# Noise Impact Assessment for the Proposed Mokala Manganese Project near Hotazel in the Northern Cape Province

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


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**Report No:** 14SLR17 v.1.4 | **Date:** October 2015


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# Report Details

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|---|---|
| **Report Title** | Noise Impact Assessment for the Proposed Mokala Manganese Project near Hotazel in the Northern Cape Province |
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# Revision Record

| Version | Date | Section(s) Revised | Summary Description of Revision(s) |
|---|---|---|---|
| 1.1 | 15 June 2015 | Section 1 | Figure 1 updated to include a more detailed site layout map |
| 1.2 | 14 August 2015 | Section 1<br>Section 3 | Page ii and Page 13 updated to reflect distance to Hotazel as 4 km |
| | | Section 1 | Page 10. Additional comments regarding blasting included. |
| | | Section 3 | Page 13. Wind direction corrected so that Table 3 corresponds to Figure 4. |
| | | Section 3 | Page 16. Comments regarding the effect of the R380 realignment on ambient noise levels included. |
| | | Section 4 | Isopleth maps updated to include IFC noise level guidelines in legend. |
| | | Section 3<br>Section 4 | Kalagadi Manganese Mine included as a sensitive receptor. |
| | | All | The term “waste rock” replaced by “overburden” |
| | | Section 1 | Figure 1 updated. |
| 1.3 | 14 September 2015 | All | Inclusion of all NEMA reporting requirements. |
| 1.4 | 28 October 2015 | Page ii | Table summarising NEMA reporting requirements included. |

# NEMA Regulation (2014), Appendix 6

| NEMA Regulations (2014) - Appendix 6 | Relevant section in report |
|---|---|
| Details of the specialist who prepared the report. | Report Details (page i) |
| The expertise of that person to compile a specialist report including curriculum vitae. | Section 8: Annex B – Specialist's Curriculum Vitae (page 45) |
| A declaration that the person is independent in a form as may be specified by the competent authority. | Report Details (page i) |
| An indication of the scope of, and the purpose for which, the report was prepared. | Section 1.1: Purpose (page 1)<br>Section 1.2: Scope of Work (page 1) |
| The date and season of the site investigation and the relevance of the season to the outcome of the assessment. | Section 3.3: Sampled Baseline and Representative Pre-development Noise Levels (page 16)<br>Note: Seasonal changes immaterial to study outcome |
| A description of the methodology adopted in preparing the report or carrying out the specialised process. | Section 1.5: Approach and Methodology (page 6) |
| The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure. | Section 3: Description of the Receiving Environment (page 13) |
| An identification of any areas to be avoided, including buffers. | Not applicable |
| 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 1.3: Description of Activities from a Noise Perspective and Selection of Assessment Scenarios, Figure 1 (page 3) |
| A description of any assumptions made and any uncertainties or gaps in knowledge. | Section 1.6: Limitations and Assumptions (page 10) |
| A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment. | Section 4: Impact Assessment (page 19) |
| Any mitigation measures for inclusion in the EMPr. | Section 5: Management, Mitigation and Recommendations (p. 33) |
| Any conditions for inclusion in the environmental authorisation | Section 5: Management, Mitigation and Recommendations (p. 33) |
| Any monitoring requirements for inclusion in the EMPr or environmental authorisation. | Section 5.3: Monitoring (p. 34) |
| A reasoned opinion as to whether the proposed activity or portions thereof should be authorised. | Section 5: Management, Mitigation and Recommendations (p. 33) |
| If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan. | Section 5: Management, Mitigation and Recommendations (p. 33) |
| 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. | No comments received. |
| Any other information requested by the competent authority. | Not applicable. |

# Glossary and Abbreviations

| | |
|---|---|
| **Airshed** | Airshed Planning Professionals (Pty) Ltd |
| **ASG** | Atmospheric Studies Group |
| **dB** | Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure. |
| **dBA** | Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure that has been A-weighted to simulate human hearing. |
| **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 |
| **kW** | Power in kilo Watt |
| **$L_{Aeq}$ (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) |
| **$L_{A90}$** | 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) |
| **$L_{PA}$** | A-weighted sound pressure level (in dBA) |
| **$L_{PZ}$** | Un-weighted sound pressure level (in dB) |
| **$L_W$** | Sound Power Level (in dB) |
| **Mtpa** | Million tonnes per annum |
| **MW** | Power in mega Watt |
| **NEMAQA** | National Environment Management Air Quality Act |
| **NSR** | Noise sensitive receptor |
| **p** | Pressure in Pa |
| **$p_{ref}$** | Reference pressure, 20 μPa |
| **rpm** | Rotational speed in revolutions per minute |
| **SABS** | South African Bureau of Standards |
| **SANS** | South African National Standards |
| **SLM** | Sound Level Meter |
| **SLR** | SLR Consulting (Africa) (Pty) Ltd |
| **SoW** | Scope of Work |
| **USGS** | United States Geological Survey |
| **WG-AEN** | Working Group – Assessment of Environmental Noise (EC) |
| **WHO** | World Health Organisation |

# Executive Summary

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by SLR Consulting (South Africa) (Pty) Ltd (SLR) to undertake an environmental noise impact assessment for the proposed Mokala Manganese Project near Hotazel in the Northern Cape Province. The main purpose of the noise study was to determine the potential impact on the acoustic climate and noise sensitive receptors (NSRs) given mining activities proposed as part of the Project. The following tasks were included as part of the scope of work:

