Environmental Noise Impact Assessment for the Uis Tin Mine, Phase 1 Fast-Tracked Stage II

Project done for **Environmental Compliance Consultancy**

Report compiled by:
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Report Details

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Revision Record

Version	Date	Comments
Rev 0	January 2022	For client review

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.
DMS	Dense Medium Separation
ECC	Environmental Compliance Consultancy
EHS	Environmental, Health, and Safety (IFC)
Hz	Frequency in Hertz
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
ISO	International Standards Organisation
km	kilometre
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_{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
MHCP	Materials Handling and Concentrating Plant
m^2	Area in square meters
mm	Millimetre
m/s	Speed in meters per second
Mtpa	Million tonnes per annum
NSR	Noise sensitive receptor
NACA	National Association for Clean Air
NEMA	National Environmental Management Act
NEMAQA	National Environmental Management Air Quality Act
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
SACNASP	South African Council for Natural Scientific Professions
SANS	South African National Standards
SLM	Social and Labour Plan
SoW	Scope of Work
STRM	Shuttle Radar Topography Mission
USGS	United States Geological Survey
VGF	Vibrating Grizzly Feeder
WHO	World Health Organisation
WRF	The Weather Research and Forecasting (WRF) Model
°C	Degrees Celsius
%	Percentage

Executive Summary

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by Environmental Compliance Consultancy (ECC) to undertake a specialist environmental noise impact study for the proposed Phase 1 Fast-Tracked Stage II expansion of the Uis Tin Mine (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 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 surveys conducted for the site.
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). 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 the SANS 10103.

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 residential developments to the proposed project consist of Uis (~1.9 km to the northwest), Uis Mining Village (~1.7 km to the east) and Tatamutsi (~3.4 km to the east). Individual farmsteads also surround the project area.
- Measured baseline noise levels were between 32.9 and 46.1 dBA during the day and between 25.6 and 55.2 dBA during the night.

A source inventory was developed for the project. Noise emissions or sound power levels (L_W's) for these were calculated using predictive equations for industrial machinery as per the Handbook of Acoustics, Chapter 69, by Bruce and Moritz (1998) and from Source Measurement Databases.

The source inventory, local meteorological conditions and information on topography and local land use were used to populate the noise propagation model (CadnaA, ISO 9613). The propagation of noise was calculated over an area of 9.68 km east-west by 10.02 km north-south. The area was divided into a grid matrix with a 20-m resolution and NSRs were included as discrete receptors.

Simulations indicate that exceedance of the day-time IFC guideline of 55 dBA for residential, educational, and institutional receptors will occur up to 450 m from the project site. The night-time simulated noise-levels exceed night-time IFC guidelines of 45 dBA for residential, educational, and institutional receptors up to ~1 km from the project site. The closest residential NSR is ~1.7 km east of the site.

It is recommended that general good practice measures for managing noise as set out in this report, be adopted as part of the facility's Environmental Management Plan. In the event that noise related complaints are received, short term (30-min to 24-hours in duration) 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 significance of environmental noise impacts was assessed according to the methodology adopted by ECC.
The significance of project operations was found to be ***minor***.

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1 Introduction

The Uis tin mine is a historical mine that was owned and operated by Imkor Tin, a subsidiary of Iscor South Africa. Mining commenced in 1958, and the operation was closed in 1991 (Maritz & Uludag, 2019).

The Uis Tin Mine infrastructure development commenced in 2018 on the historical Uis Tin Mine located adjacent to the Uis mining village which was developed to support the historical mine (AfriTin Mining, 2021).

AfriTin received a mandate to develop the Uis Tin Project in Namibia through two phases (AfriTin Mining, 2021):

1. Phase 1: Development of a pilot mining and processing facility, exploration drilling, and the completion of a bankable feasibility study for the final mine configuration.
2. Phase 2: Construction of the final mine configuration to mine and process 3.1 Mtpa ore to produce 5 ktpa of saleable tin concentrate.

Phase 1 will be implemented across various stages (AfriTin Mining, 2021):

- Stage I: Achieve steady-state production. The commissioning of the Phase 1 processing plant commenced in August 2019. Plant throughput has increased steadily month-on-month, although current production remains below the design capacity. Debottlenecking of the plant, combined with various other initiatives to improve availability and utilisation, support the ramp-up to the original steady-state production targets.
- **Stage II**: Increase production capacity and recovery by:
    - increasing throughput capacity by 50% from 80 tph to 120 tph, which can be achieved by modular expansion of individual circuits;
    - improving overall recovery of tin (Sn) from 60% to 70% by adding comminution and beneficiation capacity for tailings streams in the concentrator, which are currently discarded; and
    - improving overall recovery of tantalum (Ta) from 15% to 30% by optimising liberation between the tin and tantalum bearing minerals and improved magnetic separation efficiency.
- Stage III: Introduce a second by-product by adding a circuit to produce a petalite concentrate at 4% Li_2O to sell into the glass and ceramics market.
- Stage IV: Further expand tin and tantalum concentrate production by increasing average concentrator plant feed tin grade from 0.139% to 0.158% through implementation of an automated ore-sorting circuit after the first two crushing stages to reject barren pegmatite before the final stages of comminution and then concentration.

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by Environmental Compliance Consultancy (ECC) to undertake a specialist environmental noise impact study for the proposed Phase 1 Fast-Tracked Stage II expansion of the Uis Tin Mine (hereafter referred to as the project).

The Phase 1 Fast-Tracked Stage II expansion includes the following changes to the process flow in various sections of the plant (AfriTin Mining, 2021):

- A secondary crusher and screen are added between the primary jaw crusher and the fines crushing section.
- A stockpile is added as a buffer between the crushing and concentrating sections.
- Water rejection capacity is increased in the Dense Medium Separation (DMS) 1 section.
- The medium circuits for DMS 2 and DMS 3 are combined to improve operability of DMS 3 and maximise tin recovery from DMS 2 floats after further liberation.
- The DMS 2 floats re-crush circuit is converted to a closed circuit by adding a classification screen in the circuit. In addition, feed is added before the roll crushers to improve operability.
- Additional spirals to re-process middlings are installed in the spiral plant.
- The product handling infrastructure is relocated, and an additional shaking table is installed to improve capacity. The existing Wilfley shaking tables are replaced with Holman tables for higher separation efficiency.

The layout for the Uis Tin Mining Project and Materials Handling and Concentrating Plant (MHCP) is provided in Figure 1 and Figure 2 respectively.

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:
    a. The identification of potential 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.
    c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from a survey conducted for the site.
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 activities.
    c. The screening of simulated noise levels against environmental noise criteria.
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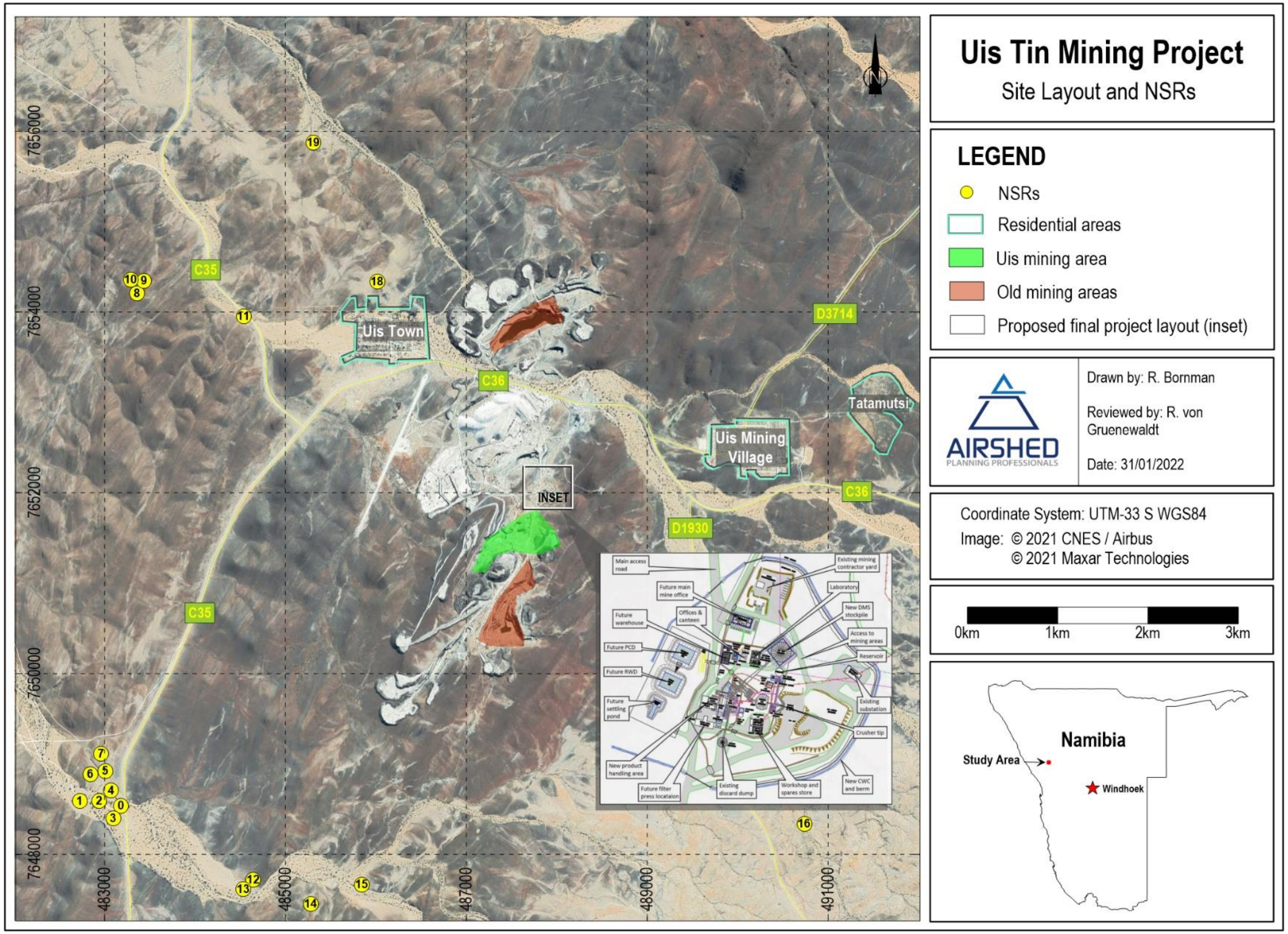


Figure 1: Layout of the Uis Tin Mining Project

Figure 2: Layout of the Materials Handling and Concentrating Plant (MHCP)

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 was made partner at 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 quality 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

1.4.1 Construction

Noise generating sources during construction include equipment used for activities such as land clearing, site preparation, excavation, clean-up, and landscaping.

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

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

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

1.4.2 Operation

Sound fields in an industrial setting are usually complex due to the participation of many sources: propagation through air (air-borne noise), propagation through solids (structure-borne noise), diffraction at the machinery boundaries, reflection from the floor, wall, ceiling and machinery surface, absorption on the surfaces, etc. High noise levels can therefore be present in the vicinity of operating machinery. The project will include pumps, secondary crushing, various screening facilities, conveyor activities and extraction fan. For a given machine, the sound pressure levels depend on the part of the total mechanical or electrical energy that is transformed into acoustical energy.

The project layout is provided in Figure 2.

1.4.3 Operational Hours

Project activities have been assumed to take place 24 hours per day.

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

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

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

Where:

L_p *is the sound pressure level in dB;*

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

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

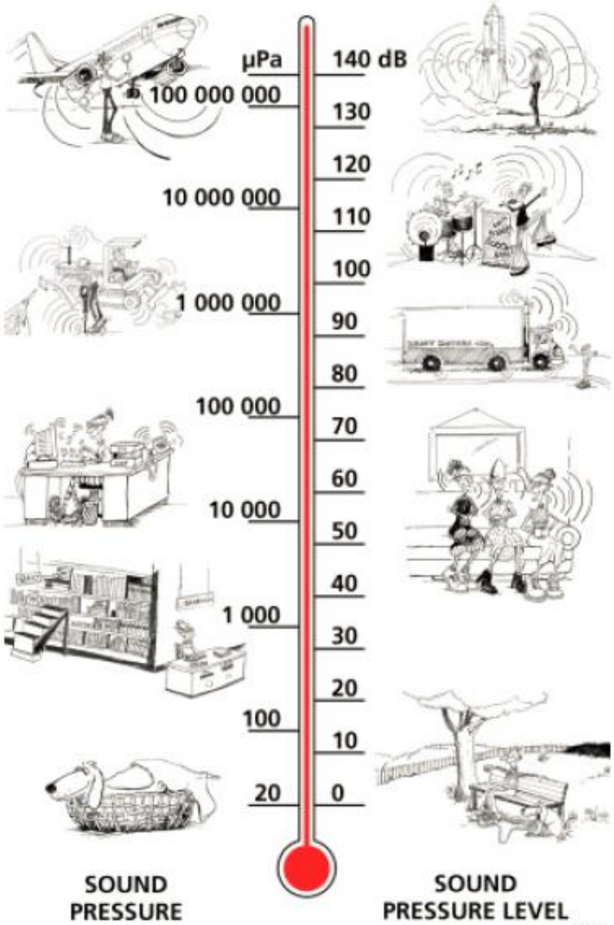


Figure 3: The decibel scale and typical noise levels (Brüel & Kjær Sound & Vibration Measurement A/S, 2000)

