.4		
		Day	07/07/2021 21:24	00:10:05	60.9	20.1	31.7	61.9	21.7		
		Night	07/06/2021 00:56	00:10:01	56.0	18.6	32.2	51.1	19.8	34.9	45
		Night	07/06/2021 22:47	00:10:04	62.4	21.3	36.5	55.0	23.3		
Site 5	NSR16	Day	06/07/2021 12:44	00:10:02	63.1	20.9	38.8	68.3	25.7	44.0	55
		Day	06/07/2021 19:46	00:10:02	64.1	25.0	40.0	50.9	30.6		
		Day	07/07/2021 21:55	00:10:02	80.6	20.9	47.6	51.9	26.0		
		Night	07/06/2021 01:38	00:10:02	66.6	21.4	38.7	69.8	25.6	38.9	45
		Night	07/06/2021 22:08	00:10:02	57.8	23.6	39.1	51.1	29.8		
Site 6	NSR20	Day	06/07/2021 16:47	00:10:02	67.5	26.5	41.4	49.4	28.7	39.3	55
		Day	06/07/2021 21:42	00:10:02	69.8	19.7	38.7	72.5	22.8		
		Day	07/07/2021 18:29	00:10:02	55.1	20.3	36.5	51.9	23.0		
		Night	06/06/2021 22:01	00:10:07	66.1	23.0	41.9	55.8	25.8	39.1	45
		Night	08/06/2021 00:59	00:10:06	50.1	19.8	29.3	51.1	21.0		

Sampling point	Closest NSR	Time of day	Start date and time	Duration	LAFmax (dBA)	LAFmin (dBA)	LAeq (dBA)	LAleq (dBA)	LA90 (dBA)	LAeq (dBA) for Comparison to IFC Noise Level Guidelines	IFC Noise Level Guideline (dBA)
Site 7	NSR2	Day	06/07/2021 14:48	00:10:01	61.5	21.2	34.6	57.0	23.2	36.0	55
		Day	06/07/2021 20:31	00:10:01	60.9	20.5	34.5	49.4	22.5		
		Day	07/07/2021 19:53	00:10:01	63.8	21.0	38.0	49.5	27.5		
		Night	06/06/2021 23:18	00:10:01	62.6	18.9	37.5	49.5	20.8	36.6	45
		Night	08/06/2021 00:17	00:10:02	55.6	22.2	35.5	49.1	24.2		
Site 8	NSR18	Day	06/07/2021 15:51	00:10:02	58.5	24.0	36.2	48.6	26.4	42.7	55
		Day	06/07/2021 21:05	00:10:08	75.4	20.5	46.8	76.8	24.4		
		Day	07/07/2021 18:00	00:10:01	54.2	21.1	34.7	47.3	23.8		
		Night	06/06/2021 22:30	00:10:02	70.0	19.4	39.5	47.4	25.2	37.4	45
		Night	08/06/2021 01:27	00:10:02	63.9	19.8	33.1	52.0	20.8		
Site 9	NSR23	Day	07/07/2021 15:38	00:10:01	64.0	25.7	45.5	52.6	34.1	42.3	55
		Day	07/07/2021 19:20	00:10:03	59.1	22.1	41.6	61.1	28.6		
		Day	08/07/2021 20:21	00:10:02	50.6	21.1	28.8	50.1	22.4		
		Night	08/06/2021 02:21	00:10:02	60.3	21.2	34.4	49.3	24.9	34.5	45
		Night	08/06/2021 22:01	00:10:02	54.5	22.8	34.5	50.5	23.4		

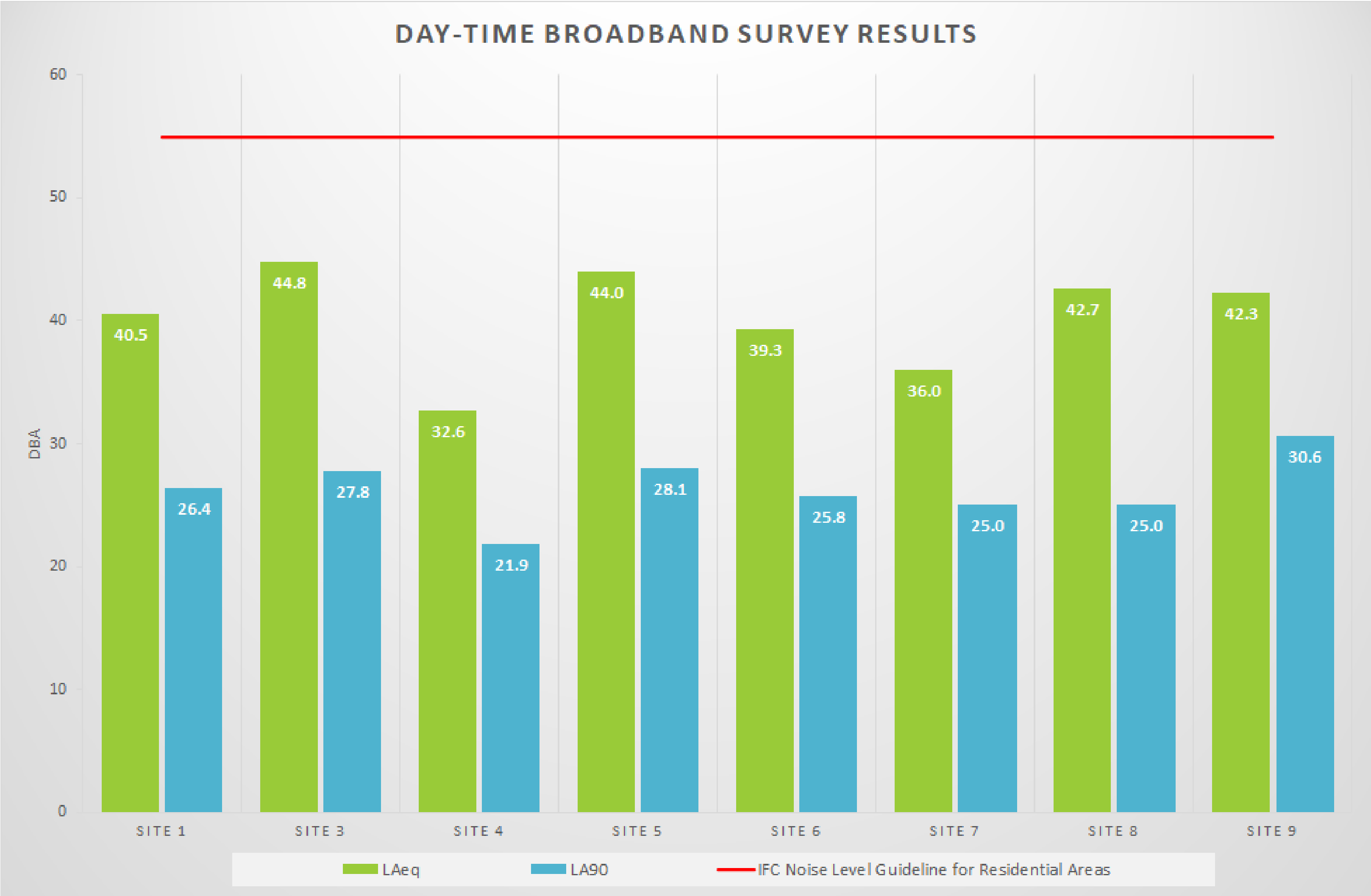


Figure 9: Day-time broadband survey results

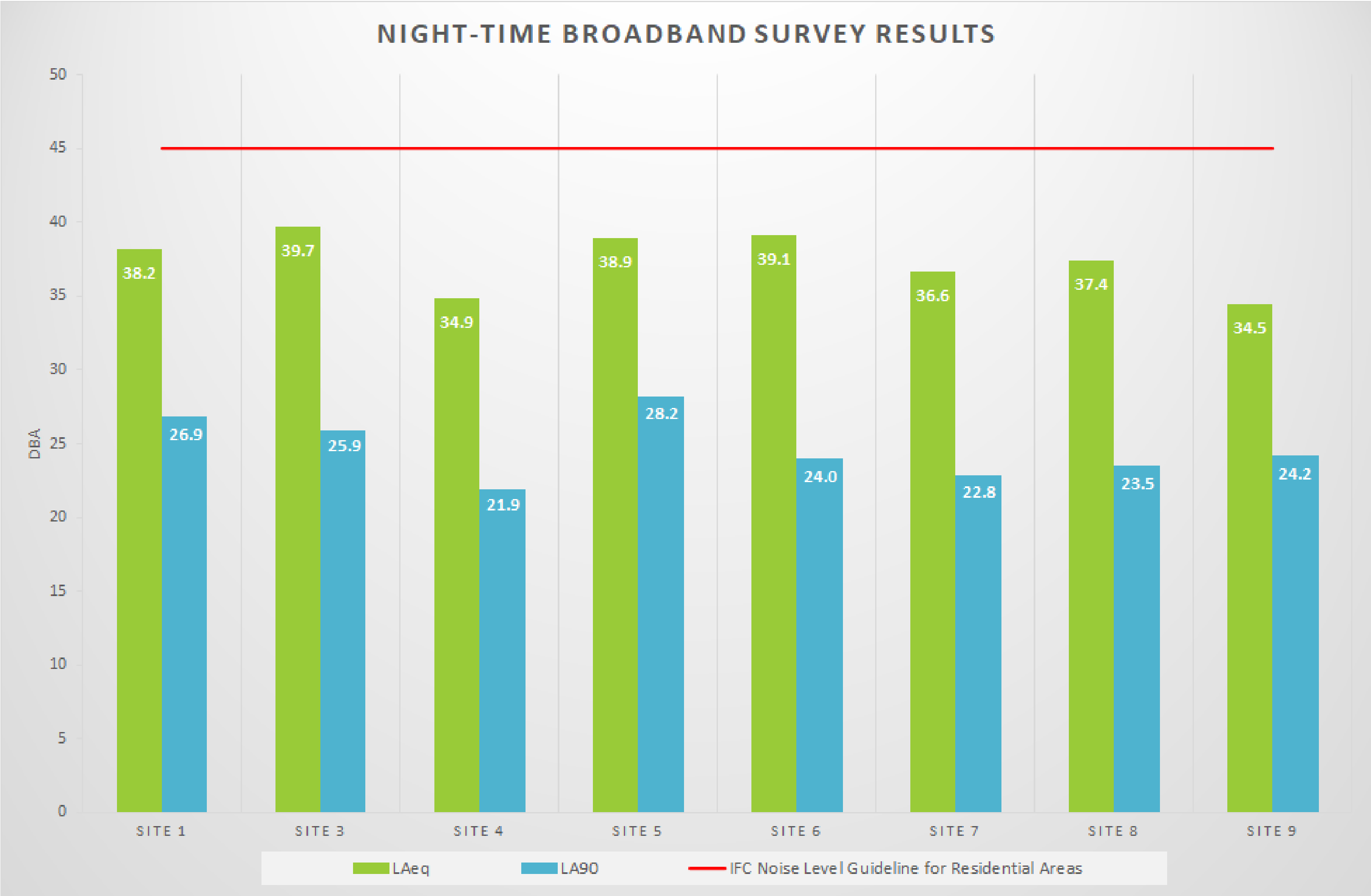


Figure 10: Night-time broadband survey results

4 Impact Assessment

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

Two operational years were selected to reflect the maximum noise impacts:

- Operational year 2022 – maximum noise impacts to the eastern section of Kolomela Mine
- Operational year 2030 – maximum noise impacts to the western section of Kolomela Mine

An additional scenario was assessed for the period 2030 where the trucks transporting the ore from KSS to the processing plant would be autonomous associated with the Kapstevel South Project. For this scenario some of the listed primary equipment quantities change slightly from the 2030 operational year and the 90t trucks are removed from Kapstevel mining area.

4.1 Noise Sources and Sound Power Levels

The complete source inventory for the Kolomela Mine is included in Table 7. Octave band frequency spectra L_W's are included in Table 8. The frequency spectra were determined for the measured source term (total dBA) provided by the proponent.

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

Haul truck traffic noise as well as access road traffic were included. Traffic parameters as determined from either mining rates and truck capacities; or reported data by Jeffares and Green as obtained from the 2015 noise assessment (von Reiche, 2015) are summarised in Table 9 along with assumptions.

Table 7: Noise source quantities for the Kolomela Mine

Category	Equipment	2022	2030	2030 - autonomous
Primary				
Shovels and Loaders	Lieb 996 FS	2	2	1
	Kom PC 4000 FS	0	0	2
	Kom PC 3000 FS	4	3	3
	Lieb 9150 EX	2	2	0
	Kom WA 1200 FEL	2	2	0
	CAT 992 FEL	3	0	0

Category	Equipment	2022	2030	2030 - autonomous
Drills	CAT MD6540 Drill	8	5	6
Haul Trucks	Kom 730-7 (180t)	26	26	26
	CAT 777 (ore) (4) (90t)	9	1	0
	Komatsu 785 (ore) (90t)	15	17	7
	Kom 830 (220t)	5	16	18
Ancilliary				
Graders and Dozers	CAT 16M (Grader)	8	3	2
	CAT 834H (Wheel dozer)	10	6	6
	Kom 375-6 (Track dozer)	17	10	10
Trucks and Bowsers	Actross 4044 ST (Stemming)	3	3	3
	CAT 730 ADT (Lube truck)	4	1	1
	CAT 740 ADT (Diesel bowser)	7	5	5
	CAT 740 ADT (Water bowser - Dril)	3	1	1
	Kom 785 (85kl) Water Bowser (dust suppression)	4	3	3
	CAT 745 ADT (New Diesel Bowser)	1	1	1
Loaders, excavators and misc	CAT 385 (Rock breaker)	4	1	1
	CAT 428 TLB	4	1	1
	CAT 770F (45t haul truck)	4	4	4
	CAT 793 (Tow haul Horse)	1	1	1
	CAT 908	3	2	2
	CAT 988H FEL (50t)	1	1	1
	Kom WA 600 (Tyre handler)	2	2	2
	Kom WA 800 FEL (100t) (Construction)	1	1	1
	Lieb 984 (Scaler)	3	3	3

Table 8: Octave band frequency spectra L_W's

Category	Equipment	Oktave Spectrum (dB)							A	lin	Source
		63	125	250	500	1000	2000	4000			
Primary											
Shovels and Loaders	Lieb 996 FS	124.0	122.0	117.0	113.0	109.0	106.0	98.0	115.4	126.9	Measured: Client Database
	Kom PC 3000 FS	117.6	115.6	110.6	106.6	102.6	99.6	91.6	109.0	120.5	Measured: Client Database
	Lieb 9150 EX	104.0	102.0	97.0	93.0	89.0	86.0	78.0	95.4	106.9	Measured: Client Database
	Kom WA 1200 FEL	116.6	114.6	109.6	105.6	101.6	98.6	90.6	108.0	119.5	Measured: Client Database
	CAT 992 FEL	119.4	117.4	112.4	108.4	104.4	101.4	93.4	110.8	122.3	Measured: Client Database
Drills	CAT MD6540 Drill	121.4	119.4	114.4	110.4	106.4	103.4	95.4	112.8	124.3	Measured: Client Database
Haul Trucks	Kom 730-7 (180t)	119.0	117.0	112.0	105.4	101.4	98.4	90.4	108.9	121.8	Measured: Client Database
	CAT 777 (ore) (4) (90t)	116.7	114.7	109.7	105.7	101.7	98.7	90.7	108.1	119.6	Measured: Client Database
	Komatsu 785 (ore) (90t)	113.0	111.0	106.0	102.0	98.0	95.0	87.0	104.4	115.9	Measured: Client Database
	Kom 830 (220t)	120.5	125.5	128.5	123.5	121.5	118.5	112.5	132.1	126.7	LW Predictions (Bruce & Moritz, 1998)
Ancillary											
Graders and Dozers	CAT 16M (Grader)	111.9	109.9	104.9	100.9	96.9	93.9	85.9	103.3	114.8	Measured: Client Database
	CAT 834H (Wheel dozer)	114.3	112.3	107.3	103.3	99.3	96.3	88.3	105.7	117.2	Measured: Client Database
	Kom 375-6 (Track dozer)	117.5	115.5	110.5	106.5	102.5	99.5	91.5	108.9	120.4	Measured: Client Database
Trucks and Bowsers	Actross 4044 ST (Stemming)	117.3	115.3	110.3	106.3	102.3	99.3	91.3	108.7	120.2	LW Predictions (Bruce & Moritz, 1998)
	CAT 730 ADT (Lube truck)	111.9	116.9	119.9	114.9	112.9	109.9	103.9	123.5	118.1	LW Predictions (Bruce & Moritz, 1998)
	CAT 740 ADT (Diesel bowser)	107.2	105.2	100.2	96.2	92.2	89.2	81.2	98.6	110.1	Measured: Client Database
	CAT 740 ADT (Water bowser - Dril)	107.2	105.2	100.2	96.2	92.2	89.2	81.2	98.6	110.1	Measured: Client Database
	Kom 785 (85kl) Water Bowser (dust suppression)	113.0	111.0	106.0	102.0	98.0	95.0	87.0	104.4	115.9	Measured: Client Database
	CAT 745 ADT (New Diesel Bowser)	118.1	123.1	126.1	121.1	119.1	116.1	110.1	129.7	124.4	LW Predictions (Bruce & Moritz, 1998)
Loaders, excavators and misc	CAT 385 (Rock breaker)	118.0	116.0	111.0	107.0	103.0	100.0	92.0	109.4	120.9	LW Predictions (Bruce & Moritz, 1998)
	CAT 428 TLB	110.5	108.5	103.5	99.5	95.5	92.5	84.5	101.9	113.4	LW Predictions (Bruce & Moritz, 1998)
	CAT 770F (45t haul truck)	117.5	115.5	110.5	106.5	102.5	99.5	91.5	108.9	120.4	LW Predictions (Bruce & Moritz, 1998)
	CAT 793 (Tow haul Horse)	120.6	125.6	128.6	123.6	121.6	118.6	112.6	132.2	126.8	LW Predictions (Bruce & Moritz, 1998)
	CAT 908	109.2	107.2	102.2	98.2	94.2	91.2	83.2	100.6	112.1	LW Predictions (Bruce & Moritz, 1998)
	CAT 988H FEL (50t)	117.7	115.7	110.7	106.7	102.7	99.7	91.7	109.1	120.6	LW Predictions (Bruce & Moritz, 1998)
	Kom WA 600 (Tyre handler)	113.7	118.7	121.7	116.7	114.7	111.7	105.7	125.3	119.9	LW Predictions (Bruce & Moritz, 1998)

Category	Equipment	Oktave Spectrum (dB)							A	lin	Source
		63	125	250	500	1000	2000	4000			
	Kom WA 800 FEL (100t) (Construction)	116.0	121.0	124.0	119.0	117.0	114.0	108.0	127.7	122.3	LW Predictions (Bruce & Moritz, 1998)
	Lieb 984 (Scaler)	104.0	102.0	97.0	93.0	89.0	86.0	78.0	95.4	106.9	Measured: Client Database

Table 9: Traffic noise

Activity/Road	Vehicles per hour 2022	Vehicles per hour 2030	Vehicles per hour 2030 - autonomous	% Heavy Vehicles
Leeufontein ore haul	12.4	-	-	100
Leeufontein waste rock haul	33.6	-	-	100
Kapstevel ore haul	11.8	29.5	12.6	100
Kapstevel waste rock haul	39.5	71.6	72.6	100
Klipbankfontein ore haul	15.9	-	-	100
Klipbankfontein waste rock haul	4.5	-	-	100
Access road (a)	200.0	200.0	200.0	15

(a) Assumed based on the 2015 assessment (von Reiche, 2015)

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 10 provides a summary of simulated noise levels for the operational period 2022 and 2030 at NSRs. Results for proposed 2022 and 2030 Kolomela Mine operations are presented in isopleth form (Figure 11 to Figure 19).