1. A review of technical project information.
2. A baseline noise survey which included:
    a. The measurement of existing/pre development environmental noise levels vicinity the Project;
    b. A survey of ground characteristics and other site specific features that may influence the propagation of noise from source to receiver; and
    c. The identification of existing sources of environmental noise in the Project area such as communities, mining, industries and public roads.
3. A review of the legal requirements and applicable environmental noise guidelines.
4. A study of the receiving (baseline) acoustic environment, including:
    a. The identification of noise sensitive receptors (NSRs) from available maps;
    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 the survey.
5. An impact assessment, including:
    a. The establishment of a source inventory for the construction and operational phases of the Project.
    b. Noise propagation simulations to determine environmental noise levels.
    c. The screening of simulated noise levels against environmental noise criteria.
6. The identification and recommendation of suitable mitigation measures and monitoring requirements.
7. A specialist noise impact assessment report.

In the assessment of sampled and simulated noise levels reference was made to the International Finance Corporation (IFC) guidelines for residential, institutional and educational receptors (55 dBA during the day and 45 dBA during the night) since these (a) are applicable to nearby NSRs which include towns and a mine village and (b) in-line with South African National Standards (SANS) 10103 guidelines for urban districts. The IFC's 3 dBA increase criterion is used to determine the potential for noise impact.

The baseline acoustic environment was described in terms of the location of NSRs in relation to approved and proposed activities, the ability of the environment to attenuate noise over long distances and existing or pre-mining noise levels. The following was found:

- NSR's include single homesteads/farmsteads, towns and a mine village. The closest NSRs include residences of the Gloria Mine village situated approximately 1.3 km north of the northern mine boundary and residences of the town of Hotazel which lies approximately 4 km east of the eastern mine boundary. The Kalagadi Manganese Mine is located 700 m to the south of the Project. All other residences, farmsteads and towns lie further than 4 km from the mine boundary. The impact of an intruding industrial/mining noise on the environment rarely extends over more than 5 km from the source and it is therefore unlikely that these will be affected by the Project.
- Atmospheric conditions are more conducive to noise attenuation during the day.

- Based on the average wind field, noise impacts are expected to be most notable to the south-west during the day and north-west during the night.
- Baseline noise levels are affected by traffic along the R380, existing mining/industrial activities, birds and insects. Representative day- and night-time noise levels of 48.8 dBA and 44.4 dBA respectively were calculated from survey results.

The following scenarios were considered:

- **Construction** phase – representative of the initial clearing and opening of a box-cut with overburden used for the construction of roads and infrastructure development (plant areas, offices etc.);
- **Operational** phase – representative of mining and associated processing, handling and transport activities.

Sound power levels for main equipment were determined from equipment specifications and calculations. The source inventory, local meteorological conditions and information on local land use were used to populate the noise propagation model (Concawe). Noise levels were calculated over an area of 5 km east-west by 5 km north-south at intervals of 100 m and at nearby NSRs. The following was found:

- Construction phase impacts are expected to be slightly less notable than operational phase impacts.
- Noise impacts during the operational phase will be more notable at night.
- Neither the construction, nor the operational phase will result in noise levels in exceedance of the selected IFC and SANS impact criteria at the nearest NSR.
- The maximum impact is expected to occur at night during the operational phase when the increase above the baseline at the nearest NSR would be 2 to 3 dBA.

It is important to note the following conservative assumptions when interpreting results summarised above:

- Baseline noise levels on the lower side of what was measured were applied in calculations. The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in the project 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.
- All mining activities were assumed to be at the surface of pit areas. The mitigating effect of pit walls and overburden dumps were therefore not accounted for.
- The section of the open pit mining area that is situated closest to the NSRs was selected for inclusion in the assessment

It was concluded that, given the conservative nature of the assessment, the implementation of the basic good practice management measures recommended in this report will ensure low significance noise impact levels. From a noise perspective the project may proceed provided that the management and mitigation measures are implemented as part of the conditions of environmental authorisation.

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# 1 INTRODUCTION

Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by SLR Consulting (Africa) (Pty) Ltd (SLR) to undertake an environmental noise impact assessment for the proposed Mokala Manganese Project near Hotazel in the Northern Cape Province. The study purpose, description of activities from an environmental noise perspective and tasks included in the Scope of Work (SoW) are given below.

## 1.1 Purpose

The main purpose of the noise study was to determine the potential impact on the acoustic climate and noise sensitive receptors (NSRs) given mining activities proposed as part of the Project. The proposed Project site layout plan is included in Figure 1.

## 1.2 Scope of Work

The following tasks were included in the SoW:

1. A review of technical project information.
2. A baseline noise survey which included:
    a. The measurement of existing/pre development environmental noise levels vicinity the Project;
    b. A survey of ground characteristics and other site specific features that may influence the propagation of noise from source to receiver; and
    c. The identification of existing sources of environmental noise in the Project area such as communities, mining, industries and public roads.
3. A review of the legal requirements and applicable environmental noise guidelines.
4. A study of the receiving (baseline) acoustic environment, including:
    a. The identification of noise sensitive receptors (NSRs) from available maps;
    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 the survey.
5. An impact assessment, including:
    a. The establishment of a source inventory for the construction and operational phases of the Project.
    b. Noise propagation simulations to determine environmental noise levels.
    c. The screening of simulated noise levels against environmental noise criteria.
6. The identification and recommendation of suitable mitigation measures and monitoring requirements.
7. A specialist noise impact assessment report.