1.5.1 Perception of Sound

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

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

1.5.2 Frequency Weighting

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

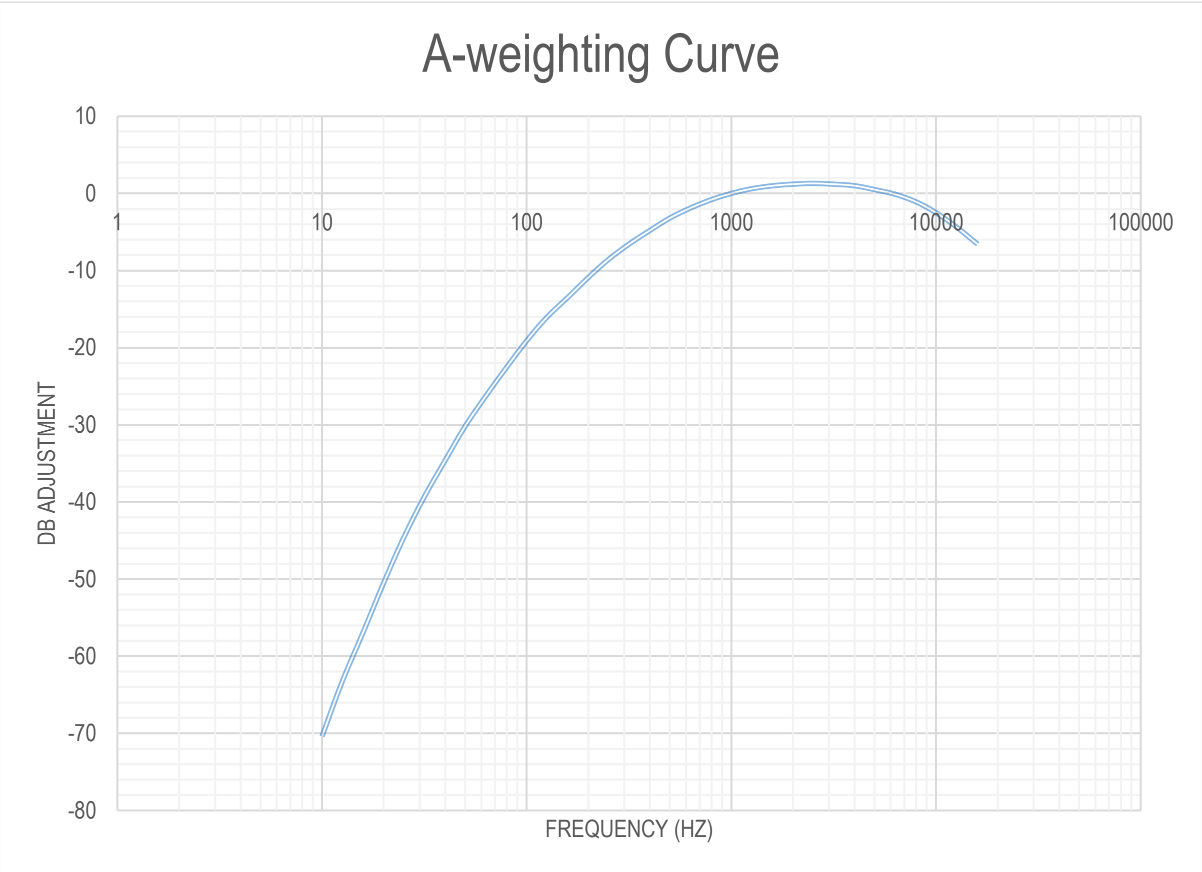


Figure 4: A-weighting curve

1.5.3 Adding Sound Pressure Levels

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

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

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

1.5.4 Environmental Noise Propagation

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

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

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

1.5.5 Environmental Noise Indices

In assessing environmental noise either by measurement or calculation, reference is 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 ECC at the onset of the project. In response to the request, the following information was supplied:

- Georeferenced project layout;
- Process description;
- Mining schedule; and,
- Project equipment details.

1.6.2 Review of Assessment Criteria

In the absence of local guidelines and standards, this study refers to noise level guidelines published by the International Finance Corporation (IFC) in their '*General Environmental, Health, and Safety (EHS) Guidelines'* (IFC, 2007), as well as South African National Standard (SANS) 10103 (2008) '*The measurement and rating of environmental noise with respect to annoyance and to speech communication'.* The latter has been widely applied in neighbouring South Africa and is frequently used by local authorities when investigating noise complaints as it provides a useful scale for relating increased environmental noise levels to expected community responses.

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. Potential NSRs were identified from satellite imagery (Google Earth).

The ability of the environment to attenuate noise as it travels through the air was studied by considering local meteorology, land use and terrain. Atmospheric attenuation potential was described based on modelled WRF meteorological data. Data for the period 2018 to 2020 was considered. Land-use was determined from satellite imagery (Google Earth) and site observations. Readily available terrain data was obtained from the United States Geological Survey (USGS) web site (https://earthexplorer.usgs.gov/) in January 2022. 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 between the 5th and 7th of May 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 conducted by ECC under the guidance of 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.
- L_{Aleq} (T), L_{Aeq} (T); L_{AFmax}; L_{AFmin}; L_{90} and octave frequency spectra were recorded.
- The SLM was located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- SANS 10103 states that one must ensure (as far as possible) that the measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer.
- A detailed log and record were kept. Records included site details, 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

1.6.5 Source Inventory

To determine the change in noise impacts associated with the project, a source inventory had to be developed. A process description (AfriTin Mining, 2021), layout images and a list of equipment for the main noise sources was provided. This information was used to compile the source inventory. L_W's for these were calculated using predictive equations for industrial machinery as per the Handbook of Acoustics, Chapter 69, by Bruce and Moritz (1998).

Conveyor, crushing and screening L_W's were obtained from a Source Measurement Databases for similar operations. Values from the database are based on source measurements carried out in accordance with the procedures specified in SANS 10103.

Construction and decommissioning activities are expected to result in noise impacts similar to or less significant than impacts associated with the operational phase. A source inventory was therefore only developed for the operational phase of the project.

1.6.6 Noise Propagation Simulations

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

1.6.6.1 ISO 9613

ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation 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 Simulation Domain

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

The propagation of noise was calculated over an area of 9.68 km east-west by 10.02 km north-south and encompasses the Uis Tin Mine. The area was divided into a grid matrix with a 20 m resolution. The model was set to calculate L_P's at each grid intercept 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 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 developed by ECC.

1.7 Management of Uncertainties

The following limitations and assumptions should be noted:

- The mitigating effect of buildings and infrastructure acting as acoustic barriers were not taken into account providing a conservative assessment of the noise impacts off-site.
- The quantification of sources of noise was limited to the operational phase of the project. Construction and closure phase activities are expected to be similar or less significant and its impacts only assessed qualitatively. Noise impacts will cease post-closure.
- 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.
- Only potential noise impacts due to the MHCP Phase 1 Fast-Tracked Stage II expansion was taken into account for the assessment. It was assumed that day- and night-time mining activities were taking place during the baseline noise survey as these activities were audible during the measurements. Mining activities were therefore not taken into consideration for the attenuation modelling (to account for changes from baseline activities) for the project.
- Although the noise impact due to equipment alarms are recognised, it is not considered as part of the environmental noise impact assessment as these signals are used for warning purposes which are excluded in impact assessments.
- The environmental noise assessment focuses on the evaluation of impacts on humans.

2 Legal Requirements and Noise Level Guidelines

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

2.1 International Finance Corporation Guidelines on Environmental Noise

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

The IFC states that noise impacts **should not exceed the levels presented in Table 2**, 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 2: IFC noise level guidelines

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

2.2 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 3 are typical rating levels that it is recommended should not be exceeded outdoors in the different districts specified. Outdoor ambient noise exceeding these levels will be annoying to the community.

Table 3: Typical rating levels for outdoor noise

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

Notes

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

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

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

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

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

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

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 1.6.6.2, the impact of an intruding industrial/mining noise on the environment rarely extends over more than 5 km from the source. The closest residential developments to the proposed project consist of Uis (~1.9 km to the northwest), Uis Mining Village (~1.7 km to the east) and Tatamutsi (~3.4 km to the east). Individual farmsteads also surround the project area (Figure 1 as identified from Google Earth).

3.2 Environmental Noise Propagation and Attenuation Potential

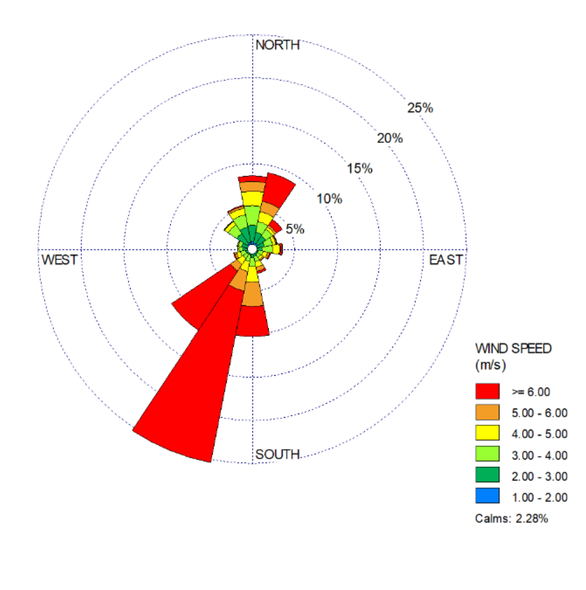
3.2.1 Atmospheric Absorption and Meteorology

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

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

Data from WRF data for the period 2018 to 2020 was used for the assessment (Figure 6). The modelled data set indicates wind flow primarily from the south southwest for day-time. At night, wind shifted to be mostly from the southern sector. On average, noise impacts are expected to be slightly more notable north northeast during the day and north of the project activities during the night.

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



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

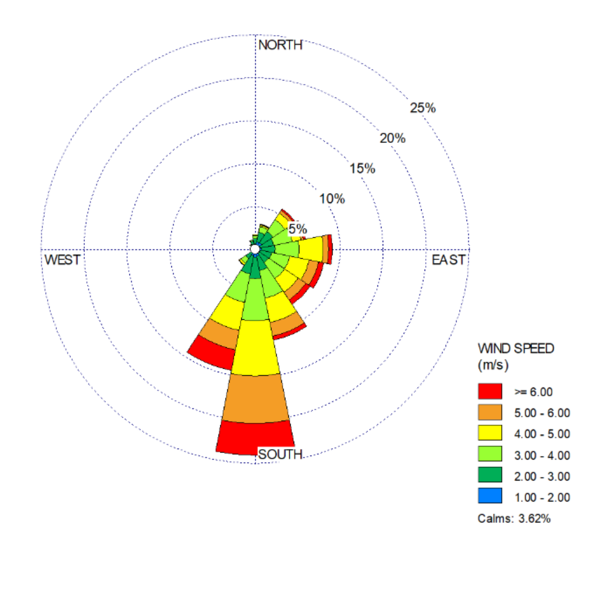


Figure 5: Wind rose for WRF data, 1 January 2018 to 31 December 2020

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.

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). CadnaA requires the definition of both temperature and humidity. An average temperature of 22°C and a humidity of 34% (as obtained from the WRF data for the period 2018-2020) were applied in simulations.

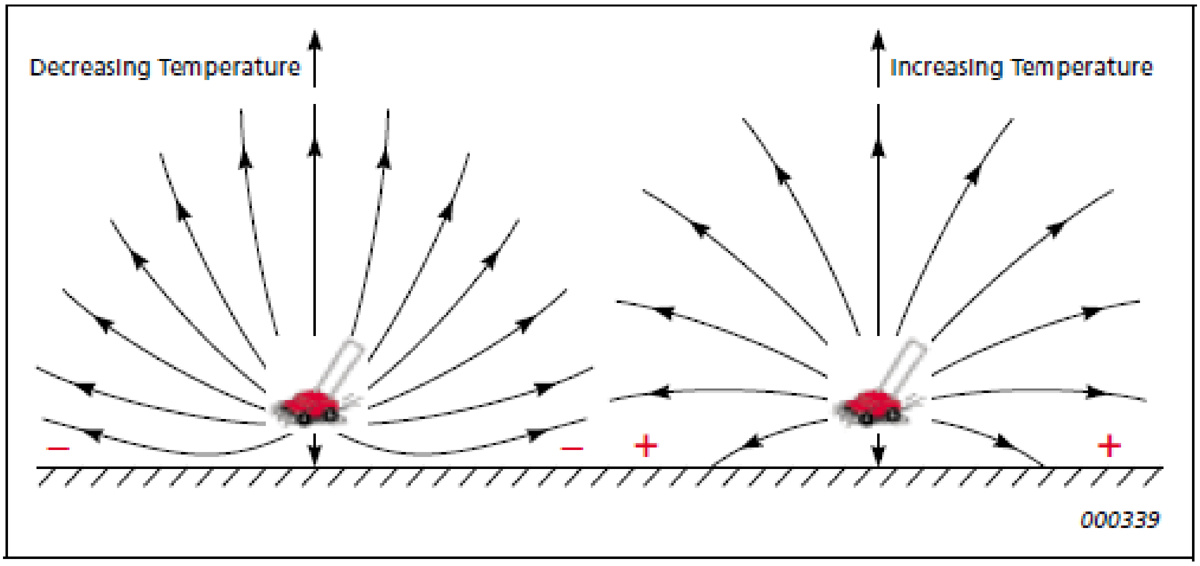


Figure 6: Bending the path of sound during typical day time conditions (image provided on the left) and night-time conditions (image provided on the right)

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). Readily available terrain data was obtained from the United States Geological Survey (USGS) web site (https://earthexplorer.usgs.gov/) in January 2022. A study was made of Shuttle Radar Topography Mission (STRM) 1 arc-sec data.

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

3.3 Baseline Noise Levels

Survey sites were selected after careful consideration of project activities, accessibility, potential noise sensitive receptors, and safety restrictions. A total of six survey sites were selected. The location of the noise survey sites is provided in Figure 4. Photographs of the sites are included in Appendix E.

Survey results for the campaign undertaken on the 5th to the 7th of May 2021 are summarised in Table 4 and for comparison purposes, visually presented in Figure 8 (day-time results) and Figure 9 (night-time results).

