## APPENDIX I: NOISE ASSESSMENT

# Gamsberg Smelter Project: Noise Specialist Study

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

**Report compiled by:**
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# Report Details

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# Revision Record

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| Rev 0.1 | April 2020 | Incorporation of client's comments |
| Rev 0.2 | July 2020 | Incorporation of client's comments |
| Rev 0.3 | August 2020 | Incorporation of client's comments |

# Glossary and Abbreviations

| | |
|---|---|
| **Airshed** | Airshed Planning Professionals (Pty) Ltd |
| **dB** | Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure. |
| **dBA** | Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure that has been A-weighted to simulate human hearing. |
| **EC** | European Commission |
| **EHS** | Environmental, Health, and Safety (IFC) |
| **Hz** | Frequency in Hertz |
| **IEC** | International Electro Technical Commission |
| **IFC** | International Finance Corporation |
| **ISO** | International Standards Organisation |
| **Kn** | Noise propagation correction factor |
| **K1** | Noise propagation correction for geometrical divergence |
| **K2** | Noise propagation correction for atmospheric absorption |
| **K3** | Noise propagation correction for the effect of ground surface; |
| **K4** | Noise propagation correction for reflection from surfaces |
| **K5** | Noise propagation correction for screening by obstacles |
| **kW** | Power in kilowatt |
| **$L_{Aeq}$ (T)** | The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA) |
| **$L_{AIeq}$ (T)** | The impulse corrected A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA) |
| **$L_{Req,d}$** | The $L_{Aeq}$ rated for impulsive sound and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00. |
| **$L_{Req,n}$** | The $L_{Aeq}$ rated for impulsive sound and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00. |
| **$L_{R,dn}$** | The $L_{Aeq}$ rated for impulsive sound and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10dB in order to account for the additional disturbance caused by noise during the night. |
| **$L_{A90}$** | The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the $L_{Aeq}$ could have been in the absence of noisy single events and is considered representative of background noise levels ($L_{A90}$) (in dBA) |
| **$L_{AFmax}$** | The A-weighted maximum sound pressure level recorded during the measurement period |
| **$L_{AFmin}$** | The A-weighted minimum sound pressure level recorded during the measurement period |
| **$L_P$** | Sound pressure level (in dB) |
| **Ltd** | Limited |
| **$L_W$** | Sound Power Level (in dB) |
| **masl** | Meters above sea level |
| **$m^2$** | Area in square meters |

| | |
|---|---|
| **m/s** | Speed in meters per second |
| **NLG** | Noise level guideline |
| **NSR** | Noise sensitive receptor |
| **p** | Pressure in Pa |
| **Pa** | Pressure in Pascal |
| **µPa** | Pressure in micro-pascal |
| **$p_{ref}$** | Reference pressure, 20 µPa |
| **Pty** | Proprietary |
| **SABS** | South African Bureau of Standards |
| **SANS** | South African National Standards |
| **SLM** | Sound Level Meter |
| **SoW** | Scope of Work |
| **STRM** | Shuttle Radar Topography Mission |
| **USGS** | United States Geological Survey |
| **WG-AEN** | Working Group – Assessment of Environmental Noise (EC) |
| **WHO** | World Health Organisation |
| **WRF** | The Weather Research and Forecasting (WRF) Model |
| **%** | Percentage |

# Executive Summary

Black Mountain Mining (Pty) Ltd, part of Vedanta Zinc International, owns and operates the Gamsberg Zinc Mine. An Environmental Impact Assessment (EIA) process was completed in 2013 (and approved on 12 August 2013 – Permit 43/2013) and amended on 2 December 2014 (Permit 43/2013 Amendment 2) (Ref: NC/EIA/NAM/KHA/AGG/2012), a Waste Management Licence (Ref: 12/9/11/L955/8); and Water Use Licence (Ref:14/D82C/ABCGI/2654)) for their open pit mining activities and concentrator plant have also been issued. The Gamsberg Zinc Mine has been in operation since June 2016 and is currently mining up to 4 million tonnes per annum (Mtpa) and producing up to 250 000 tonnes per annum (tpa) of zinc concentrate for export. Phase 2 will expand the mining capacity to 10 Mtpa and include the construction of the second concentrator plant. The Gamsberg Zinc Mine is located in the Northern Cape Province of South Africa, approximately 14 km east of the town of Aggeneys and 120 km east of Springbok along the N14.

Black Mountain Mining (Pty) Ltd is now proposing to construct a new zinc smelter and associated infrastructure to produce 300 000 tpa special high-grade zinc metal by processing 680 000 tpa of zinc concentrate (Gamsberg Smelter Project). As a by-product 450 000 tpa of pure sulphuric acid will be produced for both export and consumption within South Africa.

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

The main objective of the noise specialist study was to determine the potential impact on the acoustic environment and noise sensitive receptors (NSRs) as a result of the development of the proposed Gamsberg Smelter project 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 on 9 and 10 September 2019.
4. An impact assessment, including:
    a. The establishment of a source inventory for proposed activities.
    b. Noise propagation simulations to determine environmental noise levels as a result of the project.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. The preparation of a comprehensive specialist noise impact assessment report.

In the assessment of simulated noise levels, reference was made to the IFC noise level guidelines for residential, institutional and educational receptors (55 dBA during the day and 45 dBA during the night) which is also in line with the SANS 10103 rating for urban districts.

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

- The closest NSRs include a residential development ~4 km to the west and northwest of the project.
- The lowest baseline noise levels (as measured during the survey) were 23 dBA during the day and 29 dBA during the night.

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

The source inventory, local meteorological conditions and information on local land use were used to populate the noise propagation model (CadnaA, ISO 9613). The propagation of noise was calculated over an area of 5.2 km east-west by 5.1 km north-south. The area was divided into a grid matrix with a 10-m resolution.

The main findings of the impact assessment are:

- A general management and mitigation plan, as stipulated in Section 5, are recommended to minimise noise impacts from the project on the surrounding area.
- The noise levels due to the project operations are within IFC guidelines at the closest NSR, approximately 3.5 km to the west of the project.
- Construction and closure phase impacts are expected to be similar or slightly lower than simulated noise impacts of the operational phase.
- The significance of the project is low to very low.

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

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# 1 Introduction

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

The location of the project and the proposed layout 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.

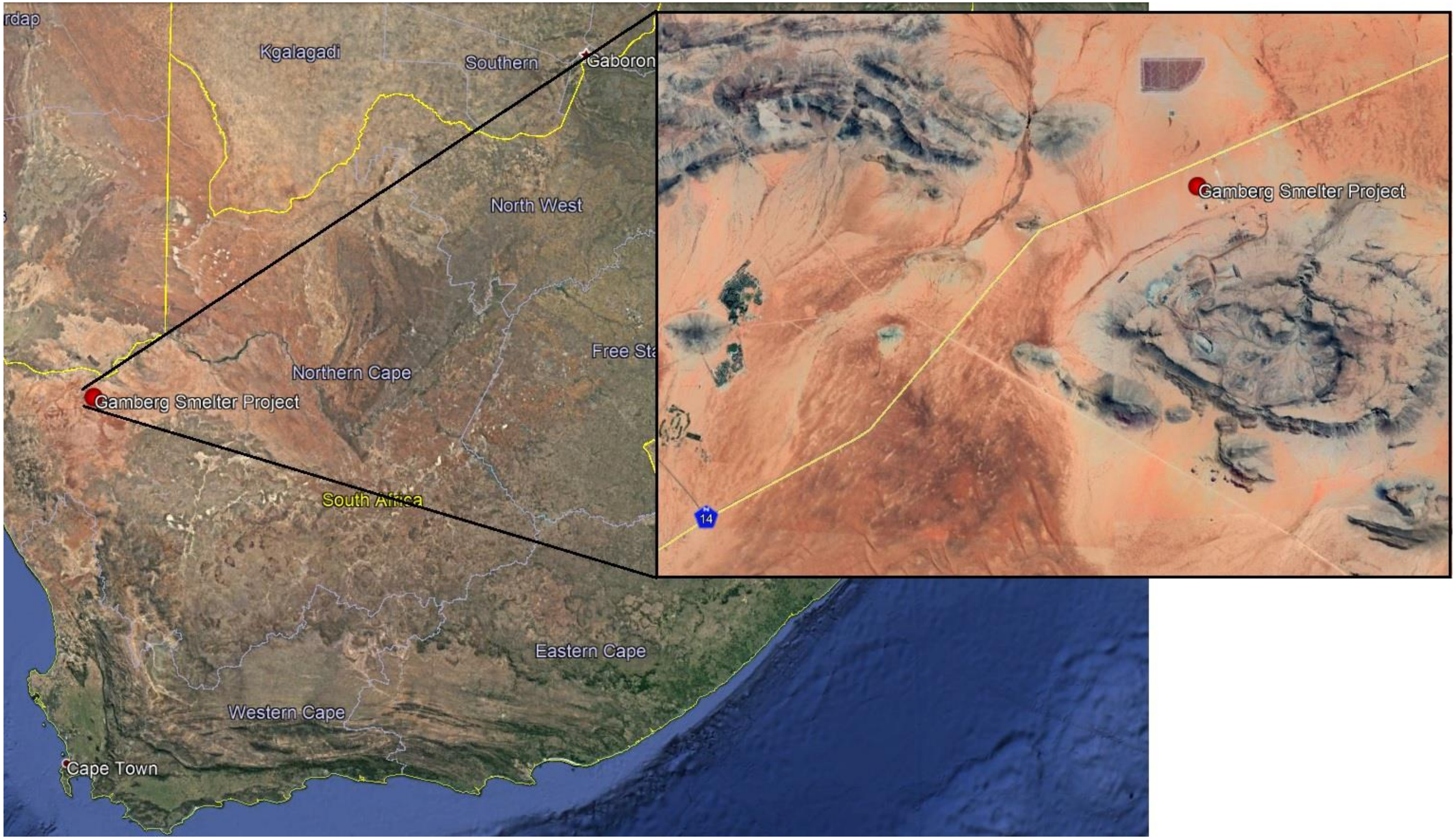


*Figure 1: Location of the proposed project*

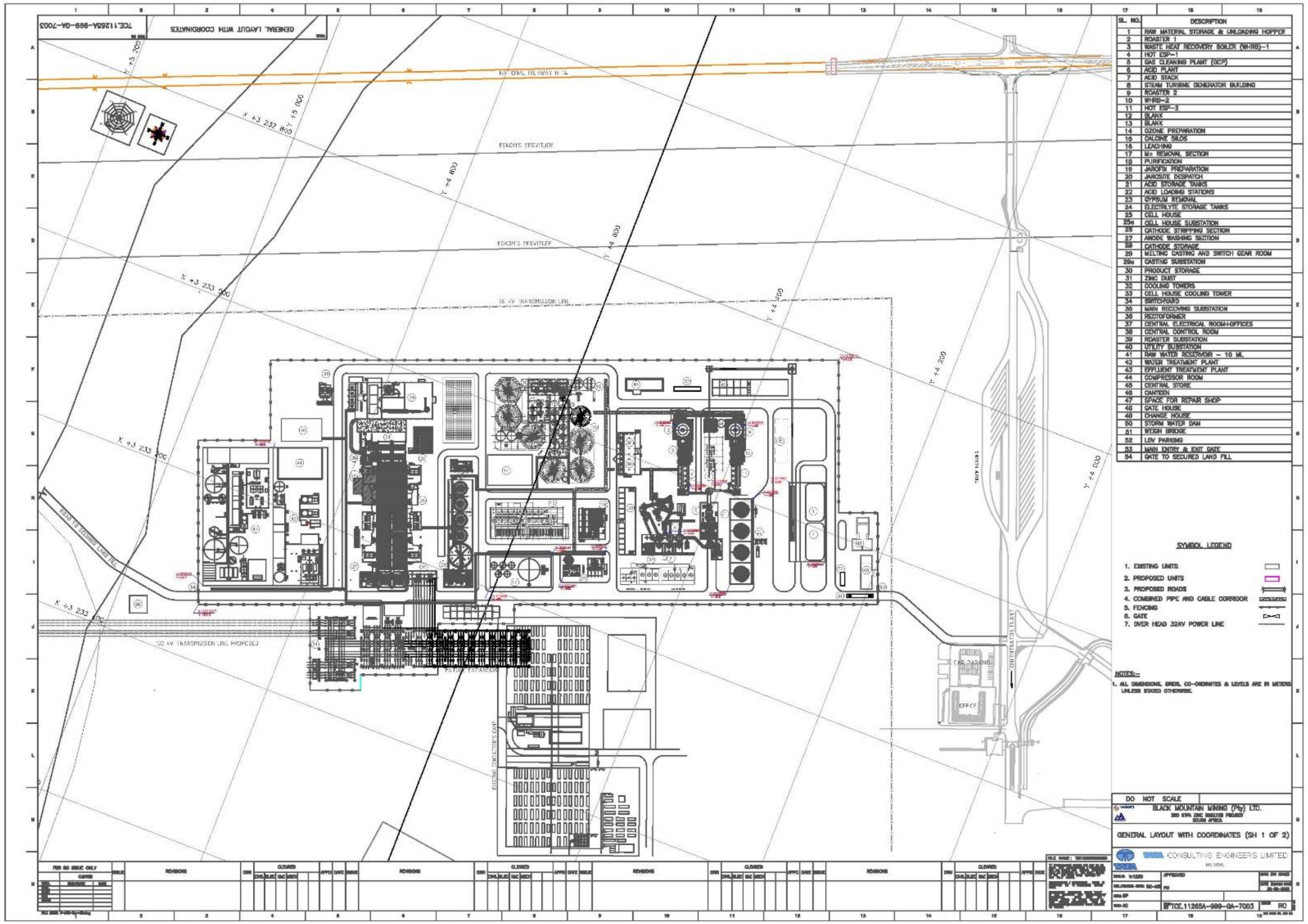


*Figure 2: Layout of the proposed project*

## 1.2 Scope of Work

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

1. A review of available technical project information.
2. A review of the legal requirements and applicable environmental noise guidelines.
3. A study of the receiving (baseline) acoustic environment, including:
    a. The identification of NSRs from available maps and field observations.
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5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. The preparation of a comprehensive specialist noise impact assessment report.

## 1.3 Specialist Details

### 1.3.1 Specialist Details

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

### 1.3.2 Competency Profile of Specialist

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

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

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

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

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

## 1.4 Description of Activities from a Noise Perspective

Sources of noise at the proposed project are expected to include:

- Stacks.
- Rotating machinery such as motors, pumps, fans, etc. For a given machine, the sound pressure level ('emission') depends on the proportion of the total mechanical or electrical energy that is transformed into acoustical energy.
- Roaster and casting.
- Other: Transport of material.

It is understood that the raw material will be located in a concentrate shed. The electrowinning and cast house will be cladded. This will provide acoustic shielding to the outside through absorption of acoustic energy and transmission losses.

## 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).*

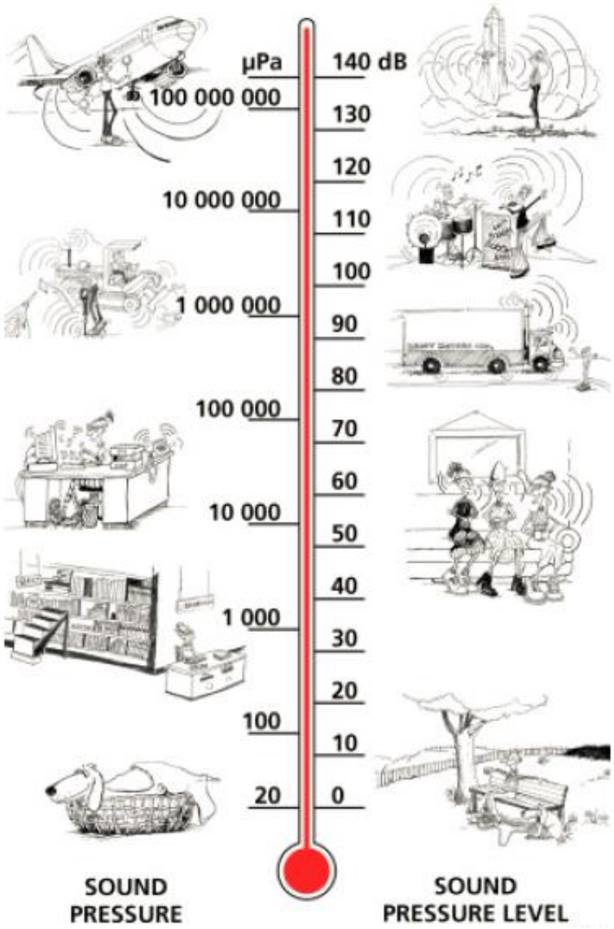



*Figure 3: The decibel scale and typical noise levels (Brüel & Kjær Sound & Vibration Measurement A/S, 2000)*

### 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.

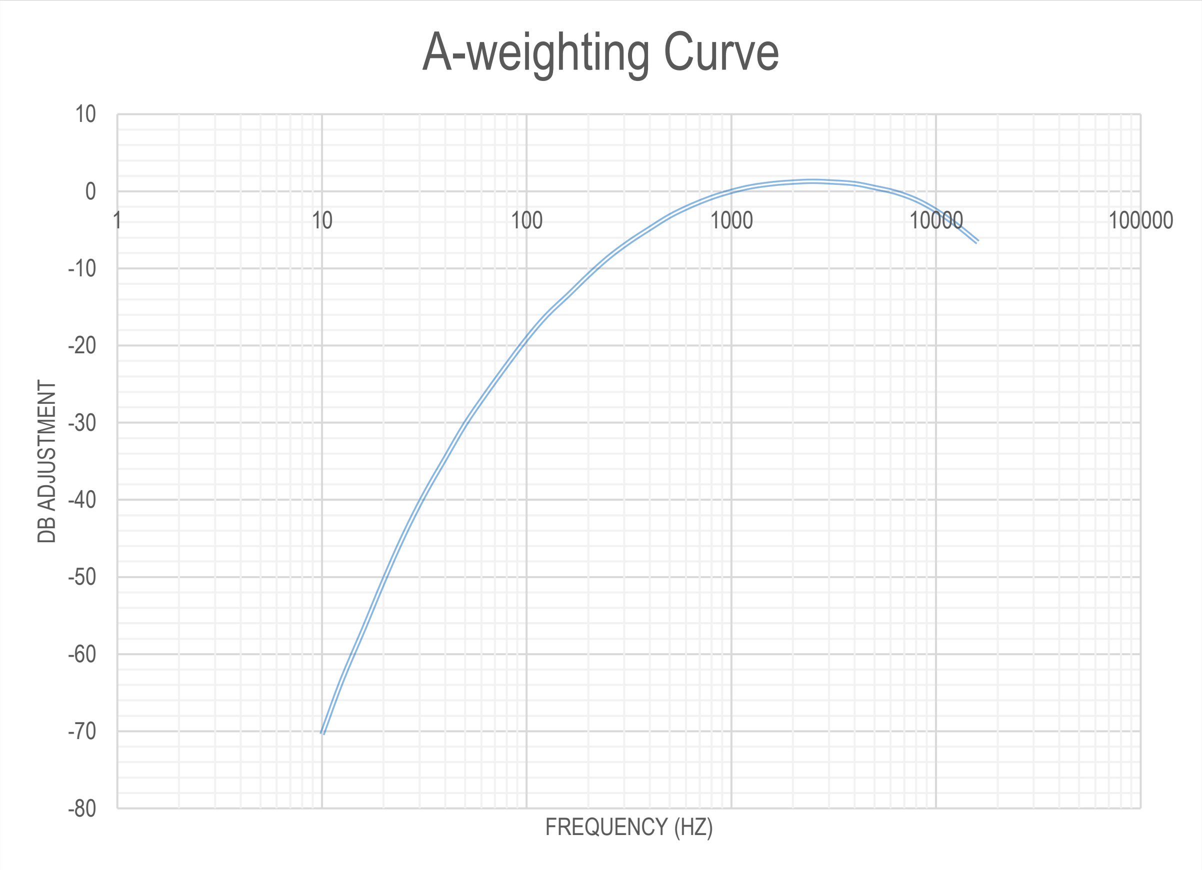



*Figure 4: A-weighting curve*

### 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:

- **$L_{Zeq}$ (T)** – The unweighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured).
- **$L_{Aeq}$ (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.

## 1.6 Approach and Methodology

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

### 1.6.1 Information Review

An information requirements list was sent to SLR Consulting (South Africa) (Pty) Ltd at the onset of the project. In response to the request, the following information was supplied:

- Layout maps;
- A process description; and,
- Mobile and non-mobile equipment details.