## 1.3 Description of Activities from a Noise Perspective and Selection of Assessment Scenarios

As is typical of opencast mining and ore processing facilities, sources of noise at the proposed Mokala Manganese Project will include the following:

- Drilling;
- Blasting;
- Ore and overburden handling (loading, unloading, pushing, dozing) in open pits, on overburden dumps or backfill areas and crusher/plant area;
- Crushing and screening of ore;

- Haul truck traffic;
- Diesel mobile equipment use (including reverse warnings);
- Diesel generators;
- Access road traffic; and
- Ore processing activities such as crushing and screening.

Whereas ore processing activities generate noise fairly constantly; drilling, blasting, ore and waste handling, transport activities and operating diesel mobile equipment generate noise that is intermittent and highly variable spatially even over 24 hours. Intuitively, the extent of noise impacts from a source point of view is a function of:

- Mining rates (activity levels);
- Fleet size;
- Spatial distribution of activities; and
- Source type.

Taking into consideration the above in addition to the location of potential NSRs in relation to operational areas the following scenarios were considered in the assessment:

- Construction Phase – representative of the initial clearing and opening of a box-cut with overburden used for the construction of roads and infrastructure development (plant areas, offices etc.);
- Operational Phase – representative of mining and associated processing, handling and transport activities.

The eastern section of the open pit, where the initial box cut will be is closest to the town of Hotazel and the Gloria Mine village to the north. The construction and mining thereof was thus selected for inclusion in the assessment in line with the conservative approach.

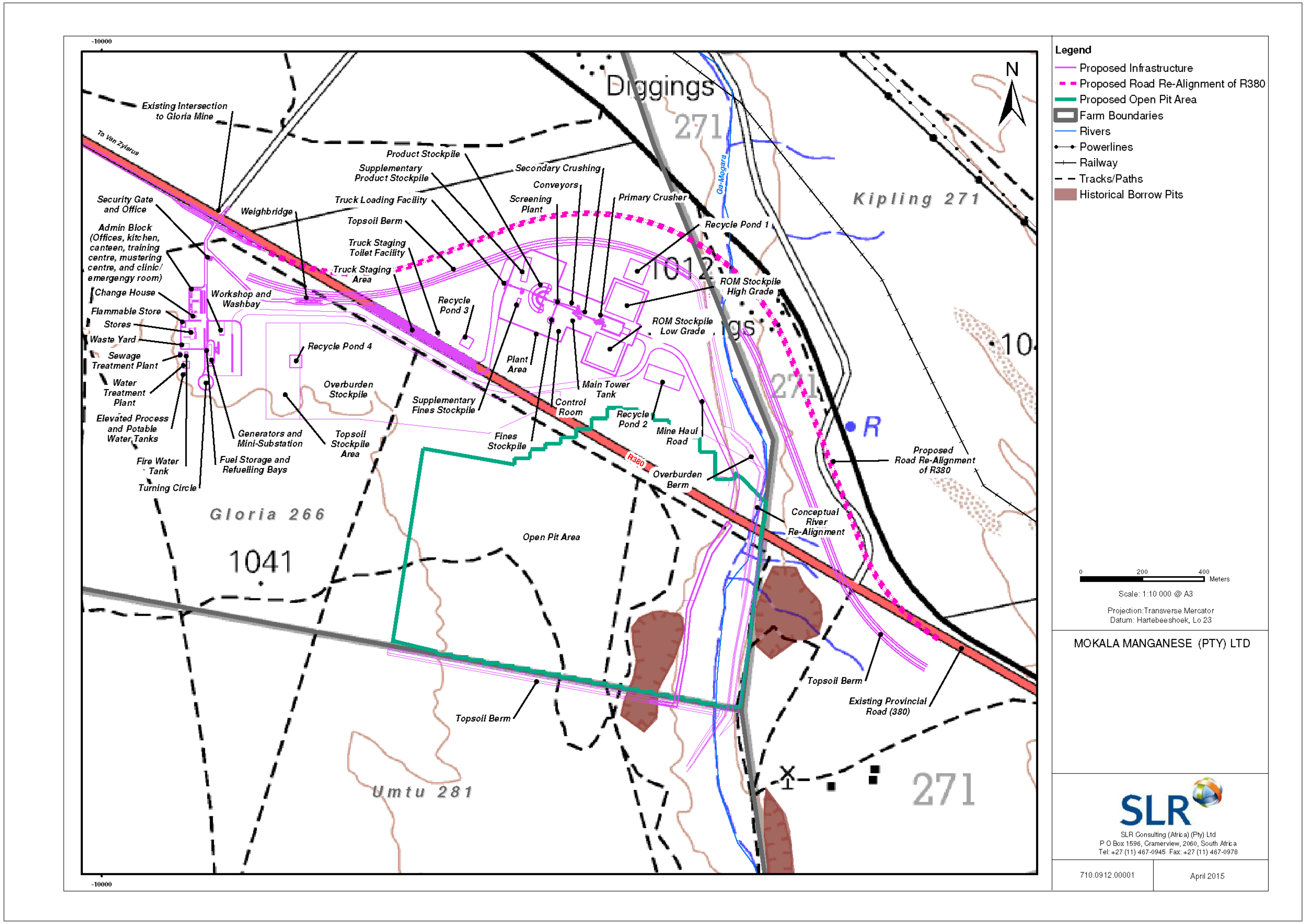



Figure 1: Proposed mine layout (layout provided by SLR)

## 1.4 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.

Noise is reported in decibels (dB). “dB” is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure. The relationship between sound pressure and sound pressure level is illustrated in this equation.