Noise levels due to Kolomela Mine operations for the periods 2022 and 2030 are predicted to exceed the night-time IFC noise guidelines for residential areas at the NSR16 only (south of Kapstevel mining area). Noise impacts at all other identified NSRs are within the IFC guidelines for residential areas.

For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. The increase in noise levels above the baseline for proposed operations for the periods 2022 and 2030 is more than 3 dBA at the NSR16. According to SANS 10103 (2008); the predicted increase in noise levels due to proposed project operations is expected to result in the following reaction from NSR16:

- Kolomela operational period 2022:
  - Day-time – 'little' reaction with 'sporadic' complaints
  - Night-time – 'little' to 'medium' reaction with 'sporadic' to 'widespread' complaints
- Kolomela operational period 2030:
  - Day-time – 'little' to 'medium' reaction with 'sporadic' to 'widespread' complaints
  - Night-time – 'strong' reaction with 'threats of community action'
- Kolomela operational period 2030 - autonomous:
  - Day-time – 'little' to 'medium' reaction with 'sporadic' to 'widespread' complaints
  - Night-time – 'strong' reaction with 'threats of community action'

It should be noted that NSR16 is a farm owned by the Kolomela Mine. If noise levels due to the project exceed the IFC guidelines and become an annoyance at NSR16 after mitigation measures have been implemented, consideration should be given to relocating the residences at this site.

The noise impacts due to the operational period 2030 compared to the autonomous scenario for 2030 is similar in magnitude and spatial distribution.

Table 10: Summary of simulated noise levels (provided as dBA) for proposed operations (year 2025) at NSR within the study area[(a)]

NSR	Kolomela (2022)		Kolomela (2030)		Kolomela (2030 - autonomous)		Baseline		Increase above baseline[(b)] for 2022		Increase above baseline[(b)] for 2030		Increase above baseline[(b)] for 2030 - autonomous	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
1	-	-	-	-	-	-	36.0	36.6	0.0	0.0	0.0	0.0	0.0	0.0
2	-	-	-	-	-	-	36.0	36.6	0.0	0.0	0.0	0.0	0.0	0.0
3	-	-	-	-	-	-	36.0	36.6	0.0	0.0	0.0	0.0	0.0	0.0
4	-	-	-	-	-	-	40.5	38.2	0.0	0.0	0.0	0.0	0.0	0.0
5	-	-	-	-	-	-	40.5	38.2	0.0	0.0	0.0	0.0	0.0	0.0
6	-	-	-	-	-	-	40.5	38.2	0.0	0.0	0.0	0.0	0.0	0.0
7	-	-	-	-	-	-	44.8	39.7	0.0	0.0	0.0	0.0	0.0	0.0
8	35.7	35.8	-	-	-	-	44.8	39.7	0.5	1.5	0.0	0.0	0.0	0.0
9	32.9	33.2	-	-	-	-	44.8	39.7	0.3	0.9	0.0	0.0	0.0	0.0
10	-	-	-	-	-	-	32.6	34.9	0.0	0.0	0.0	0.0	0.0	0.0
11	-	-	-	-	-	-	44.8	39.7	0.0	0.0	0.0	0.0	0.0	0.0
12	-	-	-	-	-	-	44.8	39.7	0.0	0.0	0.0	0.0	0.0	0.0
13	-	-	-	-	-	-	32.6	34.9	0.0	0.0	0.0	0.0	0.0	0.0
14	-	-	-	-	-	-	32.6	34.9	0.0	0.0	0.0	0.0	0.0	0.0
15	-	-	-	-	-	-	32.6	34.9	0.0	0.0	0.0	0.0	0.0	0.0
16	44.6	**45.1**	50.7	**51.2**	51.1	**51.6**	44.0	38.9	3.3	7.1	7.5	12.5	7.9	12.9
18	-	-	-	-	-	-	42.7	37.4	0.0	0.0	0.0	0.0	0.0	0.0
20	-	-	-	-	-	-	39.3	39.1	0.0	0.0	0.0	0.0	0.0	0.0
21	-	-	-	-	-	-	39.3	39.1	0.0	0.0	0.0	0.0	0.0	0.0
22	-	-	-	-	-	-	42.3	34.5	0.0	0.0	0.0	0.0	0.0	0.0
23	-	-	-	-	-	-	42.3	34.5	0.0	0.0	0.0	0.0	0.0	0.0
24	-	-	-	-	-	-	32.6	34.9	0.0	0.0	0.0	0.0	0.0	0.0
BEESHOEK	32.4	32.4	32.4	32.4	32.4	32.4	36.0	36.6	1.6	1.4	1.6	1.4	1.6	1.4
BOLTSHOKO	-	-	-	-	-	-	36.0	36.6	0.0	0.0	0.0	0.0	0.0	0.0
NEWTOWN	-	-	-	-	-	-	36.0	36.6	0.0	0.0	0.0	0.0	0.0	0.0

NSR	Kolomela (2022)		Kolomela (2030)		Kolomela (2030 - autonomous)		Baseline		Increase above baseline[(b)] for 2022		Increase above baseline[(b)] for 2030		Increase above baseline[(b)] for 2030 - autonomous	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
POSTMASBURG	-	-	-	-	-	-	36.0	36.6	0.0	0.0	0.0	0.0	0.0	0.0

Notes:

(a) Exceedance of day- and night-time IFC guideline for residential areas is provided in bold

(b) Likely community response:

0 to 1 dBA – No reaction, increase not detectable

1 to 3 dBA – Increase just detectable to persons with average hearing acuity, annoyance unlikely.

3 to 5 dBA – There will be 'little' reaction with 'sporadic complaints'.

5 to 10 dBA – There will be 'little' to 'medium' reaction with 'sporadic' to 'widespread' complaints.

10 to 20 dBA - There will be a 'strong' reaction with 'threats of community action'

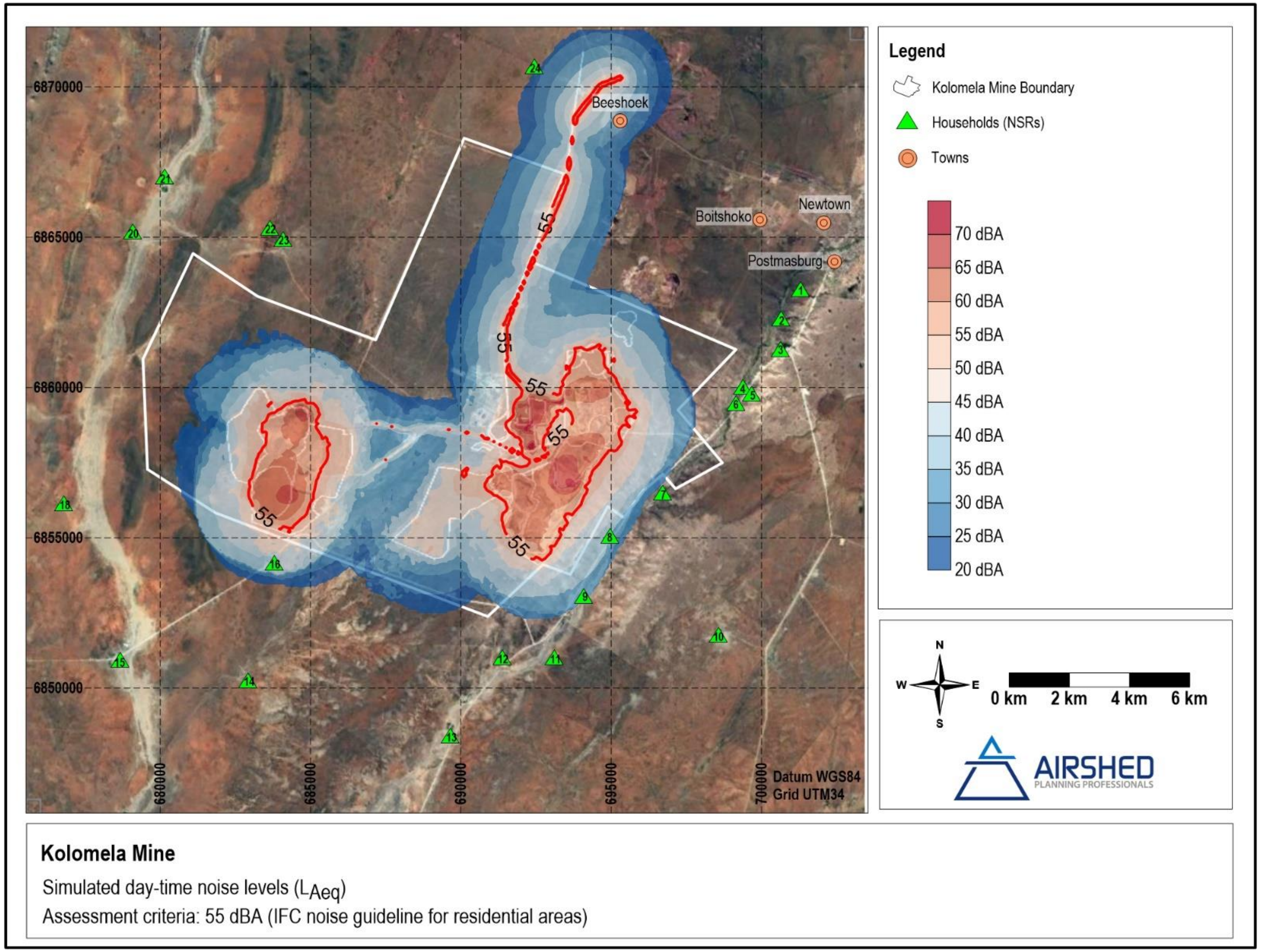


Figure 11: Simulated day-time noise levels for current Kolomela Mine activities (operational year 2022)

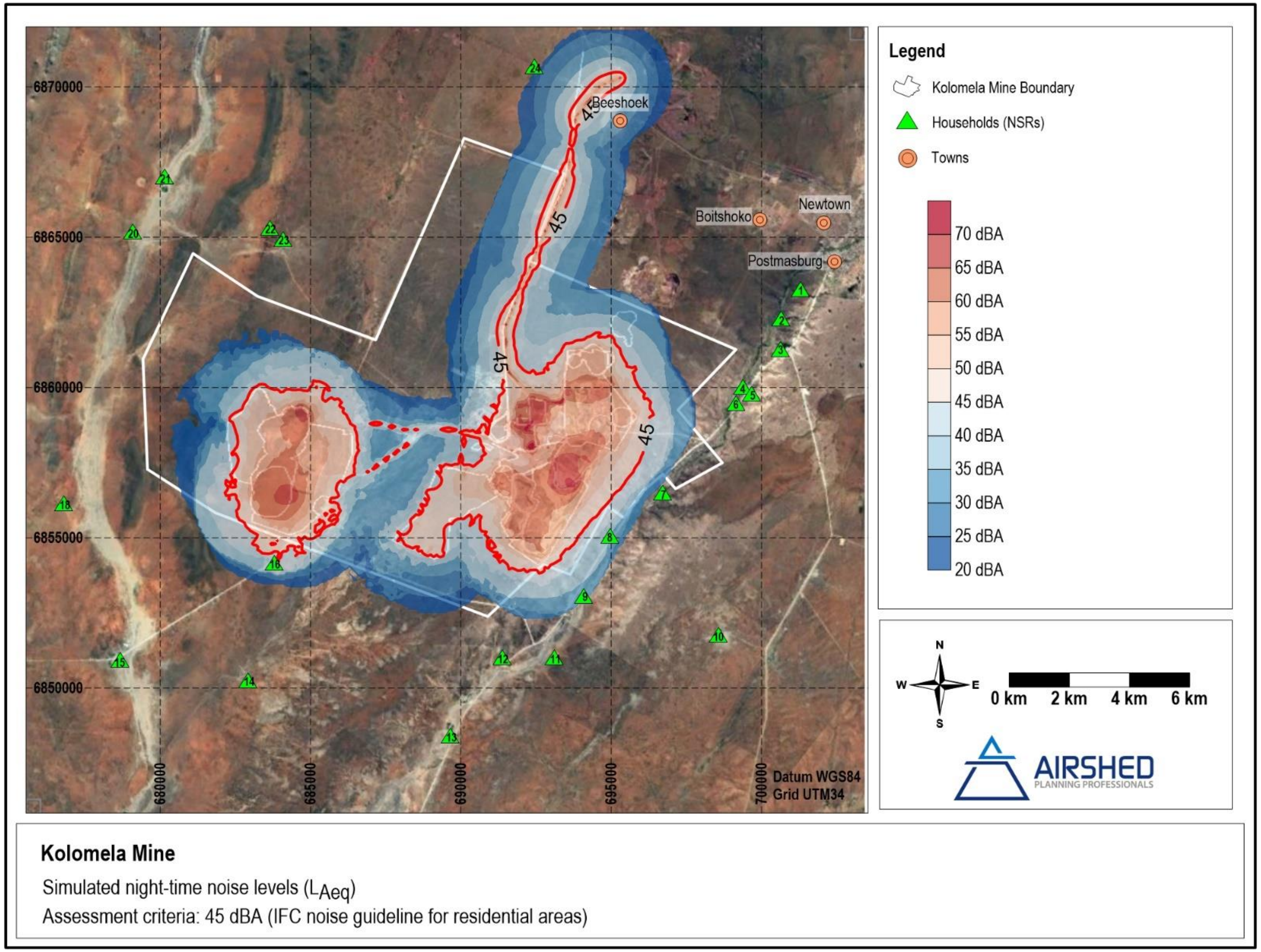


Figure 12: Simulated night-time noise levels for current Kolomela Mine activities (operational year 2022)

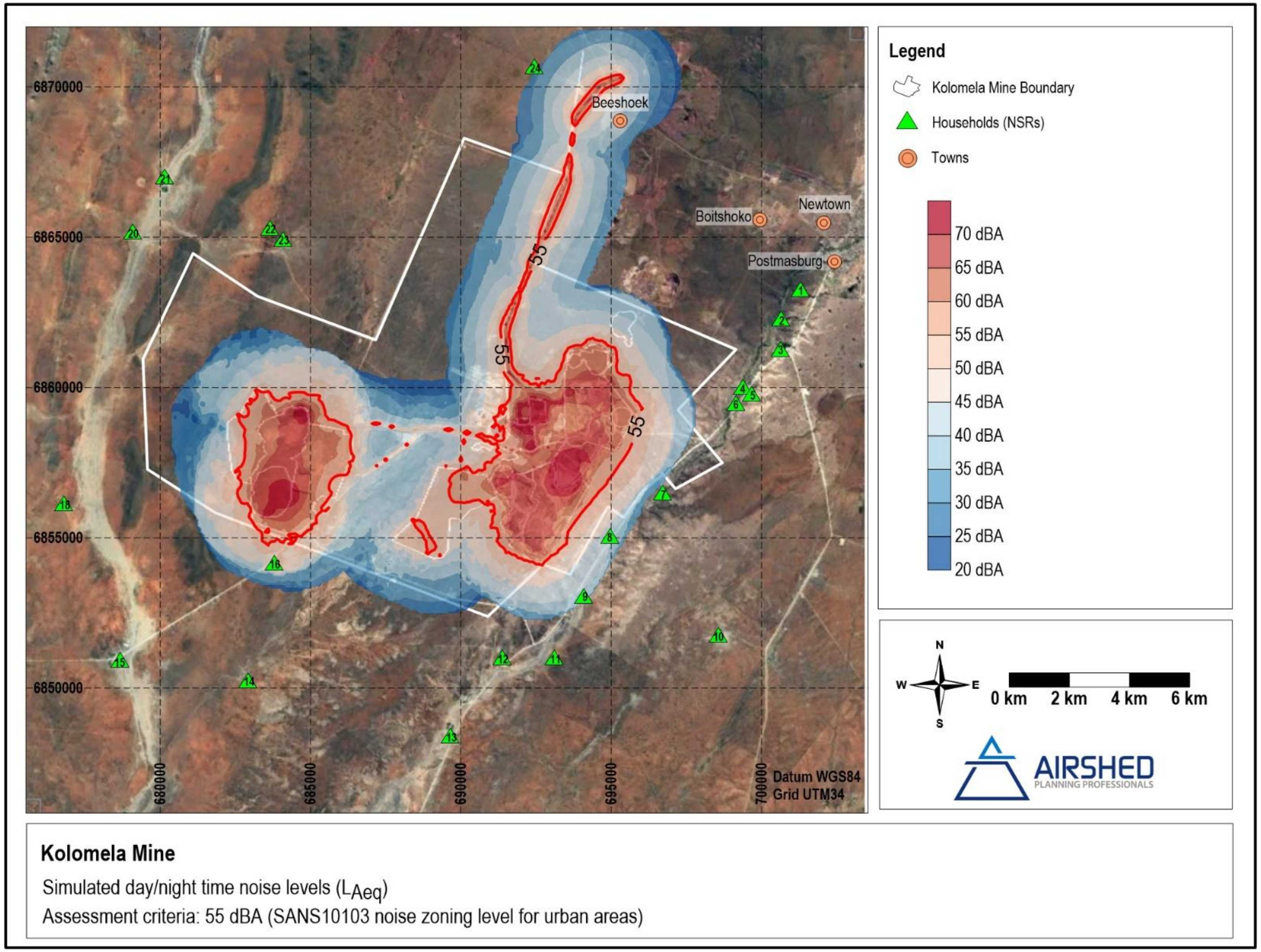


Figure 13: Simulated continuous day/night time noise levels for current Kolomela Mine activities (operational year 2022)

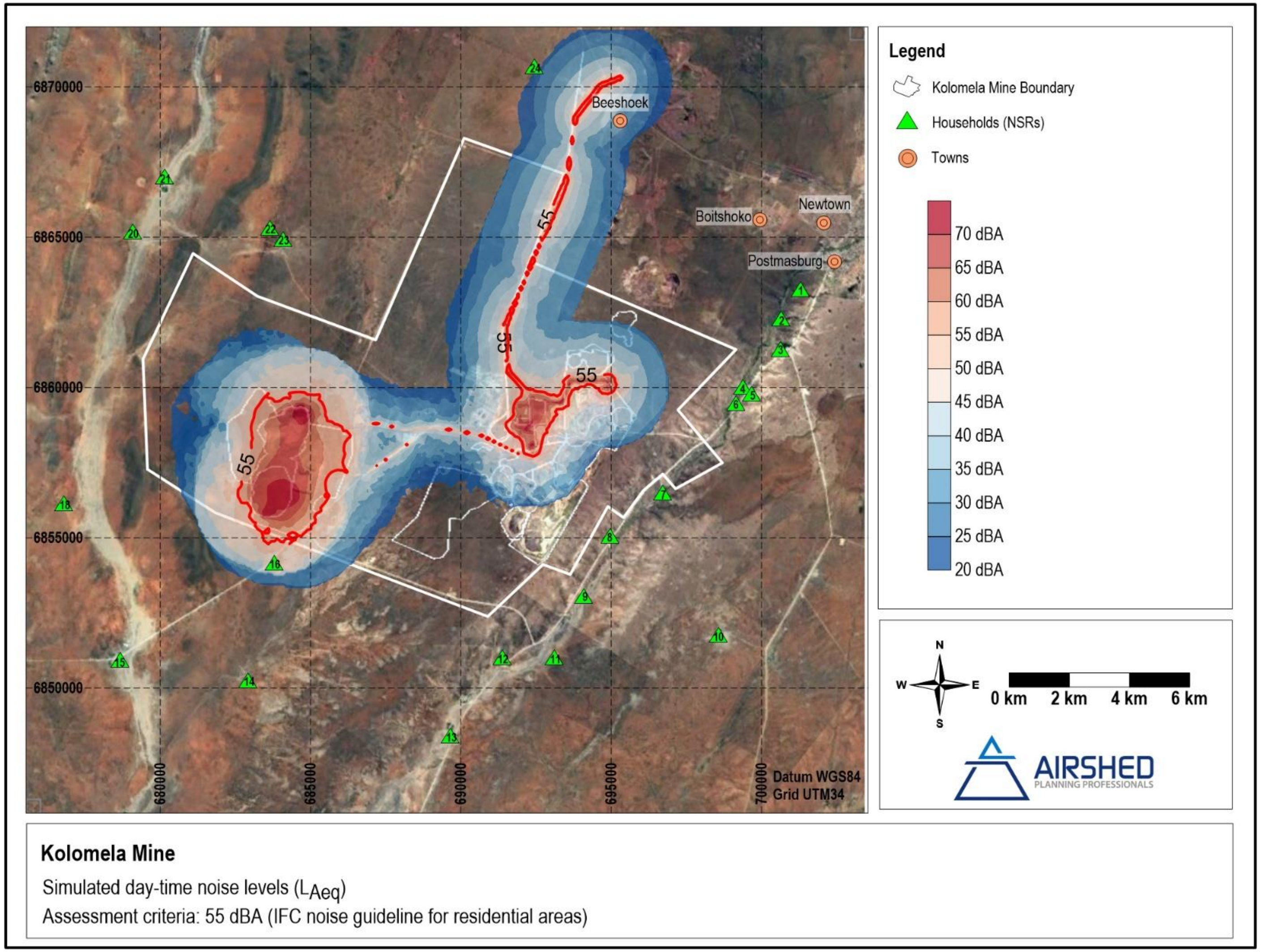


Figure 14: Simulated day-time noise levels for proposed Kolomela Mine activities (operational year 2030)