### 1.6.2 Review of Assessment Criteria

In South Africa, provision is made for the regulation of noise under the National Environmental Management Air Quality Act (NEMAQA) (Act. 39 of 2004) but environmental noise limits have yet to be set. It is believed that when published, national criteria will make extensive reference to SANS 10103 of 2008 '*The measurement and rating of environmental noise with respect to annoyance and to speech communication*'. This standard has been widely applied in South Africa and is frequently used by local authorities when investigating noise complaints. These guidelines, which are in line with those published by the IFC in their *General EHS Guidelines* (IFC 2007) and World Health Organisation (WHO) *Guidelines for Community Noise* (WHO 1999), were considered in the assessment.

### 1.6.3 Study of the Receiving Environment

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

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

Readily available terrain data was obtained from the United States Geological Survey (USGS) web site (https://earthexplorer.usgs.gov/) accessed on October 2019. A study was made of Shuttle Radar Topography Mission (STRM) 1 arc-sec data.

### 1.6.4 Noise Survey

The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in an area. Higher ambient noise levels will result in less noticeable noise impacts and a smaller impact area. The opposite also holds true. Increases in noise will be more noticeable in areas with low ambient noise levels. The data from a baseline noise surveys conducted on 9 and 10 September 2019 was studied to determine current noise levels within the area.

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

- The survey was designed and conducted by a trained specialist.
- Sampling was carried out using a Type 1 sound level meter (SLM) that meet all appropriate International Electrotechnical Commission (IEC) standards and is subject to calibration by an accredited laboratory (Appendix B). Equipment details are included in Table 1.
- The acoustic sensitivity of the SLM was tested with a portable acoustic calibrator before and after each sampling session.
- Samples, 15 to 30 minutes minutes in duration, representative and sufficient for statistical analysis were taken with the use of the portable SLM capable of logging data continuously over the sampling time period. Samples representative of the day- and night-time acoustic environment were taken. SANS 10103 defines day-time as between 06:00 and 22:00 and night-time between 22:00 and 06:00 (SANS 10103, 2008).
- $L_{Aleq}$ (T), $L_{Aeq}$ (T); $L_{AFmax}$; $L_{AFmin}$; $L_{90}$ and 3rd octave frequency spectra were recorded.
- The SLM was located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- SANS 10103 states that one must ensure (as far as possible) that the measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer.
- A detailed log and record were kept. Records included site details, weather conditions during sampling and observations made regarding the acoustic environment of each site (Appendix C).

*Table 1: Sound level meter details*

| Equipment | Serial Number | Purpose | Last Calibration Date |
|---|---|---|---|
| **Brüel & Kjær Type 2250 Lite SLM** | S/N 2731851 | Attended 30-minute sampling. | Not Applicable |
| Brüel & Kjær Type 4950 ½” Pre-polarized microphone | S/N 3177677 | Attended 30-minute sampling. | 24 July 2018 |
| SVANTEK SV33 Class 1 Acoustic Calibrator | S/N 57649 | Testing of the acoustic sensitivity before and after each daily sampling session. | 20 September 2018 |
| Kestrel 4000 Pocket Weather Tracker | S/N 559432 | Determining wind speed, temperature and humidity during sampling. | Not Applicable |

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

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

Where

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

### 1.6.5 Source Inventory

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

Construction and decommissioning activities are expected to result in noise impacts similar to or less significant than impacts associated with the operational phase. Due to the nature of these phases, the noise levels would also vary from one day to the next. 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.

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.

#### *1.6.6.1 Simulation Domain*

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

The propagation of noise was calculated over an area of 5.2 km east-west by 5.1 km north-south and encompasses the proposed project site. The area was divided into a grid matrix with a 10 m resolution. The model was set to calculate $L_P$'s at each grid and discrete receptor point at a height of 1.5 m above ground level.

### 1.6.7 Presentation of Results

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

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

### 1.6.8 Recommendations of Management and Mitigation

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

### 1.6.9 Impact Significance Assessment

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

## 1.7 Management of Uncertainties

The following limitations and assumptions should be noted:

- 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.
- The assessment is based on the list of equipment and information provided by SLR Consulting (South Africa) (Pty) Ltd. The assumption is that this information is correct and reflects the routine operational phase of the project.
- Estimates of road traffic were made with the provided truck information. The vehicle speeds and road conditions were assumed. Trucks were assumed to travel at 40 km/h on access road and 15 km/h onsite.
- Process activities were assumed to be 24 hours per day, 7 days per week.
- Although other existing sources of noise within the area were identified during the survey, such sources were not quantified but were taken into account during the baseline sampling.

# 2 Legal Requirements and Noise Level Guidelines

## 2.1 National Noise Control Regulations

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

## 2.2 South African National Standards

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

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

**Notes**

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

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

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

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

- "Δ ≤ 0 dB: There will be no community reaction;
- 0 dB < Δ ≤ 10 dB: There will be 'little' reaction with 'sporadic complaints';
- 5 dB < Δ ≤ 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 < Δ ≤ 20 dB: There will be a 'strong' reaction with 'threats of community action'; and
- 15 dB < Δ: There will be a 'very strong' reaction with 'vigorous community action'.

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

## 2.3 International Finance Corporation Guidelines on Environmental Noise

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

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

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

*Table 3: IFC noise level guidelines*

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

## 2.4 Regulations Regarding Report Writing

This report complies with the requirements of the National Environmental Management Act, 1998 (NEMA, No 107 of 1998) and the environmental impact assessment (EIA) regulations (GNR 982 of 2014), as amended in 2017. The table below provides a summary of the requirements, with cross references to the report sections where these requirements have been addressed.

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

| A specialist report prepared in terms of the Environmental Impact Regulations of 2014 (as amended in 2017) must contain: | Relevant section in report |
|---|---|
| Details of the specialist who prepared the report | Section 1.3 |
| The expertise of that person to compile a specialist report including a curriculum vitae | Section 1.3.2<br>Appendix A |
| A declaration that the person is independent in a form as may be specified by the competent authority | Section 1.3.1 |
| An indication of the scope of, and the purpose for which, the report was prepared | Section 1.2 |
| An indication of the quality and age of base data used for the specialist report; | Section 3.2<br>Section 3.3 |
| A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change | Section 4 |
| The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment | Section 3.3<br>Section 4.2 |
| A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used; | Section 1.6 |
| Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternative; | Section 3.1 |
| An identification of any areas to be avoided, including buffers | Section 3.1<br>Section 4.2 |
| A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers; | Section 4.2 |
| A description of any assumptions made and any uncertainties or gaps in knowledge; | Section 1.7 |
| A description of the findings and potential implications of such findings on the impact of the proposed activity or activities | Section 4.2 |
| Any mitigation measures for inclusion in the EMPr | Section 5 |
| Any conditions for inclusion in the environmental authorisation | Section 5 |
| Any monitoring requirements for inclusion in the EMPr or environmental authorisation | Section 5 |
| A reasoned opinion as to whether the proposed activity or portions thereof should be authorised | Section 7 |
| Regarding the acceptability of the proposed activity or activities; and | Section 4.2 |
| If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan | Section 4.2<br>Section 5<br>Section 7 |
| A description of any consultation process that was undertaken during the course of carrying out the study | Not applicable |
| A summary and copies if any comments that were received during any consultation process | None received |
| Any other information requested by the competent authority. | None received |

# 3 Description of the Receiving Environment

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

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

## 3.1 Noise Sensitive Receptors

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

As mentioned in Section 1.5.4, the impact of an intruding industrial/mining noise on the environment rarely extends over more than 5 km from the source. Potential noise sensitive receptors within the project area (indicated in Figure 5), include individual homesteads, residential areas (i.e. Aggeneys), areas of industrial activities and recreational areas.

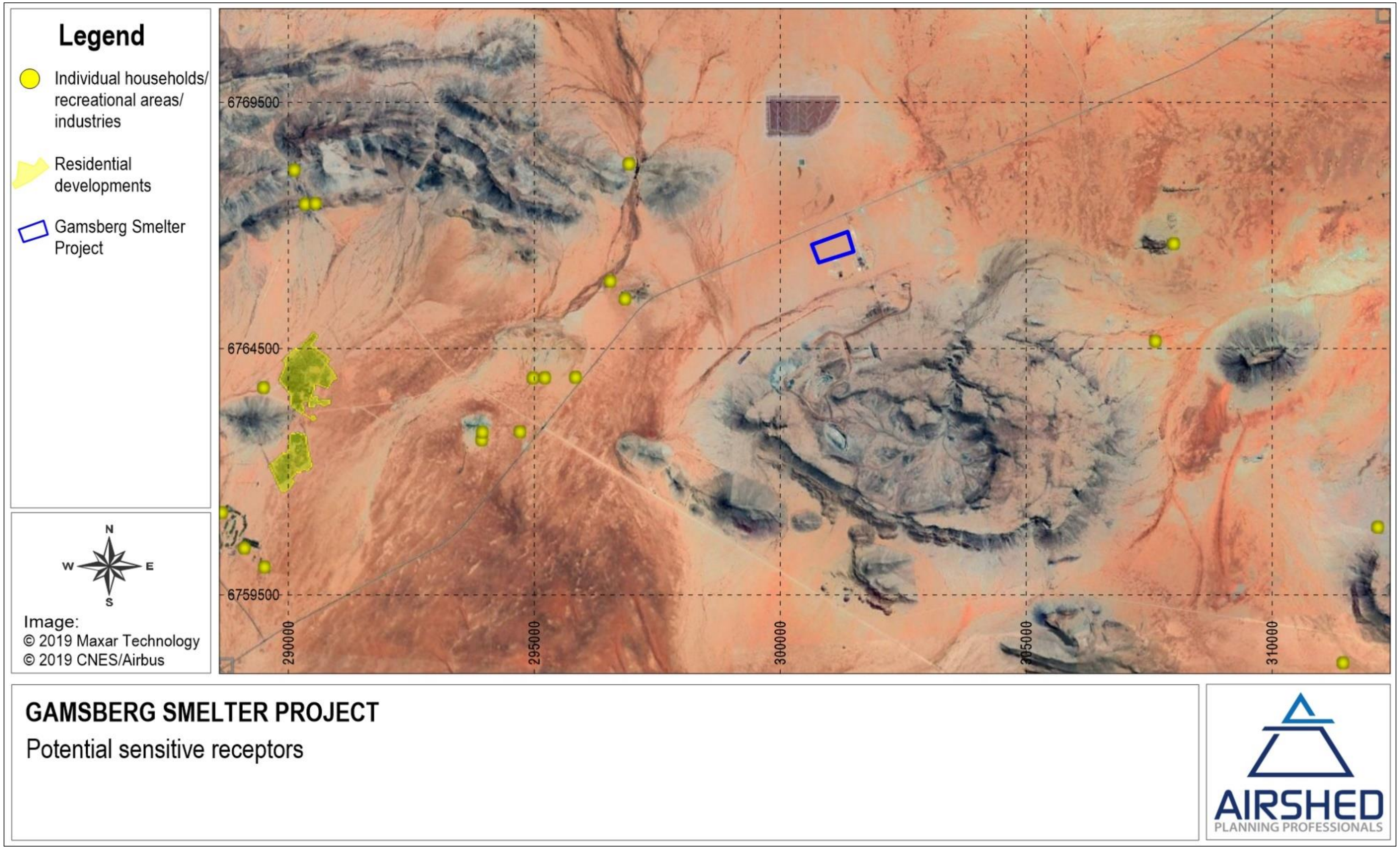



*Figure 5: Sensitive receptors within the study area*

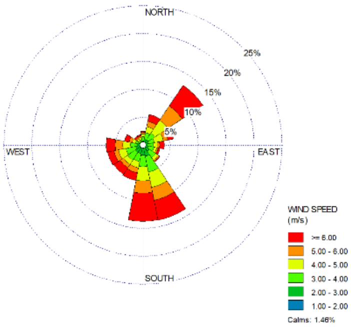
## 3.2 Environmental Noise Propagation and Attenuation potential

### 3.2.1 Atmospheric Absorption and Meteorology

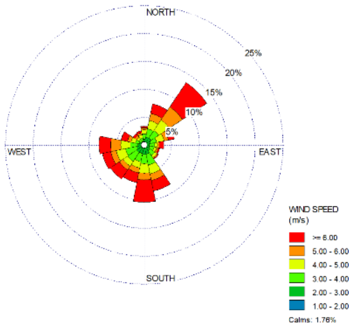
Atmospheric absorption and meteorological conditions have already been mentioned with regards to their role in the propagation of noise from a source to receiver (Section 1.5.4). The main meteorological parameters affecting the propagation of noise include wind speed, wind direction and temperature.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

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

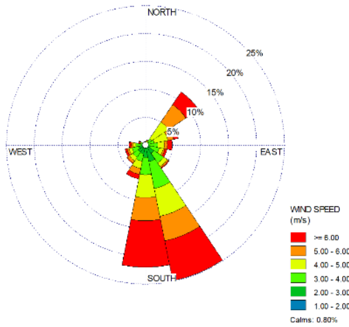
Weather Research and Forecasting (WRF)[1] data for the period 2016 to 2018 was used for the assessment. The modelled data set indicates wind flow primarily from the south, south-southeast and northeast (Figure 6 (a)). During the day, the predominant wind direction is from the southwestern sector and the north-northeast while during the night the predominant wind direction is from the south, south-southeast and northeast. On average, noise impacts are expected to be more notable north and southwest of the project activities.




(a) Period average wind rose




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




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

*Figure 6: Wind rose for WRF data, 1 January 2016 to 31 December 2018*

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

[1] The Weather Research and Forecasting (WRF) Model is a next-generation mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting applications. It features two dynamical cores, a data assimilation system, and a software architecture supporting parallel computation and system extensibility. The model serves a wide range of meteorological applications across scales from tens of meters to thousands of kilometres.

night, temperatures may increase with altitude thereby 'focusing' sound on the ground surface. Noise impacts are therefore generally more notable during the night (Figure 7).

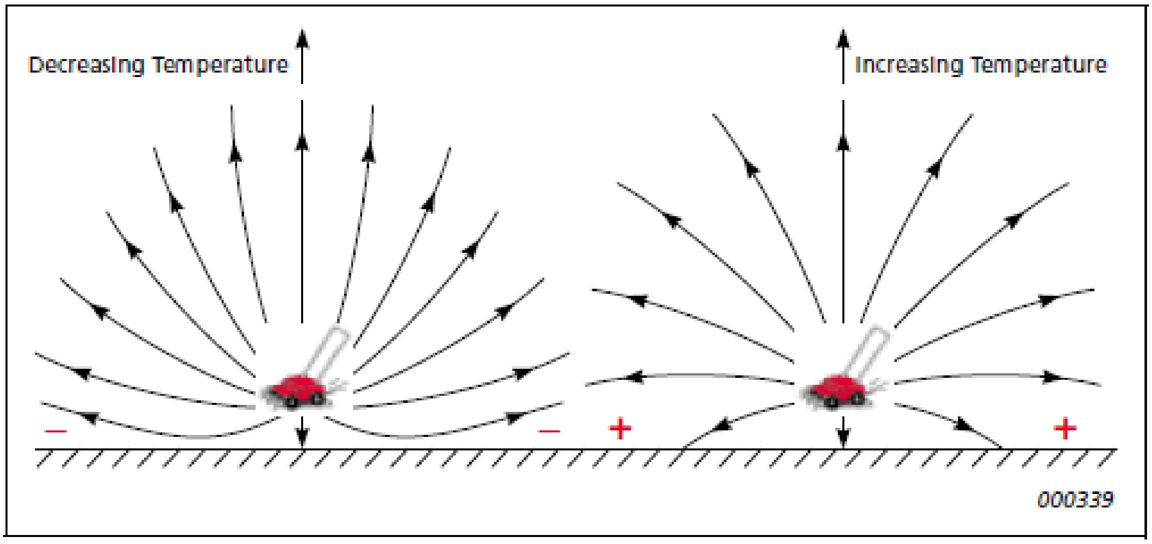



*Figure 7: Bending the path of sound during typical day time conditions (image provided on the left) and night-time conditions (image provided on the right)*

### 3.2.2 Terrain, Ground Absorption and Reflection

Noise reduction caused by a barrier (i.e. natural terrain, installed acoustic barrier, building) feature depends on two factors namely: the path difference of a sound wave as it travels over the barrier compared with direct transmission to the receiver and the frequency content of the noise (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). The topography for the study area is provided in Figure 8.

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

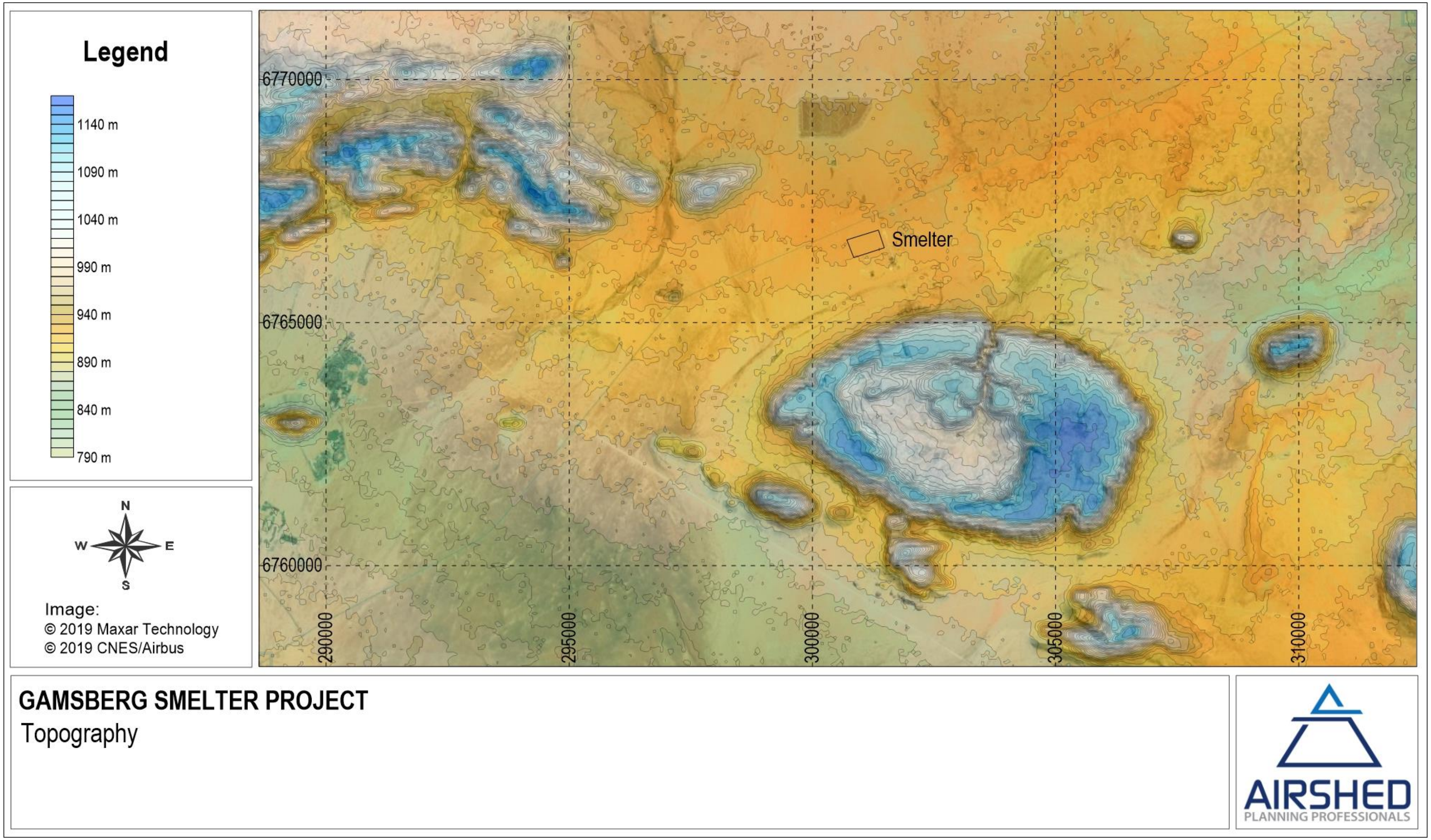



*Figure 8: Topography for the study area*

## 3.3 Baseline Noise Survey and Results

Sampling points were selected based on proposed project activities, position of sensitive receptors and previous survey locations (Figure 9). Survey results for the campaign undertaken on 9 and 10 September 2019 are summarised in Table 5 and for comparison purposes, visually presented in Figure 10 (day-time results) and Figure 11 (night-time results).