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

Where:

***$L_p$*** *is the sound pressure level in dB;*
***p*** *is the actual sound pressure in Pa; and*
***$p_{ref}$*** *is the reference sound pressure ($p_{ref}$ in air is 20 µPa)*

### 1.4.1 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 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).

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

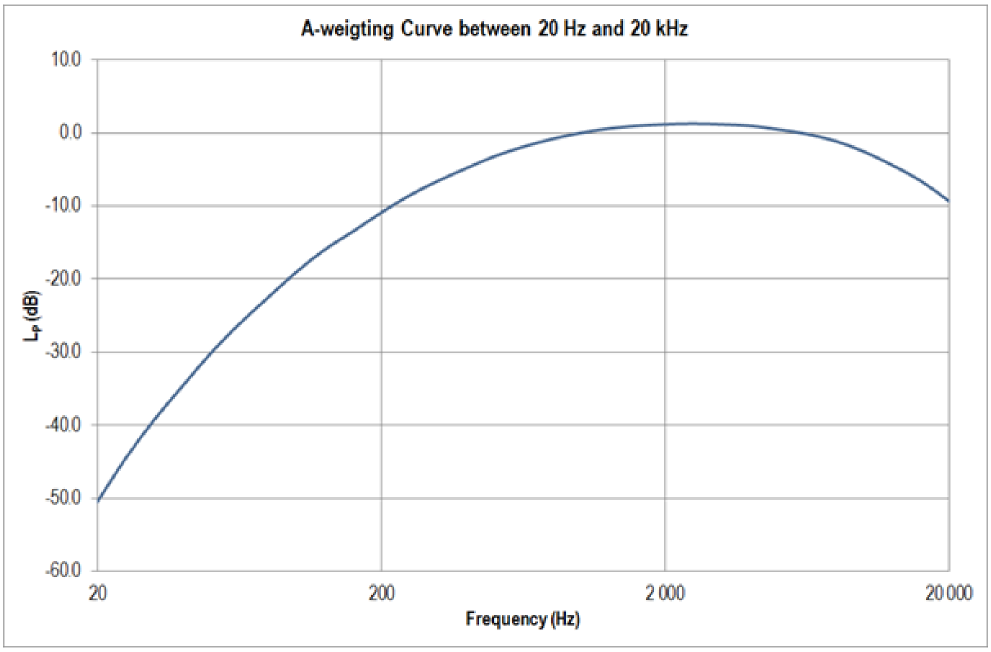



**Figure 2: A-weighting curve**

### 1.4.3 Adding Sound Pressure Levels

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

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

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

### 1.4.4 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).

### 1.4.5 Environmental Noise Indices

In assessing environmental noise either by measurement or calculation, reference is generally made to the following indices:

- **$L_{Aeq}$ (T)** – The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured). The International Finance Corporation (IFC) provides guidance with respect to $L_{Aeq}$ (1 hour), the A-weighted equivalent sound pressure level, averaged over 1 hour.
- **$L_{AIeq}$ (T)** – The impulse corrected A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured). In the South African Bureau of Standards' (SABS) South African National Standard (SANS) 10103 of 2008 for 'The measurement and rating of environmental noise with respect to annoyance and to speech communication' prescribes the sampling of $L_{AIeq}$ (T).
- **$L_{Req,d}$** – The $L_{Aeq}$ rated for impulsive sound ($L_{AIeq}$) and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.
- **$L_{Req,n}$** – The $L_{Aeq}$ rated for impulsive sound ($L_{AIeq}$) and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.
- **$L_{R,dn}$** – The $L_{Aeq}$ rated for impulsive sound ($L_{AIeq}$) and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10 dB in order to account for the additional disturbance caused by noise during the night
- **$L_{A90}$** – The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the $L_{Aeq}$ could have been in the absence of noisy single events and is considered representative of background noise levels.
- **$L_{AFmax}$** – The maximum A-weighted noise level measured with the fast time weighting. It's the highest level of noise that occurred during a sampling period.
- **$L_{AFmin}$** – The minimum A-weighted noise level measured with the fast time weighting. It's the lowest level of noise that occurred during a sampling period.

## 1.5 Approach and Methodology

The assessment included a study of the legal requirements pertaining to noise impacts, a study of the physical environment of the area surrounding the project and the analyses of existing noise levels in the area. The impact assessment focused on the estimation of sound power levels ($L_W$'s) (noise 'emissions') and sound pressure levels ($L_P$'s) (noise impacts) associated with the construction and operational phases of the Project. 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.

### 1.5.1 Information Review

An information requirements list was submitted to SLR at the onset of the study. SLR supplied, for inclusion in the assessment, the following information:

- Georeferenced maps and site layouts;
- A detailed process description;
- Mining rates; and
- A list of mining equipment (fleet information).