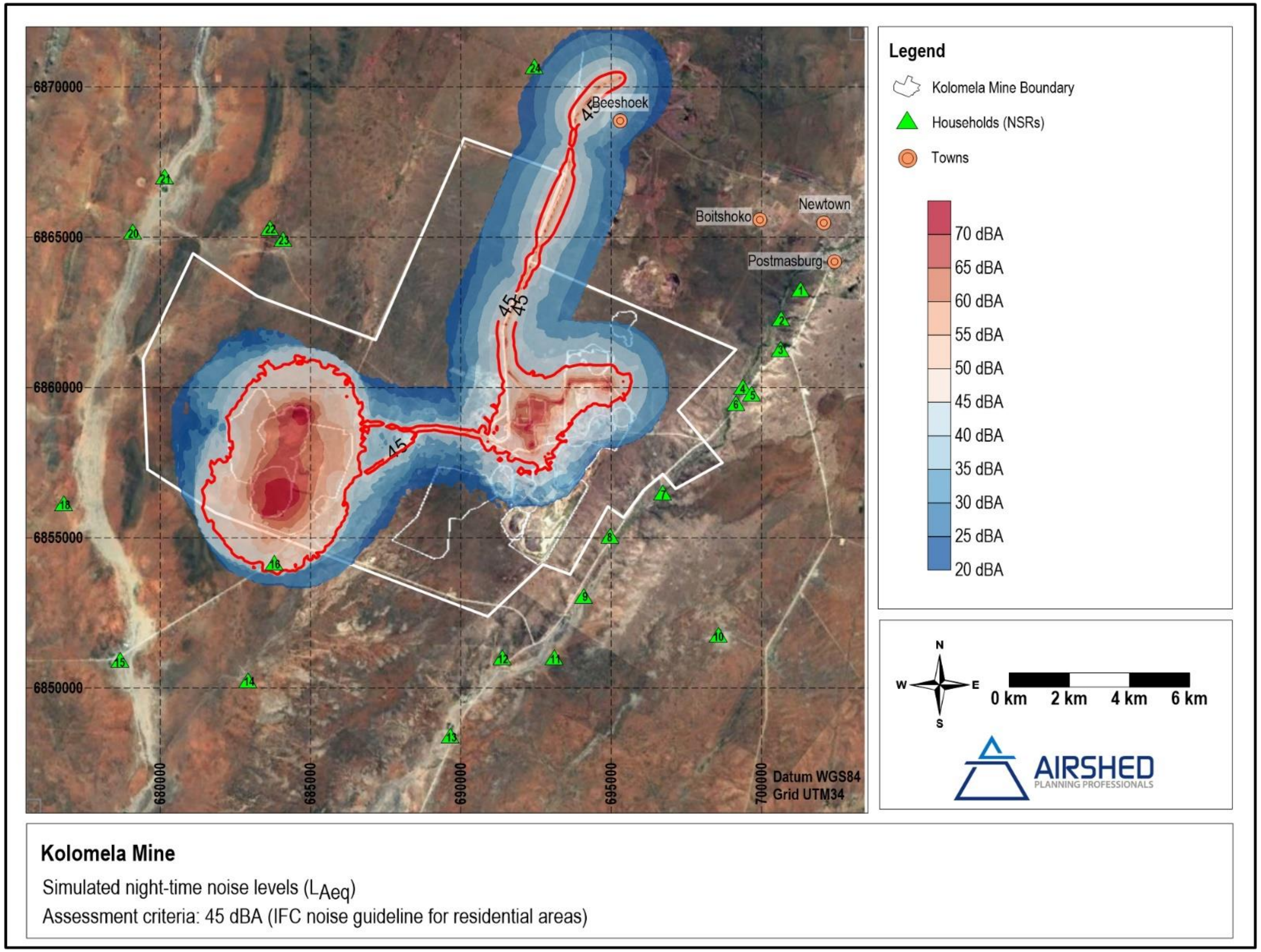


Figure 15: Simulated night-time noise levels for proposed Kolomela Mine activities (operational year 2030)

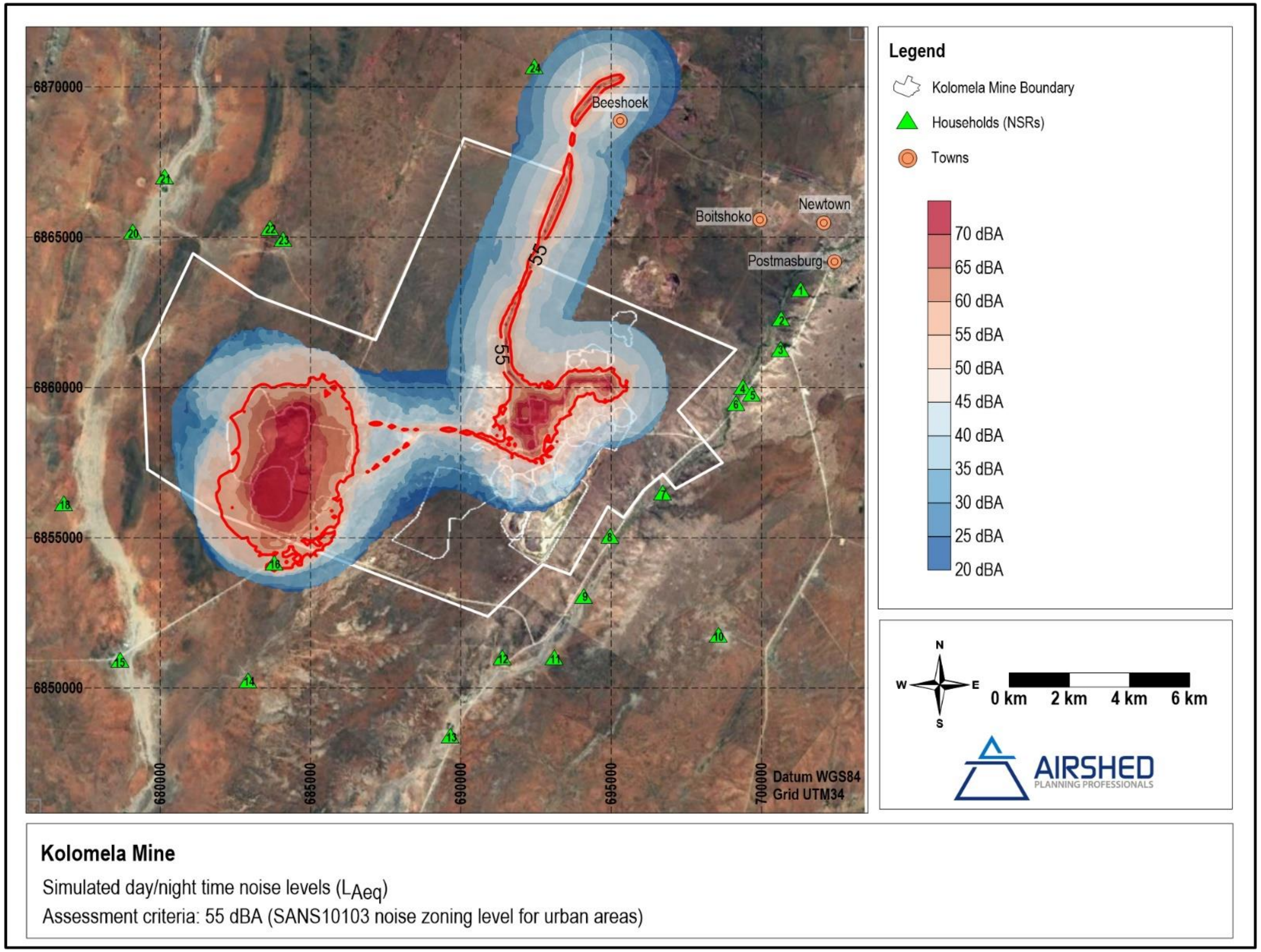


Figure 16: Simulated continuous day/night time noise levels for proposed Kolomela Mine activities (operational year 2030)

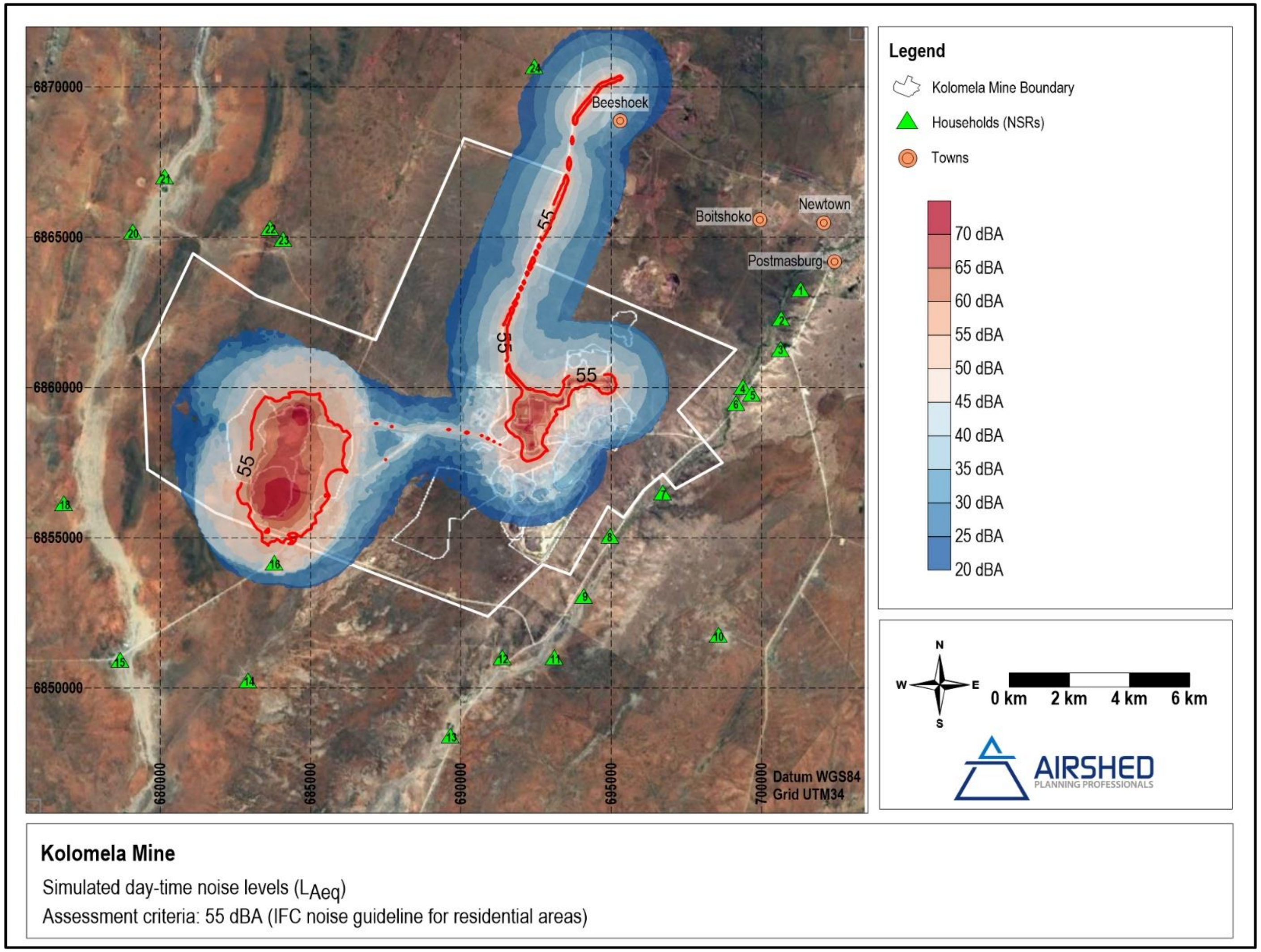


Figure 17: Simulated day-time noise levels for proposed Kolomela Mine activities (operational year 2030 - autonomous)

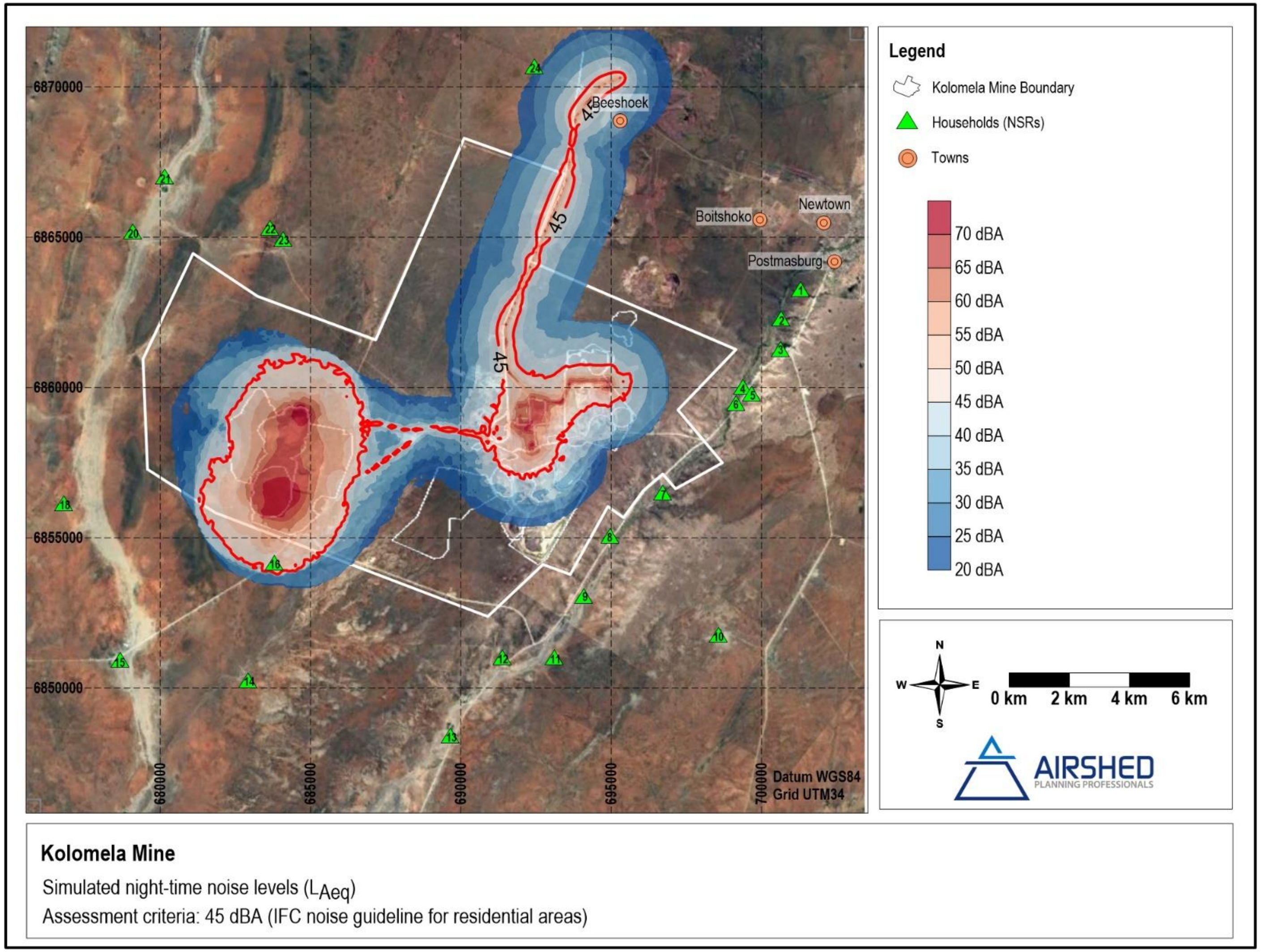


Figure 18: Simulated night-time noise levels for proposed Kolomela Mine activities (operational year 2030 - autonomous)

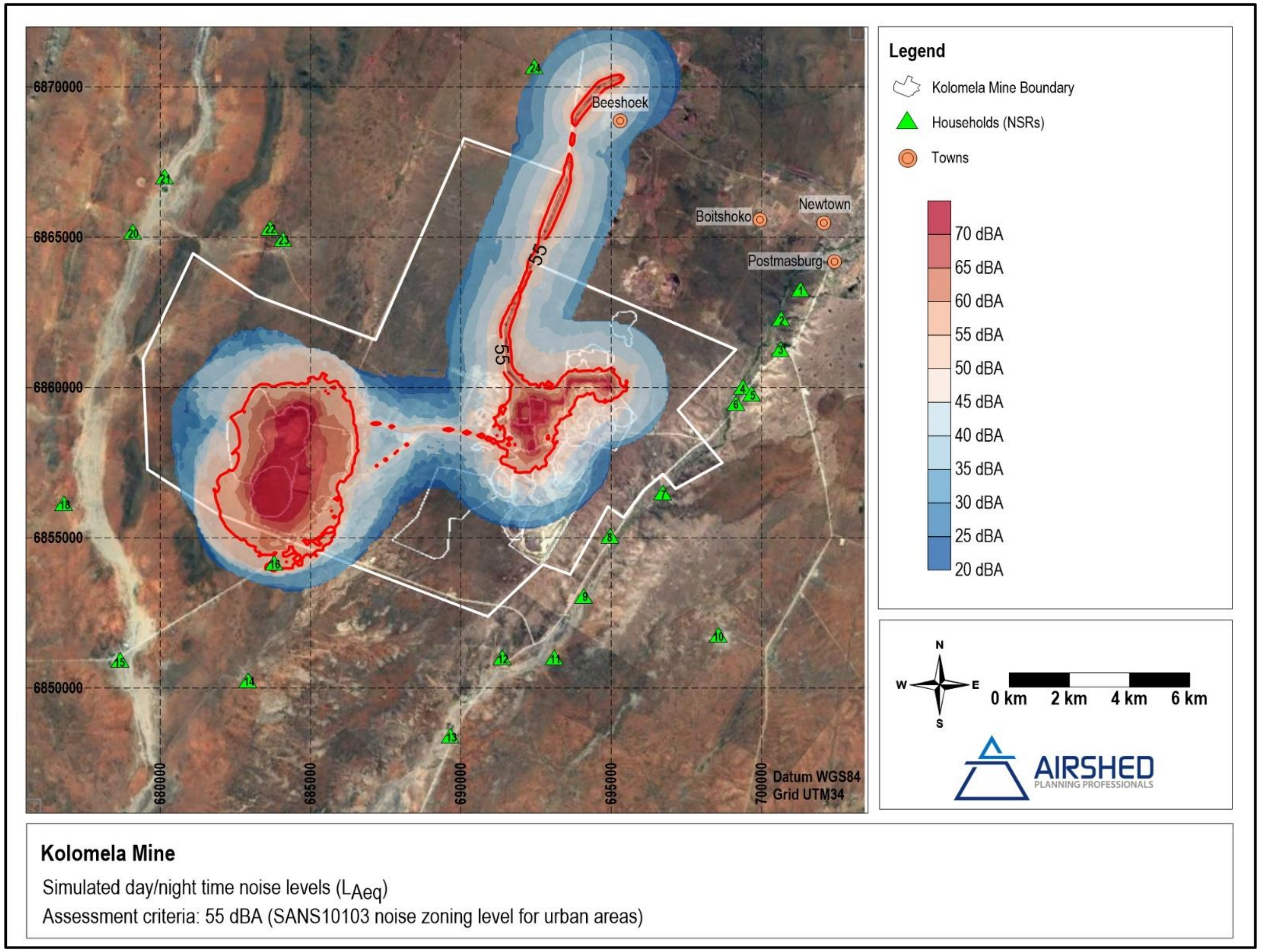


Figure 19: Simulated continuous day/night time noise levels for proposed Kolomela Mine activities (operational year 2030 - autonomous)

5 Impact Significance Rating

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

The significance of construction and decommissioning phase noise impacts on nearby NSRs is considered ***moderate*** (without mitigation) (Table 11) and ***low*** (with mitigation) (Table 12).