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

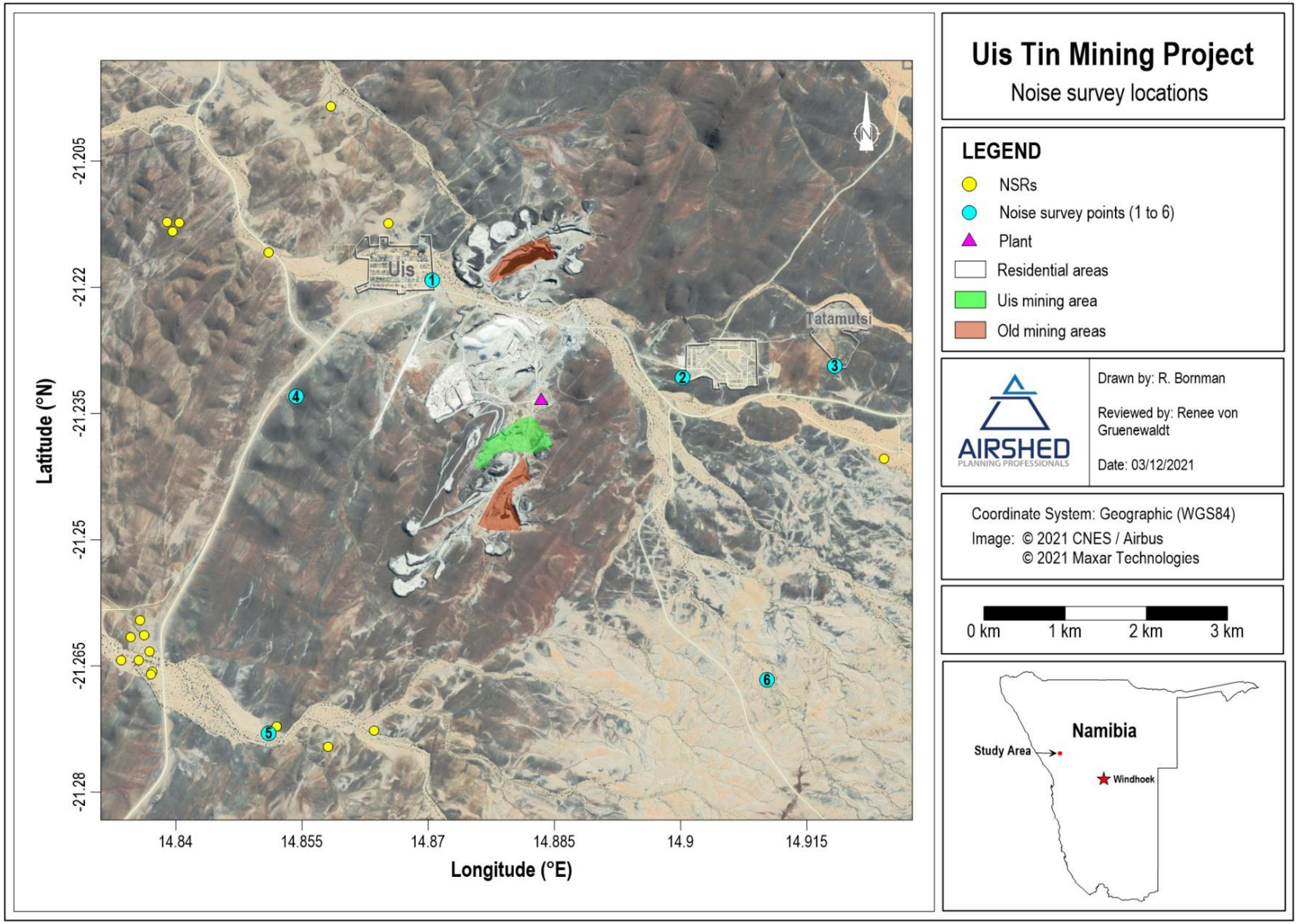


Figure 7: Noise sampling locations within the study area

Table 4: Project baseline environmental noise survey results summary

Sampling point	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
Description	Located in Uis close to townhouse.		Near a dump site and repair house.		Located close to community.		Area is surrounded by small hills made out of rocks.		Close to small settlement.		Close to an abandoned homestead.	
Coordinates	21.21916°S; 14.87049°E		21.23076°S; 14.90026°E		21.22934°S; 14.91835°E		21.23301°S; 14.854302°E		21.27301°S; 14.85106°E		21.26667°S; 14.91030°E	
Time of day	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Start date and time	06/05/2021 14:39	06/05/2021 04:38	06/05/2021 15:24	06/05/2021 05:16	06/05/2021 12:54	06/05/2021 06:19	05/05/2021 16:18	07/05/2021 05:53	05/05/2021 15:26	07/05/2021 06:29	06/05/2021 12:01	07/05/2021 05:09
Duration	00:31:30	00:21:03	00:32:10	00:20:46	00:30:37	00:20:25	00:32:22	00:21:46	00:31:19	00:20:36	00:30:57	00:20:22
Visual and acoustic observations	Birds, insects, vehicles and mining activities in the distance contribute to the acoustic sources.		Community activities and mining activities in the distance contribute to the acoustic sources.		Community activities, chickens, vehicles and excavators contribute to the acoustic sources. Distant mining activities are audible at night.		Vehicles, tractor, birds and insects contribute to the acoustic sources. Distant operations in town and dogs barking in the area audible at night.		Community activities and birds contribute to the acoustic sources during the day. Chickens and mining operations were audible during the night.		Birds and distant air traffic contribute to the acoustic sources during the day with distant mining activities contributing to the acoustic sources during the night.	
General weather conditions	Wind speeds of 1.9 m/s from the north east 28°C 80% cloud cover	Wind speeds of 1.2 m/s from the north east 22°C 70% cloud cover	Wind speeds of 0.7 m/s from the north east 28°C 70% cloud cover	Wind speeds of 1.1 m/s from the east 22°C 70% cloud cover	Wind speeds of 1.5 m/s from the east 27°C 80% cloud cover	Wind speeds of 0.6 m/s from the east 21°C 60% cloud cover	Wind speeds of 0.3 m/s from the north east 33°C 60% cloud cover	Wind speeds of 0.5 m/s from the north east 21°C 60% cloud cover	Wind speeds of 1.4 m/s from the east 31°C 60% cloud cover	Wind speeds of 0.4 m/s from the east 22°C 60% cloud cover	Wind speeds of 2.8 m/s from the north east 25°C 70% cloud cover	Wind speeds of 1.4 m/s from the north east 19°C 60% cloud cover
LAFmin (dBA)	27.0	33.6	25.6	20.4	27.0	19.5	19.3	18.2	19.5	18.9	25.1	18.8
LAFmax (dBA)	55.6	51.0	55.7	78.4	69.2	60.5	64.3	55.0	56.1	66.2	64.4	55.5
LAIeq (dBA)	50.3	52.1	54.7	59.0	52.6	57.0	57.3	51.2	50.2	52.3	51.7	50.8
LA90 (dBA)	30.6	36.0	30.4	22.5	34.1	21.8	21.6	18.2	21.3	19.9	29.1	19.9
LAeq (dBA)	39.2	44.1	37.1	**55.2**	46.1	33.2	39.4	25.6	32.9	**47.5**	38.9	26.5

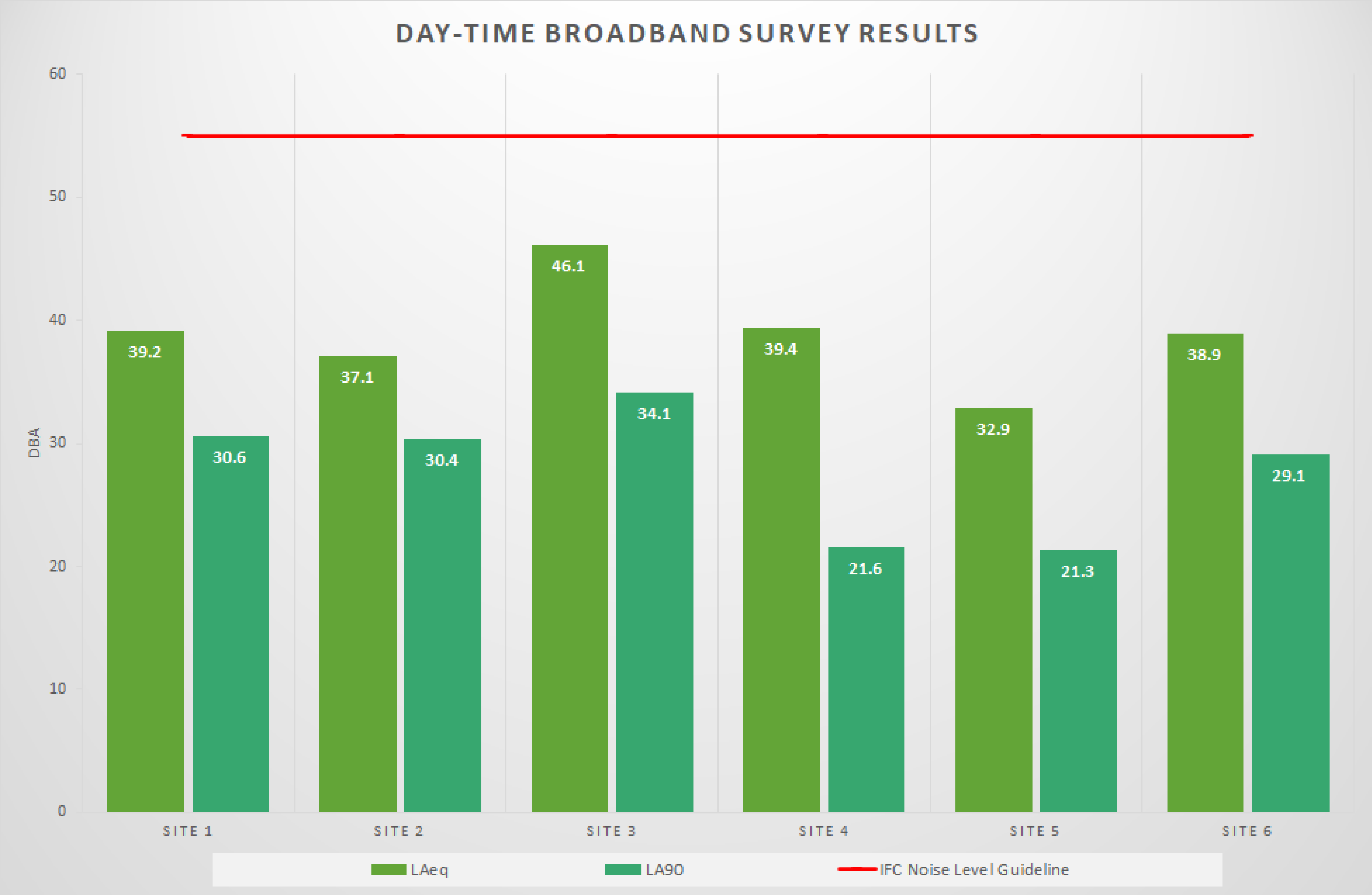


Figure 8: Day-time broadband survey results

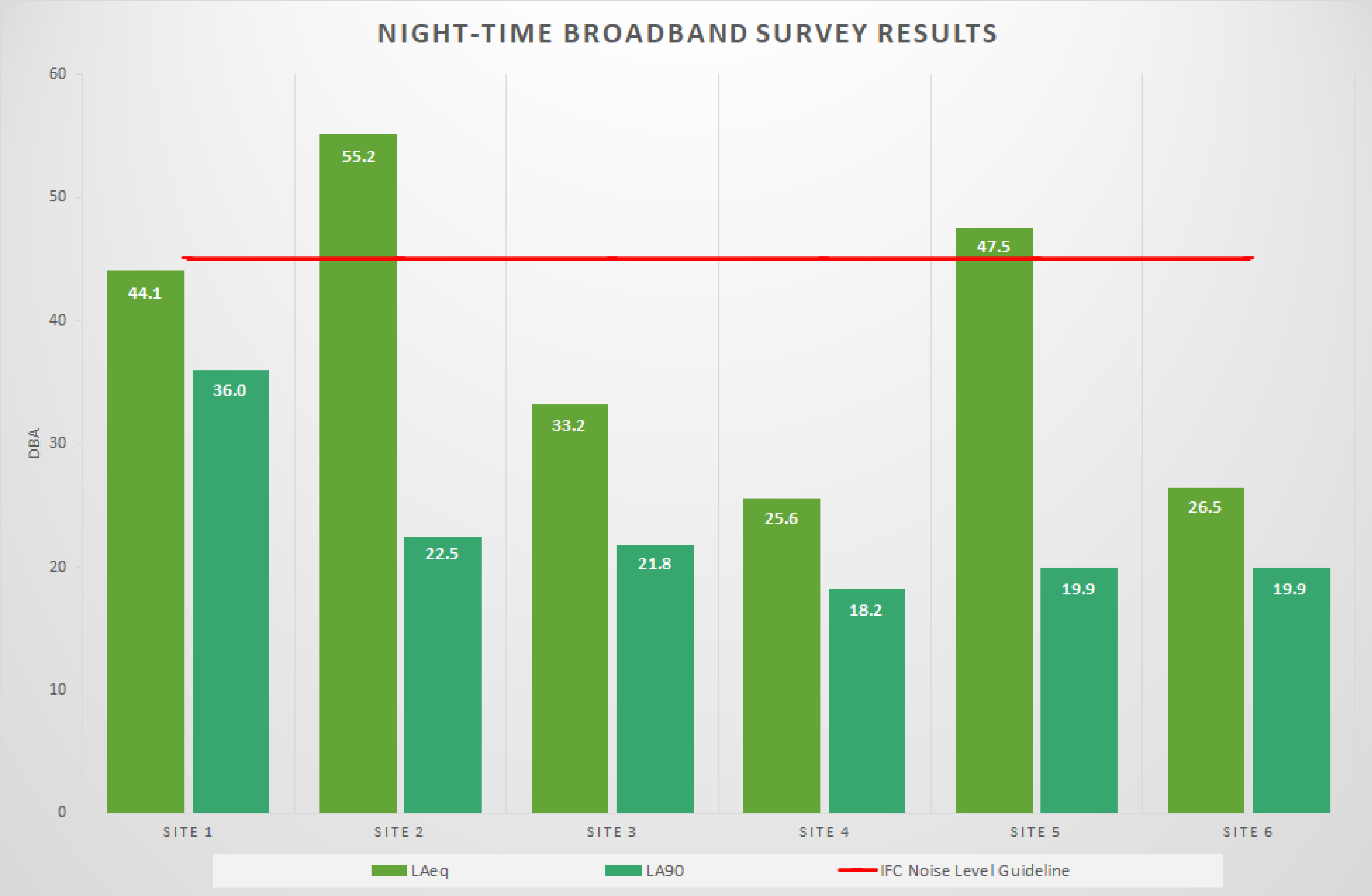


Figure 9: Night-time broadband survey results

4 Impact Assessment

The process description, noise source inventory, noise propagation modelling and results are discussed in Section 4.2, Section 4.2 and Section 4.3 respectively.

4.1 Process Description

A number of changes and upgrades are required in most areas of the MHCP and are discussed per functional area (AfriTin Mining, 2021).

4.1.1 Comminution – Dry Crushing and Screening

4.1.1.1 New Closed-Loop Secondary Crushing and Screening System

Simulations showed that the comminution system capacity can be improved by adding a closed-loop secondary crushing and screening system between the primary crusher and the existing crushed ore stockpile (Figure 10). This will introduce the following benefits:

- Correct-sized material will be removed before the existing buffer stockpile, thereby creating more capacity in the existing fines cone crushing system (currently secondary to quaternary crushers). Re-crushing of correct-sized material will also be prevented, thereby avoiding over-crushing and fines generation.
- The particle size distribution on the existing buffer stockpile will be reduced due to the removal of the correct-sized material.
- Crushing capacity will be increased through the new secondary crusher and the introduction of an additional buffer in the form of a new DMS feed stockpile that will be fed from the undersize of the new secondary screen.
- The removal of the fines in the new secondary screen unit should reduce the dust generation on this stockpile. A tunnel ventilation fan will be added in the crushed ore stockpile tunnel by a CI project.