The following is noted:

- Measurements were conducted on 9 and 10 September 2019.
- Weather conditions:
    - During the day, weather conditions consisted of cloudless skies with temperatures between 28°C and 31.4°C. Slight to moderate wind conditions (including gusts) with wind speeds between 0.1 and 5.7 m/s mostly from the northerly directions, prevailed.
    - At night, skies were clear with temperatures between 18.9°C and 22.5°C. Slight wind conditions with wind speeds between 0 and 2.3 m/s mostly from the south-westerly direction, prevailed.
- Day-time baseline noise levels:
    - Measurements indicate day-time ambient noise levels that are comparatively quiet but influenced by occasional noisy incidents such as vehicles passing by and community activities (observed at Site 6).
    - $L_{Aeq}$'s ranged between 23 dBA and 49 dBA which is considered typical of rural to suburban areas according to SANS 10103.
    - Recorded $L_{Aeq}$'s during the day were within IFC guidelines for residential, institutional and educational receptors (55 dBA).
- Night-time baseline noise levels:
    - Measurements indicate night-time ambient noise levels that are quiet but influenced by community activities (observed at Site 6) and occasional noisy incidents such as vehicles passing by.
    - Mining activities were clearly audible at Site 2 and Site 5 during the night.
    - $L_{Aeq}$'s ranged between 29 dBA and 43 dBA which is considered typical of rural to urban areas according to SANS 10103.
    - Recorded $L_{Aeq}$'s during the night were within IFC guidelines for residential, institutional and educational receptors (45 dBA).

For detailed time-series, frequency spectra and statistical results, the reader is referred to Appendix D. Field log sheets containing weather records are included in Appendix C.

Ambient baseline noise levels for all noise sampling surveys conducted in the study area are provided in Figure 12. In order to illustrate the increase in ambient noise levels as a result of the project, the following representative background noise levels (based on the lowest survey measurements as a conservative approach) were used:

- $L_{Req,d}$ – 23 dBA; and,
- $L_{Req,n}$ – 29 dBA.

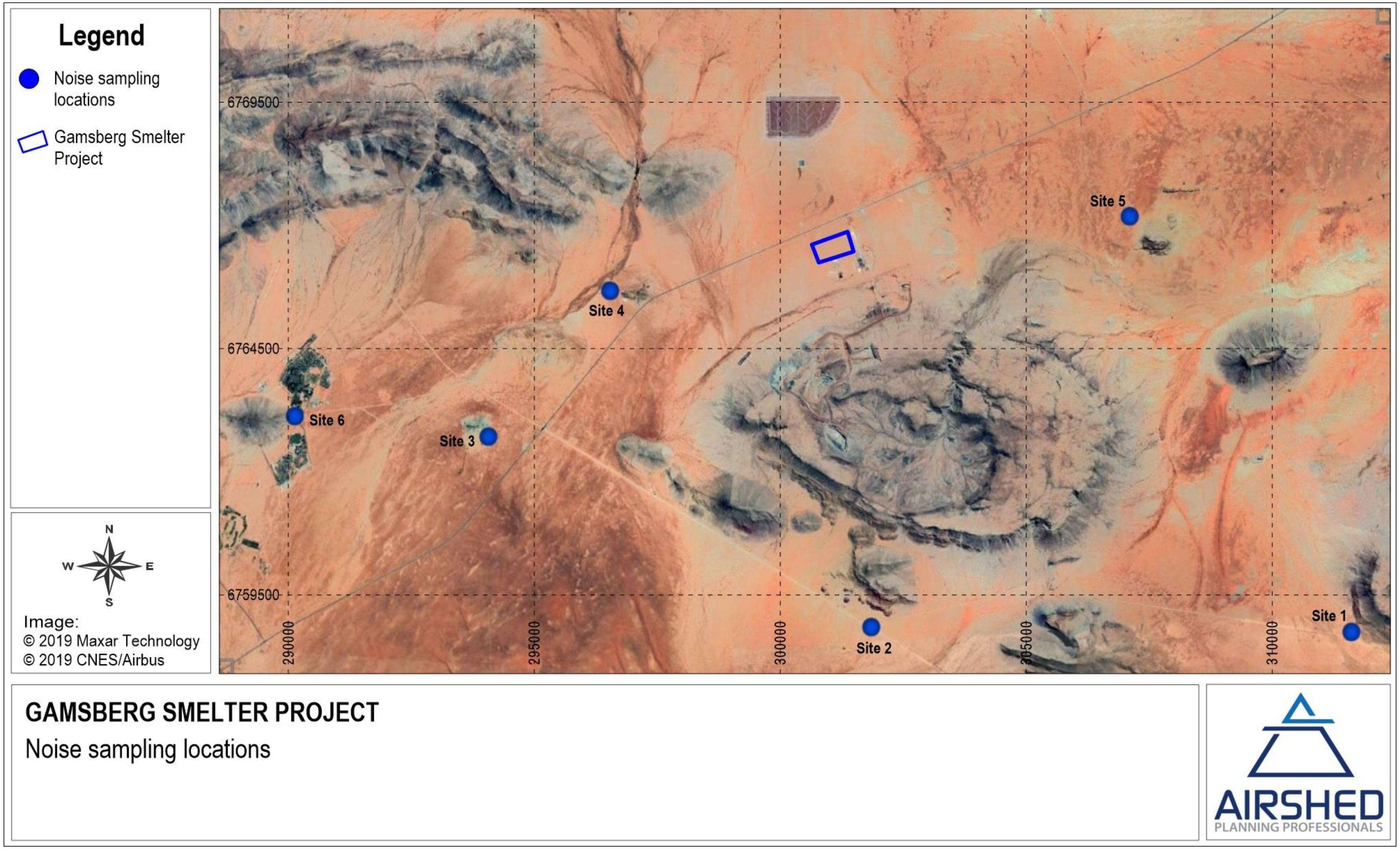



*Figure 9: Locations of environmental baseline noise survey sites*

*Table 5: Project baseline environmental noise survey results summary*

| Site | Date | Duration (minutes) | $L_{AFmax}$ (dBA) | $L_{Aleq}$ (dBA) | $L_{Aeq}$ (dBA) | $L_{AF90}$ (dBA) | Observations |
|---|---|---|---|---|---|---|---|
| **Day-time** | | | | | | | |
| Site 1 | 09/09/2019 1:44 | 30 | 50.85 | 37.02 | 33.97 | 25.40 | Gusty winds throughout the measurements, leaves rustling in the wind |
| Site 2 | 09/09/2019 2:42 | 30 | 60.69 | 37.66 | 31.04 | 24.09 | Gusty winds throughout the measurements, leaves rustling in the wind |
| Site 3 | 09/09/2019 3:47 | 30 | 55.27 | 42.91 | 41.38 | 31.13 | Traffic from the road, leaves rustling in the wind |
| Site 4 | 09/09/2019 4:42 | 30 | 55.42 | 39.62 | 33.93 | 24.61 | Leaves on shrubs and trees rustling in the wind, birds chirping |
| Site 5 | 09/09/2019 6:05 | 30 | 46.80 | 30.06 | 23.28 | 18.63 | Leaves on shrubs and trees rustling in the wind, birds chirping |
| Site 6 | 10/09/2019 10:33 | 30 | 82.81 | 56.98 | 49.06 | 33.82 | Construction vehicles, leaves on shrubs and trees rustling in the wind, community activities, birds chirping |
| **Night-time** | | | | | | | |
| Site 1 | 09/09/2019 10:07 | 15 | 54.97 | 35.5 | 29.87 | 23.25 | Insects, birds chirping, leaves on shrubs and trees rustling in the wind |
| Site 2 | 09/09/2019 10:07 | 15 | 49.39 | 32.77 | 28.89 | 25.9 | Mine operations, sounds of insects |
| Site 3 | 09/09/2019 11:20 | 15 | 55.25 | 37.37 | 33.24 | 27.28 | Sounds of insects, birds chirping, cars passing |
| Site 4 | 10/09/2019 12:35 | 15 | 53.63 | 41.86 | 36.05 | 24.27 | Sounds of insects, birds chirping |
| Site 5 | 09/09/2019 11:55 | 15 | 54.3 | 38.03 | 33.14 | 27.96 | Noise background (mine operations), sound of insects, car passing |
| Site 6 | 10/09/2019 1:23 | 15 | 67.06 | 48.21 | 43.29 | 30.89 | Dogs barking & sounds of insects, cars passing |

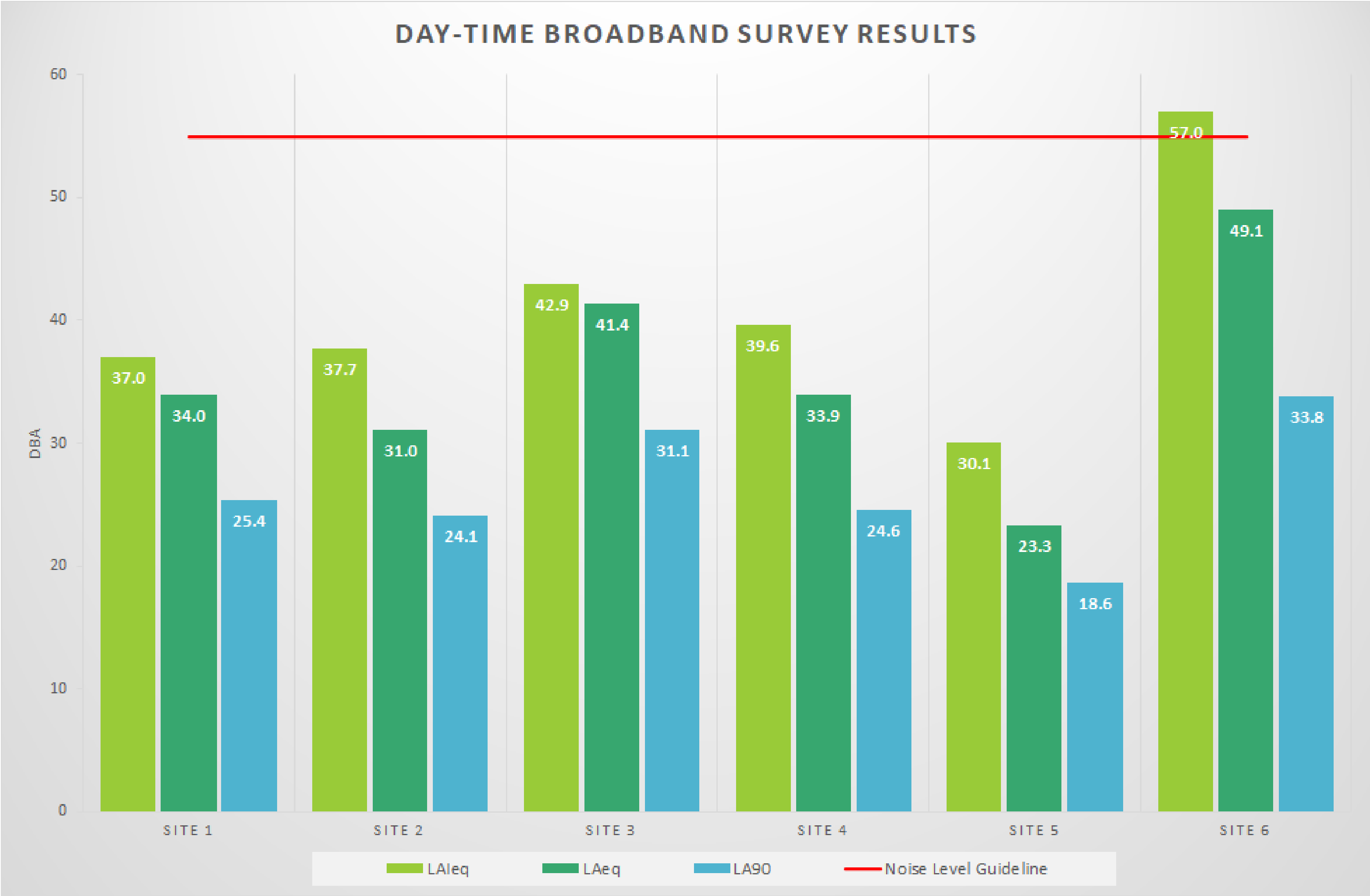



*Figure 10: Day-time broadband survey results*

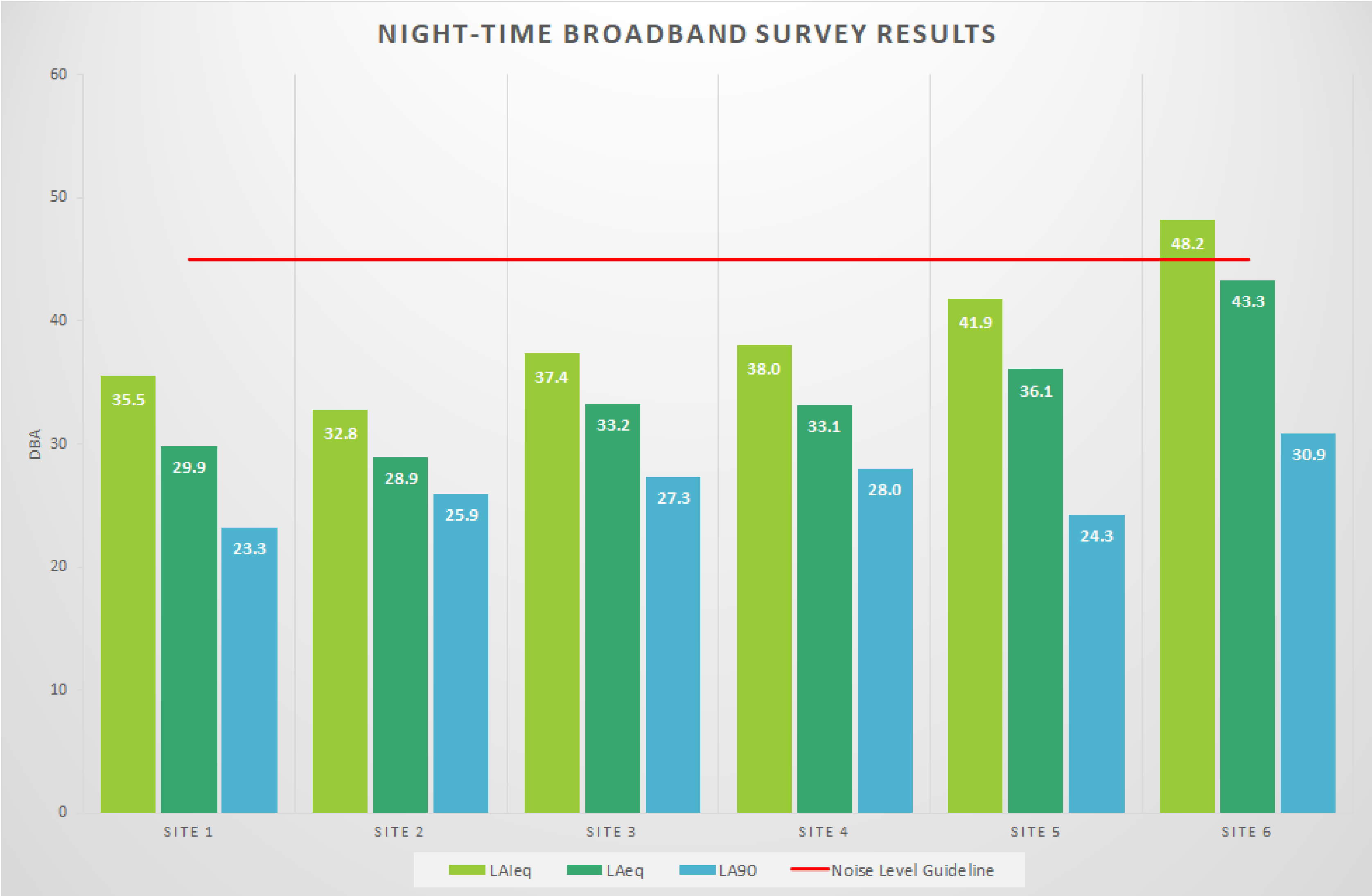



*Figure 11: Night-time broadband survey results*

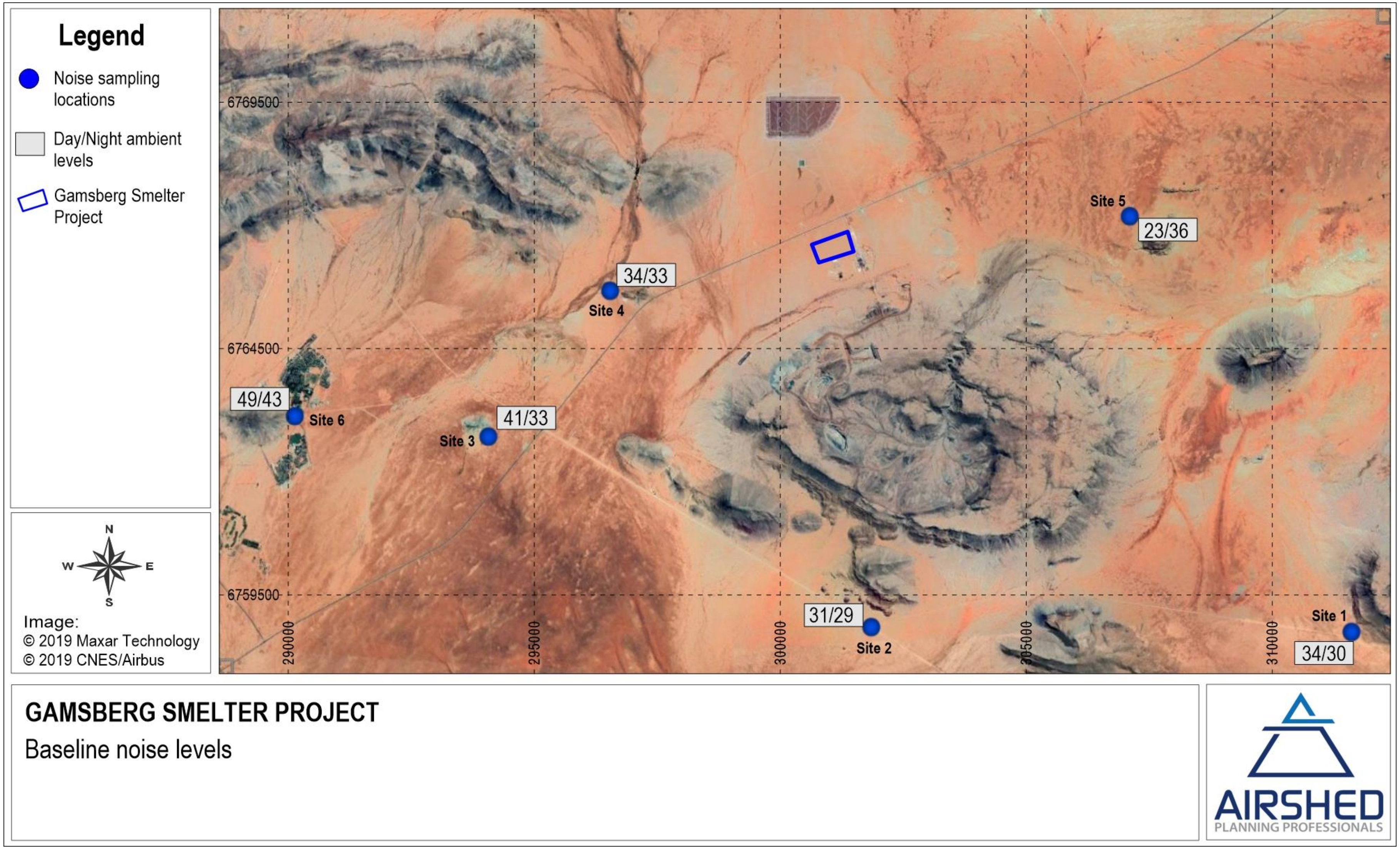



*Figure 12: Baseline noise levels*

# 4 Impact Assessment

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

## 4.1 Noise Sources and Sound Power Levels

A list of point sources (Table 6) and mobile and non-mobile equipment (Table 7) was provided which included pumps, fans, etc. Noise sound pressure levels were calculated for all the equipment with the total octave band frequency spectra $L_W$'s provided in Table 8.