The significance of the operation phase of the proposed Kolomela Mine operations were found to be ***moderate*** (Table 13). Assuming the adoption of good practice noise mitigation and management measures as recommended, the noise impacts from the surface mining and ore processing plant may be reduced but will remain at a ***moderate*** significance due to the location of NSR16 to the Kapstevel mining area (Table 14). NSR16 is a farm owned by the Kolomela Mine. If noise levels due to the project exceed the IFC guidelines and become an annoyance at NSR16 after mitigation measures have been implemented, consideration should be given to relocating the residences at this site.

With the autonomous 2030 scenario, the equipment numbers change slightly from the 2030 scenario for some of the listed primary equipment. Although the 90t trucks are removed from Kapstevel mining area for the autonomous scenario, the additional equipment alterations, and the logarithmic nature of noise results in similar noise impacts at Kapstevel mining area. The impacts due to truck trips (although decrease) are not overall significant in terms of noise. There is therefore no notable noise benefit with the autonomous scenario and the significance rating remains the same (Table 13 and Table 14).

No noise impacts are expected post-closure.

Table 11: Significance rating for construction and decommissioning phases without mitigation

Significance	RATING
Intensity = Moderate: impact is of a very moderate magnitude	3
Duration = Medium-term: impact lasts for the for more than a year but less than the life of operation	3
Extent = Small: impact extends to the whole farm portion	3
Severity = (intensity + duration) / 2	3
Consequence = (severity + extent) / 2	3
Probability = Probable: the impact will probably occur	0.8
Impact significance = (consequence x probability) = Moderate	**2.4**

Table 12: Significance rating for construction and decommissioning phases with mitigation

Significance	RATING
Intensity = Low: impact is of a low magnitude	2
Duration = Medium-term: impact lasts for the for more than a year but less than the life of operation	3
Extent = Small: impact extends to the whole farm portion	2
Severity = (intensity + duration) / 2	2.5
Consequence = (severity + extent) / 2	2.25
Probability = Probable: the impact will probably occur	0.8
Impact significance = (consequence x probability) = Low	**1.8**

Table 13: Significance rating for operation phase without mitigation

Significance	RATING
Intensity = High: impact is of high magnitude	4
Duration = Long-term: impact occurs over the operational life of the proposed extension	4
Extent = Medium: impact extends to neighbouring farm portions	3
Severity = (intensity + duration) / 2	4
Consequence = (severity + extent) / 2	3.5
Probability = Probable: the impact will probably occur	0.8
Impact significance = (consequence x probability) = Moderate	**2.8**

Table 14: Significance rating for operation phase with mitigation

Significance	RATING
Intensity = Moderate: impact is of a moderate magnitude	3
Duration = Long-term: impact occurs over the operational life of the proposed extension	4
Extent = Small: impact extends to the whole farm portion	2
Severity = (intensity + duration) / 2	3.5
Consequence = (severity + extent) / 2	2.75
Probability = Probable: the impact will probably occur	0.8
Impact significance = (consequence x probability) = Moderate	**2.2**

6 Management Measures

In the quantification of noise emissions and simulation of noise levels as a result of the project, it was found that environmental noise evaluation criteria for residential, educational, and institutional receptors is potentially exceeded at NSR16 due to proposed Kolomela operations. The noise levels at NSR16 will need to be within the IFC guidelines. This can be achieved through effective noise mitigation and management measures. NSR16 is a farm owned by the Kolomela Mine. If noise levels due to the project exceed the IFC guidelines and become an annoyance at NSR16 after mitigation measures have been implemented, consideration should be given to relocating the residences at this site.

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 not all mitigation measures are to be implemented, but should the need arise the mitigation measures as discussed in this section can be considered.

6.1 Controlling Noise at the Source

6.1.1 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 equipment 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.

6.1.2 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.

6.1.3 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. 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, there should not be any reflecting surfaces such as parked vehicles opposite the open end of a noise enclosure.

6.1.4 Use and Siting of Equipment and Noise Sources

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

6.1.5 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.

Noise generated by vibrating machinery and equipment with vibrating parts can be reduced through the use of vibration isolation mountings or proper balancing. Noise generated by friction in conveyor rollers, trolley etc. can be reduced by sufficient lubrication.

6.2 Controlling the Spread of Noise

Naturally, if noise activities can be minimised or avoided, the amount of noise reaching NSRs will be reduced. Alternatively, the distance between source and receiver must be increased, or noise reduction screens, barriers, or berms must be installed.

6.2.1 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.

6.2.2 Screening

If noise control at the source and the use of distance between source and receiver is not possible (as may be the case at NSR16), 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.

6.3 Monitoring

Noise monitoring at sites where noise is an issue or may become an issue is essential. Annual noise sampling over a period of 10 to 30 minutes for day- and night-time at NSRs surrounding the Kolomela Mine (detailed in Section 3.3) should be incorporated in an annual environmental noise monitoring programme.

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

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 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), 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.

7 Conclusion

The noise impacts due to the project may exceed IFC guidelines for residential areas at NSR16 which is a farm owned by the Kolomela Mine. Mitigation measured as recommended in Section 6 may be implemented to reduce noise levels at this NSR. If noise levels due to the project become an annoyance at NSR16 with mitigation measures in place, consideration should be given to relocating the residences at this site. A complaints register must be kept throughout the life of the operations.

8 References

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The Republic of South Africa, 1992. *Noise Control Regulations in terms of Section 25 of the Environment Conservation Act, Notice R154, Government Gazette 13717, 10 January 1992.* s.l.:Government Printing Works.

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WHO, 1999. *Guidelines to Community Noise.* s.l.:s.n.

Appendix A – Specialist Curriculum Vitae

FULL CURRICULUM VITAE

Name of Firm	Airshed Planning Professionals (Pty) Ltd
Name of Staff	Reneé von Gruenewaldt (*nee* Thomas)
Profession	Air Quality and Environmental Noise Scientist
Date of Birth	13 May 1978
Years with Firm	19 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

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 nineteen (19) years of experience in the Earth and Natural Sciences sector in the field of Air Quality and eight (8) 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. 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 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. Reneé 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

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 (NOISE)

Mining

Reneé has undertaken numerous environmental noise assessments for mining operations. These include environmental noise impact assessments including baseline noise surveys for Balama (Mozambique), Masama Coal (Botswana), Lodestone (Namibia), Prieska (SA), Kolomela (SA) Heuningkranz (SA), Syferfontein (SA), South 32 (SA), Mamatwan and Marula Platinum Mine (SA).

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.

Gas Pipelines

An environmental noise assessment is currently being undertaken 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 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: *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, Botswana, Ghana, Suriname, Afghanistan, 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	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.

____________________ 24/05/2021 ____________________

Signature of staff member Date (Day / Month / Year)

Full name of staff member: Reneé Georgeinna von Gruenewaldt

Appendix B – Declaration of Independence

DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner: René 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:
Atmospheric Impact Report in terms of section 30 of the Act.
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 6th of August 2021

SIGNATURE
Principal Noise Scientist
CAPACITY OF SIGNATORY

Appendix C – Sound Level Meter Calibration Certificates

sanas
Calibration Laboratory
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1302

M AND N ACOUSTIC SERVICES (Pty) Ltd
Co. Reg. No: 2012/123238/07 VAT NO: 4300255876 BEE Status: Level 4
P.O. Box 61713, Pierre van Ryneveld, 0045
No. 15, Mustang Avenue
Pierre van Ryneveld, 0045
Tel: 012 689-2007 (076 920 3070) • Fax: 086 211 4690
E-mail: admin@mnacoustics.co.za
Website: www.mnacoustics.co.za

CERTIFICATE OF CONFORMANCE

CERTIFICATE NUMBER	2021-AS-0246
ORGANISATION	AIRSHED PLANNING PROFESSIONALS (PTY) LTD
ORGANISATION ADDRESS	P.O. BOX 5260, HALFWAY HOUSE, 1685
CALIBRATION OF	ACOUSTIC CALIBRATOR
MANUFACTURER	SVANTEK
MODEL NUMBER	SV 33
SERIAL NUMBER	43170
DATE OF CALIBRATION	02 MARCH 2021
RECOMMENDED DUE DATE	--------------------
PAGE NUMBER	PAGE 1 OF 3

This certificate is issued in accordance with the conditions of approval granted by the South African National Accreditation System (SANAS). This Certificate may not be reproduced without the written approval of SANAS and M and N Acoustic Services.

Calibrations performed by this laboratory are in terms of standards, the accuracies of which are traceable to national measuring standards as maintained by NMISA.

The measurement results recorded in this certificate were correct at the time of calibration. The subsequent accuracy will depend on factors such as care, handling, frequency of use and the amount of different users. It is recommended that re-calibration should be performed at an interval, which will ensure that the instrument remains within the desired limits and/or manufacturer's specifications.

The South African National Accreditation System (SANAS) is member of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). This arrangement allows for mutual recognition of technical test and calibration data by member accreditation bodies worldwide. For more information on the arrangement please consult www.ilac.org

Calibrated by:	Authorized/Checked by:	Date of Issue:
W.S. SIBANYONI (CALIBRATION TECHNICIAN)	M. NAUDÉ (SANAS TECHNICAL SIGNATORY)	02 MARCH 2021

Director: Marianka Naudé

Conditions under Which M and N Acoustic Services (Pty) Ltd Will Perform Work

In this document, reference to a service of services will include: calibration, measurement analysis or conformance work performed by M and N Acoustics on behalf of the Applicant.

1. Services are carried out at the discretion of M and N Acoustic Services, which reserves the right to decline any application for performance or services when deemed to be outside the scope of services of this Company.
2. Through acceptance of the original quotation, the Applicant agrees to the quoted fee and the conditions state herein. In cases where M and N Acoustic Services has not published the amount of the fee, M and N Acoustic Services will in good faith give estimates of the time and cost of the service based upon its previous experience.
3. Payment is strictly COD, or 30 days from the date of invoice, or as mutually agreed in writing between the Applicant and M and N Acoustic Services before the service is commenced. M and N Acoustic Services retains the right to ask for a deposit for services.
4. All instruments, items of equipment, etc. sent by the Applicant for performance of service shall be delivered and collected at the Applicant's own cost and risk.
5. M and N Acoustic Services cannot guarantee to complete the work within the estimated time and cost but will consult the Applicant of it becomes apparent that either estimate will be exceeded.
6. If a service is not completed because of defects or deficiencies in the item submitted by the applicant, an appropriate reduction in the fee may be allowed depending on the amount of work already performed. The normal practice will be to charge the fee in full.
7. The Applicant hereby consents that the legal liability of M and N Acoustic Services with regard to any damage whatsoever or a mistake made by M and N Acoustic Services in services performed for the Applicant will be limited to the original quoted fee.
8. Regarding certificates and reports:
   - A certificate or report will be furnished to the Applicant on completion of the service.
   - Additional certified copies of certificates, or re-issued certificates will be subjected to an additional fee, as determined on a case by case basis.
   - The values in the issued certificates are correct at the time of calibration. Subsequently the accuracy will depend on such factors as the care exercised in handling and use of the instrument and the frequency of use.
   - Re-calibration should be performed after a period which has been chosen to ensure that the instrument's accuracy remains within the desired limits.

1. PROCEDURE

The UUT was calibrated according to the procedures 1002/P/001 and also to the IEC 60942 specifications for Sound Level Calibrators as well as the manufacturer's specifications.

2. MEASURING EQUIPMENT

Keysight	34461A	Digital Multimeter	MY 53223905
Greysinger	80 CL	Environmental Logger	02304030/1/2
G.R.A.S	42 AP	Piston Phone	256092
G.R.A.S	26 AJ	½" Pre-Amplifier	188476
B&K	2363	Measuring Amplifier	1232647
G.R.A.S	40 AG	½" Microphone	19721
Leader	LDM-170	Distortion Meter	0100240
Svantek	SV 35	Acoustic Calibrator	58106
LG	FC-7015	Universal Counter	00022701
Agilent	34461A	Digital Multimeter	MY 53205694
G.R.A.S	42 AG	Multi-Frequency Calibrator	279025

3. RESULTS

3.1 The following parameters of the Calibrator were calibrated:

Output Level	IEC 60942: Section 5.2.3
Output Frequency	IEC 60942: Section 5.3.3
Selective Distortion	IEC 60942: Section A.4.9

The Calibrator output level was found to be 114,1 dB at 1 000 Hz.
No adjustment was made.

These results were corrected to the ambient condition of 1 013,25 Pa.

Conclusion: The Calibrator complied with the above-specified clauses of the IEC 60942 specification and requirements according to ARP 0109:2014. **Class 1.**

Calibrated by:	*Authorized/Checked by:*
W.S. SIBANYONI *(CALIBRATION TECHNICIAN)*	*M. NAUDÉ* *(SANAS TECHNICAL SIGNATORY)*

Director: Marianka Naudé

4. REMARKS

4.1 The reported expanded uncertainties of measurements are based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95,45 %, the uncertainties of measurements have been estimated in accordance with the principles defined in the GUM (Guide to Uncertainty of Measurement) ISO, Geneva, 1993.

4.2 The environmental conditions were:

Temperature:	(23 ± 2) °C
Relative Humidity:	(50 ± 15) %RH

4.3 Calibration labels bearing cal date, due date (if requested), certificate number and serial number have been affixed to the instrument.

4.4 The above statement of conformance is based on the measurement values obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limits

4.5 The uncertainty of measurements was estimated as follows:

Acoustic Calibrator:	± 0,19 dB

4.6 The results on this Certificate relates only to the items and parameters calibrated.

-----------SECTION 4.5 THE END OF CERTIFICATE----------

Calibrated by:	*Authorized/Checked by:*
W.S. SIBANYONI *(CALIBRATION TECHNICIAN)*	*M. NAUDÉ* *(SANAS TECHNICAL SIGNATORY)*

Director: Marianka Naudé

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1302

M AND N ACOUSTIC SERVICES (Pty) Ltd
Co. Reg. No: 2012/123238/07 VAT NO: 4300255876 BEE Status: Level 4
P.O. Box 61713, Pierre van Ryneveld, 0045
No. 15, Mustang Avenue
Pierre van Ryneveld, 0045
Tel: 012 689-2007 (076 920 3070) • Fax: 086 211 4690
E-mail: admin@mnacoustics.co.za
Website: www.mnacoustics.co.za

CERTIFICATE OF CALIBRATION

CERTIFICATE NUMBER	2021-AS-0250
ORGANISATION	AIRSHED PLANNING PROFESSIONALS (PTY) LTD
ORGANISATION ADRESS	P.O. BOX 5260, HALFWAY HOUSE, 1685
CALIBRATION OF	SOUND & VIBRATION ANALYZER complete with built-in ⅓-OCTAVE/OCTAVE FILTER, ½" PRE-AMPLIFIER and ½" MICROPHONE
MANUFACTURERS	SVANTEK and ACO
MODEL NUMBERS	SVAN 977, SV 12L and 7052E
SERIAL NUMBERS	36183, 40659 and 78692
DATE OF CALIBRATION	01-02 MARCH 2021
RECOMMENDED DUE DATE	-------------------------
PAGE NUMBER	PAGE 1 OF 6

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The measurement results recorded in this certificate were correct at the time of calibration. The subsequent accuracy will depend on factors such as care, handling, frequency of use and the number of different users. It is recommended that re-calibration should be performed at an interval, which will ensure that the instrument remains within the desired limits and/or manufacturer's specifications.

The South African National Accreditation System (SANAS) is member of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). This arrangement allows for mutual recognition of technical test and calibration data by member accreditation bodies worldwide. For more information on the arrangement please consult www.ilac.org

Calibrated by:	Authorized/~~Checked by~~:	Date of Issue:
W.S. SIBANYONI (CALIBRATION TECHNICIAN)	M. NAUDÉ (SANAS TECHNICAL SIGNATORY)	03 MARCH 2021

Director: Marianka Naudé

Conditions under Which M and N Acoustic Services (Pty) Ltd Will Perform Work

In this document, reference to a service of services will include: calibration, measurement analysis or conformance work performed by M and N Acoustics on behalf of the Applicant.

1. Services are carried out at the discretion of M and N Acoustic Services, which reserves the right to decline any application for performance or services when deemed to be outside the scope of services of this Company.

2. Through acceptance of the original quotation, the Applicant agrees to the quoted fee and the conditions state herein. In cases where M and N Acoustic Services has not published the amount of the fee, M and N Acoustic Services will in good faith give estimates of the time and cost of the service based upon its previous experience.

3. Payment is strictly COD, or 30 days from the date of invoice, or as mutually agreed in writing between the Applicant and M and N Acoustic Services before the service is commenced. M and N Acoustic Services retains the right to ask for a deposit for services.

4. All instruments, items of equipment, etc. sent by the Applicant for performance of service shall be delivered and collected at the Applicant's own cost and risk.

5. M and N Acoustic Services cannot guarantee to complete the work within the estimated time and cost but will consult the Applicant of it becomes apparent that either estimate will be exceeded.

6. If a service is not completed because of defects or deficiencies in the item submitted by the applicant, an appropriate reduction in the fee may be allowed depending on the amount of work already performed. The normal practice will be to charge the fee in full.

7. The Applicant hereby consents that the legal liability of M and N Acoustic Services with regard to any damage whatsoever or a mistake made by M and N Acoustic Services in services performed for the Applicant will be limited to the original quoted fee.

8. Regarding certificates and reports:

   - A certificate or report will be furnished to the Applicant on completion of the service.
   - Additional certified copies of certificates, or re-issued certificates will be subjected to an additional fee, as determined on a case by case basis.
   - The values in the issued certificates are correct at the time of calibration. Subsequently the accuracy will depend on such factors as the care exercised in handling and use of the instrument and the frequency of use.
   - Re-calibration should be performed after a period which has been chosen to ensure that the instrument's accuracy remains within the desired limits.