Gaps or limitations in the information supplied were identified. These were addressed by making suitable technical assumptions which were approved by SLR and the Project Proponent.

### 1.5.2 Baseline Noise Survey

The survey methodology, which closely follows guidance provided by the IFC General Environmental Health and Safety (EHS) Guidelines (IFC, 2007) and SANS 10103 (SANS 10103, 2008), is summarised below:

- The survey was designed and conducted by a trained specialist.
- Sampling was carried out using Type 1 sound level meters (SLM's) that meet all appropriate International Electrotechnical Commission (IEC) standards and is subject to annual calibration by an accredited laboratory.
- The acoustic sensitivity of SLM's was tested with a portable acoustic calibrator before and after each sampling session.
- Samples of between 20 and 30 minutes, representative and sufficient for statistical analysis were 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[1] acoustic climate were taken.
- As recommended, the following acoustic indices were recoded:
  - SANS 10103 - The impulse corrected equivalent A-weighted sound pressure level ($L_{AIeq}$ (T)). In the absence of impulsive sounds which is often the case with measurements in rural areas, $L_{Aeq}$ (T) = $L_{AIeq}$ (T). $L_{AIeq}$ (T) is used to determine day and night-time rating levels as prescribed in SANS 10103 (2008).
  - IFC General EHS Guidelines - The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) ($L_{Aeq}$ (T))
  - Other:
    - 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 ($L_{A90}$).
    - The maximum A-weighted noise level measured with the fast time weighting ($L_{AFmax}$). It is the highest level of noise that occurred during a sampling period.
    - The minimum A-weighted noise level measured with the fast time weighting ($L_{AFmin}$). It is the lowest level of noise that occurred during a sampling period.
    - Although not required by the IFC or SANS 10103, octave band frequency spectra were also recorded to assist with characterising the acoustic climate. A frequency analysis was conducted as part of the desktop baseline study.
  - 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. It does not specify a wind speed limit or weather condition limitations. The following good practice was applied during sampling; avoid measurements when wind speeds of more than 5 m/s occur and while raining or the ground is wet.
  - A detailed electronic log and record was kept. Records included site details, weather conditions during sampling and observations made regarding the acoustic climate of each site.

[1] The IFC defines day-time as between 07:00 and 22:00 and night-time between 22:00 and 07:00 (IFC, 2007). SANS 10103 defines day-time as between 06:00 and 22:00 and night-time between 22:00 and 06:00 (SANS 10103, 2008). The overlap hour between 06:00 and 07:00 was avoided during attended day- and night-time sampling.

### 1.5.3 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'*. These guidelines, which are in line with those published by the IFC and World Health Organisation (WHO), were considered in the assessment.

### 1.5.4 Study of the Receiving Environment

NSRs generally include private residences, community buildings such as schools, hospitals and any publically accessible areas outside the industrial facility's property. Homesteads and residential areas which were included in the assessment as NSRs were identified from available maps and observations made during a visit to the Project area.

The ability of the environment to attenuate noise as it travels through the air was studied by considering local meteorology, land use and terrain. Atmospheric attenuation potential was described based on site specific simulated weather data obtained for 2011 to 2013. Readily available terrain and land cover data was obtained from the Atmospheric Studies Group (ASG) via the United States Geological Survey (USGS) web site. A study was made of Shuttle Radar Topography Mission (STRM) (90 m, 3 arc-sec) data and Global Land Cover Characterisation (GLCC) data for Africa.

The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in the Project 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 baseline noise survey was studied to determine representative baseline noise levels for use in the assessment of cumulative impacts.

### 1.5.5 Source Inventory

The source noise inventory was informed by:

- Equipment specific $L_W$ predictive equations for the mine fleet and power generation as published by Crocker (1998);
- Generic area wide $L_W$'s for industrial areas as published by the European Commission (EC WG-AEN, 2003); and
- Traffic noise determined in accordance with SANS 10210 (2008), *'Calculating and Predicting Road Traffic Noise'*.

### 1.5.6 Noise Propagation Modelling

The propagation of noise from proposed activities was calculated according *to 'The Calculation of Sound Propagation by the Concawe method'* (SANS 10357, 2004) and well as SANS 10210 (2008) *'Calculating and Predicting Road Traffic Noise'*. The Concawe method makes use of the International Organisation for Standardization's (ISO) air absorption parameters and equations for noise attenuation as well as the factors for barriers and ground effects. In addition to the ISO method, the Concawe method facilitates the calculation of sound propagation under a variety of meteorological conditions. A basic representation of the model is given:

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

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 meteorological effects*

*$K_5$ is the correction for the height of the source and the height of the receiver*

*$K_6$ is the correction for barriers*

The calculation is repeated for every source and receiver at the octave band centre frequencies (63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz and 4 kHz). Average day- and night-time meteorological conditions were considered.

If the dimensions of a noise source are small compared with the distance to the listener, it is called a point source. All sources at noise at the proposed plant were quantified as 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/mining 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 km east-west by 5 km north-south with the Project located centrally. The area was divided into a grid matrix with a 100 m resolution and NSRs were included as discrete receptors. The model calculates $L_P$'s at each grid and discrete receptor point at a height of 1.5 m above ground level.

### 1.5.7 Presentation of Results

Noise impacts were calculated in terms of:

- Day- and night time noise levels as a result of the Project in comparison with guidelines; and
- The effective increase ambient day and night-time noise levels over the baseline as a result of the project.