*Table 6: Project point source directivity*

| Source name | Height of Release Above Ground (m) | Diameter at Stack Tip / Vent Exit (m) | Actual Gas Exit Temperature (°C) | Actual Gas Exit Velocity (m/s) | $L_{WA}$ (dBA) | Source |
|---|---|---|---|---|---|---|
| Acid Plant Stack | 70 | 2.5 | 70 | 20 | 131.6 | Calculated with LW Predictions (Bruce & Moritz, 1998) |
| Casting Stack | 30 | 2 | 60 | 7 | 131.6 | Calculated with LW Predictions (Bruce & Moritz, 1998) |
| Dross Treatment Stack | 20 | 1 | 50 | 5 | 131.6 | Calculated with LW Predictions (Bruce & Moritz, 1998) |
| Zinc Dust Plant | 20 | 1 | 50 | 5 | 76.6 | Calculated with LW Predictions (Bruce & Moritz, 1998) |

*Table 7: Noise source inventory for the project*

| Area/Sub-Area Description | Source type | Qty. | Vehicles per day | Operating time, day and night-time hours | | $L_W$ (dB) |
|---|---|---|---|---|---|---|
| Smelter - Calcine storage | Area | 1 | 0 | 16 | 8 | 102.6 |
| Smelter - Casting | Area | 1 | 0 | 16 | 8 | 140.8 |
| Smelter - Cells and electrolyte handling | Area | 1 | 0 | 16 | 8 | 122.0 |
| Smelter - Conversion (Ferrite treatment) | Area | 1 | 0 | 16 | 8 | 111.5 |
| Smelter - Dross treatment | Area | 1 | 0 | 16 | 8 | 134.8 |
| Smelter - Electrolyte circuit | Area | 1 | 0 | 16 | 8 | 126.6 |
| Smelter - Enrichment plant | Area | 1 | 0 | 16 | 8 | 104.6 |
| Smelter - Flocculant preparation | Area | 1 | 0 | 16 | 8 | 98.6 |
| Smelter - Gypsum removal | Area | 1 | 0 | 16 | 8 | 120.6 |
| Smelter - Hot purification | Area | 1 | 0 | 16 | 8 | 110.0 |
| Smelter - Jarosite Filtration | Area | 1 | 0 | 16 | 8 | 98.6 |
| Smelter - Lime milk preparation | Area | 1 | 0 | 16 | 8 | 134.7 |
| Smelter - Melting | Area | 1 | 0 | 16 | 8 | 135.0 |

| Area/Sub-Area Description | Source type | Qty. | Vehicles per day | Operating time, day and night-time hours | | $L_W$ (dB) |
|---|---|---|---|---|---|---|
| Smelter - Mn Removal | Area | 1 | 0 | 16 | 8 | 112.9 |
| Smelter - Neutral leaching | Area | 1 | 0 | 16 | 8 | 107.7 |
| Smelter - Polishing | Area | 1 | 0 | 16 | 8 | 107.3 |
| Smelter - Reagent preparation | Area | 1 | 0 | 16 | 8 | 90.7 |
| Smelter - Weak acid leaching | Area | 1 | 0 | 16 | 8 | 106.0 |
| Smelter - Zinc dust plant | Area | 1 | 0 | 16 | 8 | 134.8 |
| Roaster | Area | 2 | 0 | 16 | 8 | 141.3 |
| Water System - Near clarified water storage reservoir in plant | Area | 1 | 0 | 16 | 8 | 91.5 |
| Water System - WTP of smelter | Area | 1 | 0 | 16 | 8 | 99.2 |
| Water System - Smelter | Area | 1 | 0 | 16 | 8 | 93.3 |
| Water System - Roaster area | Area | 1 | 0 | 16 | 8 | 102.7 |
| ETP | Area | 1 | 0 | 16 | 8 | 116.3 |
| Mobile equipment for transport of Concentrate | Moving point source | 1 | 48 | 16 | 8 | 124.1 |
| Mobile equipment for transport of Zn Ingot | Moving point source | 1 | 23 | 16 | 8 | 124.1 |
| Mobile equipment for transport of Sulphuric acid | Moving point source | 1 | 37 | 16 | 8 | 124.1 |
| Mobile equipment for transport of Store materials | Moving point source | 1 | 4 | 16 | 8 | 119.5 |
| Mobile equipment for transport of Jarosite and other materials | Moving point source | 1 | 19 | 16 | 8 | 124.1 |
| Mobile equipment for transport of Mn Cake | Moving point source | 1 | 1 | 16 | 8 | 124.1 |
| Mobile equipment for transport of Product | Moving point source | 1 | 57 | 16 | 8 | 123.4 |

*Table 8: Octave band frequency spectra $L_W$'s for the project equipment*

| Area/Sub-Area Description | Type | $L_W$ octave band frequency spectra (dB) | | | | | | | | | $L_W$ (dB) | $L_{WA}$ (dBA) | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | | | |
| Smelter - Calcine storage | $L_W$ | 88.4 | 88.4 | 91.4 | 93.4 | 96.4 | 96.4 | 95.4 | 90.4 | 82.4 | 102.6 | 101.1 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Smelter - Casting | $L_W$ | 130.0 | 131.0 | 132.0 | 133.0 | 133.0 | 133.0 | 131.0 | 127.0 | 126.0 | 140.8 | 137.7 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Smelter - Cells and electrolyte handling | $L_W$ | 101.7 | 97.9 | 99.0 | 101.9 | 103.9 | 106.3 | 109.4 | 113.7 | 120.6 | 122.0 | 121.4 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Smelter - Conversion (Ferrite treatment) | $L_W$ | 97.4 | 97.5 | 100.3 | 102.3 | 105.2 | 105.3 | 104.2 | 99.3 | 91.4 | 111.5 | 110.0 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Smelter - Dross treatment | $L_W$ | 124.0 | 125.0 | 126.0 | 127.0 | 127.0 | 127.0 | 125.0 | 121.0 | 120.0 | 134.8 | 131.7 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Smelter - Electrolyte circuit | $L_W$ | 118.2 | 121.2 | 121.2 | 118.2 | 115.3 | 111.5 | 108.5 | 105.4 | 97.5 | 126.6 | 117.6 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Smelter - Enrichment plant | $L_W$ | 90.4 | 90.5 | 93.4 | 95.4 | 98.3 | 98.4 | 97.3 | 92.3 | 84.4 | 104.6 | 103.0 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Smelter - Flocculant preparation | $L_W$ | 84.6 | 84.8 | 87.4 | 89.4 | 92.1 | 92.4 | 91.2 | 86.3 | 78.6 | 98.6 | 97.0 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Smelter - Gypsum removal | $L_W$ | 112.2 | 115.2 | 115.2 | 112.2 | 109.3 | 105.4 | 102.5 | 99.4 | 91.5 | 120.6 | 111.5 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Smelter - Hot purification | $L_W$ | 95.8 | 95.9 | 98.8 | 100.8 | 103.7 | 103.8 | 102.7 | 97.7 | 89.8 | 110.0 | 108.4 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Smelter - Jarosite Filtration | $L_W$ | 86.0 | 87.0 | 88.1 | 90.1 | 90.3 | 93.1 | 90.2 | 86.1 | 80.0 | 98.6 | 96.7 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Smelter - Lime milk preparation | $L_W$ | 124.0 | 125.0 | 126.0 | 127.0 | 127.0 | 127.0 | 125.0 | 121.0 | 120.0 | 134.7 | 131.6 | $L_W$ Predictions (Bruce & Moritz, 1998) |

| Area/Sub-Area Description | Type | Lw octave band frequency spectra (dB) | | | | | | | | | Lw (dB) | LwA (dBA) | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | | | |
| Smelter - Melting | Lw | 124.1 | 125.1 | 126.1 | 127.1 | 127.3 | 127.4 | 125.6 | 121.5 | 120.1 | 135.0 | 132.1 | Lw Predictions (Bruce & Moritz, 1998) |
| Smelter - Mn Removal | Lw | 98.7 | 98.8 | 101.7 | 103.7 | 106.5 | 106.7 | 105.6 | 100.6 | 92.7 | 112.9 | 111.3 | Lw Predictions (Bruce & Moritz, 1998) |
| Smelter - Neutral leaching | Lw | 93.6 | 93.8 | 96.5 | 98.5 | 101.3 | 101.5 | 100.4 | 95.5 | 87.6 | 107.7 | 106.1 | Lw Predictions (Bruce & Moritz, 1998) |
| Smelter - Polishing | Lw | 93.2 | 93.3 | 96.1 | 98.1 | 100.9 | 101.1 | 99.9 | 95.0 | 87.2 | 107.3 | 105.7 | Lw Predictions (Bruce & Moritz, 1998) |
| Smelter - Reagent preparation | Lw | 77.6 | 78.4 | 80.0 | 82.0 | 83.3 | 85.0 | 82.8 | 78.4 | 71.6 | 90.7 | 89.0 | Lw Predictions (Bruce & Moritz, 1998) |
| Smelter - Weak acid leaching | Lw | 91.8 | 91.9 | 94.8 | 96.8 | 99.6 | 99.8 | 98.7 | 93.7 | 85.8 | 106.0 | 104.4 | Lw Predictions (Bruce & Moritz, 1998) |
| Smelter - Zinc dust plant | Lw | 124.0 | 125.0 | 126.0 | 127.0 | 127.0 | 127.0 | 125.0 | 121.0 | 120.0 | 134.8 | 131.6 | Lw Predictions (Bruce & Moritz, 1998) |
| Roaster | Lw | 130.5 | 131.5 | 132.5 | 133.5 | 133.5 | 133.5 | 131.5 | 127.5 | 126.5 | 141.3 | 138.2 | Lw Predictions (Bruce & Moritz, 1998) |
| Water System - Near clarified water storage reservoir in plant | Lw | 79.0 | 80.0 | 81.0 | 83.0 | 83.0 | 86.0 | 83.0 | 79.0 | 73.0 | 91.5 | 89.6 | Lw Predictions (Bruce & Moritz, 1998) |
| Water System - WTP of smelter | Lw | 86.7 | 87.7 | 88.7 | 90.7 | 90.7 | 93.7 | 90.7 | 86.7 | 80.7 | 99.2 | 97.3 | Lw Predictions (Bruce & Moritz, 1998) |
| Water System - Smelter | Lw | 80.8 | 81.8 | 82.8 | 84.8 | 84.8 | 87.8 | 84.8 | 80.8 | 74.8 | 93.3 | 91.4 | Lw Predictions (Bruce & Moritz, 1998) |
| Water System - Roaster area | Lw | 90.2 | 91.2 | 92.2 | 94.2 | 94.2 | 97.2 | 94.2 | 90.2 | 84.2 | 102.7 | 100.8 | Lw Predictions (Bruce & Moritz, 1998) |

| Area/Sub-Area Description | Type | $L_W$ octave band frequency spectra (dB) | | | | | | | | | $L_W$ (dB) | $L_{WA}$ (dBA) | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | | | |
| ETP | $L_W$ | 99.0 | 100.8 | 102.7 | 106.3 | 108.2 | 110.2 | 111.0 | 106.0 | 100.0 | 116.3 | 115.6 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Mobile equipment for transport of Concentrate | $L_W$ | | 112.5 | 117.5 | 120.5 | 115.5 | 113.5 | 110.5 | 104.5 | 98.5 | 124.1 | 118.7 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Mobile equipment for transport of Zn Ingot | $L_W$ | | 112.5 | 117.5 | 120.5 | 115.5 | 113.5 | 110.5 | 104.5 | 98.5 | 124.1 | 118.7 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Mobile equipment for transport of Sulphuric acid | $L_W$ | | 112.5 | 117.5 | 120.5 | 115.5 | 113.5 | 110.5 | 104.5 | 98.5 | 124.1 | 118.7 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Mobile equipment for transport of Store materials | $L_W$ | | 107.8 | 112.8 | 115.8 | 110.8 | 108.8 | 105.8 | 99.8 | 93.8 | 119.5 | 114.1 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Mobile equipment for transport of Jarosite and other materials | $L_W$ | | 112.5 | 117.5 | 120.5 | 115.5 | 113.5 | 110.5 | 104.5 | 98.5 | 124.1 | 118.7 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Mobile equipment for transport of Mn Cake | $L_W$ | | 112.5 | 117.5 | 120.5 | 115.5 | 113.5 | 110.5 | 104.5 | 98.5 | 124.1 | 118.7 | $L_W$ Predictions (Bruce & Moritz, 1998) |
| Mobile equipment for transport of Product | $L_W$ | | 111.7 | 116.7 | 119.7 | 114.7 | 112.7 | 109.7 | 103.7 | 97.7 | 123.4 | 118.0 | $L_W$ Predictions (Bruce & Moritz, 1998) |

## 4.2 Noise Propagation and Simulated Noise Levels

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

Results are presented in isopleth form (Figure 13 to Figure 18). The simulated equivalent continuous day-time rating level ($L_{Req,d}$) due to project operations of 55 dBA (IFC guideline level) extends ~900 m from the plant. The simulated equivalent continuous night-time rating level ($L_{Req,n}$) of 45 dBA (IFC guideline level) due to project operations extends ~1.8 km from the plant.

The proposed operational phase related noise due to the project is predicted to be in compliance with the IFC guidelines at all sensitive receptors off-site.

For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. With the approach adopted for the assessment (detailed in Section 1.6), the predicted increase in noise levels of 3 dBA above baseline (i.e. notable increase in noise) due to the project operations are expected up to a distance of ~2 km from the plant (Figure 16 to Figure 18). The closest potential NSR is ~3.8 km to the northwest and west of the project.

The 1992 Noise Control Regulations defines a “disturbing noise” as a noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dBA or more. The predicted increase in noise levels due to project operations at all NSRs are below 7 dBA (Figure 16 to Figure 18).

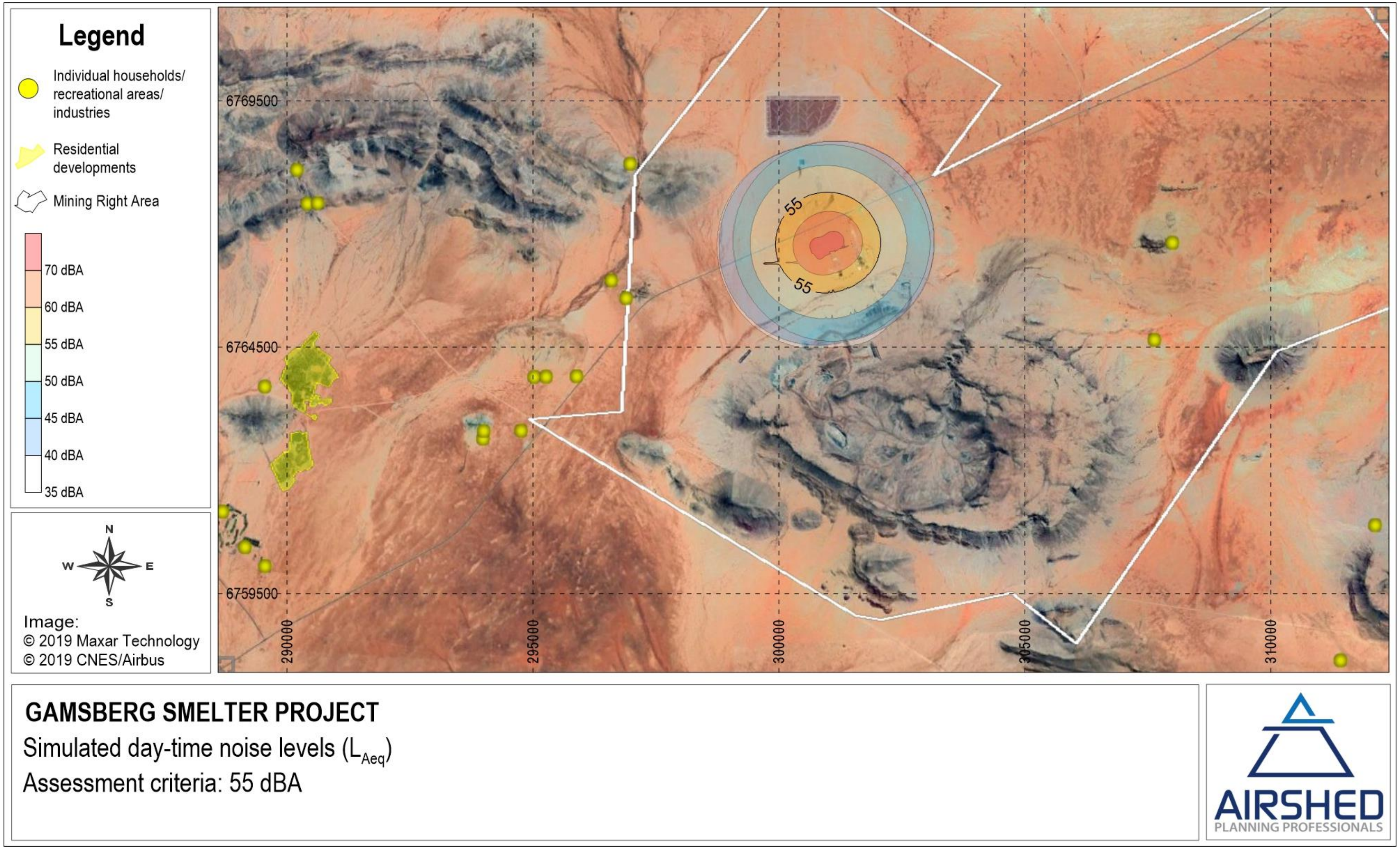



*Figure 13: Simulated equivalent continuous day-time rating level ($L_{Req,d}$) for project activities*

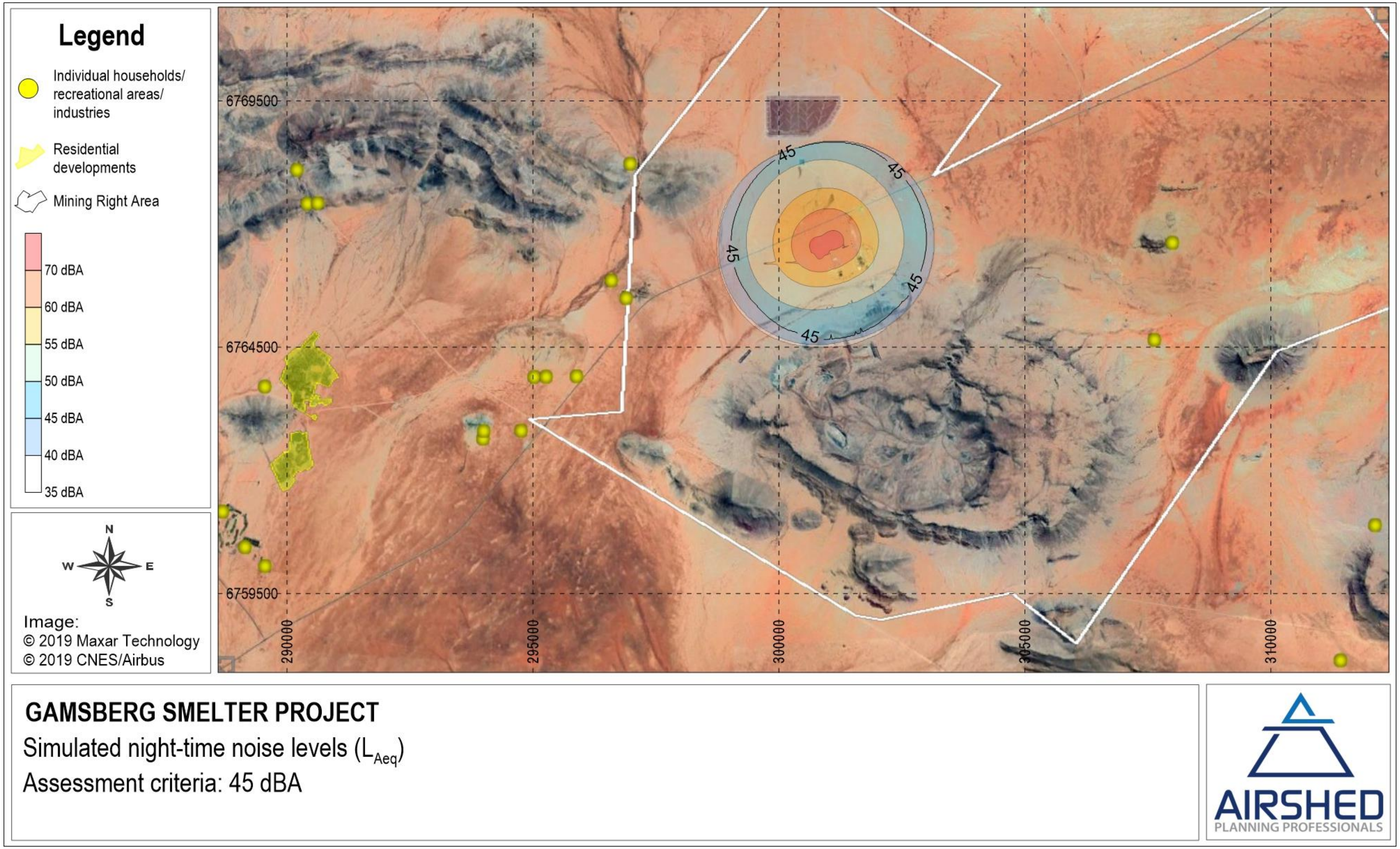



*Figure 14: Simulated equivalent continuous night-time rating level ($L_{Req,n}$) for project activities*