1. PROCEDURE

The Integrating Sound Level Meter was calibrated according to procedure 1002/P/013 and to the IEC 61672-3:2006 specifications as well as the manufacturer's specifications.

The ½" Microphone was calibrated according to procedure 1002/P/002 and 1002/P/011 as well as the manufacturer's specifications.

The ⅓-Octave/Octave Filter was calibrated according to procedure 1002/P/008 and to the IEC 61260 specification as well as the manufacturer's specifications.

2. MEASURING EQUIPMENT

JFW	50BR-022	50 Ohm Step Attenuator	4610290708
Agilent	33522A	Function Generator	MY 50005443
Agilent	34461A	Digital Multimeter	MY 53224004
Onset	UX100-011	Environmental Logger	2047747
Majortech	MT669	Environmental Logger	150828469
Svantek	SV 35	Acoustical Calibrator	58106
Keysight	34461A	Digital Multimeter	MY 53223905
G.R.A.S	42 AP	Piston Phone	256092
G.R.A.S	26 AJ	½" Pre-Amplifier	188476
G.R.A.S	40 AG	½" Microphone	19721
B&K	4226	Multi-Functional Calibrator	3081642
Greysinger	80 CL	Data Logger	02304030/1/2
Gems	3500B0001A01B000	Pressure Sensor	1606-0204475
B&K	2829	4-Ch Microphone Power Supply	2329283

Calibrations performed by this laboratory are in terms of standards, the accuracies of which are traceable to national measuring standards as maintained by NMISA.

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3. RESULTS - ACCORDING TO THE IEC 61672-3: 2006:

3.1 The following parameters of the Integrating Sound Level Meter were calibrated:

Parameter	Specification	Uncertainty of Measurement in dB
Calibration Check Frequency at 114,0 dB at 1 000 Hz at Nominal Range: High	IEC 61672-3: Clause 9	± 0,3
Self-Generated Noise: A-Weighted with Microphone 37,7 dB A-Weighted Electrical 1,1 dB C-Weighted Electrical 0,0 dB Z-Weighted Electrical 3,7 dB B-Weighted Electrical - 0,2 dB	IEC 61672-3: Clause 10	-------
Level Linearity at 8 000 Hz Nominal Range: High Reference Level at 114,0 dB: (59,3 dB to 148,9 dB)	IEC 61672-3: Clause: 14	± 0,3
Level Range Control at 1 000 Hz Reference Level at 114,0 dB Nominal Range: High Low Range	IEC 61672-3: Clause: 15	± 0,3
Frequency and Time Weightings at 1 000 Hz at 114,0 dB	IEC 61672-3: Clause 13	± 0,3
Tone Burst Response (Max. Fast, Max. Slow, LA_{eq} and SEL)	IEC 61672-3: Clause 16	± 0,3

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Parameter	Specification	Uncertainty of Measurement in dB
A-Weighting Network (31,5 to 20 000) Hz	IEC 61672-3: Clause 12	± 0,3
C-Weighting Network (31,5 to 20 000) Hz	IEC 61672-3: Clause 12	± 0,3
Z- Weighting Network (31,5 to 20 000) Hz	IEC 61672-3: Clause 12	± 0,3
B- Weighting Network (31,5 to 20 000) Hz	IEC 61672-3: Clause 12	± 0,3
Peak, C Low Peak Range	IEC 61672-3: Clause 17	± 0,3

Conclusion: The Integrating Sound Level Meter complied with the above-specified clauses of the IEC 61672-3:2006 specifications and requirements according to ARP 0109:2014. **Class 1.**

3.2 The following parameters of the built-in ⅓-Octave/Octave Filter were calibrated:

Octave Frequency Response (31,5 to 16 000) Hz	IEC 61260: Sections 4.7 & 5.6
⅓-Octave Frequency response (25 to 20 000) Hz	IEC 61260: Sections 4.7 & 5.6

The uncertainty of measurement was estimated as follows: ± 0,3 dB

Conclusion: The built-in Octave Filter complied with the above-specified clauses of the IEC 61260 specification, **Class 1.**

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3.3 The following parameters of the ½" Microphone were calibrated and the results were corrected to the ambient condition of 1 013,25 mBar:

Output Sensitivity at 250 Hz at 94,0 dB
Frequency Response (31,5 to 16 000) Hz

The uncertainty of measurements was estimated as follows: ± 0,3 dB

Conclusion: The parameters measured for the ½" Microphone, complied with the manufacturer's specification.

3.4 The ½" Microphone was calibrated Electroacoustic according to Clause 12 of IEC 61672-3: 2006 complete with Integrating Sound Level Meter and Svantek SV 12L ½" Pre-amplifier Serial No: 25686, free-field corrections were taken into consideration and the results were corrected to the ambient condition of 1 013,25 mBar:

FREQUENCY (Hz)	CALCULATED EXPECTED VALUE (dB)	MEASURED VALUE (dB)	DEVIATION (dB)	UoM (dB)
1 000 (Ref)	114,1	114,1	0,0	± 0,3
31,5	111,3	111,2	- 0,1	± 0,3
63	113,4	113,3	- 0,1	± 0,3
125	113,9	113,9	0,0	± 0,3
250	114,1	114,0	- 0,1	± 0,3
500	114,0	114,0	0,0	± 0,3
1 000	114,1	114,1	0,0	± 0,3
2 000	113,9	113,9	0,0	± 0,3
4 000	113,4	113,5	+ 0,1	± 0,3
8 000	109,4	109,2	- 0,2	± 0,3
12 500	106,5	106,9	+ 0,4	± 0,3
16 000	103,3	104,0	+ 0,7	± 0,3

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4. REMARKS

4.1 The reported expanded uncertainties of measurements are based on a standard uncertainty multiplied by a coverage factor of *k=2*, providing a level of confidence of approximately 95,45 %, the uncertainties of measurements have been estimated in accordance with the principles defined in the GUM (Guide to Uncertainty of Measurement) ISO, Geneva, 1993

4.2 The environmental conditions during calibration of items in section 3 were:
Temperature: (23 ± 2) °C
Relative Humidity: (50 ± 15) %RH

4.3 Calibration labels bearing cal date, due date (if requested), certificate number and serial number have been affixed to the instrument.

4.4 The above statement of conformance is based on the measurement values obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limits

4.5 The microphone's frequency range determines the useful frequency range of the sound level meter and vice versa.

4.6 The results on this Certificate relates only to the items and parameters calibrated.

4.7 Abbreviation:
UoM = Uncertainty of Measurement

------------SECTION 4.7 THE END OF CERTIFICATE-----------

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Director: Marianka Naudé

Appendix D – Survey Site Photos

Figure 20: Photographs of environmental noise survey Site 1

Figure 21: Photographs of environmental noise survey Site 3

Figure 22: Photographs of environmental noise survey Site 4

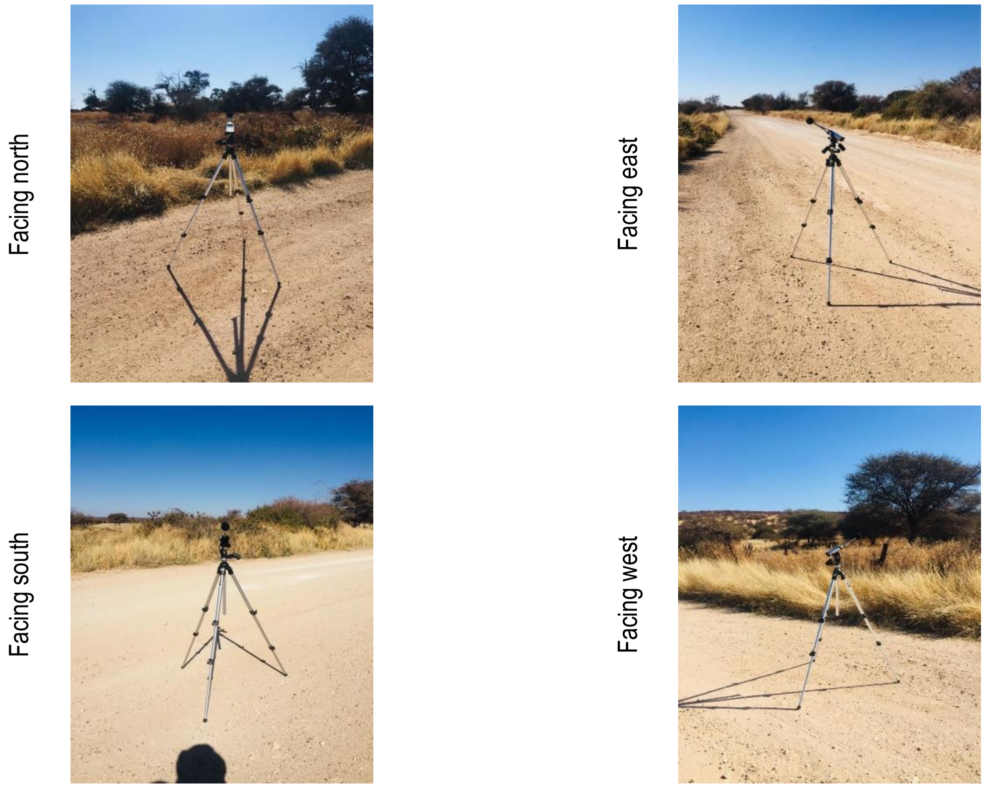
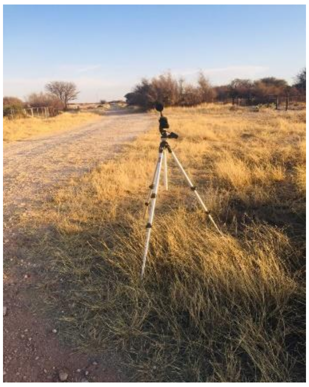