Results are presented in isopleth form. An isopleth is a line on a map connecting points at which a given variable (in this case $L_P$) 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, reference was made to guidelines published in SANS 10103.

### 1.5.8 Recommendations of Management and Mitigation

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

## 1.6 Limitations and Assumptions

- The study excluded the assessment of the impact of blasting. The 'noise' aspect of blasting is referred to as the air blast overpressure. Predicting the noise caused by the air overpressure generated during a blasting event is a highly complex process. The air overpressure consists of air transmitted sound pressure waves that move outwards from an exploding charge. The reader is referred to the Preliminary Blast Evaluation for the Mokala Manganese Project by Cambrian CC (Kohler, 2015). This report deals with the impacts of the air blast in detail.
- All mining activities were assumed to be at the surface of pit areas. The mitigating effect of pit walls and overburden dumps were therefore not accounted for.

# 2 LEGAL REQUIREMENTS AND NOISE LEVEL GUIDELINES

## 2.1 SANS 10103 (2008)

SANS 10103 (2008) successfully addresses the manner in which environmental noise measurements are to be taken and assessed in South Africa, and is fully aligned with the WHO guidelines for Community Noise (WHO, 1999). The values given in Table 1 are typical rating levels that should not be exceeded outdoors in the different districts specified. Outdoor ambient noise exceeding these levels will be considered to be annoying to the community.

**Table 1: Typical rating levels for outdoor noise, SANS 10103 (2008)**

| 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 $L_{Aeq}$[2] rated for impulsive sound and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.

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

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

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

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

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

[2] $L_{Aeq,T}$ is the A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured).

### 2.2 IFC Guidelines on Environmental Noise

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

The IFC states that noise impacts **should not exceed the levels presented in Table 2**, or result in a maximum **increase above background levels of 3 dBA** at the nearest receptor location off-site (IFC, 2007). For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. $\Delta$ = 3 dBA is, therefore, a useful significance indicator for a noise impact.

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

**Table 2: IFC noise level guidelines**

| **Noise Level Guidelines** (IFC, 2007) | | |
|---|---|---|
| **Area** | **One Hour $L_{Aeq}$ (dBA) 07:00 to 22:00** | **One Hour $L_{Aeq}$ (dBA) 22:00 to 07:00** |
| Industrial receptors | 70 | 70 |
| Residential, institutional and educational receptors | 55 | 45 |

### 2.3 Criteria Applied in this Assessment

Reference is made to the IFC guidelines for residential, institutional and educational receptors (55 dBA during the day and 45 dBA during the night) since these (a) are applicable to nearby NSRs which include towns and a mine village and (b) in-line with SANS 10103 guidelines for urban districts. The IFC's 3 dBA increase criterion is used to determine the potential for noise impact.

# 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
- Sampled baseline or pre-development noise levels.

## 3.1 Noise Sensitive Receptors

A map of potential NSRs is included in Figure 3. These include single homesteads/farmsteads, towns and a mine village. The closest NSRs include residences of the Gloria Mine village situated approximately 1.3 km north of the northern mine boundary and residences of the town of Hotazel which lies approximately 4 km from the eastern mine boundary. The Kalagadi Manganese Mine (700 m to the south) is included as an industrial receptor.

All other residences, farmsteads and towns lie further than 4 km from the mine boundary. As indicated earlier, the impact of an intruding industrial/mining noise on the environment rarely extends over more than 5 km from the source and it is therefore unlikely that these will be affected by the Project.

## 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 its role in the propagation on noise from a source to receiver (Section 1.4.4). 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. Average day-and night time wind speed, wind direction, temperature, relative humidity, pressure and solar radiation used as input to the selected noise propagation model are provided in Table 3. In the absence of reliable surface data, simulated MM5 data (2011 to 2013) for an on-site location was referred to.

Wind speed increases with altitude. This results in the 'bending' of the path of sound to 'focus' it on the downwind side and creating a 'shadow' on the upwind side of the source. Depending on the wind speed, the downwind level may increase by a few dB but the upwind level can drop by more than 20 dB (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). It should be noted that at wind speeds of more than 5 m/s ambient noise levels are mostly dominated by wind generated noise. The on-site diurnal wind field is presented in Figure 4. Wind roses represent wind frequencies for the 16 cardinal wind directions. Frequencies are indicated by the length of the shaft when compared to the circles drawn to represent a frequency of occurrence. Wind speed classes are assigned to illustrate the frequencies with high and low winds occurring for each wind vector. The frequencies of calms, defined as periods for which wind speeds are below 1 m/s, are also indicated.

On average, noise impacts are expected to be most notable to the south-west during the day and north-west during the night.