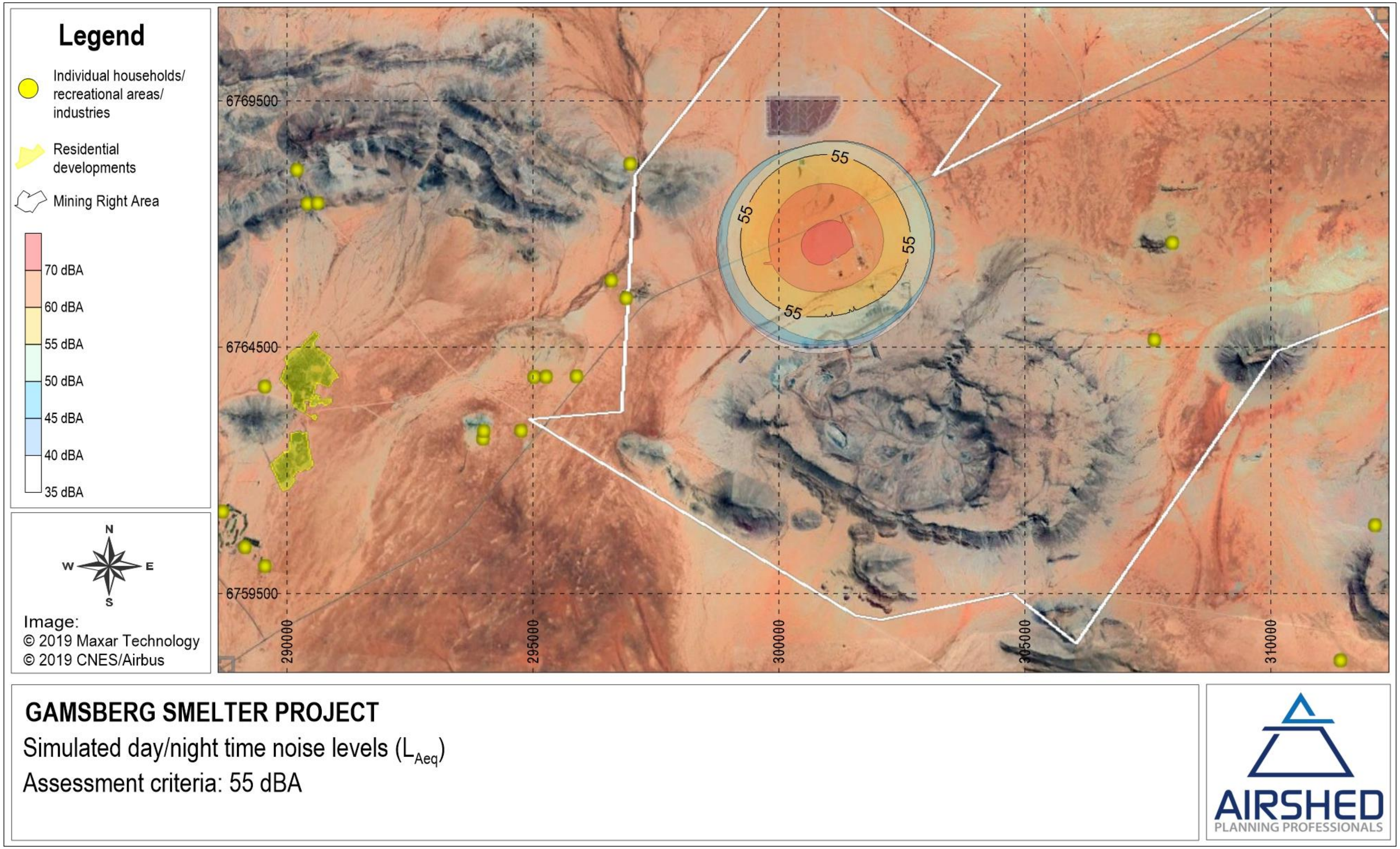



*Figure 15: Simulated equivalent continuous day/night-time rating level ($L_{Req,dn}$) for project activities*

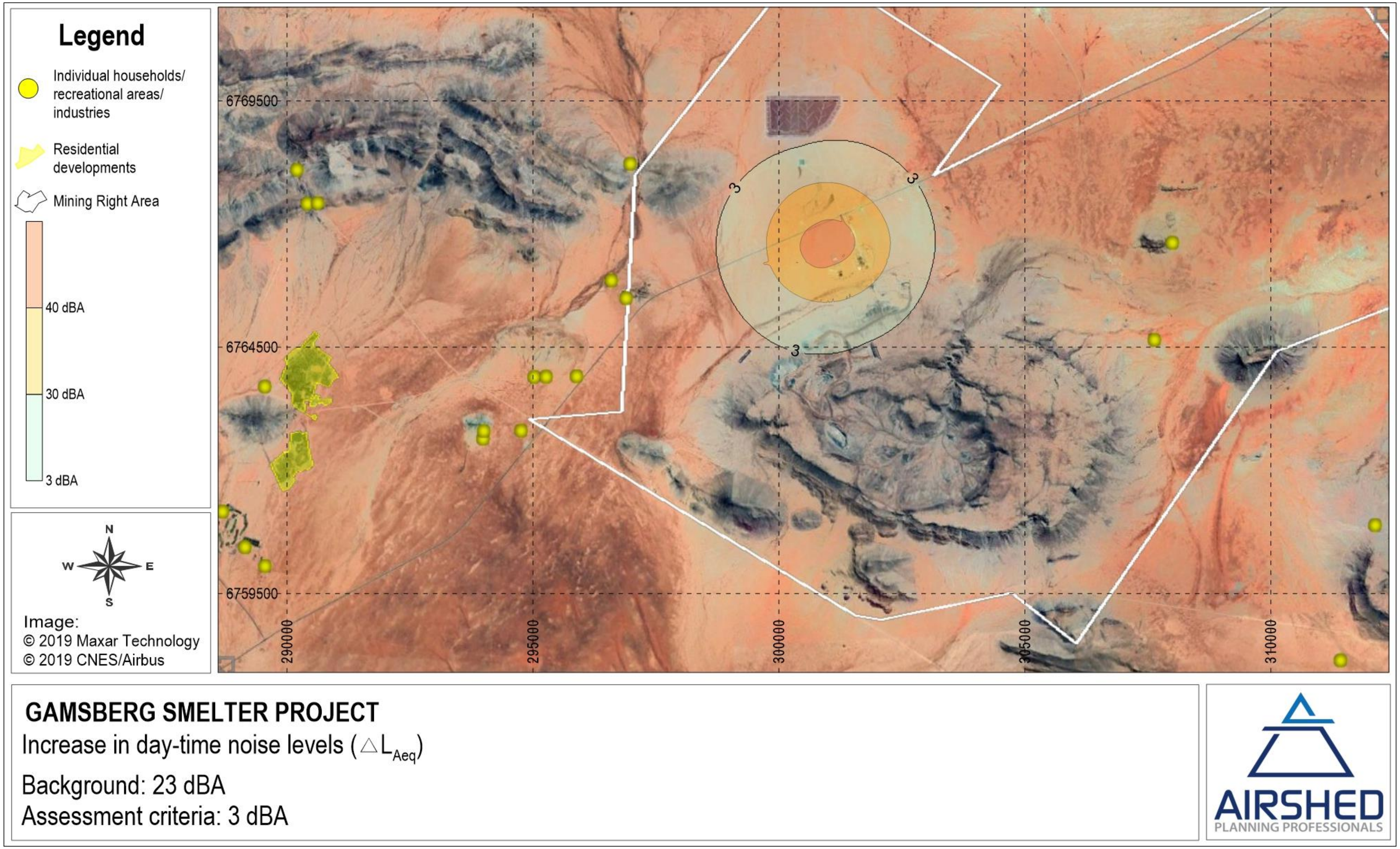



*Figure 16: Simulated increase in equivalent continuous day-time rating level ($\Delta L_{Req,d}$) above the baseline*

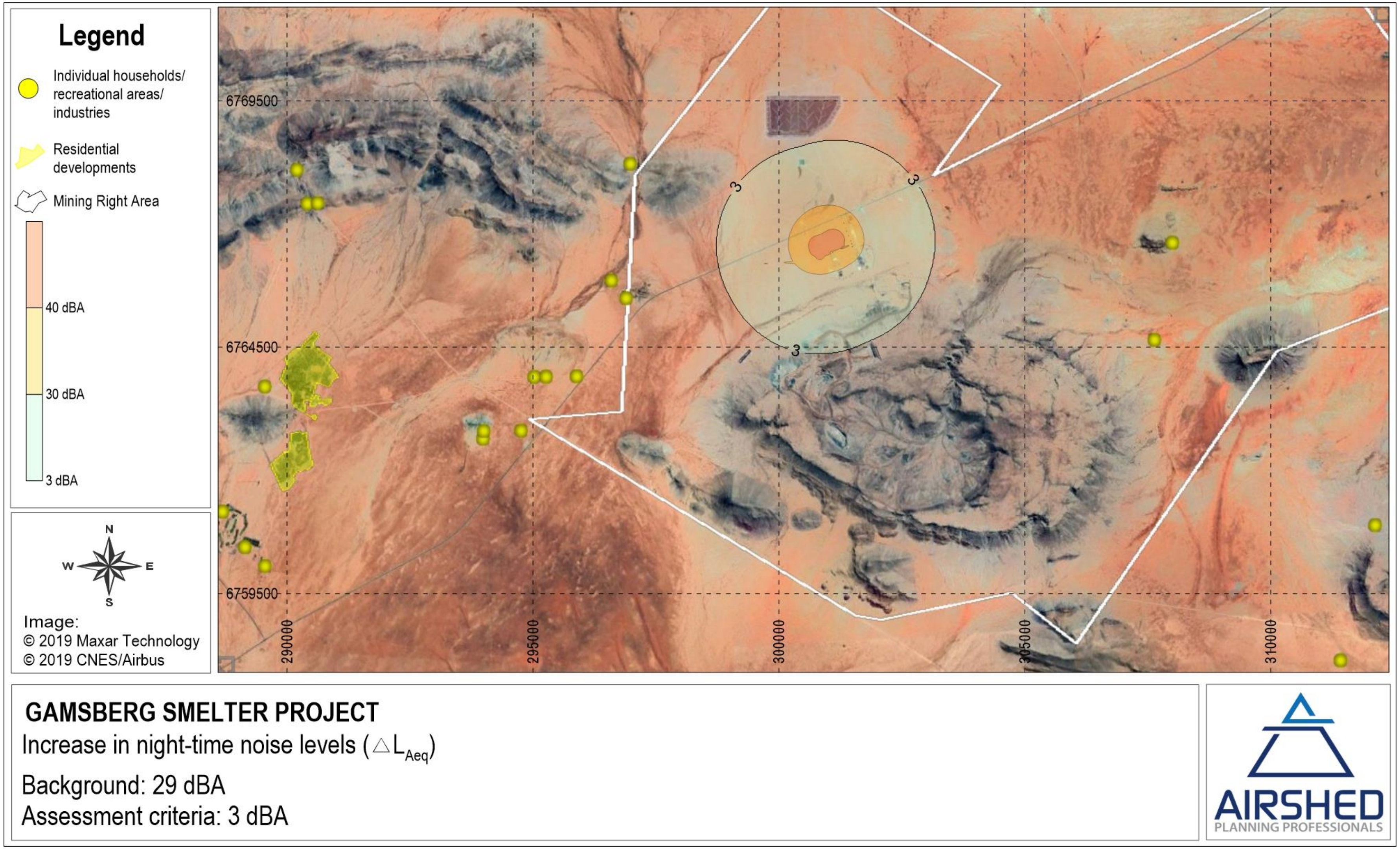



*Figure 17: Simulated increase in equivalent continuous night-time rating level ($\Delta L_{Req,n}$) above the baseline*

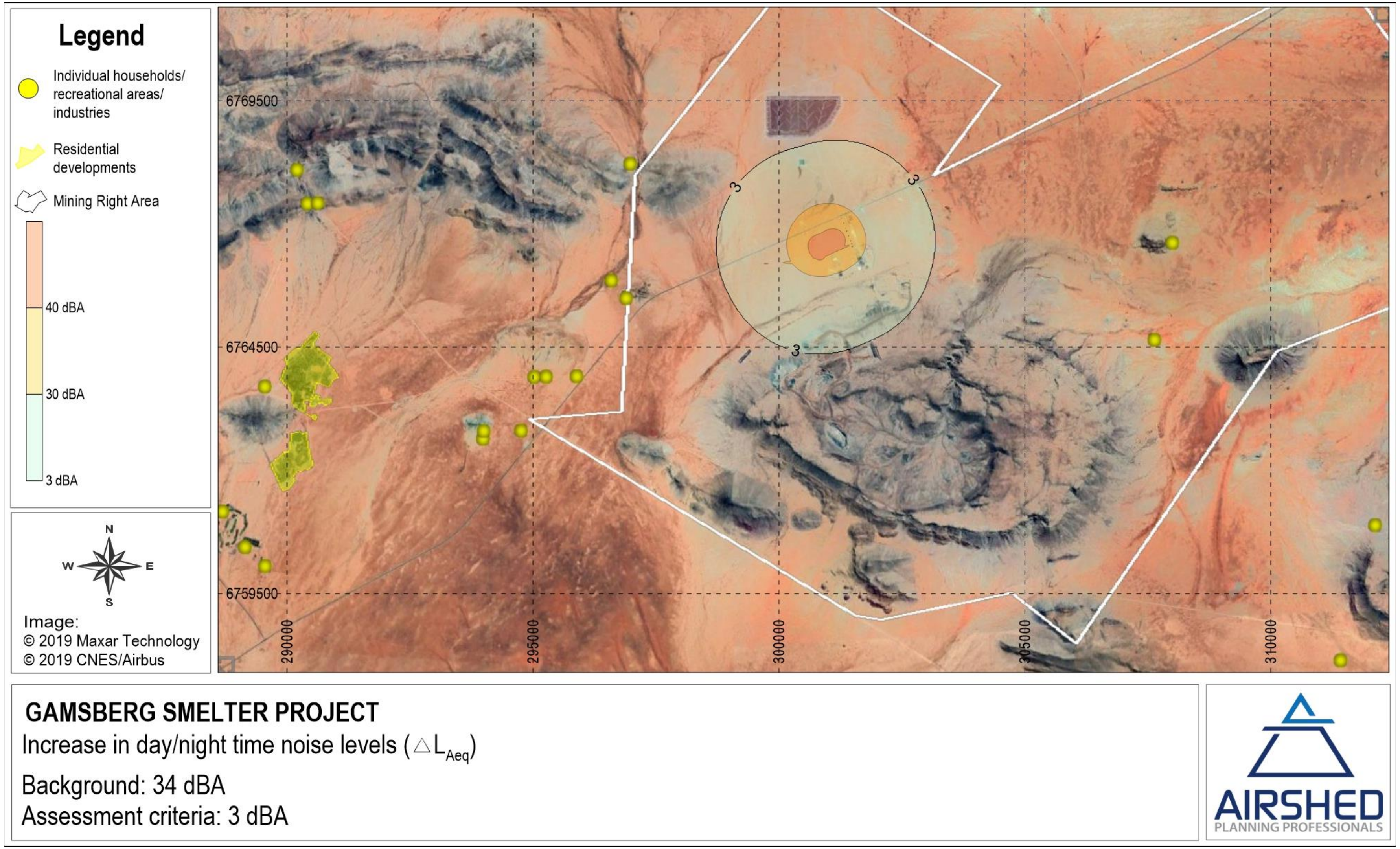



*Figure 18: Simulated increase in equivalent continuous day/night-time rating level ($\Delta L_{Req,dn}$) above the baseline*

# 5 Impact Significance Rating

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

The significance of the noise impacts due to project activities were found to be ***low*** (Table 9). Assuming the adoption of good practice noise mitigation and management measures as recommended, the significance of project noise impacts may be reduced to ***very low*** (Table 9).

No noise impacts are expected post-closure.

*Table 9: Significance rating for noise impacts due to project activities*

| Project Activity | Noise | | Probability | Consequence | | | | Significance Rating |
|---|---|---|---|---|---|---|---|---|
| | Description | Impacts | | Intensity | Duration | Extent | Consequence | |
| **Project activities only** | | | | | | | | |
| Project construction activities | Impact from construction activities associated with the Gamsberg Smelter Project | Increased noise on NSR's due to construction activities. | Without Mitigation | | | | | |
| | | | M | M | L | M | M | Low |
| | | | With Mitigation | | | | | |
| | | | M | L | L | L | L | Very Low |
| Project operation activities | Impact from operational activities associated with the Gamsberg Smelter Project | Increased noise on NSR's due to operational activities. | Without Mitigation | | | | | |
| | | | L | L | H | M | M | Low |
| | | | With Mitigation | | | | | |
| | | | L | VL | H | L | L | Very Low |
| Project closure activities | Impact from closure activities associated with the Gamsberg Smelter Project | Increased noise on NSR's due to closure activities. | Without Mitigation | | | | | |
| | | | M | M | L | M | M | Low |
| | | | With Mitigation | | | | | |
| | | | M | L | L | L | L | Very Low |
| **Cumulative (project activities as well as baseline noise levels)** | | | | | | | | |
| Project construction activities | Impact from construction activities associated with the Gamsberg Smelter Project | Increased noise on NSR's due to construction activities. | Without Mitigation | | | | | |
| | | | M | M | L | M | M | Low |
| | | | With Mitigation | | | | | |
| | | | M | L | L | L | L | Very Low |
| Project operation activities | Impact from operational activities associated with the Gamsberg Smelter Project | Increased noise on NSR's due to operational activities. | Without Mitigation | | | | | |
| | | | L | L | H | M | M | Low |
| | | | With Mitigation | | | | | |
| | | | L | VL | H | L | L | Very Low |

<table>
<tr><th rowspan="2">Project Activity</th><th colspan="2">Noise</th><th rowspan="2">Probability</th><th colspan="4">Consequence</th><th rowspan="2">Significance Rating</th></tr>
<tr><th>Description</th><th>Impacts</th><th>Intensity</th><th>Duration</th><th>Extent</th><th>Consequence</th></tr>
<tr><td rowspan="4">Project closure activities</td><td rowspan="4">Impact from closure activities associated with the Gamsberg Smelter Project</td><td rowspan="4">Increased noise on NSR's due to closure activities.</td><td colspan="6">Without Mitigation</td></tr>
<tr><td>M</td><td>M</td><td>L</td><td>M</td><td>M</td><td>Low</td></tr>
<tr><td colspan="6">With Mitigation</td></tr>
<tr><td>M</td><td>L</td><td>L</td><td>L</td><td>L</td><td>Very Low</td></tr>
</table>

# 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 traffic noise and are considered good practice by the IFC (2007) and British Standard BSI (2008).

## 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 (refer to Section 5.2), 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. Generators, pumps and blowers are examples of such equipment.

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

### 6.1.4 Use and Siting of Equipment and Noise Sources

The following good practice should be implemented:

a) 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.
b) Acoustic covers of engines should be kept closed when in use or idling.
c) Doors to pump houses, and generators should be kept closed when in use.

### 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 management and mitigation measures are in place, it is the specialist opinion that the project may be authorised.

# 8 References


Bruce, R. D. & Moritz, C. T., 1998. Sound Power Level Predictions for Industrial Machinery. In: M. J. Crocker, ed. *Handbook of Acoustics.* Hoboken: John Whiley & Sons, Inc, pp. 863-872.

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

BSI, 2008. *Code of practice for noise and vibration control on construction and open sites - Part 1: Noise.* s.l.:s.n.

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

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

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

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

# Appendix A – Specialist Curriculum Vitae



## *FULL CURRICULUM VITAE*

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

## MEMBERSHIP OF PROFESSIONAL SOCIETIES

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

## KEY QUALIFICATIONS

René von Gruenewaldt (Air Quality Scientist): René joined Airshed Planning Professionals (Pty) Ltd (previously known as Environmental Management Services cc) in 2002. She has, as a Specialist, attained over fifteen (15) years of experience in the Earth and Natural Sciences sector in the field of Air Quality and six (6) years of experience in the field of noise assessments. As an environmental practitioner, she has provided solutions to both large-scale and smaller projects within the mining, minerals, and process industries.

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

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

## RELEVANT EXPERIENCE

### Mining and Ore Handling

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

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

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

### Metal Recovery

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

### Chemical Industry

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

### Petrochemical Industry

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

### Pulp and Paper Industry

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

### Power Generation

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

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

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

### Waste Disposal

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

### Cement Manufacturing

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

### Management Plans

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

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

### Other Experience (2001)

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

## EDUCATION

| | |
|---|---|
| **M.Sc Earth Sciences** | University of Pretoria, RSA, Cum Laude (2009)<br>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)<br>Environmental Management and Impact Assessments |
| **B.Sc Earth Sciences** | University of Pretoria, RSA, (2000)<br>Atmospheric Sciences: Meteorology |

## ADDITIONAL COURSES

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

## COUNTRIES OF WORK EXPERIENCE

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

## EMPLOYMENT RECORD

### January 2002 - Present

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

### 2001

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

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

### 1999 - 2000

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

## CONFERENCE AND WORKSHOP PRESENTATIONS AND PAPERS

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

## LANGUAGES

| | Speak | Read | Write |
|---|---|---|---|
| **English** | Excellent | Excellent | Excellent |
| **Afrikaans** | Fair | Good | Good |

## CERTIFICATION

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

| | |
|---|---|
| Signature of staff member | 06/08/2019<br>Date (Day / Month / Year) |

Full name of staff member: René Georgeinna von Gruenewaldt

# Appendix B – Sound Level Meter Calibration Certificates

nmisa
National Metrology Institute of South Africa

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

## Certificate of Conformance

| | |
|---|---|
| **Calibration of:** | SOUND CALIBRATOR |
| **Manufacturer:** | SVANTEK |
| **Model number:** | SV33 |
| **Serial number:** | 57649 |
| **Calibrated for:** | AIRSHED PLANNING PROFESSIONALS (PTY) LTD<br>480 Smuts Drive<br>Halfway Gardens<br>Midrand |
| **Calibration procedure:** | AV\AS-0008 |
| **Period of calibration:** | 20 September 2018 |

**1 PROCEDURE**

The sound calibrator was calibrated according to IEC 60942: 2003 specification.