Figure 23: Photographs of environmental noise survey Site 5

Facing north

Facing east

Facing south



Facing west

Figure 24: Photographs of environmental noise survey Site 6

Facing north

Facing east

Facing south

Facing west

Figure 25: Photographs of environmental noise survey Site 7

Figure 26: Photographs of environmental noise survey Site 8

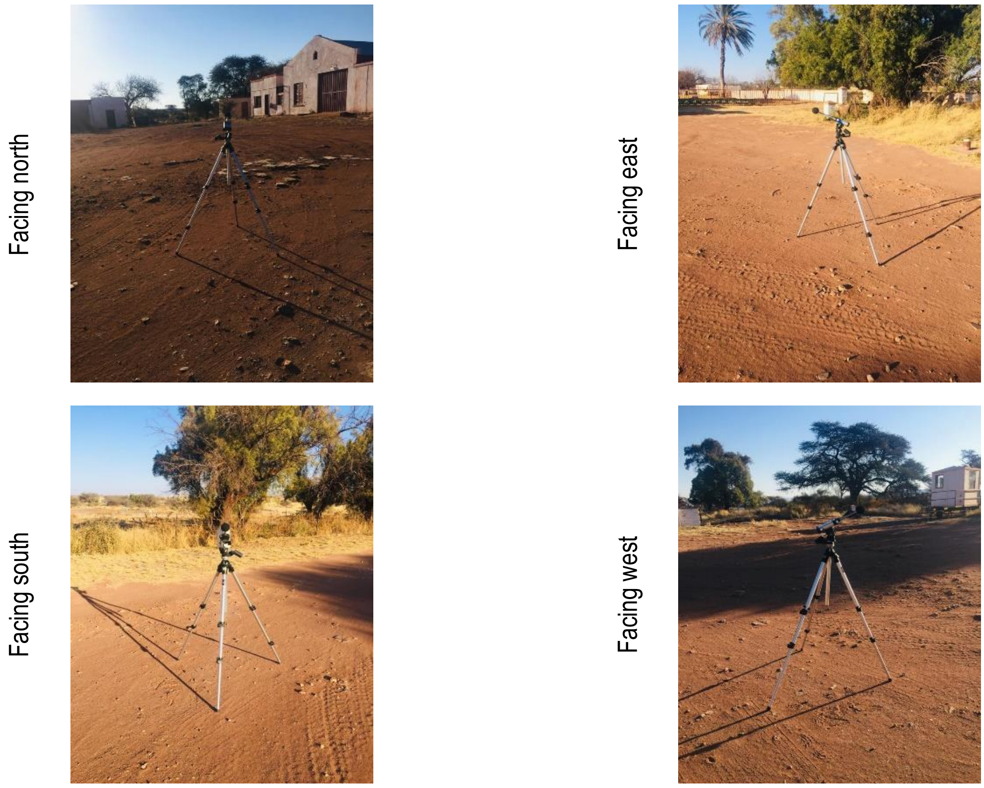


Figure 27: Photographs of environmental noise survey Site 9

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

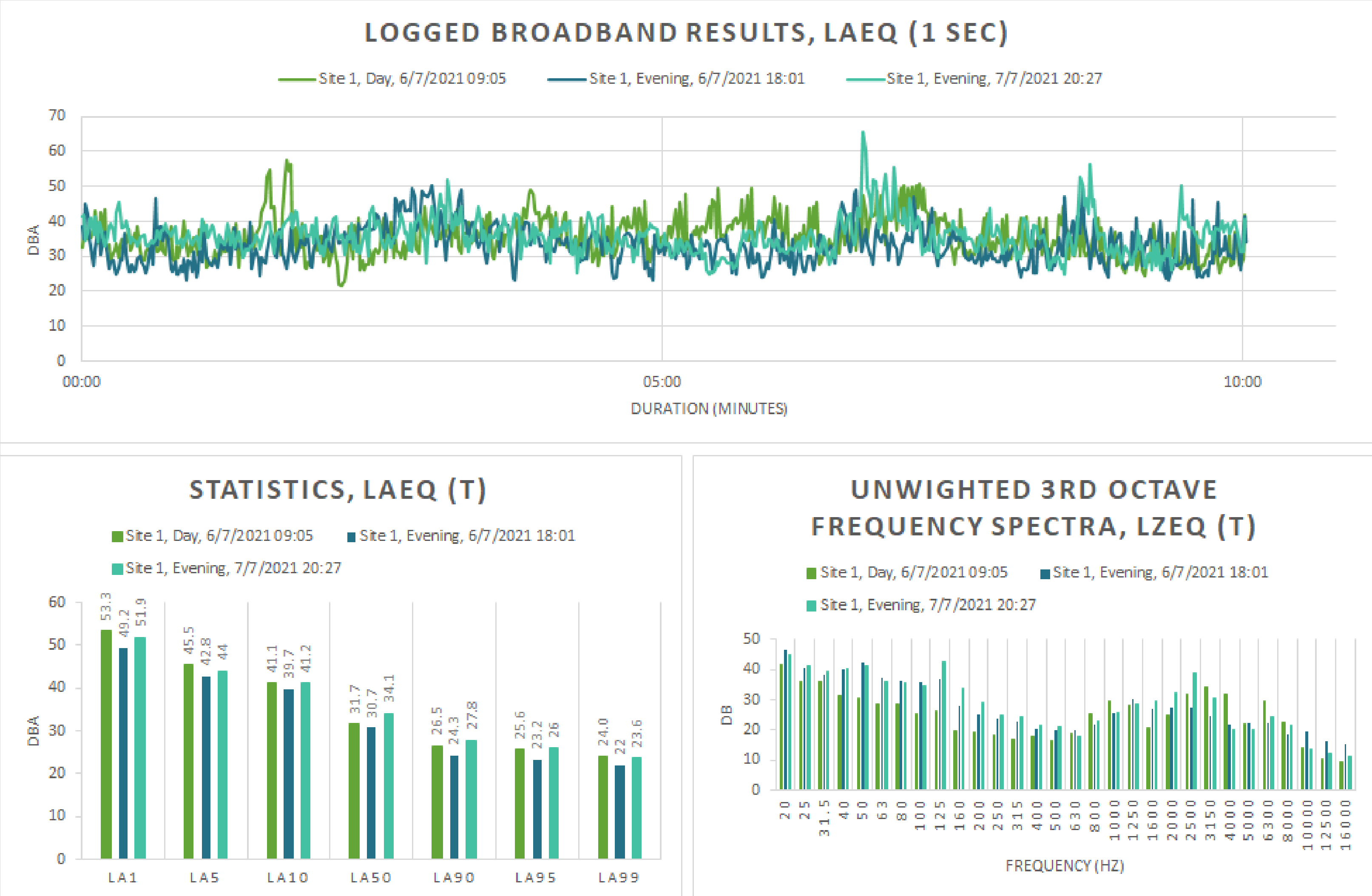


Figure 28: Detailed day-time survey results for Site 1

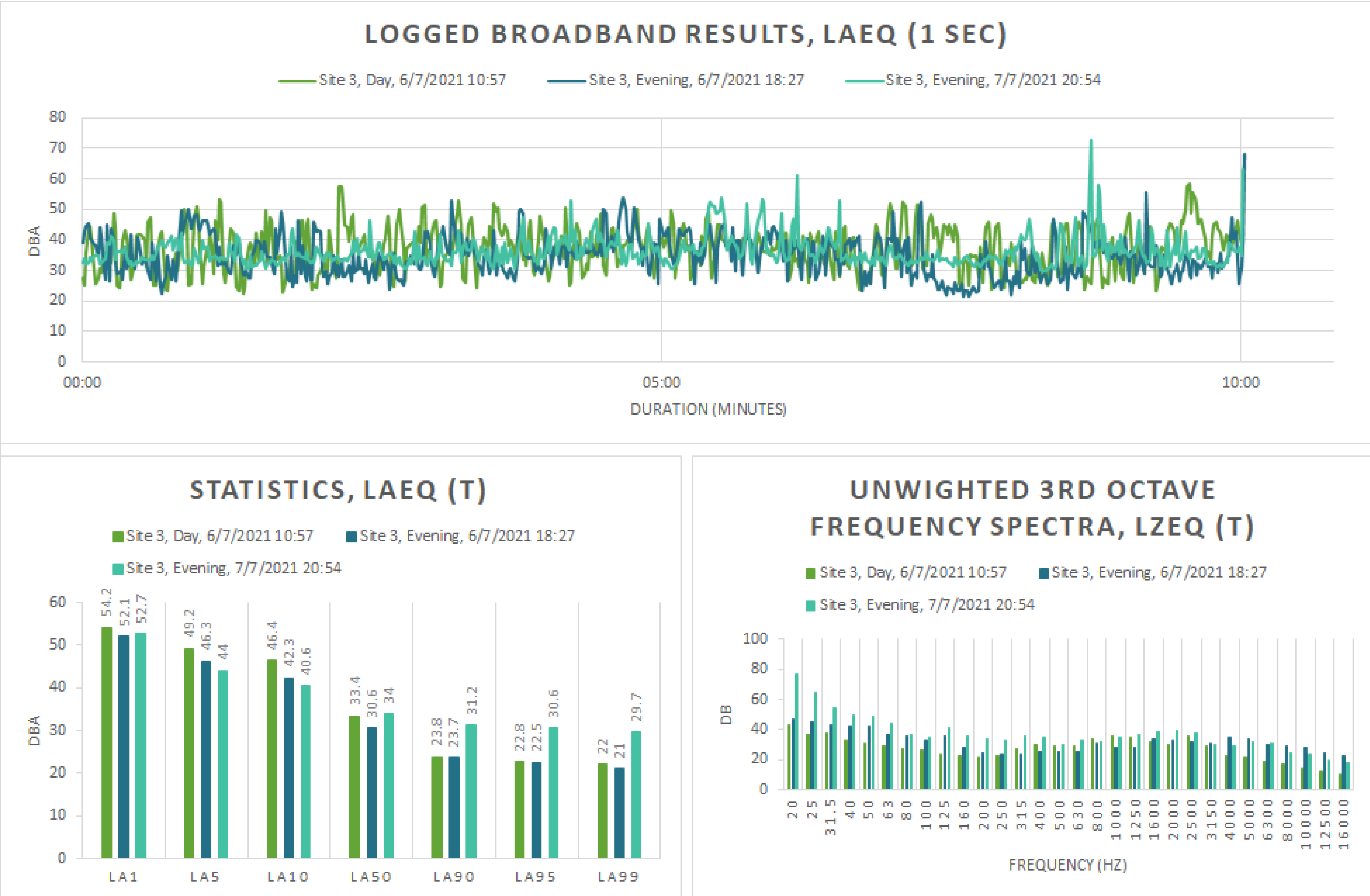


Figure 29: Detailed day-time survey results for Site 3

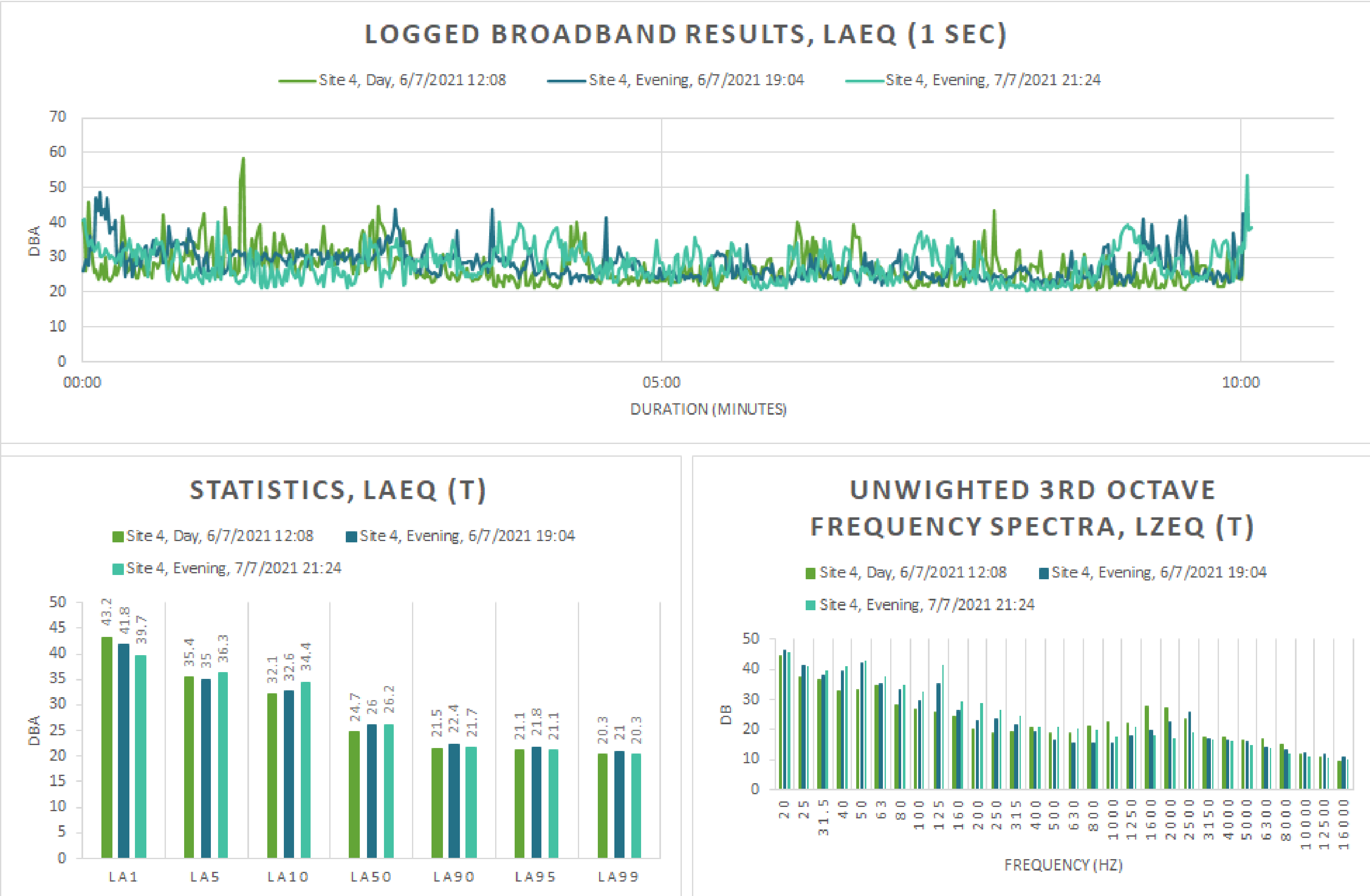


Figure 30: Detailed day-time survey results for Site 4

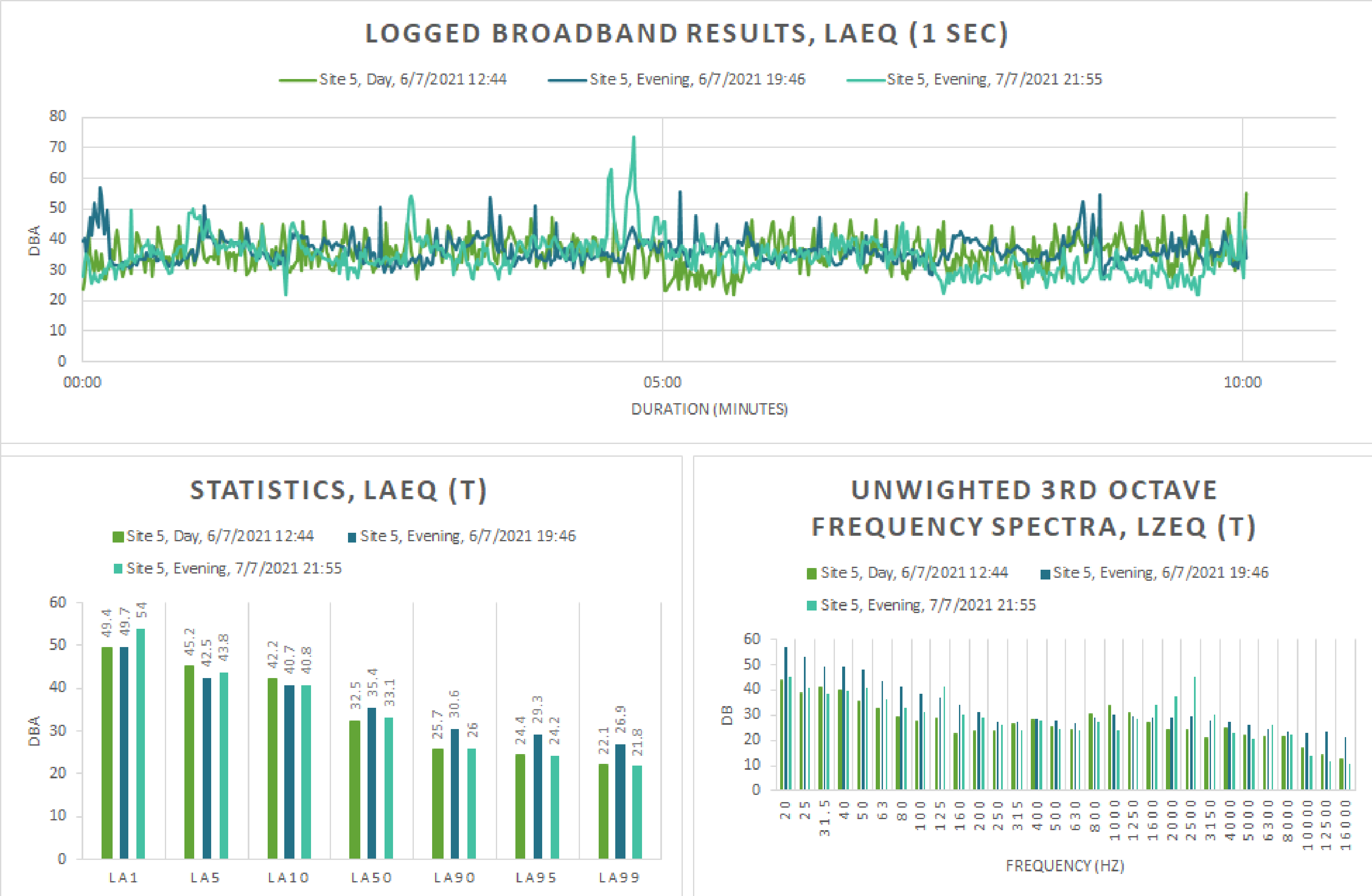


Figure 31: Detailed day-time survey results for Site 5

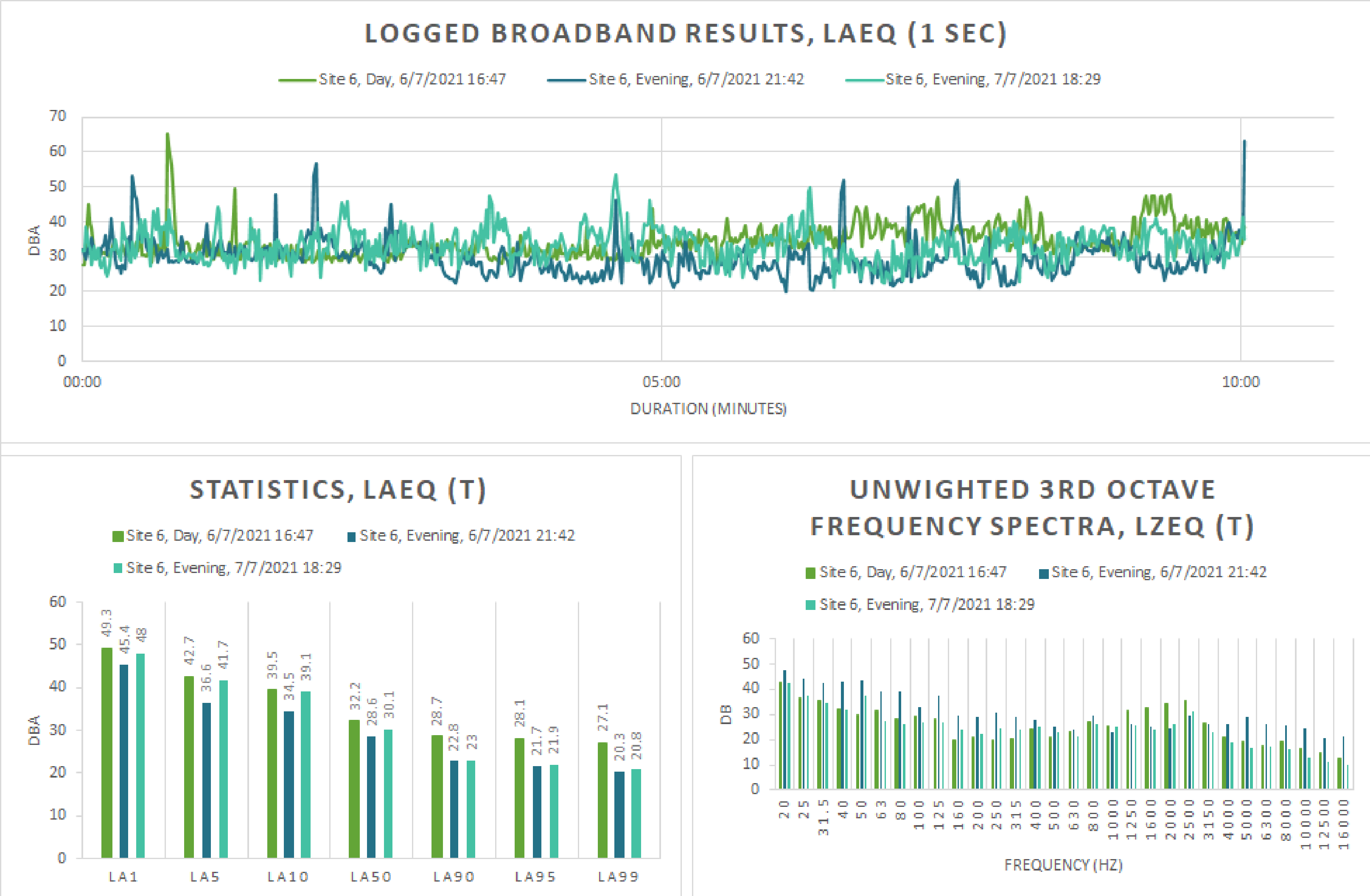


Figure 32: Detailed day-time survey results for Site 6

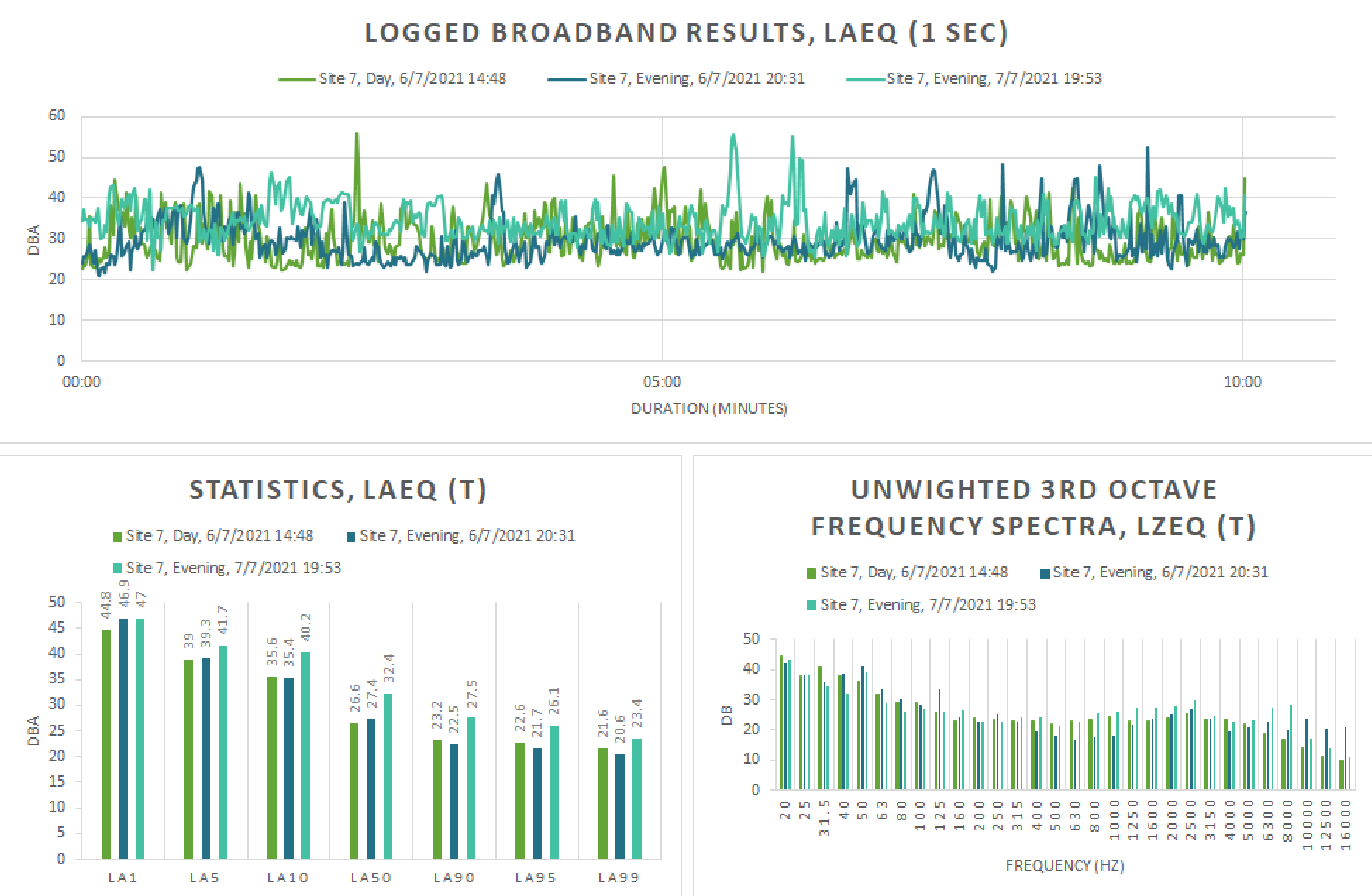


Figure 33: Detailed day-time survey results for Site 7

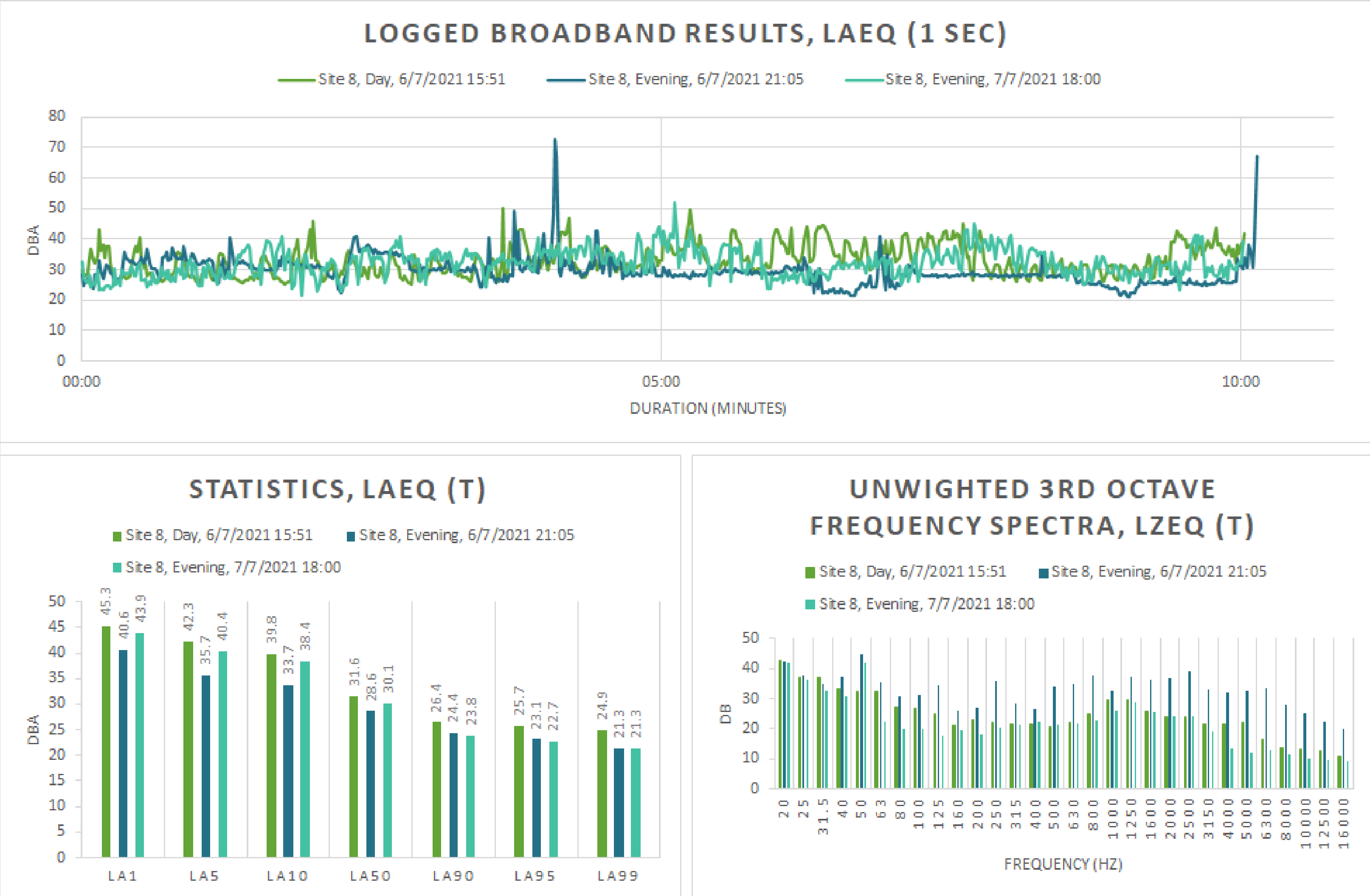


Figure 34: Detailed day-time survey results for Site 8

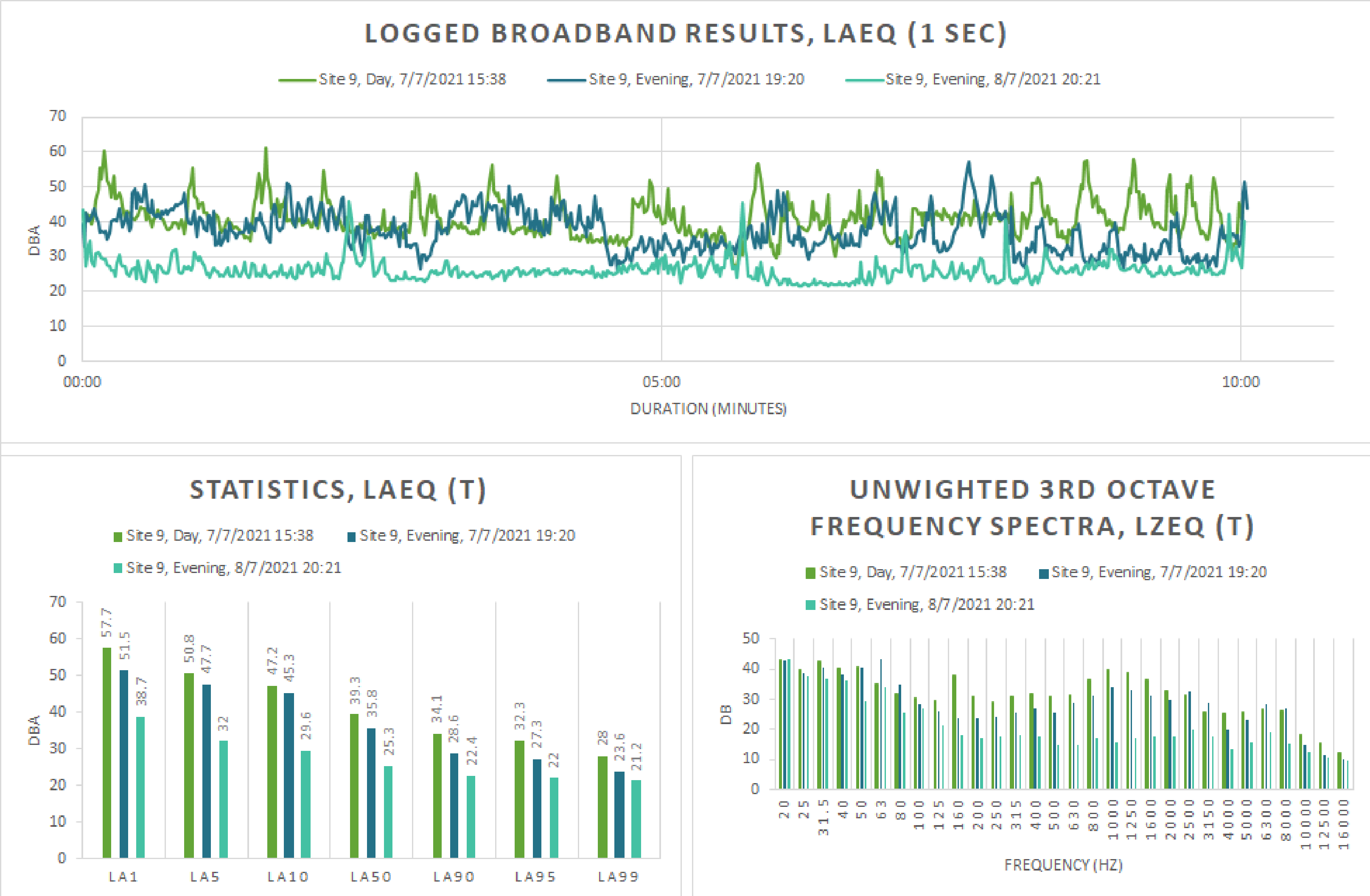


Figure 35: Detailed day-time survey results for Site 9

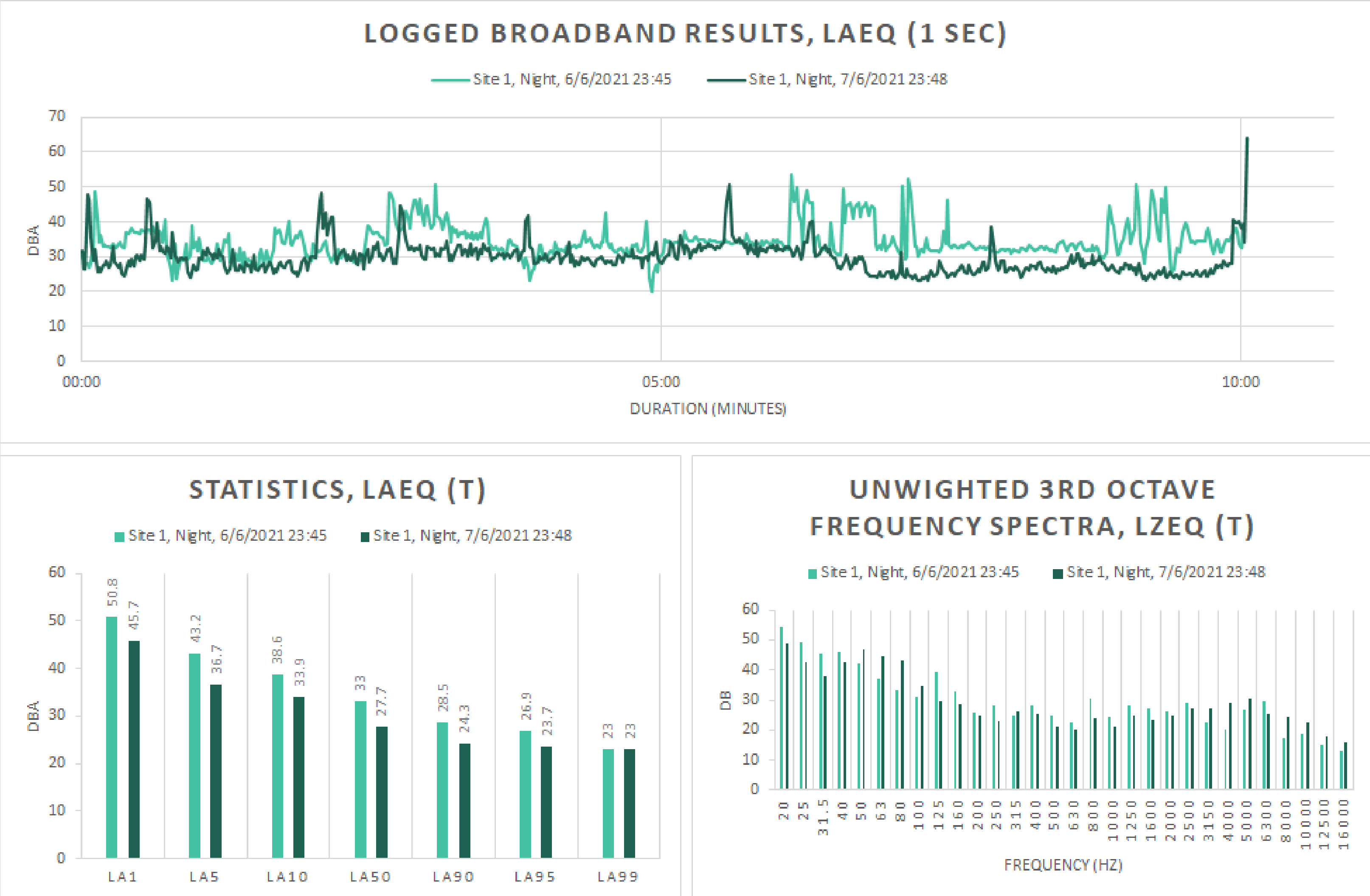


Figure 36: Detailed night-time survey results for Site 1

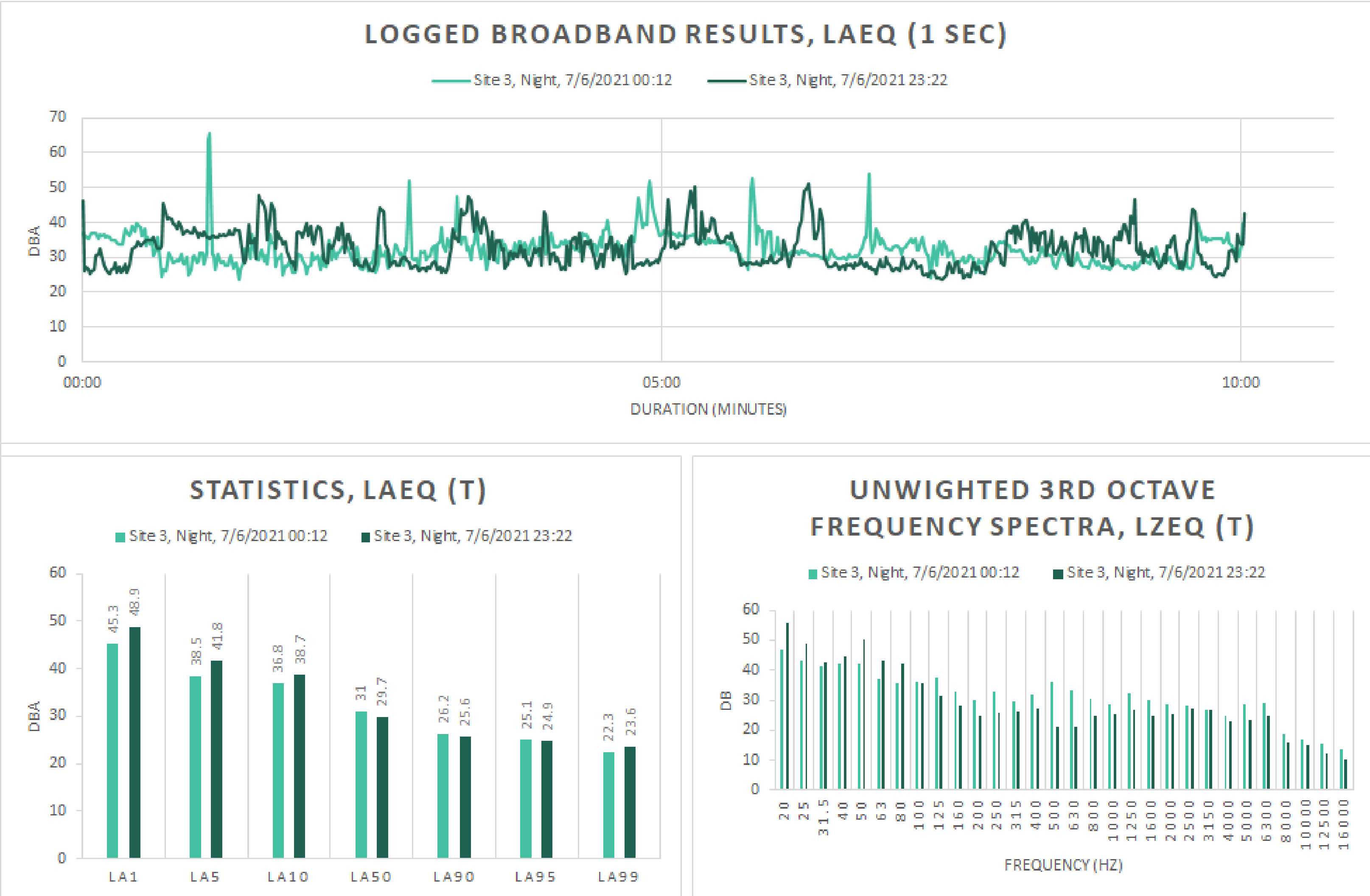


Figure 37: Detailed night-time survey results for Site 3

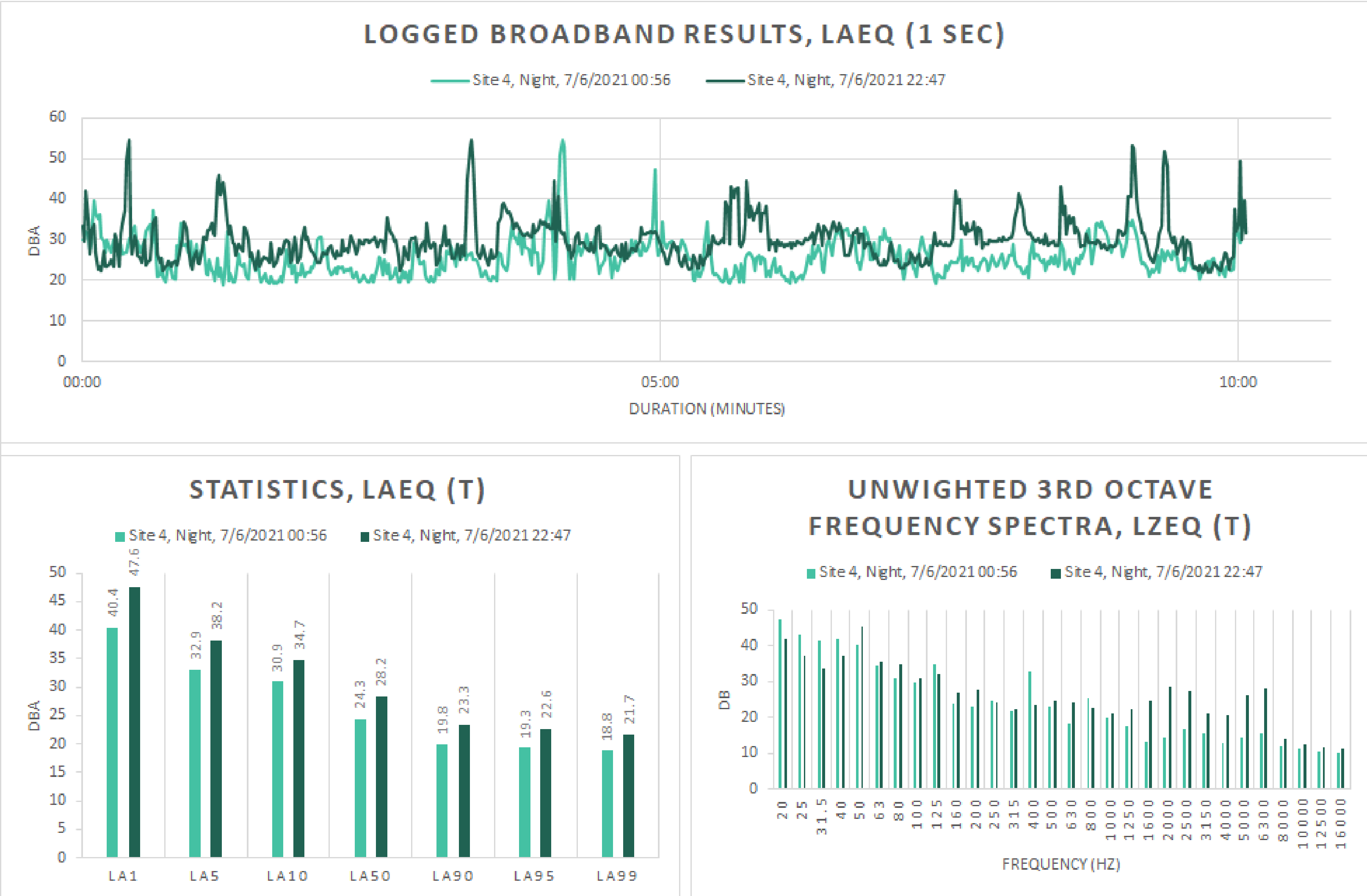


Figure 38: Detailed night-time survey results for Site 4

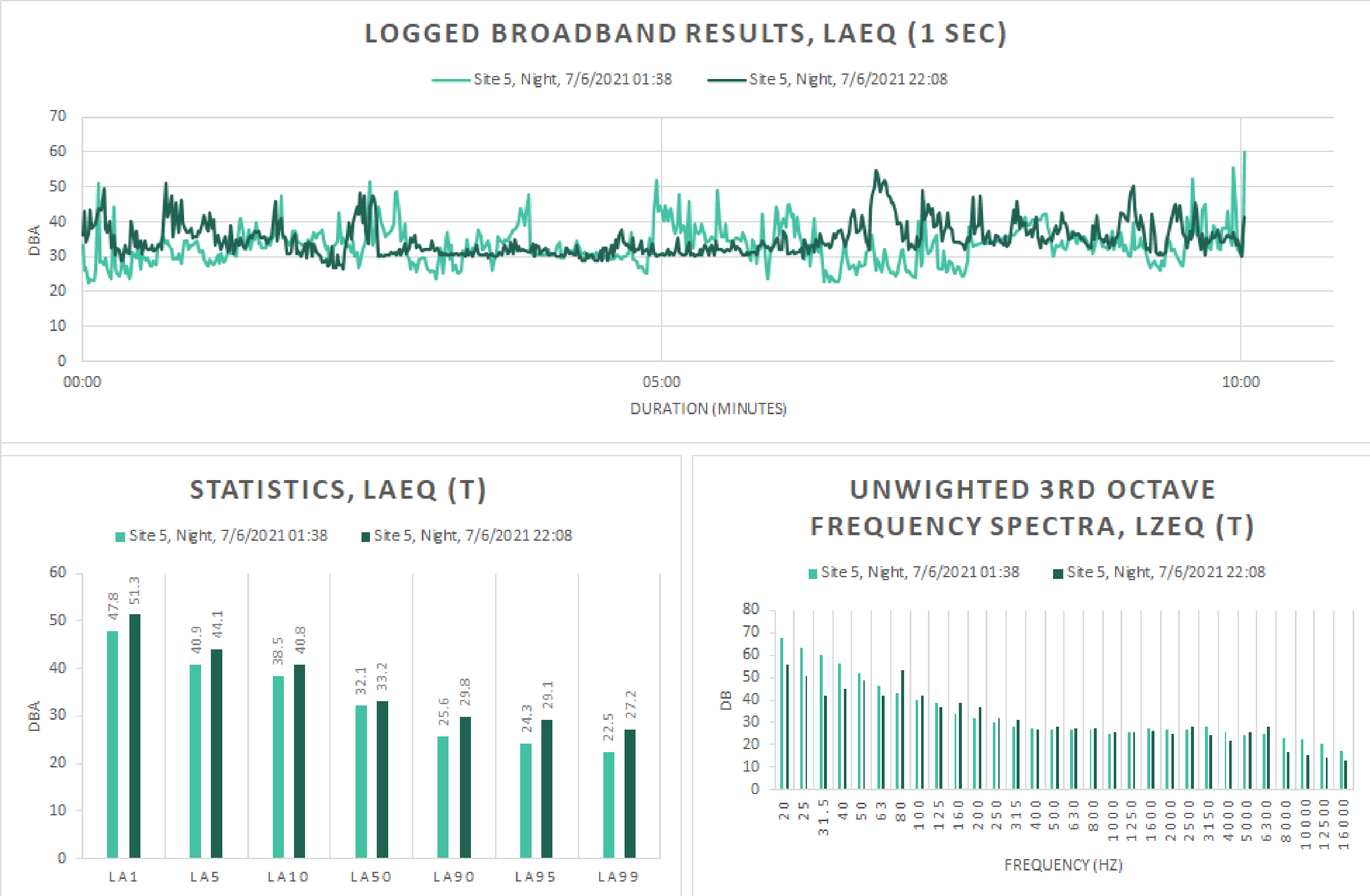


Figure 39: Detailed night-time survey results for Site 5

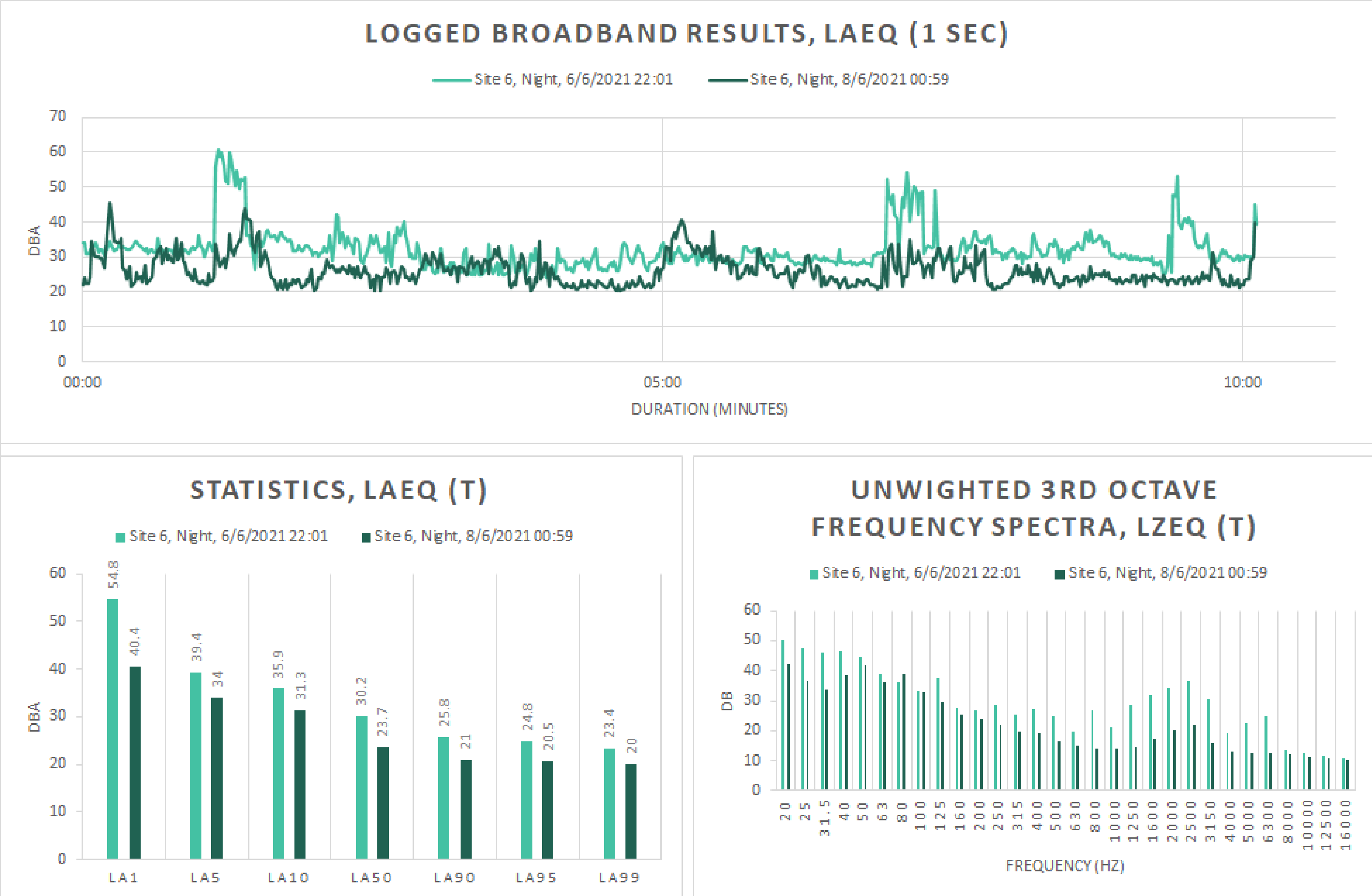


Figure 40: Detailed night-time survey results for Site 6

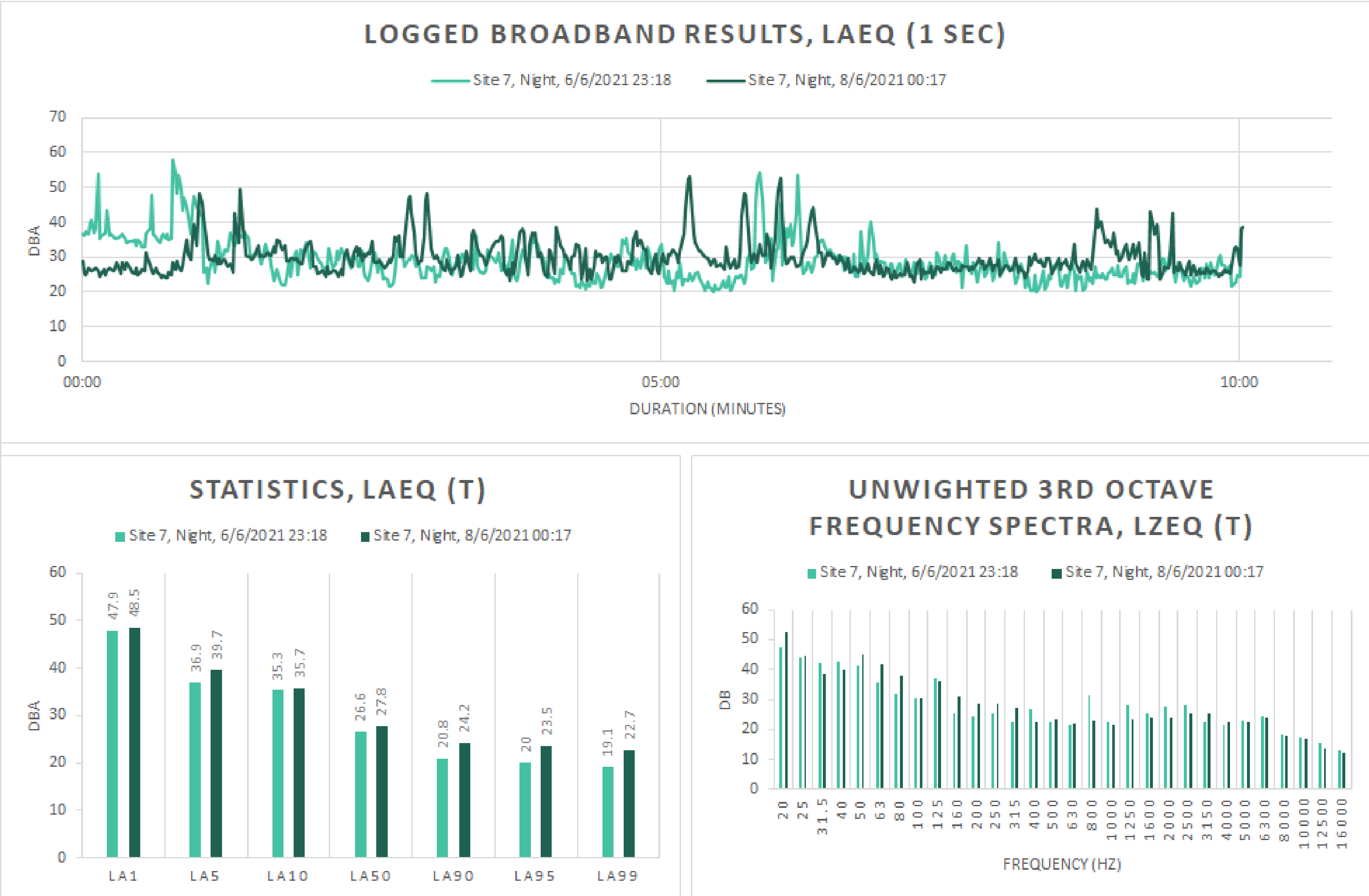


Figure 41: Detailed night-time survey results for Site 7

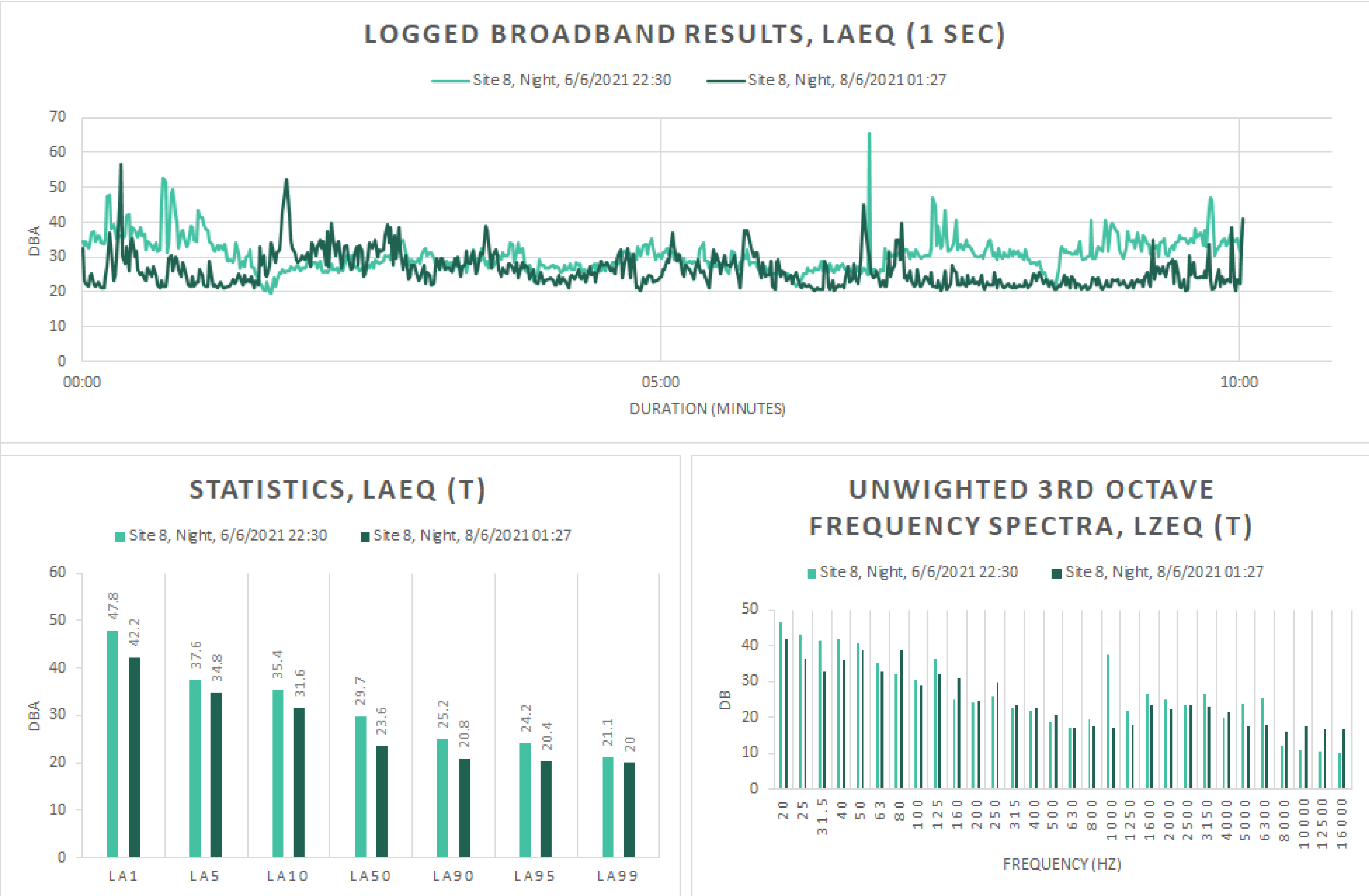


Figure 42: Detailed night-time survey results for Site 8

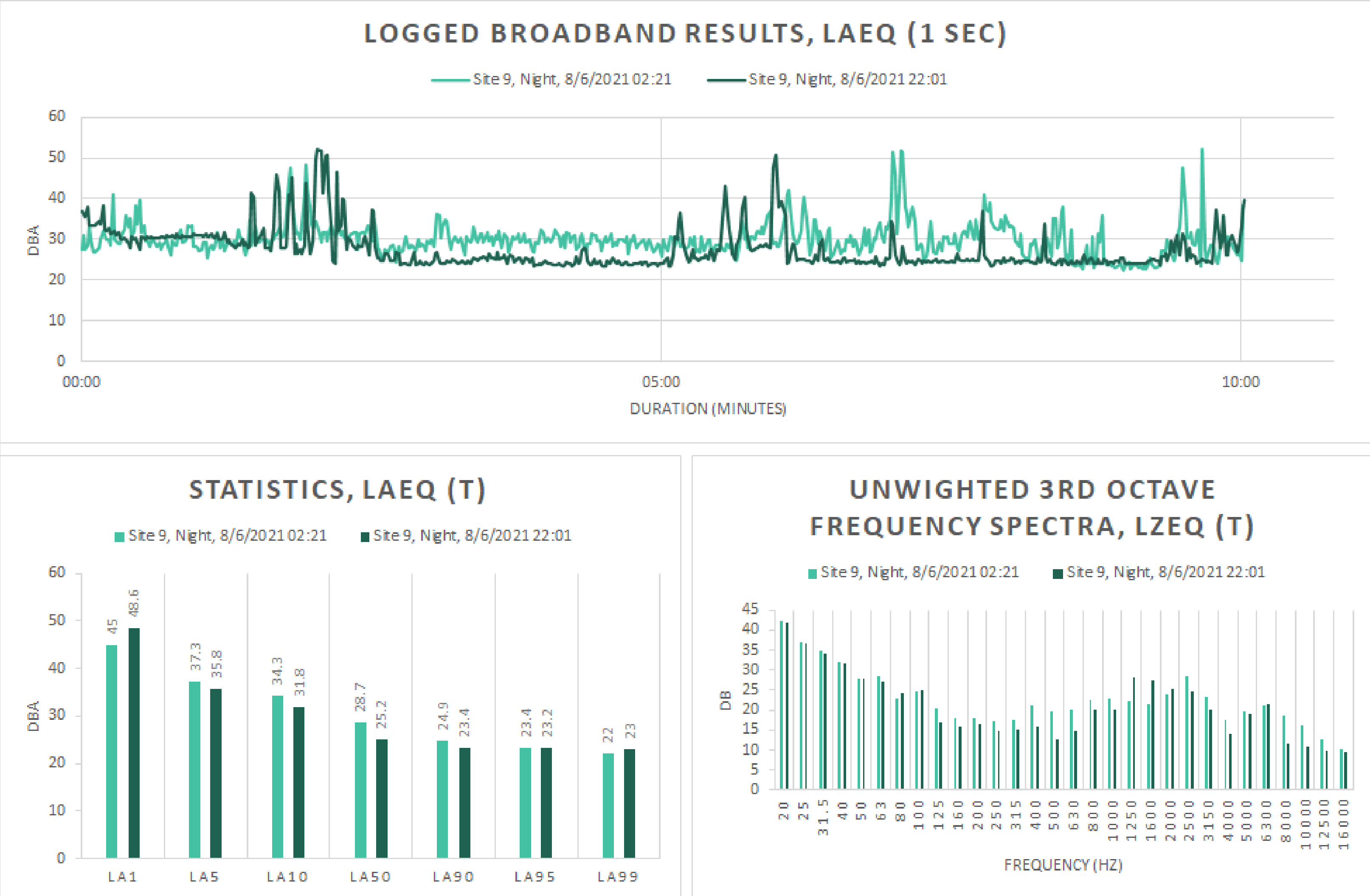


Figure 43: Detailed night-time survey results for Site 9