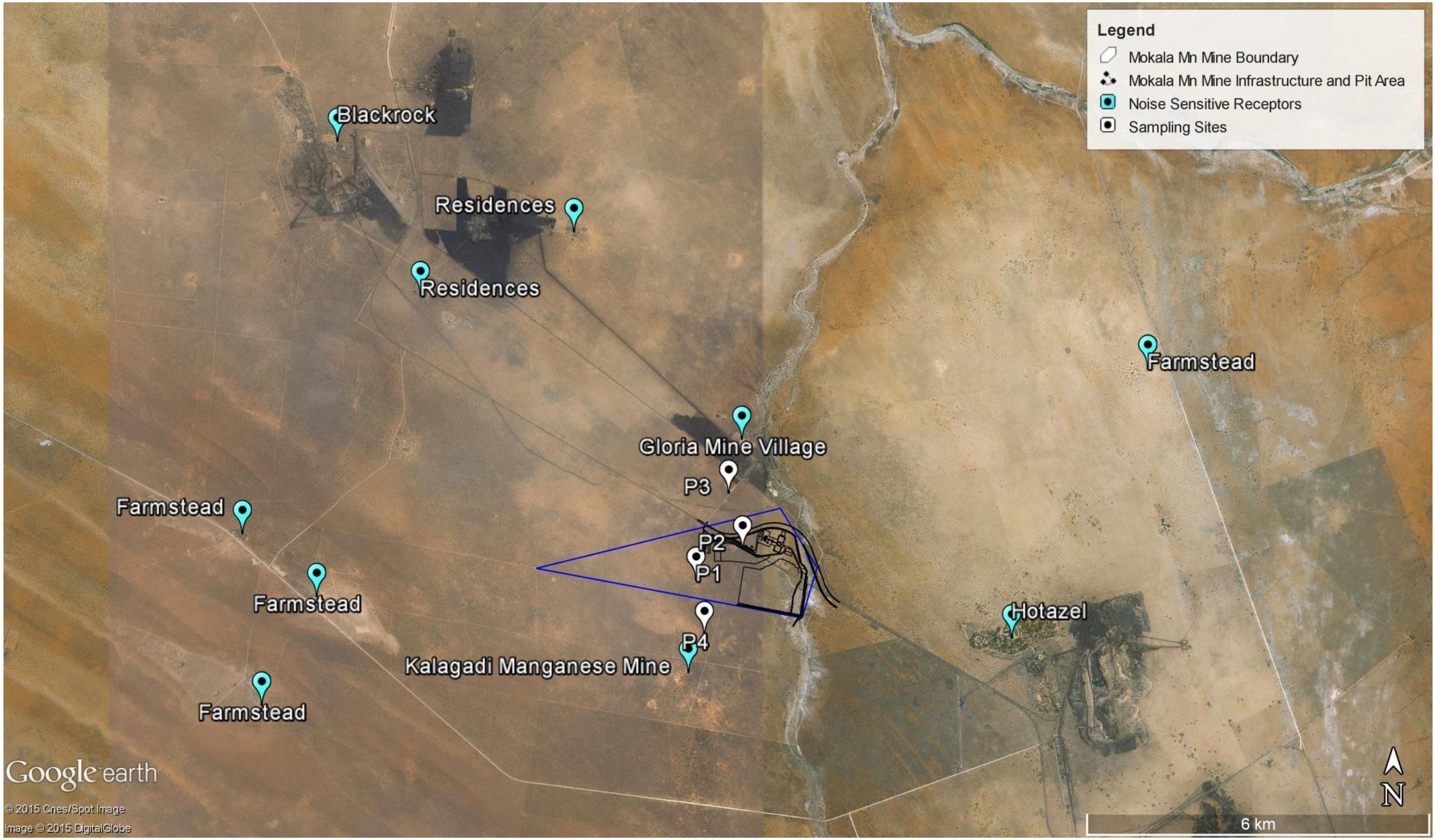
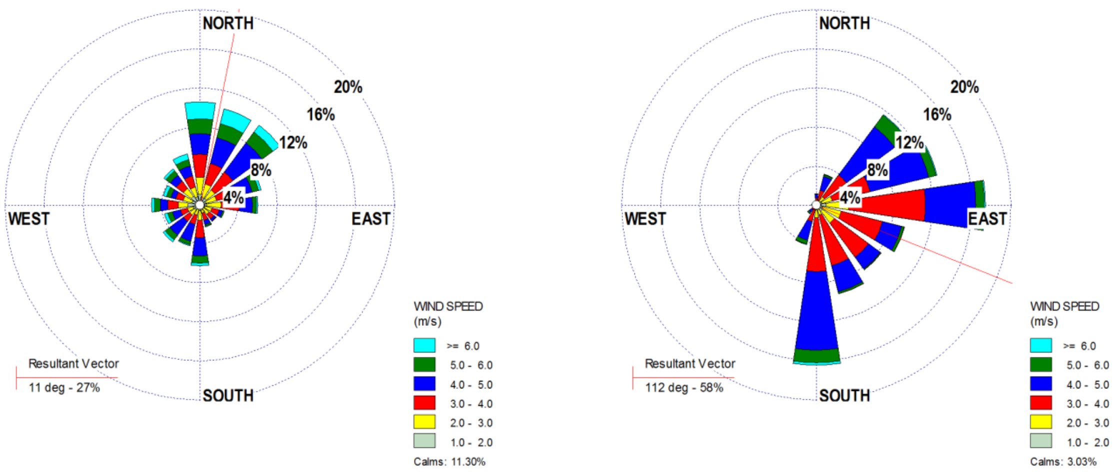



Figure 3: Location of NSRs




**(a) Day-time wind field (06:00 to 22:00)** **(b) Night-time wind field (22:00 to 06:00)**

**Figure 4: Wind roses**

Temperature gradients in the atmosphere create effects that are uniform in all directions from a source. On a sunny day with no wind, temperature decreases with altitude and creates a 'shadowing' effect for sounds. On a clear night, temperatures may increase with altitude thereby 'focusing' sound on the ground surface. Noise impacts are therefore generally more notable during the night.