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

The following equipment was used:

| | |
|---|---|
| Brüel & Kjær 2673 preamplifier | (AS-59) |
| MadgeTech PRHTemp2000 | (AS-106) |
| Brüel & Kjær 3630 Calibration platform | (AS-109) |
| Brüel & Kjær 4228 Pistonphone | (AS-WSTD-13) |
| Brüel & Kjær 4192 Pressure Microphone | (AS-WSTD-15) |

| | | |
|---|---|---|
| Calibrated by<br>**R Nel**<br>**Metrologist (Technical Signatory)** | Checked by<br>**AE Karsten**<br>**Metrologist** | For Chief Executive Officer |
| Date of Issue<br>**20 September 2018** | **Page 1 of 2** | Certificate number<br>**AV\AS-4782** |

*Your measure of excellence*

## 2 RESULTS

2.1 The following parameters of the sound calibrator were calibrated and conformed to IEC 60942: 2003 specification, class 1:

| | |
|---|---|
| Frequency<br>(IEC 60942 clause B.3.5)<br>1 000 Hz | $U$ = 0,10 Hz |
| Sound Pressure Level<br>(IEC 60942 clause B.3.4)<br>114 dB | $U$ = 0,15 dB |
| Total Distortion<br>(IEC 60942 clause B.3.6) | $U$ = 0,13 % |

## 3 REMARKS

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

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

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

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

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

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

| Calibrated by | Checked by | For Chief Executive Officer |
|---|---|---|
| **R Nel**<br>**Metrologist (Technical Signatory)** | **AE Karsten**<br>**Metrologist** | |
| Date of Issue<br>**20 September 2018** | **Page 2 of 2** | Certificate number<br>**AV\AS-4782** |

**Brüel & Kjær**

# Prepolarized Free-field 1/2" Microphone Type 4950

**Calibration Chart**

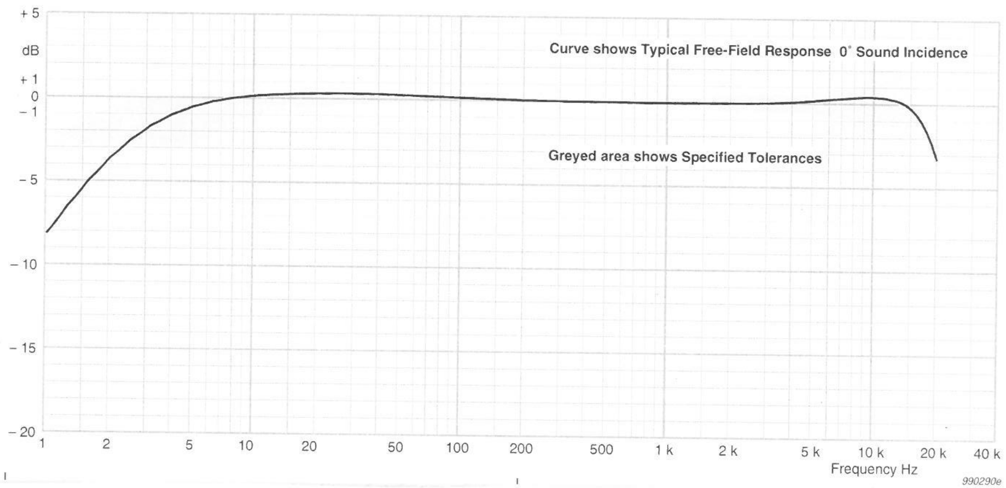
**Serial No:** **3177677**

| | | |
|---|---|---|
| **Open-circuit Sensitivity*, $S_0$:** | ***-26.9*** | dB re 1V/Pa |
| Equivalent to: | ***45.3*** | mV/Pa |
| Uncertainty, 95 % confidence level | 0.2 | dB |
| **Capacitance:** | ***12.8*** | pF |
| **Valid At:** | | |
| Temperature: | 23 | °C |
| Ambient Static Pressure: | 101.3 | kPa |
| Relative Humidity: | 50 | % |
| Frequency: | 251.2 | Hz |
| Polarization Voltage, external: | 0 | V |

**Sensitivity Traceable To:**
DPLA: Danish Primary Laboratory of Acoustics
NIST: National Institute of Standards and Technology, USA

**Environmental Calibration Conditions:**
101.2 kPa 24 °C 55 % RH

**Procedure:** 704875 **Date:** 24. Jul. 2018 **Signature:**



# Appendix C – Fieldwork Log Sheets and Photos

Day

| SITE NUMBER: Site 1 | | SLM DATA RECORD: gambrg001 |
|---|---|---|
| Longitude/Easting: | Latitude/Northing: | Elevation: |
| Short Location Description & Notes: | | |

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

| METEOROLOGY | Wind Speed (m/s) | Wind Direction (°) | Temperature (°C) | Humidity (%) | Clouds (%) | Remarks: |
|---|---|---|---|---|---|---|
| Start | 0.9-4.1 | N | 29.6 | 18.9 | 0 | - Gusty winds @ 142dB |
| Middle | | | | | | |
| End | | | | | | |

| NOISE CLIMATE | ☐ Birds | ☐ Insects | ☐ Dogs | ☐ Music | ☐ Community | ☐ Air Traffic | ☐ Road Traffic | ☐ Constr. | ☐ Other |
|---|---|---|---|---|---|---|---|---|---|
| Description: open land, small shrubs, uncultivated land, mountain on the north ± 150m | | | | | | | | | |

| EVENTS | | | | | | | |
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| Time | Description | Time | Description | Time | Description | Time | Description |
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Day

| SITE NUMBER: Site 2 | | SLM DATA RECORD: gambrg002 | |
|---|---|---|---|
| Longitude/Easting: | Latitude/Northing: | | Elevation: |
| Short Location Description & Notes: | | | |

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

| METEOROLOGY | Wind Speed (m/s) | Wind Direction (°) | Temperature (°C) | Humidity (%) | Clouds (%) | Remarks: |
|---|---|---|---|---|---|---|
| Start | 0.8 – 2.9 | N.E | 31.2 | 13 | 0 | Gusty winds throughout @±46dB |
| Middle | | | | | | |
| End | | | | | | |

| NOISE CLIMATE | ☐ Birds | ☐ Insects | ☐ Dogs | ☐ Music | ☐ Community | ☐ Air Traffic | ☐ Road Traffic | ☐ Constr. | ☐ Other |
|---|---|---|---|---|---|---|---|---|---|
| Description: Open land, near gravel road ±2m, mountain like structure on the north | | | | | | | | | |

EVENTS

| Time | Description | Time | Description | Time | Description | Time | Description |
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Day

| SITE NUMBER: Site 3 | | SLM DATA RECORD: gam8brg003 |
|---|---|---|
| Longitude/Easting: | Latitude/Northing: | Elevation: |
| Short Location Description & Notes: | | |

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

| METEOROLOGY | Wind Speed (m/s) | Wind Direction (°) | Temperature (°C) | Humidity (%) | Clouds (%) | Remarks: |
|---|---|---|---|---|---|---|
| Start | 0.9–5.6 | N.E | 31.4 | 12.4 | 0 | - Gusty winds<br>- Road traffic @ ±50dB |
| Middle | | | | | | |
| End | | | | | | |

| NOISE CLIMATE | ☐ Birds | ☐ Insects | ☐ Dogs | ☐ Music | ☐ Community | ☐ Air Traffic | ☒ Road Traffic | ☐ Constr. | ☐ Other |
|---|---|---|---|---|---|---|---|---|---|
| Description: Open land, shrubs, | | | | | | | | | |

**EVENTS**

| Time | Description | Time | Description | Time | Description | Time | Description |
|---|---|---|---|---|---|---|---|
| 15:53:50 | Car passing | | | | | | |
| 16:01:27 | " | | | | | | |
| 08:10 | " | | | | | | |
| 11:20 | " | | | | | | |
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Page __ of __

Receptor Day

| SITE NUMBER: Site 4 | | SLM DATA RECORD: gamsbrg 004 |
|---|---|---|
| Longitude/Easting: | Latitude/Northing: | Elevation: |
| Short Location Description & Notes: | | |

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

| METEOROLOGY | Wind Speed (m/s) | Wind Direction (°) | Temperature (°C) | Humidity (%) | Clouds (%) | Remarks: |
|---|---|---|---|---|---|---|
| Start | 0.1 - 2.4 | N.E. | 30.2 | 12.3 | 0 | Birds @ ±43.3dB - 48dB Gusty winds |
| Middle | | | | | | |
| End | | | | | | |

| NOISE CLIMATE | ☒ Birds | ☐ Insects | ☐ Dogs | ☐ Music | ☐ Community | ☐ Air Traffic | ☐ Road Traffic | ☐ Constr. | ☐ Other |
|---|---|---|---|---|---|---|---|---|---|

Description: lots of shrubs, uncultivated land, open land

**EVENTS**

| Time | Description | Time | Description | Time | Description | Time | Description |
|---|---|---|---|---|---|---|---|
| 16:44:41 | Birds | | | | | | |
| 45:00 | 〃 | | | | | | |
| 51:45 | Birds | | | | | | |
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| SITE NUMBER: Site 5 | | SLM DATA RECORD: gamsbrg 005 |
|---|---|---|
| Longitude/Easting: | Latitude/Northing: | Elevation: |
| Short Location Description & Notes: | | |

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

| METEOROLOGY | Wind Speed (m/s) | Wind Direction (°) | Temperature (°C) | Humidity (%) | Clouds (%) | Remarks: |
|---|---|---|---|---|---|---|
| Start | 0.2 - 2.4 | NE | ~~27.1~~ 28 | 15.3 | 0 | Birds @ ±40 dB |
| Middle | | | | | | |
| End | | | | | | |

| NOISE CLIMATE | ☒ Birds | ☐ Insects | ☐ Dogs | ☐ Music | ☐ Community | ☐ Air Traffic | ☐ Road Traffic | ☐ Constr. | ☐ Other |
|---|---|---|---|---|---|---|---|---|---|
| Description: open land, shrubs | | | | | | | | | |

| EVENTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Time | Description | Time | Description | Time | Description | Time | Description |
| 18:27:49 - 31:54 | Birds | | | | | | |
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Day Receptor

| SITE NUMBER: | Site 6 | | SLM DATA RECORD: | gamb(gn 007 |
|---|---|---|---|---|
| Longitude/Easting: | | Latitude/Northing: | | Elevation: |
| Short Location Description & Notes: | | | | |

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

| METEOROLOGY | Wind Speed (m/s) | Wind Direction (°) | Temperature (°C) | Humidity (%) | Clouds (%) | Remarks: |
|---|---|---|---|---|---|---|
| Start | 0.9 – 5.7 | N.W | 29.2 | 18.9 | 0 | - Gusty winds throughout |
| Middle | | | | | | - Men working (far away) |
| End | | | | | | |

| NOISE CLIMATE | ☒ Birds | ☐ Insects | ☒ Dogs | ☐ Music | ☒ Community | ☐ Air Traffic | ☒ Road Traffic | ☐ Constr. | ☐ Other |
|---|---|---|---|---|---|---|---|---|---|

Description: Aggeneys town, trees & shrubs, semi-cultivated land

**EVENTS**

| Time | Description | Time | Description | Time | Description | Time | Description |
|---|---|---|---|---|---|---|---|
| 10:35:06 | Cars passing | | | | | | |
| 39:37 | Car passing | | | | | | |
| | | | | | | | |
| 55:08 | | | | | | | |
| 55:35 | | | | | | | |
| | | | | | | | |
| 58:53 | People walking | | | | | | |
| | passing by | | | | | | |
| | | | | | | | |
| 5932 | Heavy vehicle | | | | | | |
| | passing | | | | | | |
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Night

| SITE NUMBER: | Site 1 | SLM DATA RECORD: | 9gm3brgn 001 |
|---|---|---|---|
| Longitude/Easting: | Latitude/Northing: | Elevation: | |
| Short Location Description & Notes: | | | |

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

| METEOROLOGY | Wind Speed (m/s) | Wind Direction (°) | Temperature (°C) | Humidity (%) | Clouds (%) | Remarks: |
|---|---|---|---|---|---|---|
| Start | 0,1 - 2.3 | W | 20.9 | 41 | 0 | Insects & Birds throughout |
| Middle | | | | | | |
| End | | | | | | |

| NOISE CLIMATE | ☑ Birds | ☑ Insects | ☐ Dogs | ☐ Music | ☐ Community | ☐ Air Traffic | ☐ Road Traffic | ☐ Constr. | ☐ Other |
|---|---|---|---|---|---|---|---|---|---|
| Description: | | | | | | | | | |

EVENTS

| Time | Description | Time | Description | Time | Description | Time | Description |
|---|---|---|---|---|---|---|---|
| 22:13:37 | Birds | | | | | | |
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Night

| SITE NUMBER: Site 2 | | SLM DATA RECORD: gamsbrgn 002 |
|---|---|---|
| Longitude/Easting: | Latitude/Northing: | Elevation: |
| Short Location Description & Notes: | | |

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

| METEOROLOGY | Wind Speed (m/s) | Wind Direction (°) | Temperature (°C) | Humidity (%) | Clouds (%) | Remarks: |
|---|---|---|---|---|---|---|
| Start | 0.1 – 1.8 | SW | 19.2 | 43 | 0 | |
| Middle | | | | | | |
| End | | | | | | |

| NOISE CLIMATE | ☑ Birds | ☑ Insects | ☐ Dogs | ☐ Music | ☐ Community | ☐ Air Traffic | ☐ Road Traffic | ☐ Constr. | ☐ Other |
|---|---|---|---|---|---|---|---|---|---|
| Description: | | | | | | | | | |

EVENTS

| Time | Description | Time | Description | Time | Description | Time | Description |
|---|---|---|---|---|---|---|---|
| 22:52:27 | Sounds coming from mine (mine operations) | | | | | | |
| 22:56:05 31 | " | | | | | | |
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Night

| SITE NUMBER: Site 3 | | SLM DATA RECORD: gambrgn003 | |
|---|---|---|---|
| Longitude/Easting: | Latitude/Northing: | Elevation: | |
| Short Location Description & Notes: | | | |

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

| METEOROLOGY | Wind Speed (m/s) | Wind Direction (°) | Temperature (°C) | Humidity (%) | Clouds (%) | Remarks: |
|---|---|---|---|---|---|---|
| Start | 0-0.2 | S.W | 21.2 | 40 | 0 | |
| Middle | | | | | | |
| End | | | | | | |

| NOISE CLIMATE | ☒ Birds | ☒ Insects | ☐ Dogs | ☐ Music | ☐ Community | ☐ Air Traffic | ☐ Road Traffic | ☐ Constr. | ☐ Other |
|---|---|---|---|---|---|---|---|---|---|
| Description: | | | | | | | | | |

| EVENTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Time | Description | Time | Description | Time | Description | Time | Description |
| 23:22:46 | Cars passing | | | | | | |
| -23:32 | Hooter (car) | | | | | | |
| 27:53 - 28:25 | car passing | | | | | | |

Receptor Night

| SITE NUMBER: | Site 4 | SLM DATA RECORD: | gambrgn 005 |
|---|---|---|---|
| Longitude/Easting: | Latitude/Northing: | Elevation: | |
| Short Location Description & Notes: | | | |

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

| METEOROLOGY | Wind Speed (m/s) | Wind Direction (°) | Temperature (°C) | Humidity (%) | Clouds (%) | Remarks: |
|---|---|---|---|---|---|---|
| Start | 0,1 - 1,7 | S.W | 19.8 | 40 | 0 | Insects & Birds throughout I 40dB |
| Middle | | | | | | |
| End | | | | | | |

| NOISE CLIMATE | ☑ Birds | ☑ Insects | ☐ Dogs | ☐ Music | ☐ Community | ☐ Air Traffic | ☐ Road Traffic | ☐ Constr. | ☐ Other |
|---|---|---|---|---|---|---|---|---|---|
| Description: | | | | | | | | | |

EVENTS

| Time | Description | Time | Description | Time | Description | Time | Description |
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| SITE NUMBER: Site 5 | | SLM DATA RECORD: gamsbrgn004 | |
|---|---|---|---|
| Longitude/Easting: | Latitude/Northing: | | Elevation: |
| Short Location Description & Notes: | | | |

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

| METEOROLOGY | Wind Speed (m/s) | Wind Direction (°) | Temperature (°C) | Humidity (%) | Clouds (%) | Remarks: |
|---|---|---|---|---|---|---|
| Start | 0.1 - 1.7 | S.W | 18.9 | 44.1 | 0 | Mine operations noise background |
| Middle | | | | | | |
| End | | | | | | |

| NOISE CLIMATE | ☒ Birds | ☒ Insects | ☐ Dogs | ☐ Music | ☐ Community | ☐ Air Traffic | ☐ Road Traffic | ☐ Constr. | ☐ Other |
|---|---|---|---|---|---|---|---|---|---|
| Description: Hooter @ 146dB | | | | | | | | | |

EVENTS

| Time | Description | Time | Description | Time | Description | Time | Description |
|---|---|---|---|---|---|---|---|
| 23:58:08 | Car passing from far away | | | | | | |
| 04:49 | hooter from mine | | | | | | |

Receptor Aggeneys Town Residential area Night

| SITE NUMBER: Site 6 | | SLM DATA RECORD: gamsbrgn 006 |
|---|---|---|
| Longitude/Easting: | Latitude/Northing: | Elevation: |
| Short Location Description & Notes: | | |

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

| METEOROLOGY | Wind Speed (m/s) | Wind Direction (°) | Temperature (°C) | Humidity (%) | Clouds (%) | Remarks: |
|---|---|---|---|---|---|---|
| Start | 0 - 1.1 | SW | 22.5 | 42 | 0 | Dogs faraway (throughout) @ ± 60dB |
| Middle | | | | | | |
| End | | | | | | |

| NOISE CLIMATE | ☒ Birds | ☒ Insects | ☒ Dogs | ☐ Music | ☐ Community | ☐ Air Traffic | ☐ Road Traffic | ☐ Constr. | ☐ Other |
|---|---|---|---|---|---|---|---|---|---|
| Description: Aggeneys, trees & shrubs, open land (semi) | | | | | | | | | |

**EVENTS**

| Time | Description | Time | Description | Time | Description | Time | Description |
|---|---|---|---|---|---|---|---|
| 1:27:16 | Car passing | | | | | | |
| | " | | | | | | |
| 28:37 | " | | | | | | |
| 38:14 | " | | | | | | |
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*Figure 19: Photographs of environmental noise survey Site 1*