Appendix F – Impact Assessment Methodology

The methodology used for assessing the significance of the impact was obtained from EXM. The significance of the impact is dependent on the consequence and the probability that the impact will occur.

impact significance = (consequence x probability)

Where:

consequence = (severity + extent)/2

and

severity = (intensity + duration)/2

Each criterion is given a score from 1 to 5 based on the definitions given in Table 11 to Table 13. Although the criteria used for the assessment of impacts attempts to quantify the significance, it is important to note that the assessment is generally a qualitative process and therefore the application of this criteria is open to interpretation. The process adopted will therefore include the application of scientific measurements and professional judgement to determine the significance of environmental impacts associated with the proposed project. The assessment thus largely relies on experience of the environmental assessment practitioner (EAP) and the information provided by the specialists appointed to undertake studies for the EIA.

Where the consequence of an event is not known or cannot be determined, the “precautionary principle” will be adhered to and the worst-case scenario assumed. Where possible, mitigation measures to reduce the significance of negative impacts and enhance positive impacts will be recommended. The detailed actions, which are required to ensure that mitigation is successful, will be provided in the EMPR, which will form part of the EIA report. Consideration will be given to the phase of the project during which the impact occurs. The phase of the development during which the impact will occur will be noted to assist with the scheduling and implementation of management measures.

Table 15: Criteria for Assessing the Impact Significance (Severity Criteria)

INTENSITY = MAGNITUDE OF IMPACT	RATING
Insignificant: impact is of a very low magnitude	1
Low: impact is of low magnitude	2
Medium: impact is of medium magnitude	3
High: impact is of high magnitude	4