An Osborn Crusher module and Osborn Screen module that are available were pre-selected (to reduce engineering design and supply times) and this guided the layout of the secondary crushing and screening circuit. The new closed-loop secondary crusher and screen system will have the following features:

- The discharge from the Vibrating Grizzly Feeder (VGF) and jaw crusher is collected onto conveyor CV-001. CV-001 will be modified to feed onto the new screen feed conveyor CV-025. Conveyor CV-025 will have a self-cleaning belt magnet to remove tramp metal.
- A new modular Osborn double-deck screening unit will be installed.
- The screen top deck will feed the new secondary crusher with conveyor CV-028. Discharge from the secondary crusher is transferred with a new conveyor CV-007 back onto CV-025 to be screened again.
- The bottom deck will feed the existing crushed ore stockpile via conveyors CV-027 and CV-002. Conveyor CV-002 will be 3 m higher to fit the new conveyor arrangement.
- The underpan will feed the new DMS feed stockpile via conveyors CV-026 and CV-024.
- The new Osborn secondary cone crusher module consists of an Osborn 44SBS type H cone crusher, with a 9 m^3 feed bin and vibrating feeder. This crusher is equipped with a combined lubrication and

hydraulic unit with oil cooling, allowing for hydraulic adjustment for release of tramp material, gap adjustment, and unscrewing of the bowl.

- A dust scrubbing system will be installed to extract dust from both the existing primary jaw crusher and the new secondary crusher and screen.

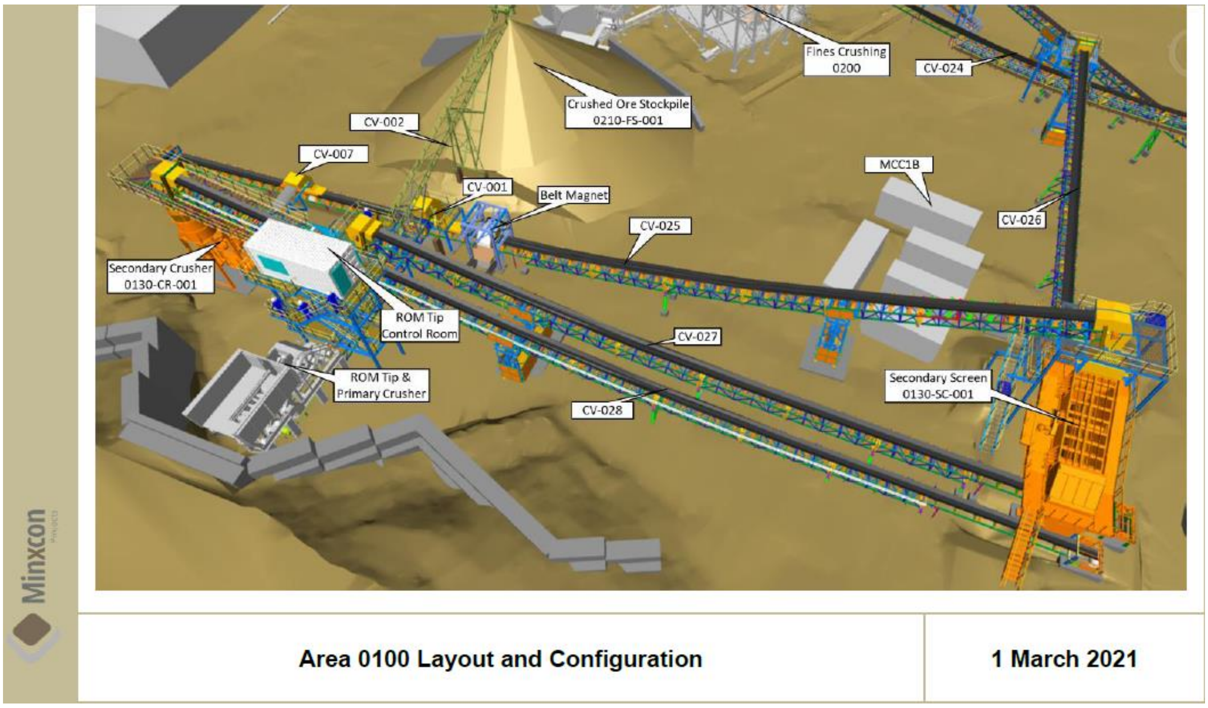


Figure 10: Area 0100 Layout and Configuration

4.1.1.2 Fines Crushing 0200

The only changes to be made in area 0200 are:

- Shorten CV-012 to feed onto new CV-024; and
- Replace conveyor CV-014 with a wider (for the increased capacity) and longer conveyor to receive material from stockpile extraction conveyor CV-029.

4.1.1.3 New DMS Feed Stockpile 0300

Limited DMS 1 feed bin capacity results in difficult feed control to the DMS 1 feed preparation screen. A new DMS feed stockpile will be constructed to combine all crushed ore, before feeding the DMS 1 plant (Figure 11).

Conveyor CV-024 feeds the new DMS feed stockpile. The secondary screen underflow reports to conveyor CV-026 and will be combined with the fines crushing underflow on conveyor CV-024. This will create additional buffer capacity between the comminution system and the concentrator and will be the sole feed source to DMS 1. During maintenance of the existing Area 0200 crushing system, DMS 1 can still be fed at full rate from the DMS feed stockpile.

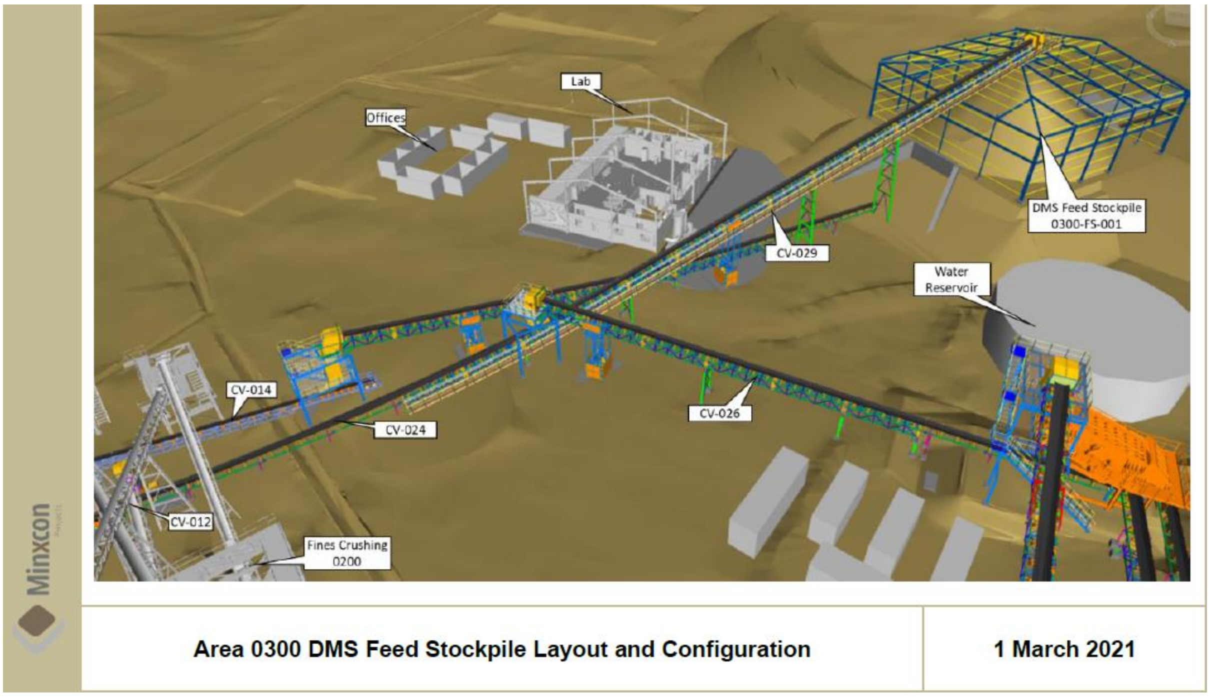


Figure 11: Area 0300 DMS Feed Stockpile Layout and Configuration

Bulk flow tests and a functional design were done for the DMS stockpile. Based on the functional design recommendations, a horizontal above-ground tunnel was designed. There will be three withdrawal points, for controlled feed with variable-speed belt feeders onto a new conveyor CV-029 feeding into a small surge bin (on the extended tail of existing DMS 1 feed conveyor CV-014). Initially only one belt feeder will be installed. A new VSD control on the replaced wider CV-014 will allow for controlled feed to the DMS 1 feed preparation screen. A terrace will be constructed around the stockpile tunnel to form a base for a square enclosed building. The tunnel will be equipped with lights and a second escape route.

This stockpile will generate wind-borne dust when dropping from the conveyor head chute onto the stockpile and must therefore be enclosed. Maintenance doors will allow access to the stockpile and the withdrawal chutes and liners (installed from the top).

4.1.2 Concentrator

4.1.2.1 DMS 1 Circuit

The DMS 1 feed is split into two streams on the preparation screen: the DMS 1 pre-concentration stream and spiral plant stream. The Phase 1 plant worked with an aperture of 0.5 mm to 0.63 mm as the design basis. This aperture will be increased to 1 mm for the increased capacity required for a 0.85 Mtpa plant. The underflow of the prep screen increases, and the DMS 1 stream increases based on this split. DMS 1 was originally designed for a high variability in the fines circuit, but this is currently reduced by managing the PSD of the plant feed prior to feeding the plant. A second pipe densifier will be added to run in parallel with the existing unit and can fit into the slot allowed for in the current plant.

Only the DMS 1 plant is affected by the increased feed rate. The DMS 2 and DMS 3 circuits are not affected by this change, because DMS 1 is controlled to keep the DMS 2 plant at a steady feed rate by changing the cut point of the cyclones.

4.1.2.2 DMS 2 and DMS 3 Circuits

DMS 3 will be reintroduced into the circuit, by combining the DMS 2 and 3 medium circuits and installing a new DMS 3 prep screen as well as a new drain and rinse screen (Figure 12).

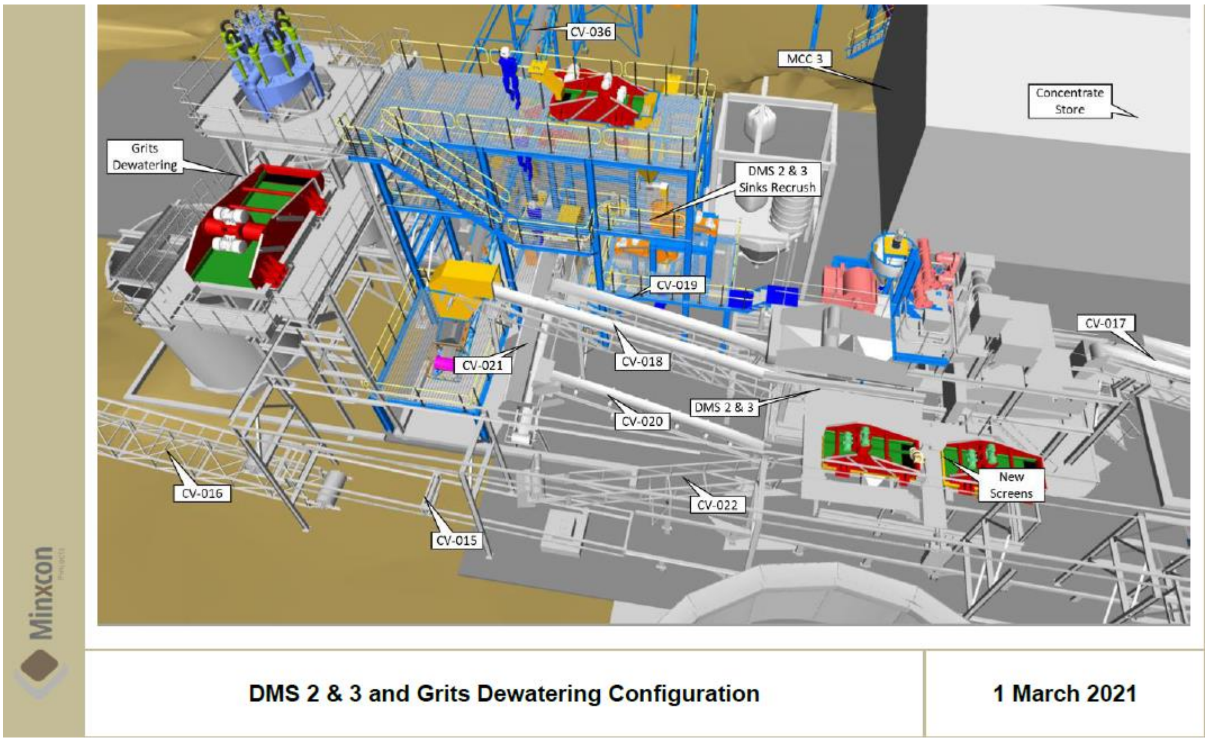


Figure 12: DMS 2 & 3 and Grits Dewatering Configuration

4.1.2.3 Roll Crushers and Ancillary Circuits

This circuit requires a redesign to improve crusher performance and availability (Figure 13). The existing four conveyors (CV-018, 019, 020 and 021) are maintained. A new middlings re-crusher facility is included to provide buffering and feed rate control. A screen (0350-SC-001) is used to control the minimum size of particles to DMS 3 and the spiral plant.

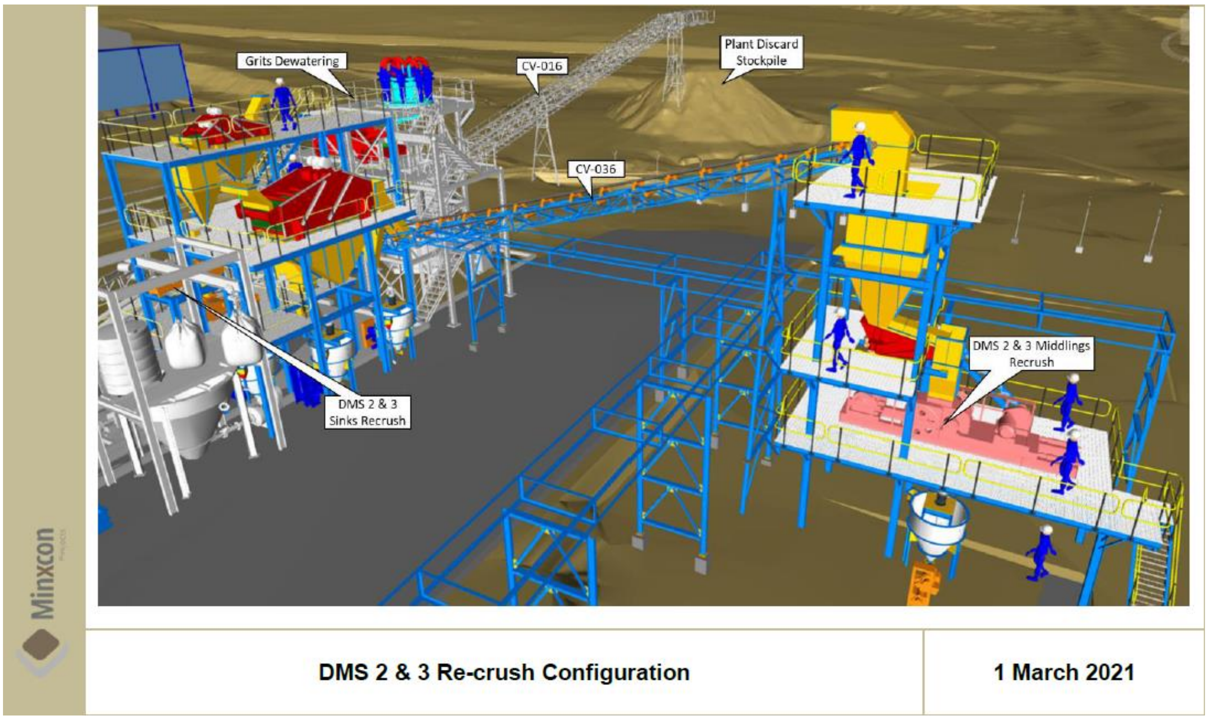


Figure 13: DMS 2 & 3 Re-crush Configuration

A second structure houses the sink crusher circuit and the screen 0350-SC-001. The order between screen and crusher is reversed in this application to prevent over crushing of the sized ore. An additional crusher is added to reduce the reduction ratio. The rest of the system is like the middlings crusher circuit, but on a smaller scale. Both circuits have buffer tanks to prevent settling and provide buffer capacity.