*Figure 20: Photographs of environmental noise survey Site 2*

Facing north

Facing east

Facing south

Facing west

*Figure 21: Photographs of environmental noise survey Site 3*

Facing north

Facing east

Facing south

Facing west

*Figure 22: Photographs of environmental noise survey Site 4*


*Figure 23: Photographs of environmental noise survey Site 5*


*Figure 24: Photographs of environmental noise survey Site 6*

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

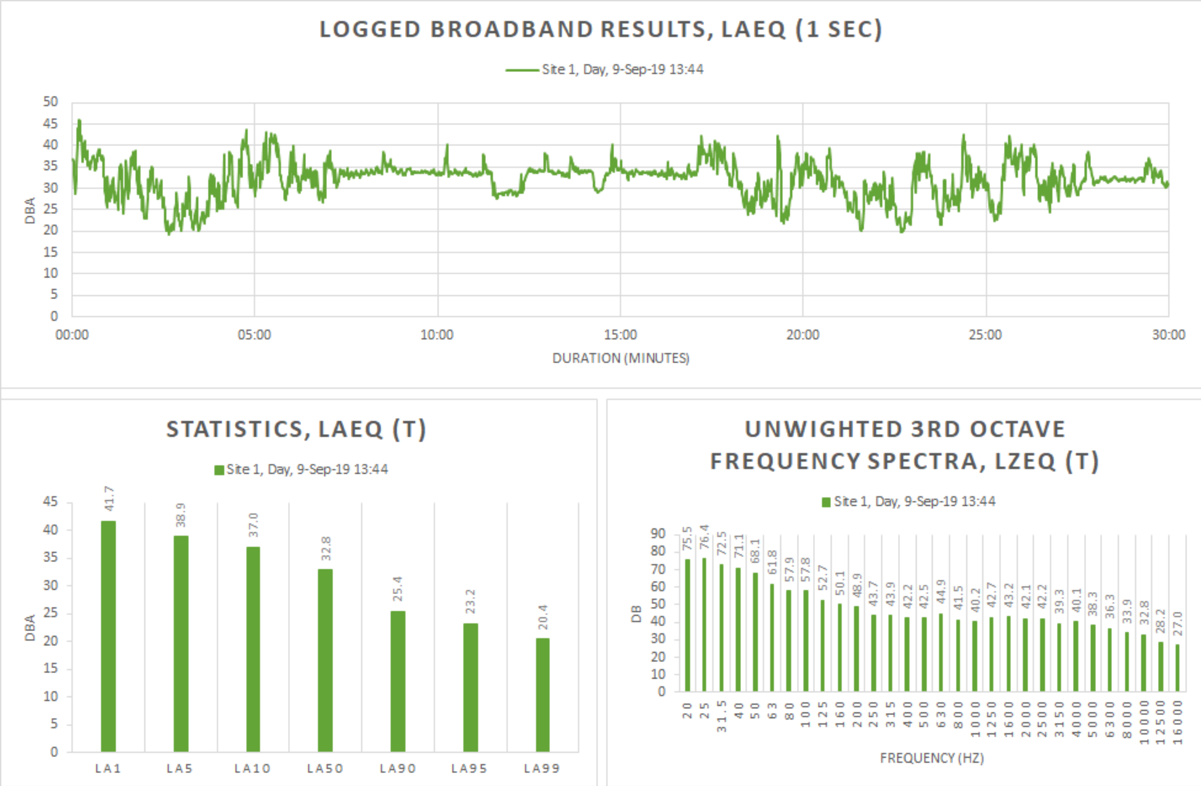


*Figure 25: Detailed day-time survey results for Site 1*

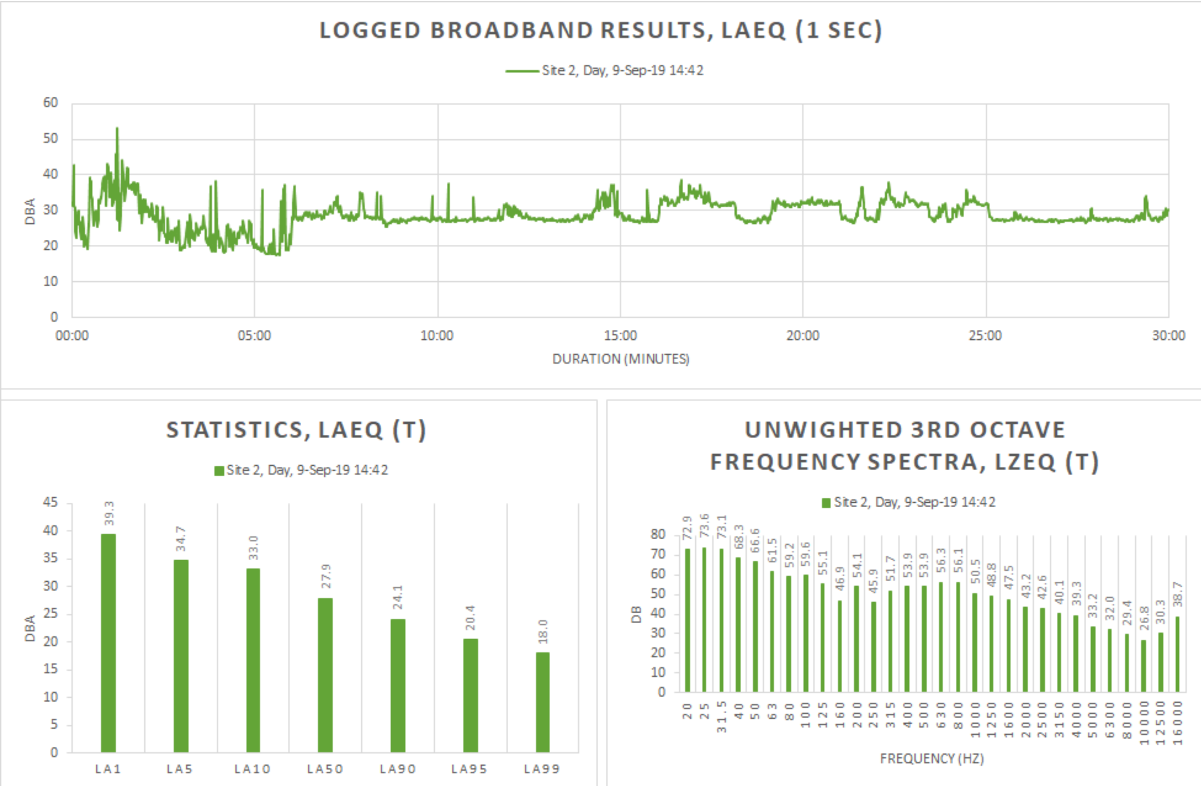


*Figure 26: Detailed day-time survey results for Site 2*

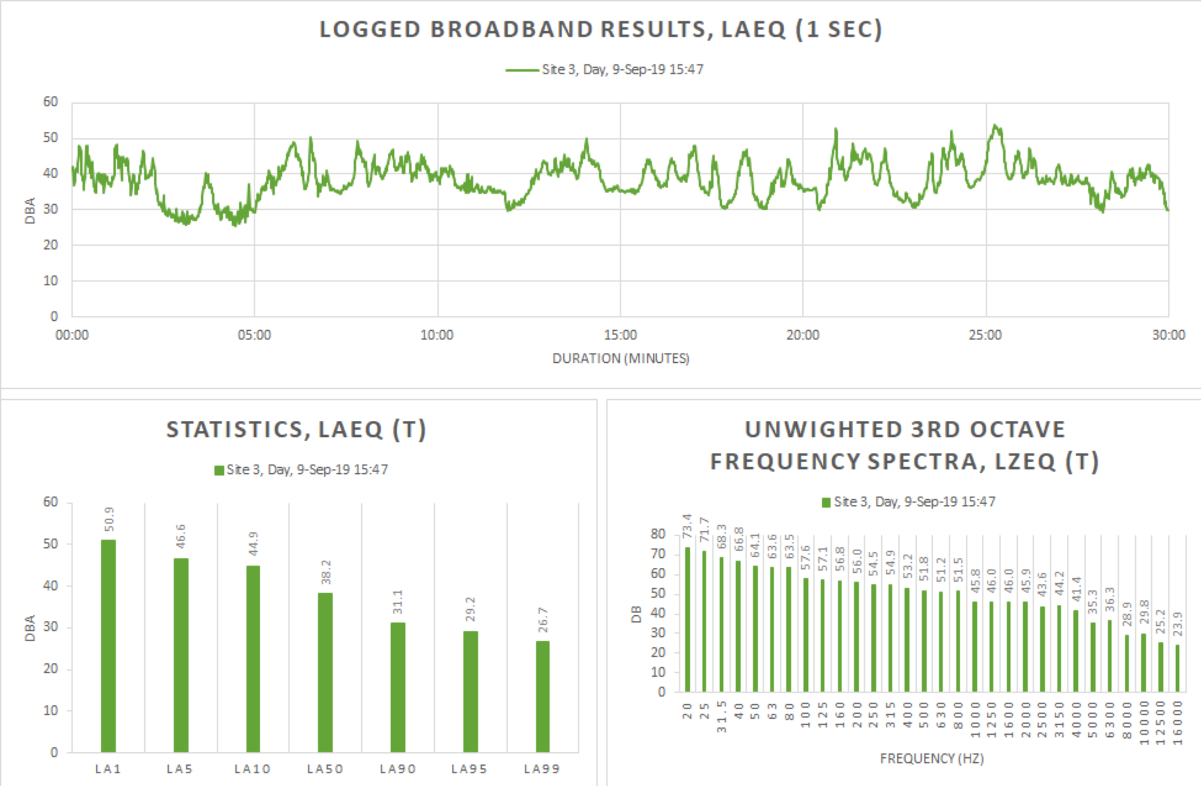


*Figure 27: Detailed day-time survey results for Site 3*

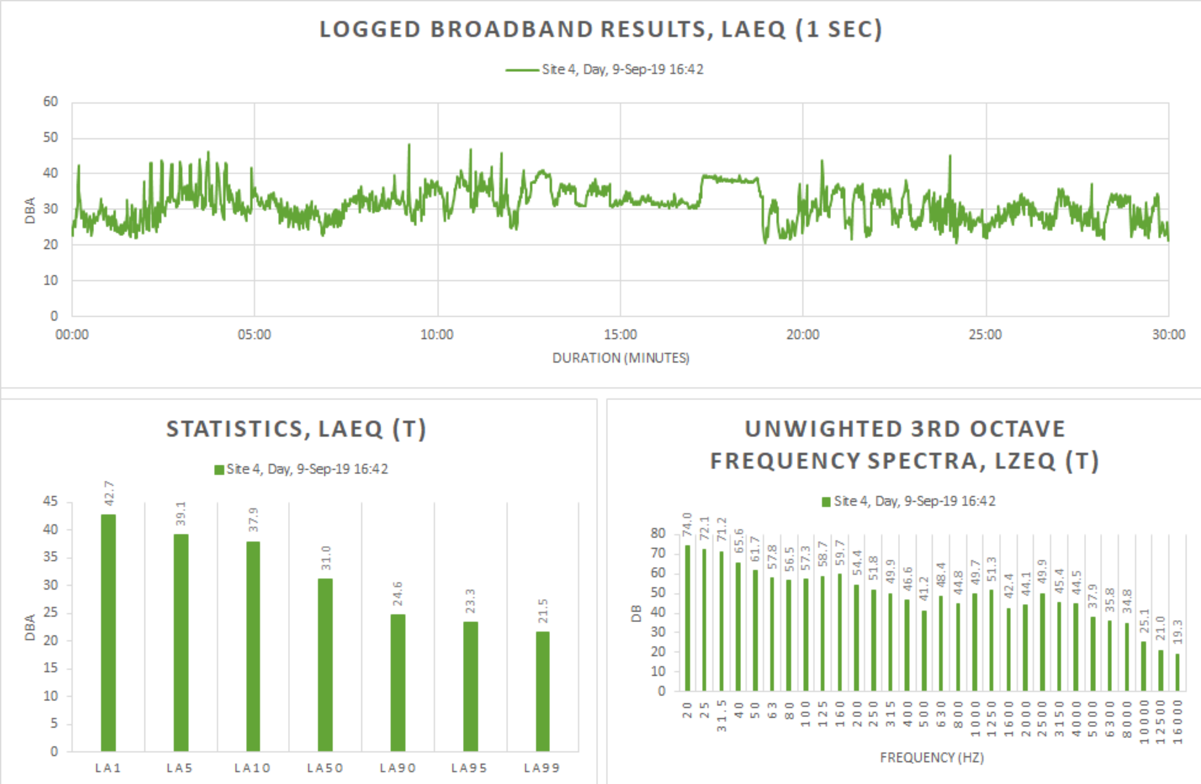


*Figure 28: Detailed day-time survey results for Site 4*

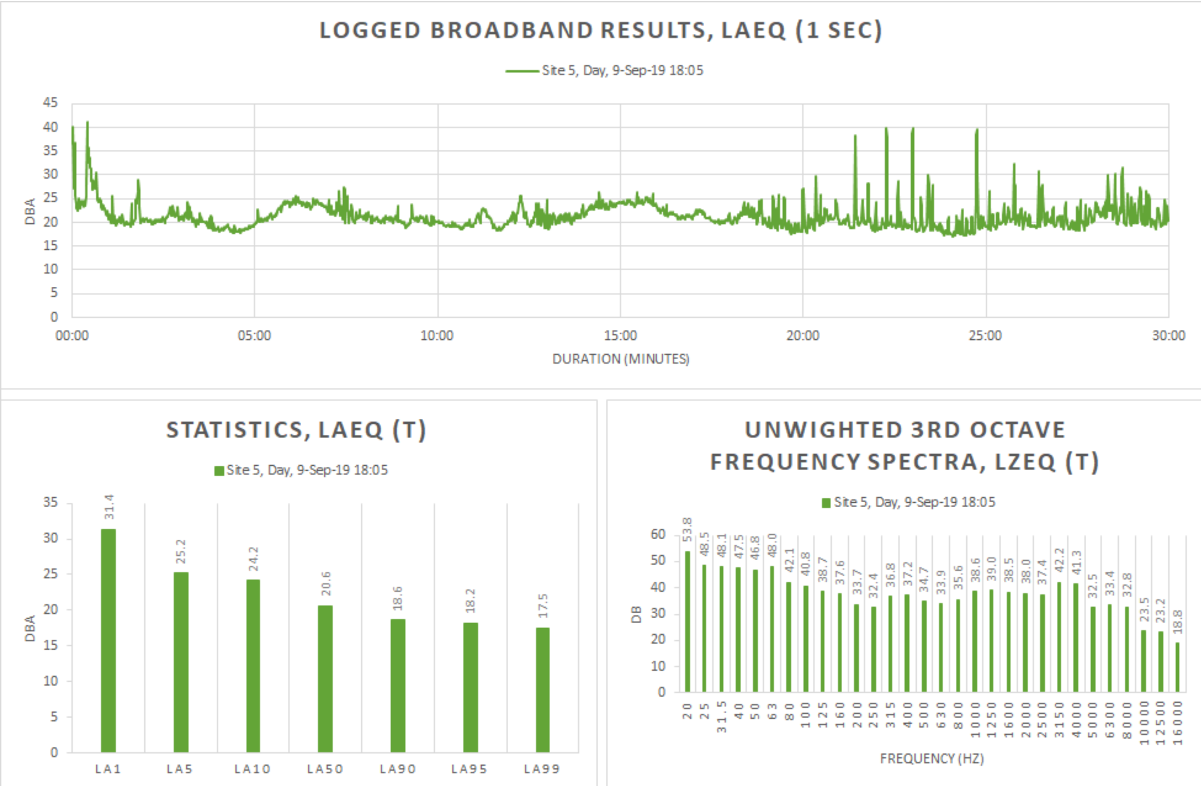


*Figure 29: Detailed day-time survey results for Site 5*

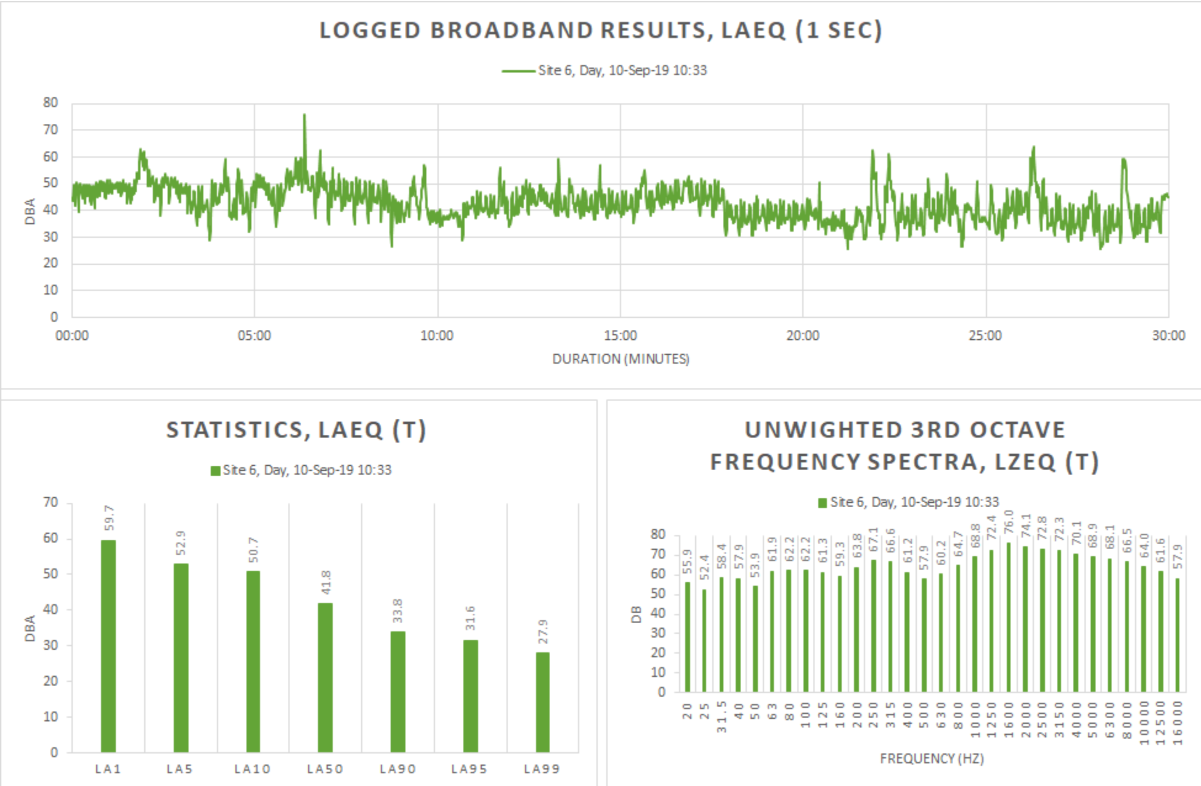


*Figure 30: Detailed day-time survey results for Site 6*

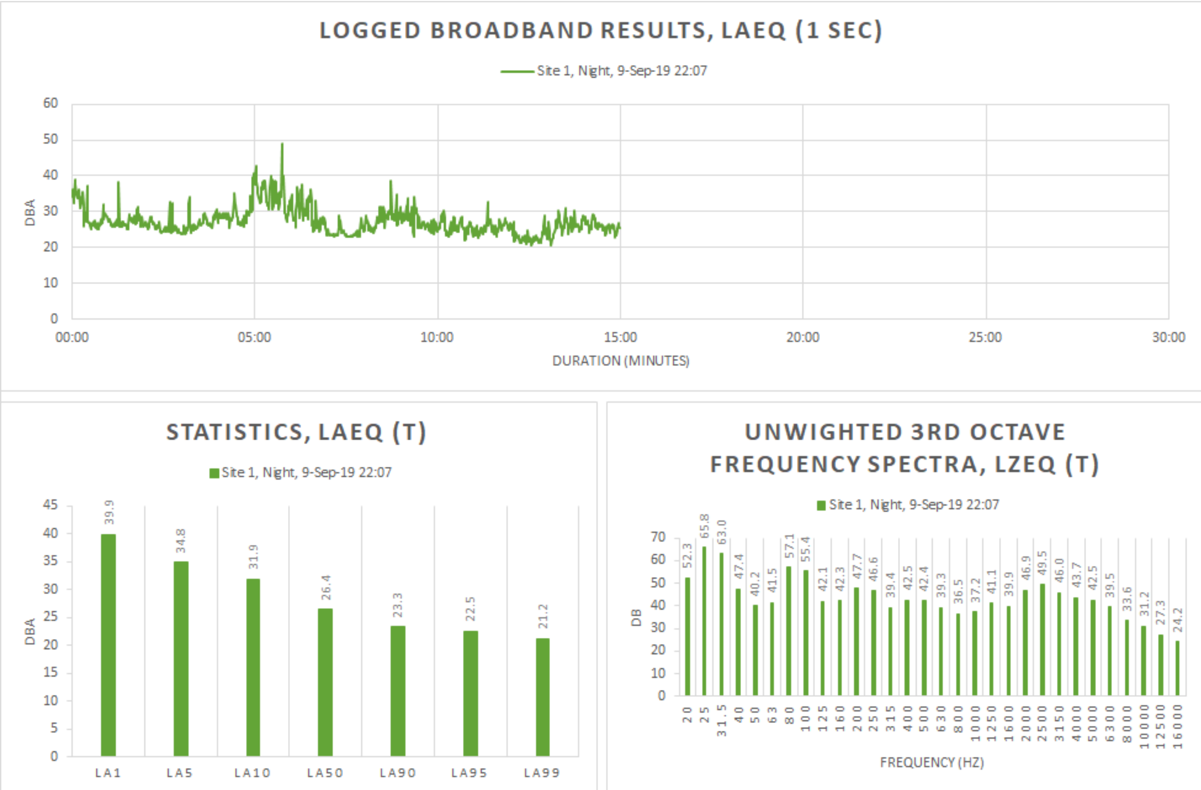


*Figure 31: Detailed night-time survey results for Site 1*

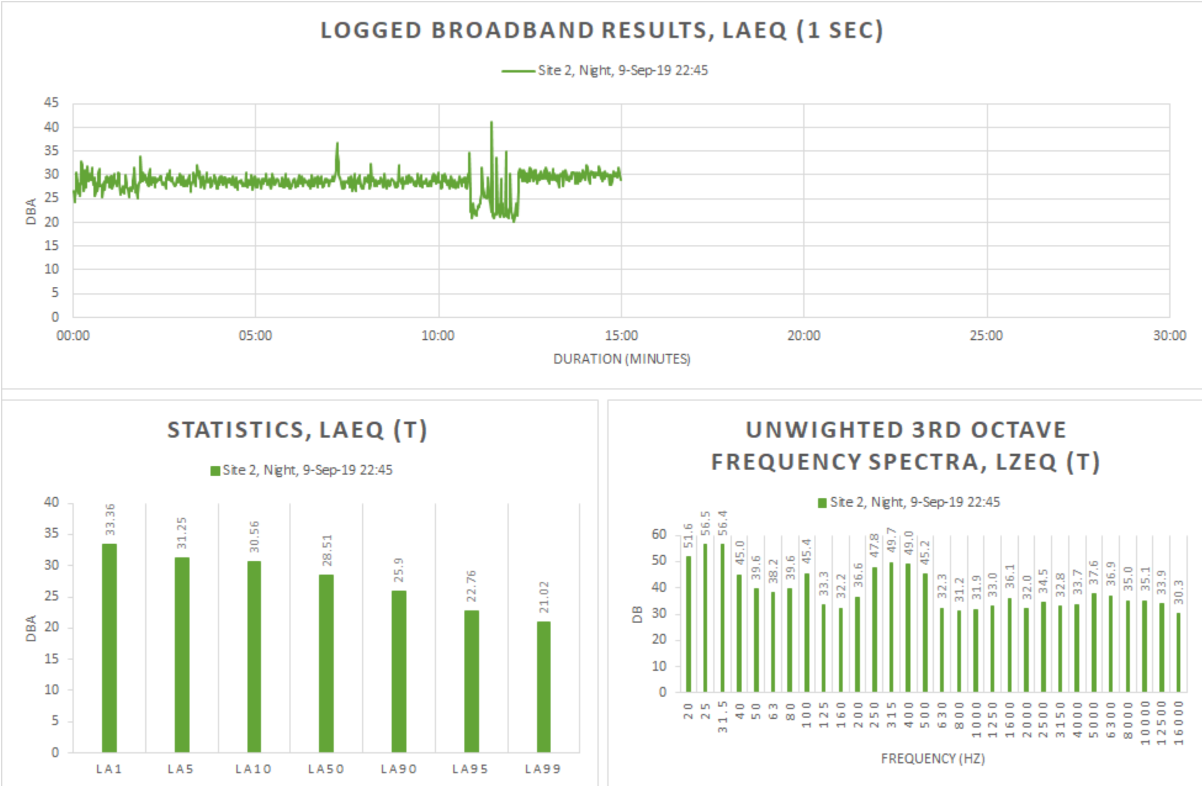


*Figure 32: Detailed night -time survey results for Site 2*

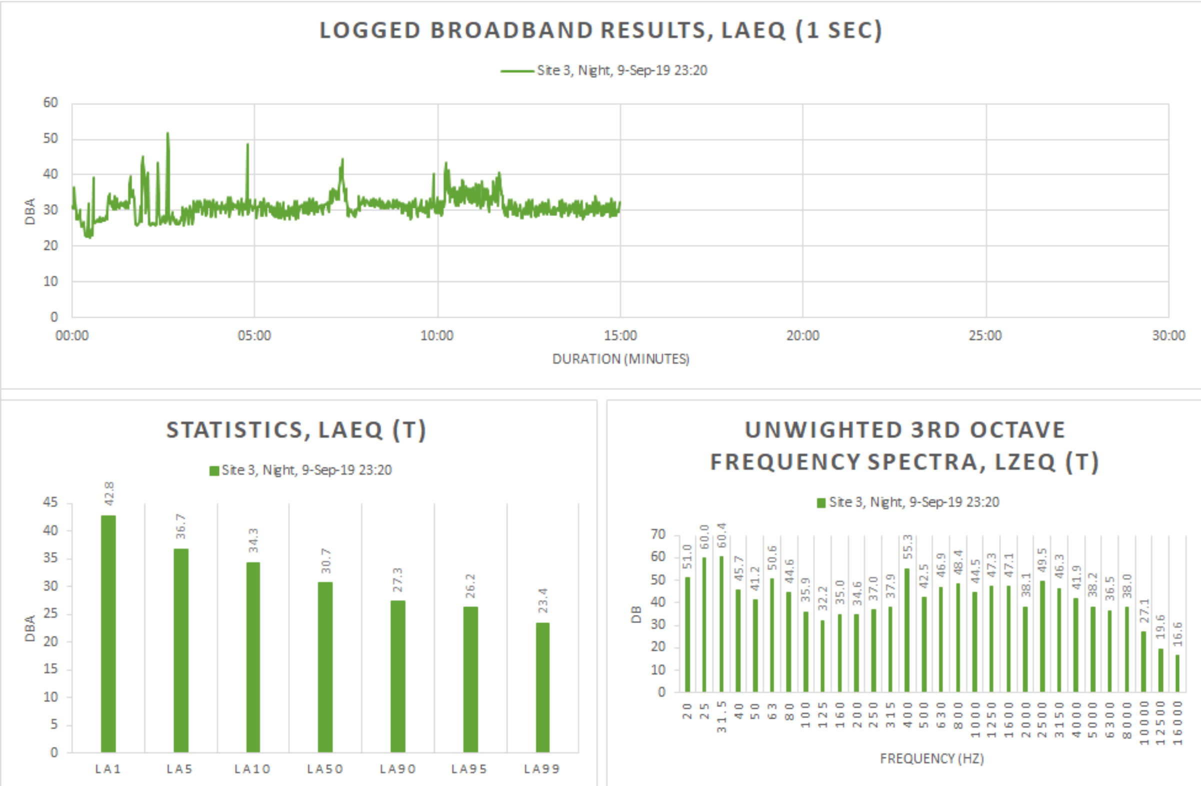


*Figure 33: Detailed night -time survey results for Site 3*

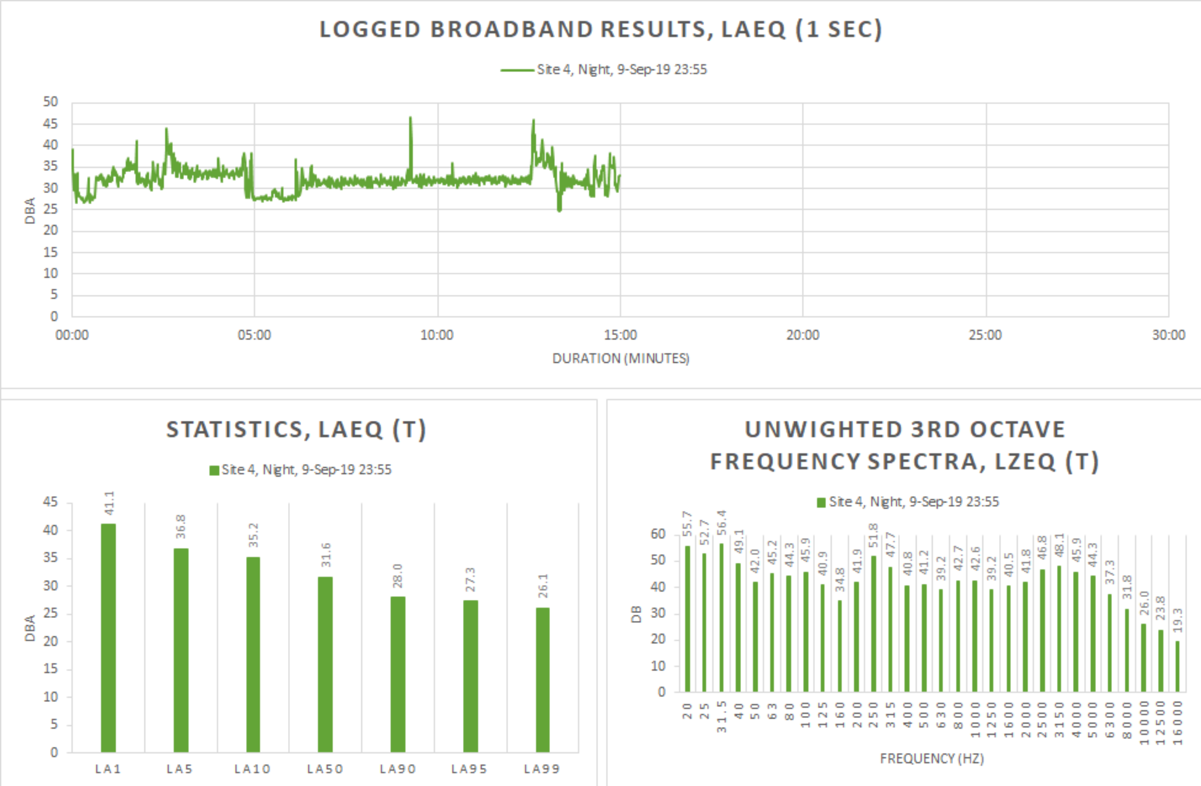


*Figure 34: Detailed night -time survey results for Site 4*

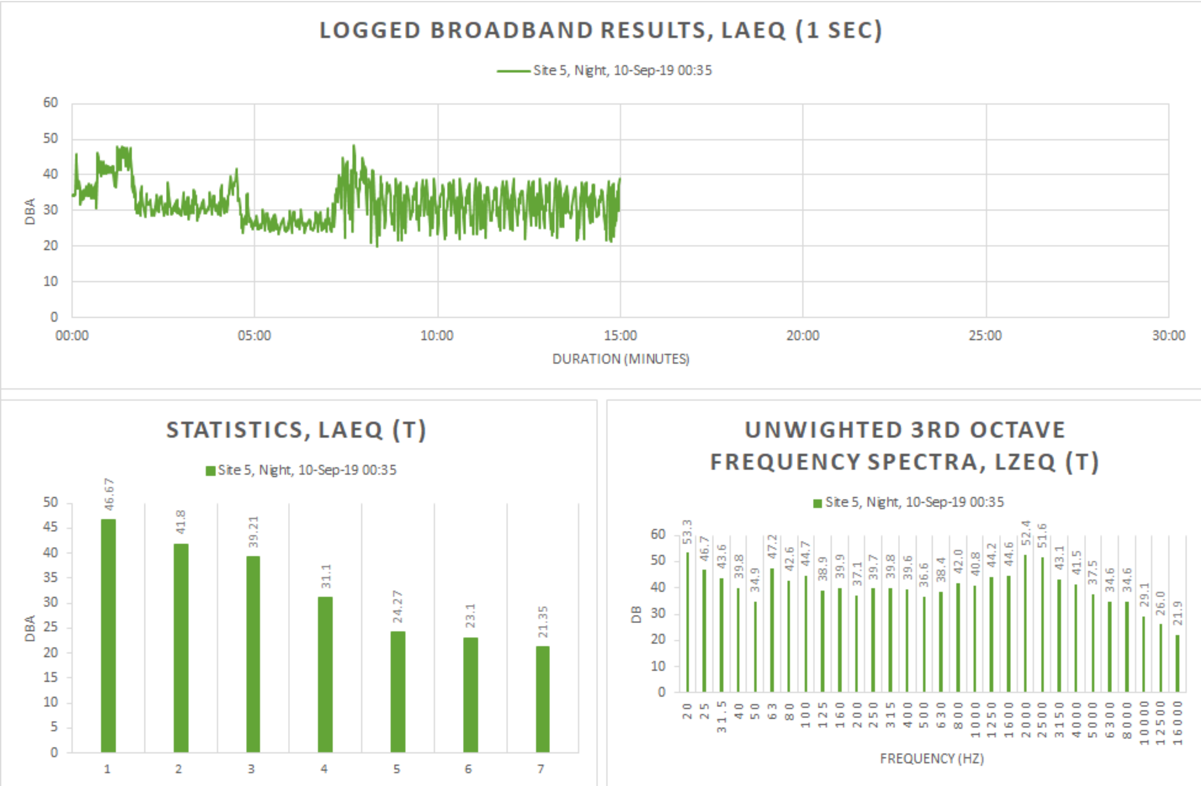


*Figure 35: Detailed night -time survey results for Site 5*

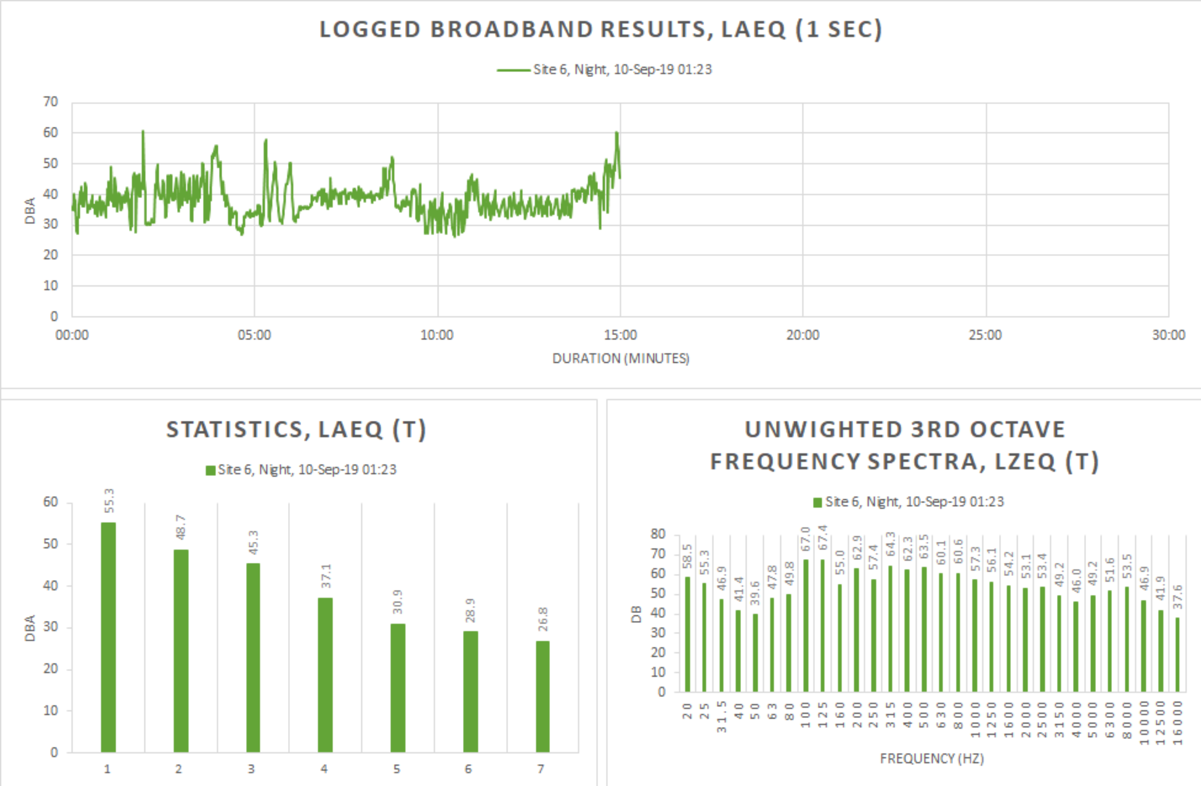


*Figure 36: Detailed night -time survey results for Site 6*

# Appendix E – Impact Assessment Methodology

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

| PART A: DEFINITIONS AND CRITERIA | | |
|---|---|---|
| **Definition of SIGNIFICANCE** | | **Significance = consequence x probability** |
| **Definition of CONSEQUENCE** | | **Consequence is a function of intensity, spatial extent and duration** |
| **Criteria for ranking of the INTENSITY of environmental impacts** | **VH** | Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs. |
| | **H** | Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place. |
| | **M** | Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected. |
| | **L** | Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected. |
| | **VL** | Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated. |
| | **VL+** | Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range. |
| | **L+** | Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits. |
| | **M+** | Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits. |
| | **H+** | Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support. |
| | **VH+** | Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected. |
| **Criteria for ranking the DURATION of impacts** | **VL** | Very short, always less than a year. Quickly reversible |
| | **L** | Short-term, occurs for more than 1 but less than 5 years. Reversible over time. |
| | **M** | Medium-term, 5 to 10 years. |
| | **H** | Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity) |
| | **VH** | Very long, permanent, +20 years (Irreversible. Beyond closure) |
| **Criteria for ranking the EXTENT of impacts** | **VL** | A part of the site/property. |
| | **L** | Whole site. |
| | **M** | Beyond the site boundary, affecting immediate neighbours |
| | **H** | Local area, extending far beyond site boundary. |
| | **VH** | Regional/National |

| PART B: DETERMINING CONSEQUENCE | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | EXTENT | | | | |
| | | | A part of the site/property | Whole site | Beyond the site, affecting neighbours | Local area, extending far beyond site. | Regional/ National |
| | | | **VL** | **L** | **M** | **H** | **VH** |
| **INTENSITY = VL** | | | | | | | |
| **DURATION** | Very long | **VH** | **Low** | **Low** | **Medium** | **Medium** | **High** |