Very high: impact is of highest order possible	5
DURATION = HOW LONG THE IMPACT LASTS	**RATING**
Very short-term: impact lasts for a very short time (less than a month)	1
Short-term: impact lasts for a short time (months but less than a year)	2
Medium-term: impact lasts for more than a year but less than the life of operation	3
Long-term: impact occurs over the operational life of the proposed extension	4
Residual: impact is permanent (remains after mine closure)	5
EXTENT = SPATIAL SCOPE OF IMPACT/ FOOTPRINT AREA / NUMBER OF RECEPTORS	**RATING**
Limited: impact affects the mine site	1
Small: impact extends to the whole farm portion	2
Medium: impact extends to neighbouring properties	3
Large: impact affects the surrounding community	4
Very Large: The impact affects an area larger the municipal area	5

Table 16: Criteria for Assessing the Impact Significance (Probability)

PROBABILITY = LIKELIHOOD THAT THE IMPACT WILL OCCUR	RATING
Highly unlikely: the impact is highly unlikely to occur	0.2
Unlikely: the impact is unlikely to occur	0.4
Possible: the impact could possibly occur	0.6
Probable: the impact will probably occur	0.8
Definite: the impact will occur	1.0

Table 17: Criteria for Assessing the Impact Significance (Impact Significance)

Negative Impacts		
≤ 1	Very Low	Impact is negligible. No mitigation required.
> 1 ≤ 2	Low	Impact is of a low order. Mitigation could be considered to reduce impacts. But does not affect environmental acceptability.
> 2 ≤ 3	Moderate	Impact is real but not substantial in relation to other impacts. Mitigation should be implemented to reduce impacts.
> 3 ≤ 4	High	Impact is substantial. Mitigation is required to lower impacts to acceptable levels.
> 4 ≤ 5	Very High	Impact is of the highest order possible. Mitigation is required to lower impacts to acceptable levels. Potential Fatal Flaw.

Positive impacts		
≤ 1	Very Low	Impact is negligible.
> 1 ≤ 2	Low	Impact is of a low order.
> 2 ≤ 3	Moderate	Impact is real but not substantial in relation to other impacts.
> 3 ≤ 4	High	Impact is substantial.
> 4 ≤ 5	Very High	Impact is of the highest order possible.