4.1.2.4 Spiral Plant

The spiral plant feed into the rougher spirals is fed from two sources: desliming cyclone 1 cluster and the new desliming cyclone 2 cluster. A new distributor 0440-DI-003 for the middlings spirals will be added.

The spiral concentrate will be collected in a new tank 0440-TK-005, which replaces the original unit and has limited buffer capacity for smoothing. The concentrate will then be transferred with jet pump 0440-PJ-001 at the required density to cleaning table circuit feed buffer tank 0500-TK-001.

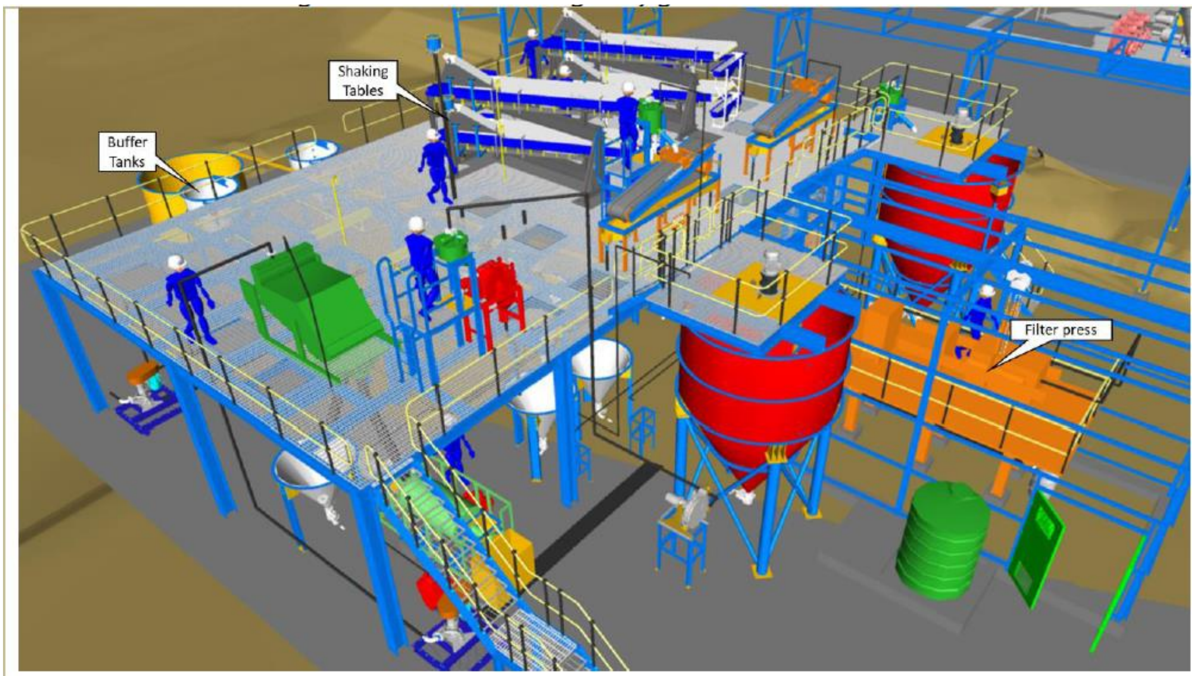
4.1.3 Concentrate Handling

The Phase 1 concentrate handling circuit was limited to two Wilfley tables located on the top floor of DMS 1. The original design utilised a pumped layout to the top level and a gravity flow down through the magnetic circuit. This did not provide the desired result, and a new plant layout has been designed with the focus on the mine's specific material and the settling properties of the slurry, in conjunction with equipment feed densities and steady-state volume requirements. The entire concentrate cleaning circuit has been redesigned and will be relocated to the new concentrate handling area.

4.1.3.1 Cleaning Tables Circuit

The plant design philosophy utilised constant density tanks to increase density in dilute streams where required (Figure 14). This allows for the control of density at the setpoint, and the water recovered is used for the wash-water on the tables to limit the possibility of product losses. Using this philosophy, the slurry from the DMS 2 and 3 sinks is dewatered in the buffer tank (1-hour storage capacity). The spiral concentrate is pumped at the correct density to its own buffer tank (½-hour storage capacity).

Individual pump streams are fed to the Holman cleaning tables, mounted on a concrete foundation, at set volumes and density for optimum recovery. The concentrate, middlings and tails streams are collected for the DMS cleaning table and scavenger table double-deck installation and are transferred to the double-deck spiral tables collection tanks per table grouping and then pumped to those specific streams for the plant for further processing.



Concentrate Cleaning and Product Handling Configuration	1 March 2021

Figure 14: Concentrate Cleaning and Product Handling Configuration

4.1.3.2 Scavenger Tables Circuit

The middlings are combined in two tanks in series, with a combined buffer capacity of one hour, and then pumped to the top deck of the DMS cleaning table and scavenger table set for the scavenging of the middlings. The middlings and tailings streams are combined to be discarded. The concentrate is combined with the concentrate from other tables.

4.1.3.3 Concentrate Dewatering Circuit

The final Sn concentrate slurry is pumped to a buffer tank (24-hour storage capacity). This slurry is filtered in a plate and frame filter with an air pressing cycle, before being bagged.

4.1.4 Discard Dewatering and Disposal

4.1.4.1 Thickener

The existing thickener will remain as is, with the thickener discharge pump feeding the discard filter press.

4.1.4.2 Discard Filter Press System

The existing discard filter press will remain in its current position and configuration and will discharge dried filter cakes onto discard conveyor CV-015.

4.1.4.3 Process Water Supply and Reticulation

The current process water flow will be increased to accommodate the increased water demand.

The largest water demand occurs at start-up of the plant, when the facility is run on water only, supplied by pump 0630-PU-003 with a pressure controller at 6 Bar pressure. This demand is reduced with the feeding of ore into the plant.

The main process water line is reticulated on the pipe gantry to all the process areas. The water is controlled into tanks using modulating valves, knife gate valves with orifice plates, and float valves.

A makeup water line will provide water to the flocculant plant and the two scrubbers in areas 0110 and 0300. Further makeup water will be added to the process water tank from 0010-PU-009.

4.2 Noise Sources and Sound Power Levels

The complete source inventory and octave band frequency spectra L_W's are included in Table 5. The directivity of stack source for the primary and secondary scrubber is provided in Table 6.

Table 5: Octave band frequency spectra L_W's

Plant Section	Equipment	Type	L_W octave band frequency spectra (dB)								L_W (dB)	L_{WA} (dBA)	Source
			63	125	250	500	1000	2000	4000	8000			
Secondary crusher	Secondary crusher	L_W	113.3	115.4	119.3	123.9	122.8	117.6	110.3		128.1	126.1	L_W Database
	Secondary screen	L_W	115.0	109.7	105.3	104.2	103.5	103.1	99.9		117.2	109.1	L_W Database
	Conveyor transfer (x5)	L_W	107.4	105.7	106.2	107.5	105.5	101.7	97.2		113.9	109.8	L_W Database
	Conveyor belt (x5)	L_W"	67.0	61.0	65.0	66.0	64.0	52.0	40.0		72.1	67.1	L_W Database
	Secondary crushing sump pump	L_W	81.5	82.5	84.5	84.5	87.5	84.5	80.5	74.5	92.7	91.1	L_W Predictions (Bruce & Moritz, 1998)
	Dust collection fan: primary and secondary crusher	L_W	95.2	97.2	96.2	95.2	95.2	91.2	87.2	80.2	103.3	99.0	L_W Predictions (Bruce & Moritz, 1998)
Area 0300 (stockpile area enclosed)	Conveyor transfer	L_W	107.4	105.7	106.2	107.5	105.5	101.7	97.2		113.9	109.8	L_W Database
	Conveyor belt	L_W"	67.0	61.0	65.0	66.0	64.0	52.0	40.0		72.1	67.1	L_W Database
DMS 2 and 3 circuits	New DMS 3 prep screen	L_W	113.3	109.0	108.4	108.4	108.2	105.8	102.4		117.4	112.6	L_W Database
	New drain and rinse screen	L_W	111.4	102.7	100.5	102.0	95.6	90.8	86.1		112.8	101.9	L_W Database
Roll crushers and ancillary circuits	New middlings re-crusher facility	L_W	113.0	113.0	115.0	119.0	111.0	106.0	98.0		122.3	117.9	L_W Database
Spiral Plant	Sump pump	L_W	81.5	82.5	84.5	84.5	87.5	84.5	80.5	74.5	92.7	91.1	L_W Predictions (Bruce & Moritz, 1998)
Water Services	Water supply pump	L_W	82.8	83.8	85.8	85.8	88.8	85.8	81.8	75.8	94.0	92.3	L_W Predictions (Bruce & Moritz, 1998)

Table 6: The directivity of the primary and secondary scrubber stack source

Description	Value	Unit
Stack height	5.5	m
Exit diameter	0.45	m
Exit velocity	16	m/s
Exit temperature	25	°C

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.

4.3 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 4.2, were applied in the model.

Table 7 provides a summary of simulated noise levels for the project operations at closest NSRs within the study area. Simulated noise levels due to project operations are also presented in isopleth form (Figure 15 and Figure 16).

Noise levels due to project operations are not predicted to exceed the IFC noise guidelines for residential areas at any potential NSR within the study area.

For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. The largest change to baseline noise levels, due to project operations, was predicted at the Uis Mining Village ~1.7 km east of the plant for day-time conditions (2.3 dBA). According to SANS 10103 (2008); this increase in noise levels is expected to be imperceptible.

Table 7: Summary of simulated noise levels (provided as dBA) for proposed project operations at NSRs within the study area

Noise Sensitive Receptor	Project operations [a]		Baseline		Increase Above Baseline [c]	
	Day	Night	Day	Night	Day	Night
Uis	18.2	19.2	39.2	44.1	0.0	0.0
Uis Mining Village ~1.7 km east of the plant	35.6	34.8	37.1	55.2	2.3	0.0
Tatamutsi	0	0	46.1	33.2	0.0	0.0
Individual homesteads at and to the east of sampling site 5 (NSR12, NSR13, NSR14, NSR15 – Figure 1)	0	0	32.9	47.5	0.0	0.0
Individual homesteads at sampling site 6 (NSR16 – Figure 1)	0	0	38.9	26.5	0.0	0.0
Individual homesteads ~1.6 km northwest of sampling site 5 (NSR0, NSR1, NSR2, NSR3, NSR4, NSR5, NSR6, NSR7 – Figure 1) (baseline measurements at site 5 assumed representative of the site)	0	0	32.9 [b]	47.5 [b]	0.0	0.0

Notes:

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

(b) Baseline measurements based on closest sampling sites.

(c) Likely community response in accordance with the SANS 10103:

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

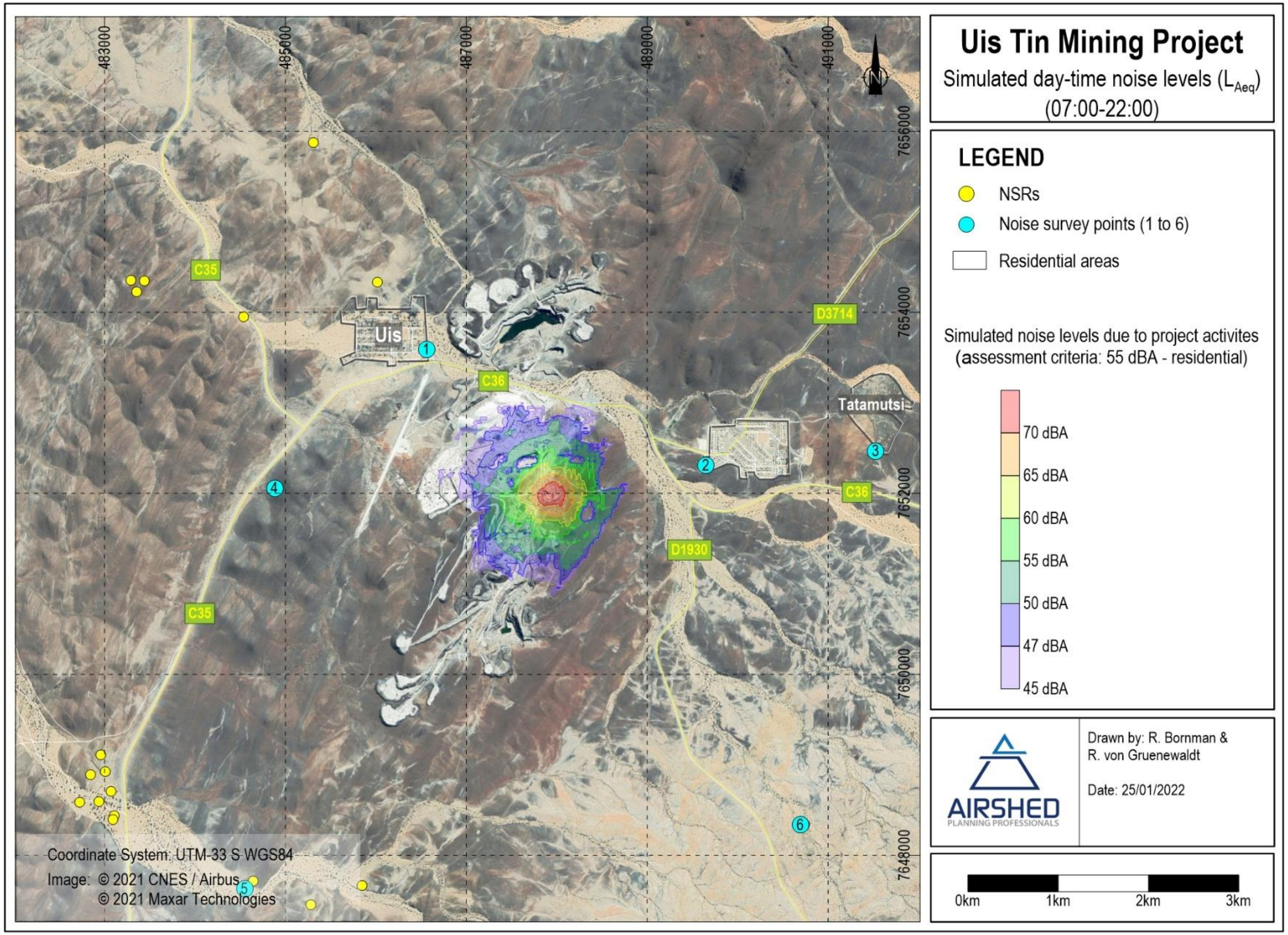


Figure 15: Simulated day-time noise levels due to proposed project operations

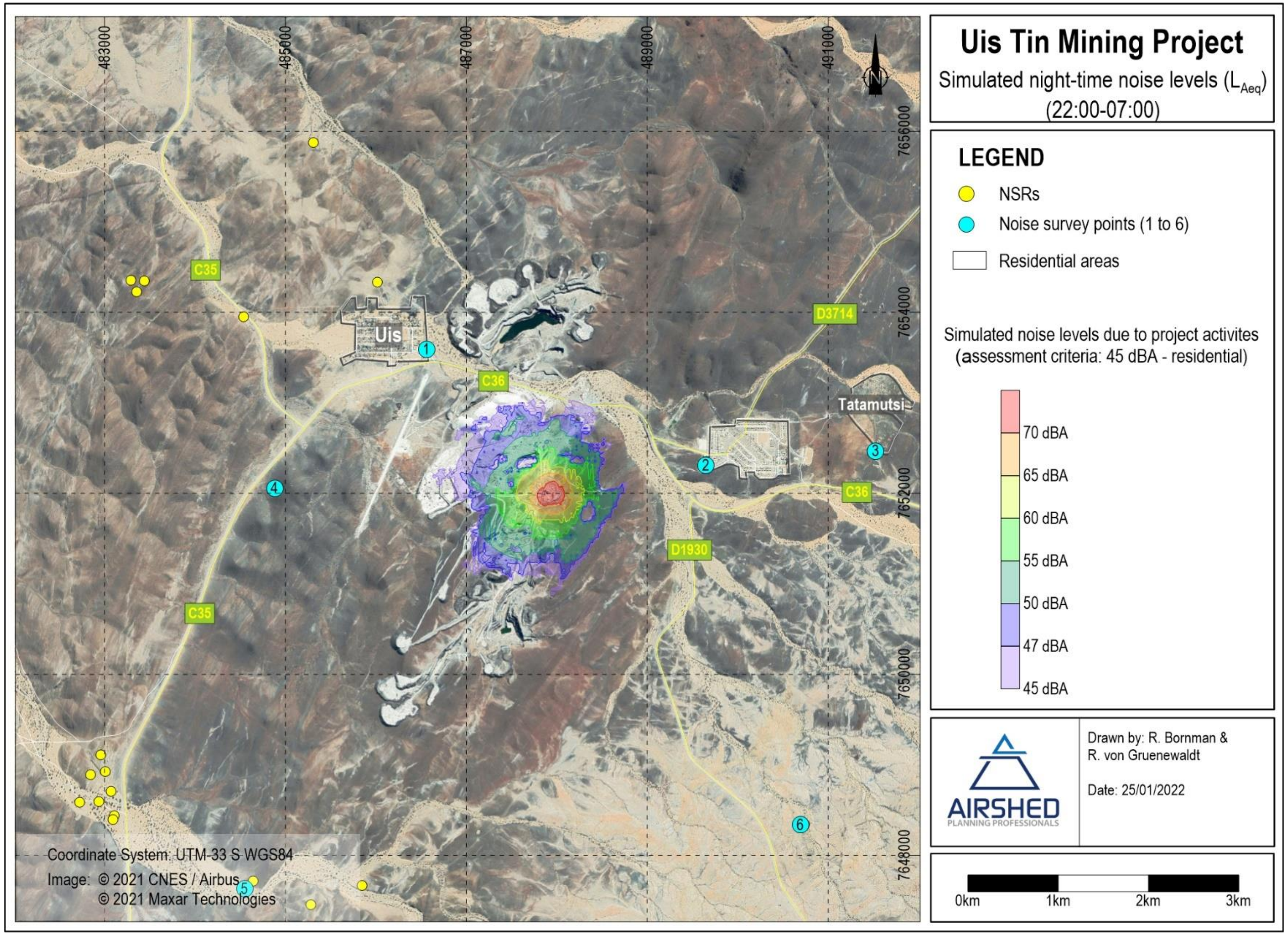


Figure 16: Simulated night-time noise levels due to proposed project operations

5 Impact Significance Rating

The significance of environmental noise impacts was assessed according to the methodology adopted by ECC.

Due to the proximity of potential NSRs to the project activities, the significance of construction, operation and decommissioning phase noise impacts is ***minor.*** The impact assessment has been provided in a separate impact assessment spreadsheet to ECC.

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 will be met at all off-site noise sensitive receptors.

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 (2008).

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:

- Unless it is an emergency situation, non-routine noisy activities such as construction, decommissioning, start-up and maintenance, should be limited to day-time hours.
- A complaints register, including the procedure which governs how complaints are received, managed and responses given, must be implemented, and maintained.

6.1.2 Specifications and Equipment Design

Equipment 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, sources of significant noise should be enclosed. The extent of enclosure will depend on the nature of the machine and their ventilation requirements. Pumps are examples of such equipment.

It should be noted that the effectiveness of partial enclosures and screens can be reduced if used incorrectly, e.g. noise should be directed into a partial enclosure and not out of it, 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

The following good practice should be implemented:

- Machines and mobile equipment 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.
- Acoustic covers of engines should be kept closed when in use or idling.
- Reduction of operational frequency of low-pressure compressors can be considered during night-time conditions to further reduce noise impacts.

6.1.5 Maintenance

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

6.2 Monitoring

In the event that noise related complaints are received short term ambient noise measurements, at the complainant, 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 (for complaints):

- 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

Based on the findings of the assessment and provided the recommended general "good practice" management and mitigation measures are in place, it is the specialist opinion that the project may be authorised.

8 References

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Brüel & Kjær Sound & Vibration Measurement A/S, 2000. *www.bksv.com.* [Online] Available at: http://www.bksv.com [Accessed 14 October 2011].

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IFC, 2007. *General Environmental, Health and Safety Guidelines,* s.l.: s.n.

Maritz, J. & Uludag, S., 2019. Developing a mining plan for restarting the operation at Uis Mine. *Journal of the South African Institute of Mining and Metallurgy,* Volume 119, pp. 621 - 630.

SANS 10103, 2008. *The measurement and rating of environmental noise with respect to annoyance and to speech communication,* Pretoria: Standards South Africa.

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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:
I, René von Gruenewaldt, declare that:

- I act as the independent specialist;
- I am conducting any work and activity relating to the proposed FCR plant and PGM flotation plant Project in an objective manner, even if this results in views and findings that are not favourable to the client;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have the required expertise in conducting the specialist report and I will comply with legislation and any guidelines that have relevance to the proposed activity;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority 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 competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this declaration are true and correct.

Signed at Pretoria on this 27th of January 2022

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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Calibration Laboratory
148
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

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.

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.

Calibrated by:	*Authorized/Checked by:*
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Director: Marianka Naudé

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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Director: Marianka Naudé

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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Director: Marianka Naudé

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

Calibrated by:	*Authorized/Checked by:*
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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 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-----------

Calibrated by:	*Authorized/Checked by:*
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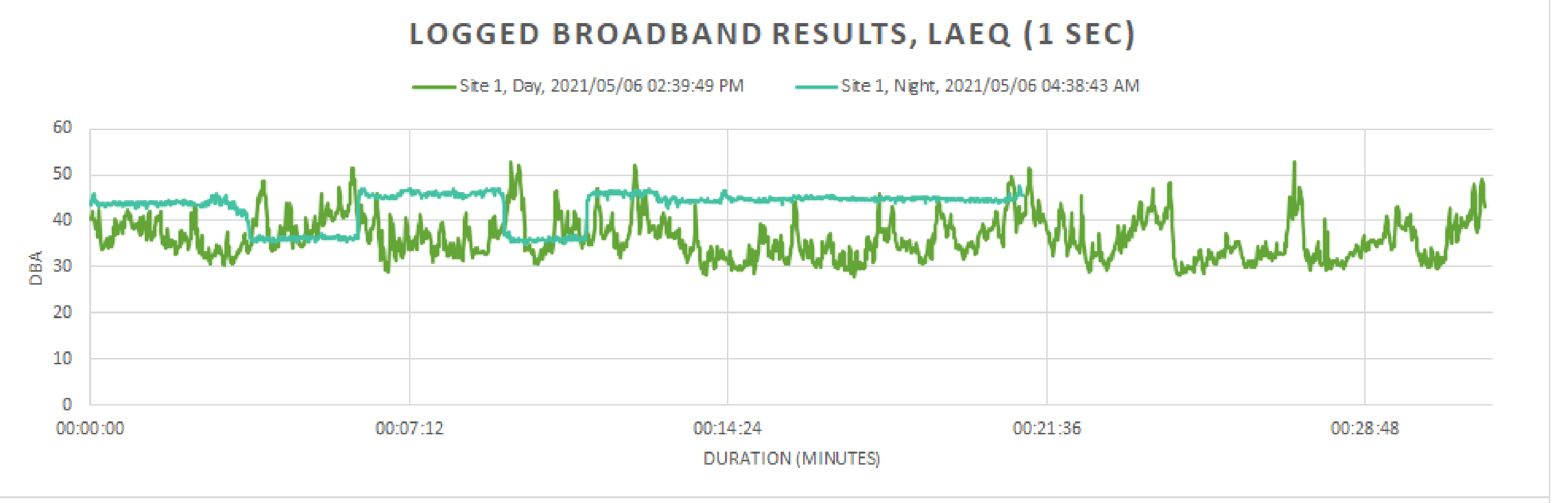
Director: Marianka Naudé