| | Long term | **H** | **Low** | **Low** | **Low** | **Medium** | **Medium** |
| | Medium term | **M** | **Very Low** | **Low** | **Low** | **Low** | **Medium** |
| | Short term | **L** | **Very low** | **Very Low** | **Low** | **Low** | **Low** |
| | Very short | **VL** | **Very low** | **Very Low** | **Very Low** | **Low** | **Low** |
| **INTENSITY = L** | | | | | | | |
| **DURATION** | Very long | **VH** | **Medium** | **Medium** | **Medium** | **High** | **High** |
| | Long term | **H** | **Low** | **Medium** | **Medium** | **Medium** | **High** |
| | Medium term | **M** | **Low** | **Low** | **Medium** | **Medium** | **Medium** |
| | Short term | **L** | **Low** | **Low** | **Low** | **Medium** | **Medium** |
| | Very short | **VL** | **Very low** | **Low** | **Low** | **Low** | **Medium** |
| **INTENSITY = M** | | | | | | | |
| **DURATION** | Very long | **VH** | **Medium** | **High** | **High** | **High** | **Very High** |
| | Long term | **H** | **Medium** | **Medium** | **Medium** | **High** | **High** |
| | Medium term | **M** | **Medium** | **Medium** | **Medium** | **High** | **High** |
| | Short term | **L** | **Low** | **Medium** | **Medium** | **Medium** | **High** |
| | Very short | **VL** | **Low** | **Low** | **Low** | **Medium** | **Medium** |
| **INTENSITY = H** | | | | | | | |
| **DURATION** | Very long | **VH** | **High** | **High** | **High** | **Very High** | **Very High** |
| | Long term | **H** | **Medium** | **High** | **High** | **High** | **Very High** |
| | Medium term | **M** | **Medium** | **Medium** | **High** | **High** | **High** |
| | Short term | **L** | **Medium** | **Medium** | **Medium** | **High** | **High** |
| | Very short | **VL** | **Low** | **Medium** | **Medium** | **Medium** | **High** |
| **INTENSITY = VH** | | | | | | | |
| **DURATION** | Very long | **VH** | **High** | **High** | **Very High** | **Very High** | **Very High** |
| | Long term | **H** | **High** | **High** | **High** | **Very High** | **Very High** |
| | Medium term | **M** | **Medium** | **High** | **High** | **High** | **Very High** |
| | Short term | **L** | **Medium** | **Medium** | **High** | **High** | **High** |
| | Very short | **VL** | **Low** | **Medium** | **Medium** | **High** | **High** |
| | | | **VL** | **L** | **M** | **H** | **VH** |
| | | | A part of the site/property | Whole site | Beyond the site, affecting neighbours | Local area, extending far beyond site. | Regional/ National |
| | | | **EXTENT** | | | | |

| PART C: DETERMINING SIGNIFICANCE | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PROBABILITY (of exposure to impacts)** | Definite/ Continuous | **VH** | **Very Low** | **Low** | **Medium** | **High** | **Very High** |
| | Probable | **H** | **Very Low** | **Low** | **Medium** | **High** | **Very High** |
| | Possible/ frequent | **M** | **Very Low** | **Very Low** | **Low** | **Medium** | **High** |
| | Conceivable | **L** | **Insignificant** | **Very Low** | **Low** | **Medium** | **High** |
| | Unlikely/ improbable | **VL** | **Insignificant** | **Insignificant** | **Very Low** | **Low** | **Medium** |
| | | | **VL** | **L** | **M** | **H** | **VH** |
| | | | **CONSEQUENCE** | | | | |

| PART D: INTERPRETATION OF SIGNIFICANCE | |
|---|---|
| **Significance** | **Decision guideline** |
| Very High | Potential fatal flaw unless mitigated to lower significance. |
| High | It must have an influence on the decision. Substantial mitigation will be required. |
| Medium | It should have an influence on the decision. Mitigation will be required. |
| Low | Unlikely that it will have a real influence on the decision. Limited mitigation is likely to be required. |
| Very Low | It will not have an influence on the decision. Does not require any mitigation |
| Insignificant | Inconsequential, not requiring any consideration. |

***VH = very high, H = high, M= medium, L= low and VL= very low and + denotes a positive impact.**