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



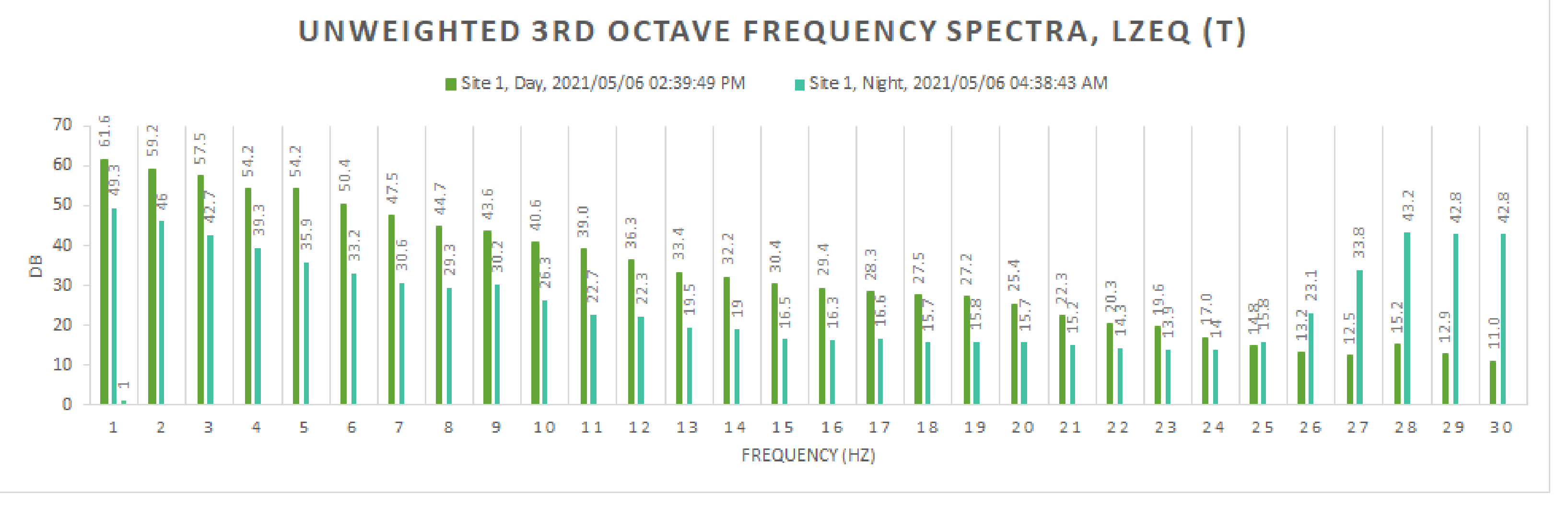


Figure 17: Detailed survey results for Site 1

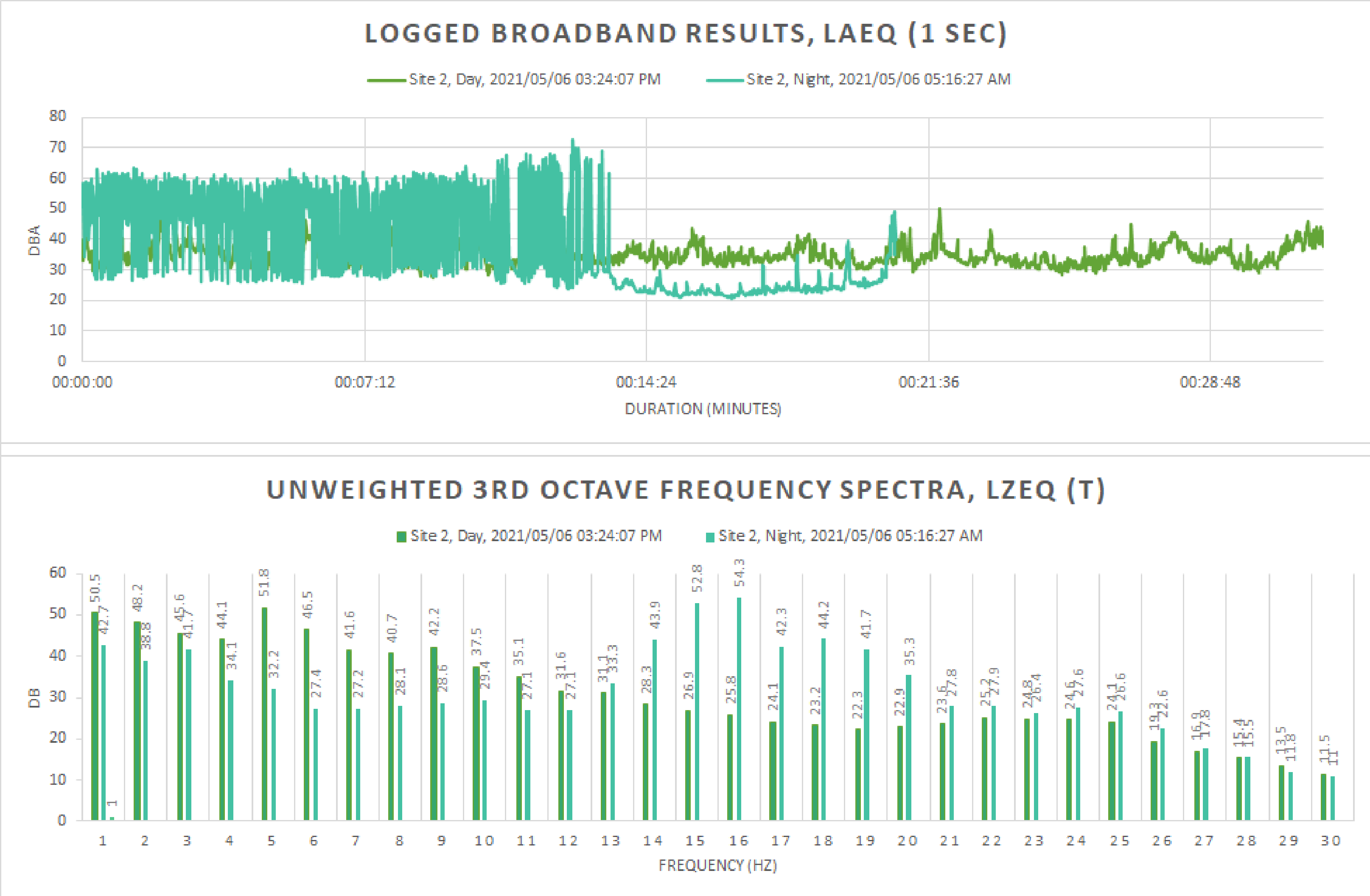


Figure 18: Detailed survey results for Site 2

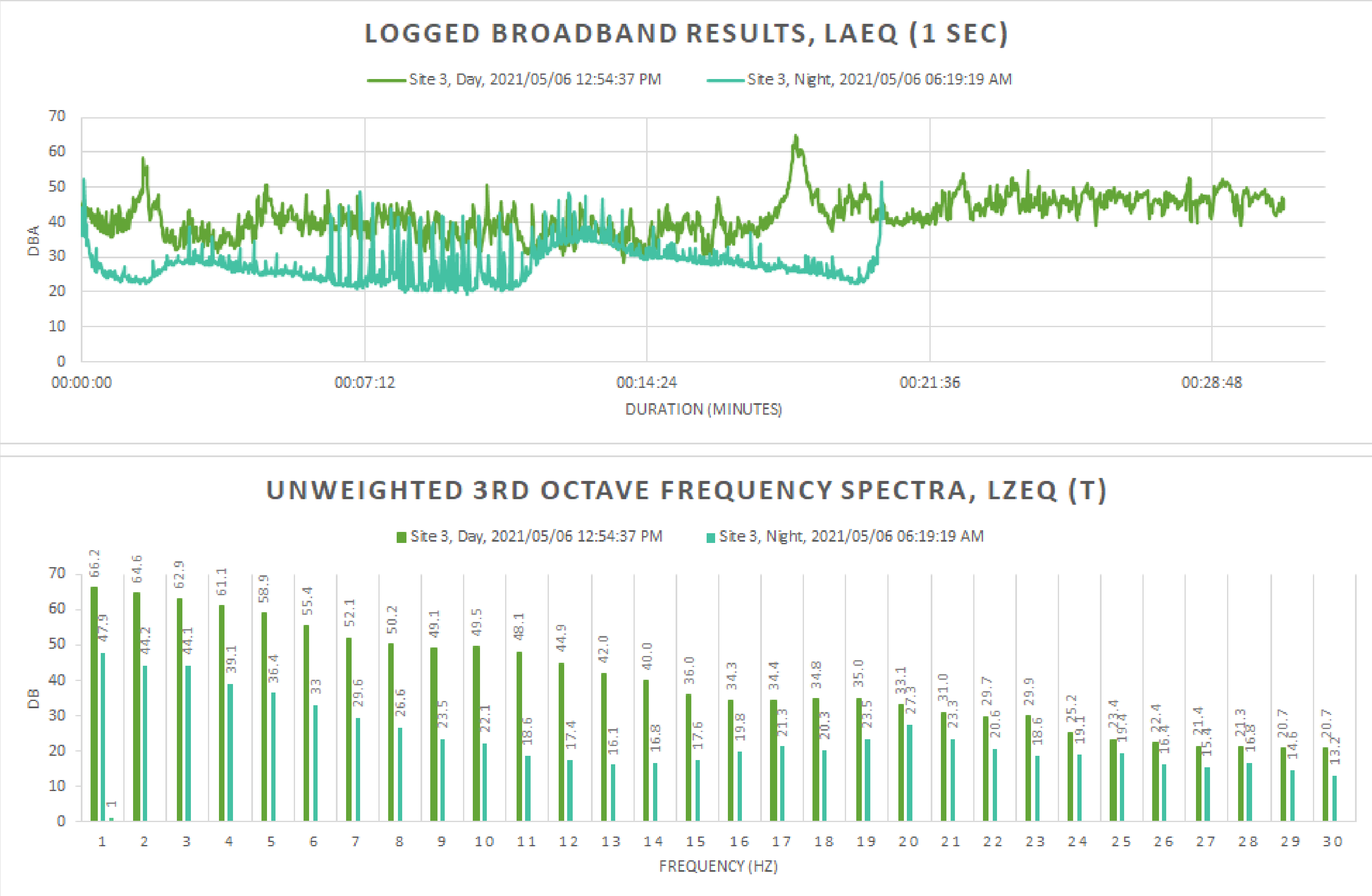


Figure 19: Detailed survey results for Site 3

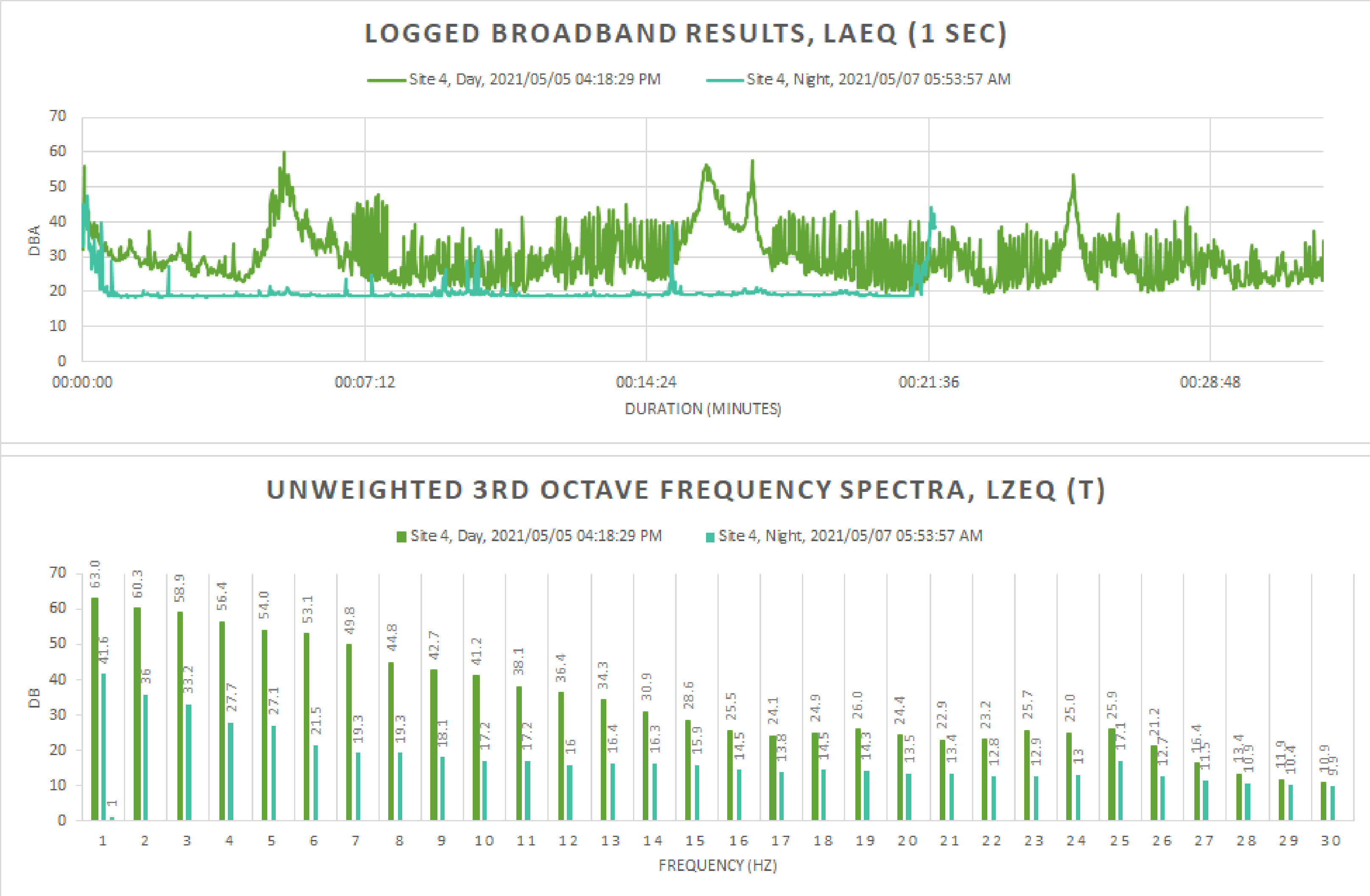


Figure 20: Detailed survey results for Site 4

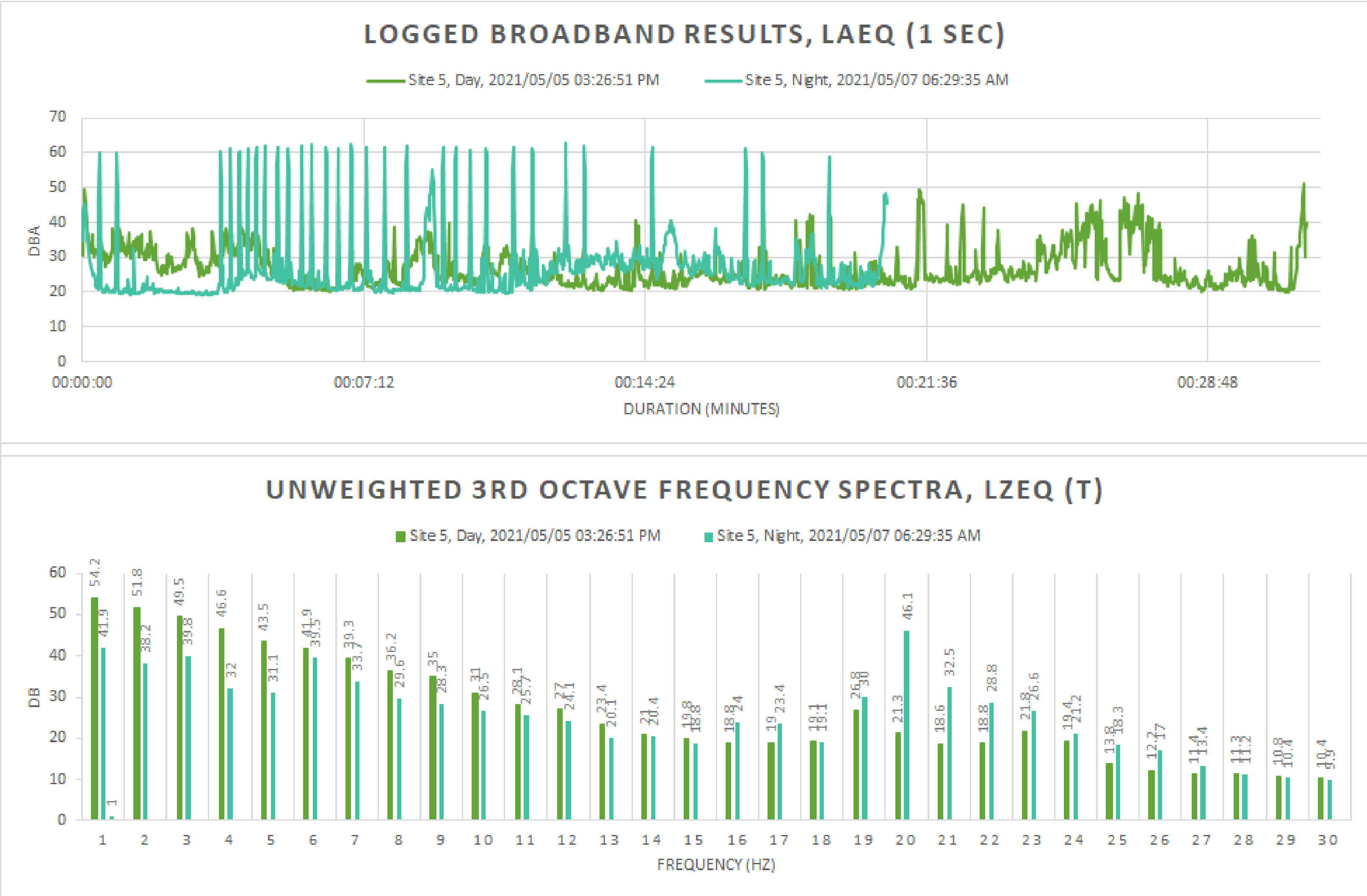


Figure 21: Detailed survey results for Site 5

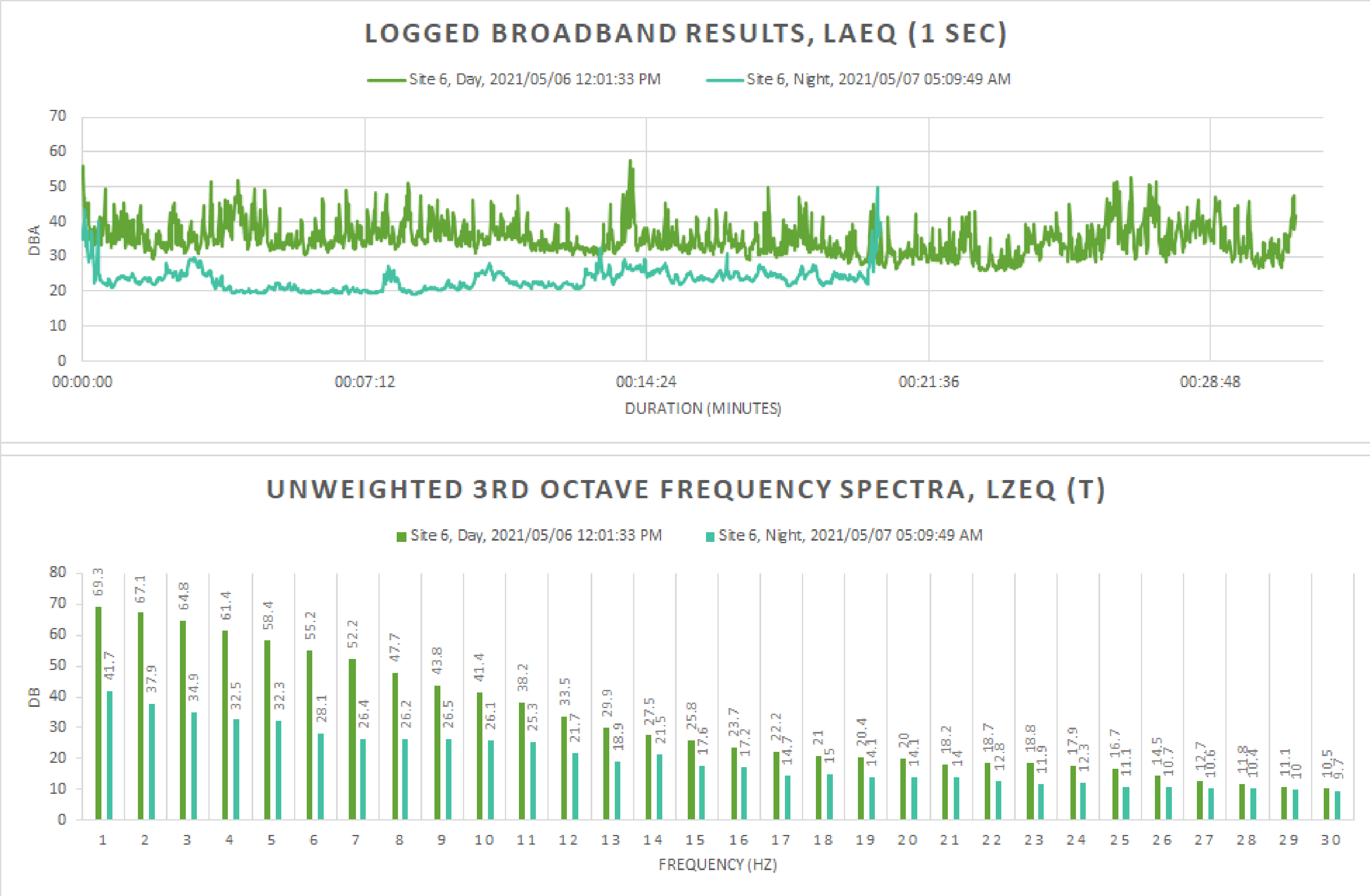


Figure 22: Detailed survey results for Site 6

Appendix E – Site Photographs

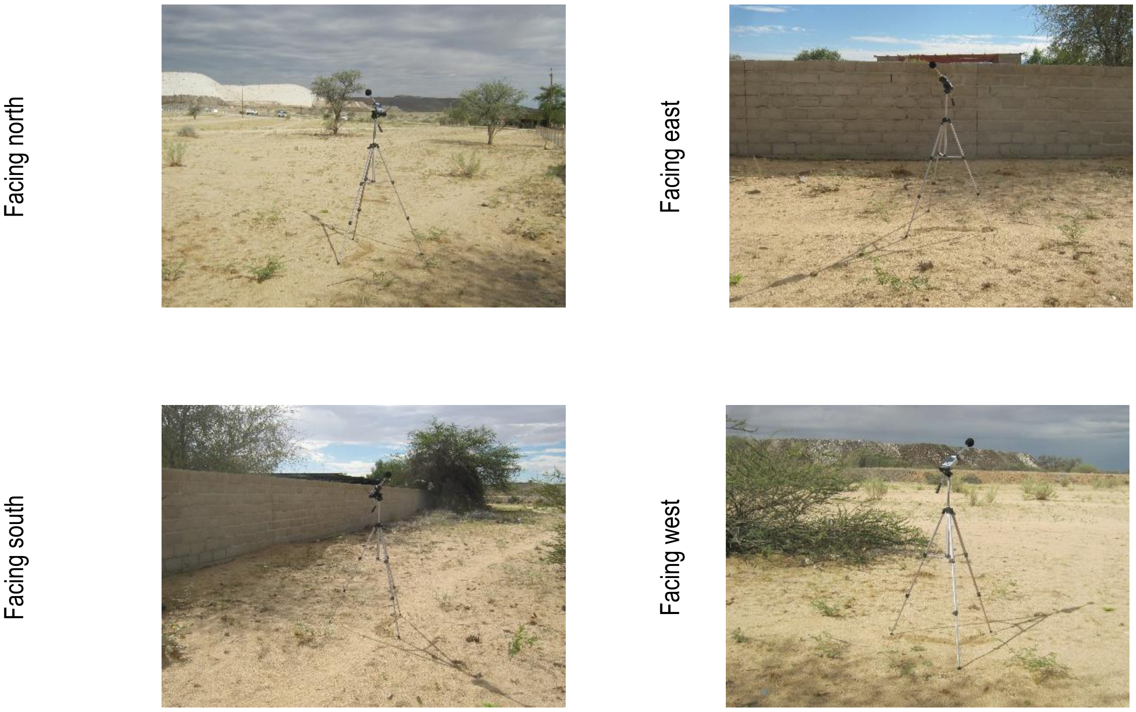


Figure 23: Photographs of environmental noise survey Site 1

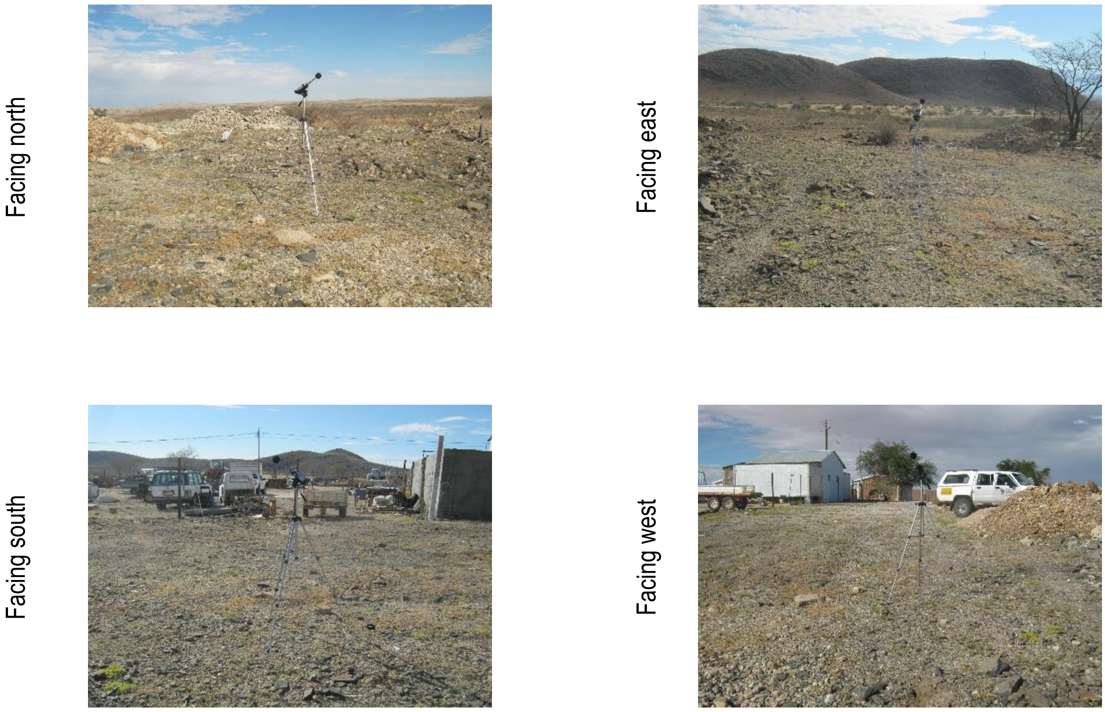


Figure 24: Photographs of environmental noise survey Site 2

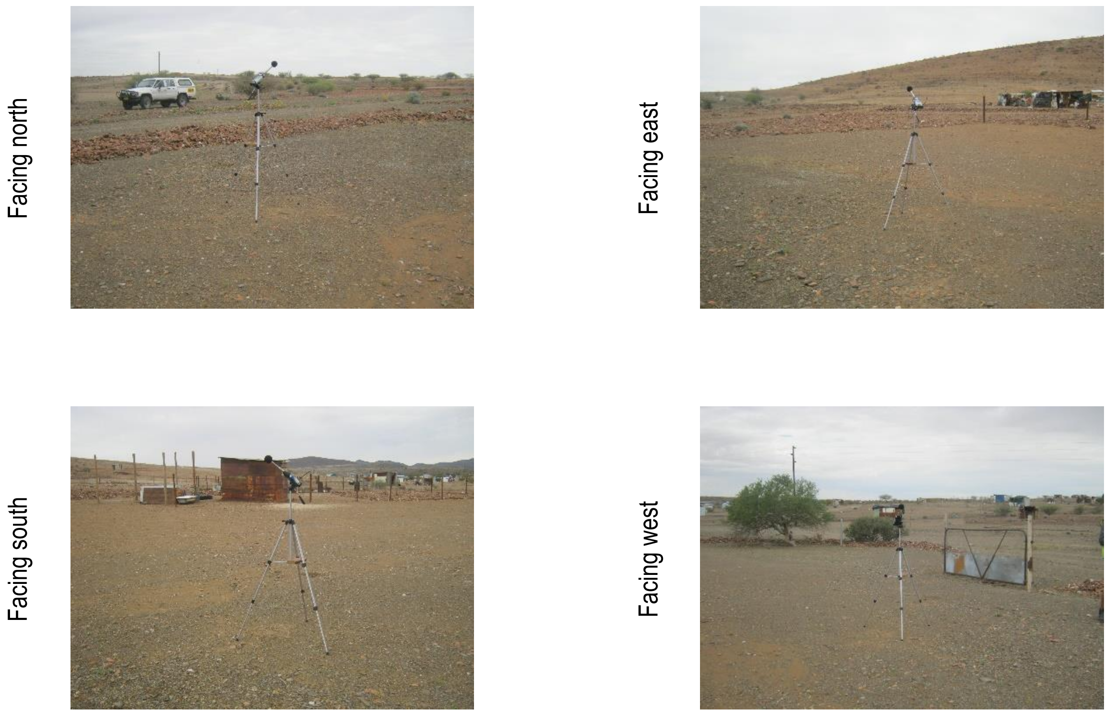


Figure 25: Photographs of environmental noise survey Site 3

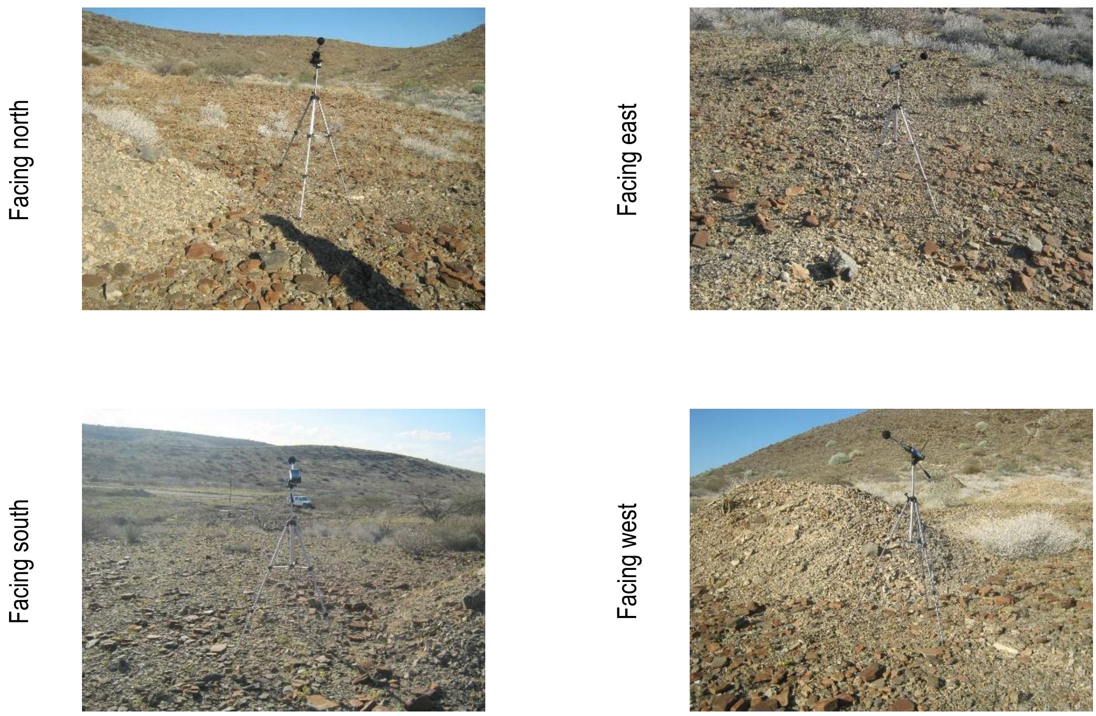
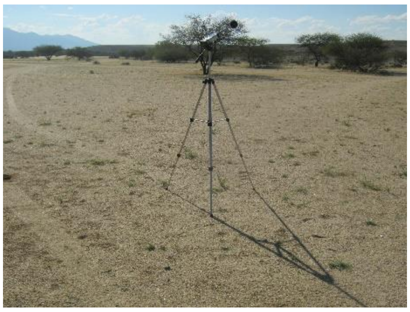


Figure 26: Photographs of environmental noise survey Site 4

Facing north

Facing east

Facing south



Facing west

Figure 27: Photographs of environmental noise survey Site 5

Facing north

Facing east

Facing south

Facing west

Figure 28: Photographs of environmental noise survey Site 6