**Table 3: Average diurnal meteorological parameters**

| Parameter | Average Diurnal Meteorological Parameters (MM5 data 2011 to 2013) | |
|---|---|---|
| | Day-time | Night-time |
| Temperature | 22.4 °C | 17.5 °C |
| Relative Humidity | 57% | 80% |
| Wind Speed | 3.2 m/s | 3.5 m/s |
| Wind Direction (from) | NNE | ESE |
| Air Pressure | 85.4 kPa | 85.5 kPa |
| Solar Radiation | 389 W/m$^2$ | not applicable |
| Assumed cloud cover (octas) | 3 | 4 |

### 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 the 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). There are however no significant natural features with the local study area that may act as acoustic barriers between the operations and NSRs. Pit edges and overburden dumps may act as acoustic barriers but, as a conservative measure, were not included in the assessment.

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 a visit to site, ground cover was found to be acoustically hard (not conducive to noise attenuation) due the area's semi-arid nature.

### 3.3 Sampled Baseline and Representative Pre-development Noise Levels

As part of the scope of work, a baseline noise survey was conducted in January 2015. The survey was conducted in accordance with the guidelines as set out in SANS 10103 (2008) at sites indicated in Figure 5. The survey consisted of attended 20 to 30 minute samples during the day and night (results summarised in Table 4). The main findings of the survey is summarised below.

- Ambient noise levels are affected by traffic on the R380, mining and ore storage/handling activities directly north of the R380 and Mokala Manganese Project area, birds and insects.
- Since realignment of the R380 will be required as part of the project, baseline noise levels as a result of traffic may be slightly higher at Gloria Mine that at present. The realignment is not expected to have an effect on noise levels within Hotazel.
- At P1 and P4 sampled noise levels correspond to what SANS 10103 states is typically found in rural areas. The small difference between day- and night-time noise levels at these locations correspond with what is found in areas with limited human activity. Insect noise at night often results in night-time noise levels that are slightly higher than during the day.
- Noise levels at P2 and P3 correspond to what SANS 10103 states is typically found in suburban areas i.e. areas with some human activity. The 5 to 10 dBA difference between day- and night-time noise levels at these locations are as a result of changes in traffic volumes along the R380.
- Baseline noise levels in the Project area do not currently exceed IFC guidelines.

For estimating the increase in ambient noise levels as a result of the Mokala Manganese Project, the following representative background noise levels were calculated from survey results.

- 48.8 dBA for the day; and
- 44.4 dBA for the night.

Detailed results and a photo log of the survey are included in Annex A and B respectively.

Table 4: Summary of attended 20 minute survey conducted on 6 and 7 January 2015

| Sampling Point | P1 | | P2 | | P3 | | P4 | |
|---|---|---|---|---|---|---|---|---|
| **Description** | In an open area near the old crusher plant. | | On the current R380 near the proposed truck staging area. | | Close to the northern fence, surrounded by trees. | | In an open area near the south fence security gate. | |
| **Latitude** | S 27.19141 | | S 27.18652 | | S 27.17777 | | S 27.19993 | |
| **Longitude** | E 22.90116 | | E 22.90936 | | E 22.90690 | | E 22.90263 | |
| **Time of Day** | Day | Night | Day | Night | Day | Night | Day | Night |
| **Start Time** | 12:02:43 | 23:45:26 | 10:59:40 | 23:14:48 | 14:27:42 | 22:44:39 | 12:49:46 | 00:16:35 |
| **Duration** | 00:30.00 | 00:22:07 | 00:30.00 | 00:20:18 | 00:30.00 | 00:21:01 | 00:30.00 | 00:19:40 |
| **Acoustic Observations** | Short trees, medium height grass with sandy patches.<br>R380 traffic (900 m away).<br>Birds | Short trees, medium height grass with sandy patches<br>R380 traffic (900 m away)<br>Bird and insects | Short trees, medium height grass with sandy patches<br>R380 traffic (nearby)<br>Birds | Short trees, medium height grass with sandy patches<br>R380 traffic (nearby)<br>Bird and insects | Short trees and medium height.<br>Close to wired fence & northern access road from R380.<br>People nearby in conversation<br>Birds | Short trees and medium height<br>Close to wired fence & northern access road from R380.<br>Birds and insects | Short trees and medium height grass<br>Close to southern service road<br>Noise from distant mine activity (about 300 metres east)<br>Birds | Short trees and medium height grass<br>Close to southern service road<br>Noise from distant mine activity (about 300 metres east)<br>Birds and insects |
| **$L_{Amax}$ (dBA)** | 51.0 | 51.5 | 73.2 | 65.5 | 68.7 | 62.6 | 62.8 | 56.1 |
| **$L_{Amin}$ (dBA)** | 26.8 | 30.9 | 56.0 | 27.4 | 42.6 | 34.9 | 30.6 | 41.6 |
| **$L_{Aeq}$ (dBA) Comparable to IFC Noise Level Guidelines** | 37.4 | 36.1 | 51.5 | 44.5 | 51.7 | 42.6 | 42.5 | 47.7 |
| **$L_{A90}$ (dBA)** | 33.1 | 34.3 | 42.2 | 30.3 | 49.1 | 37.7 | 37.2 | 44.0 |

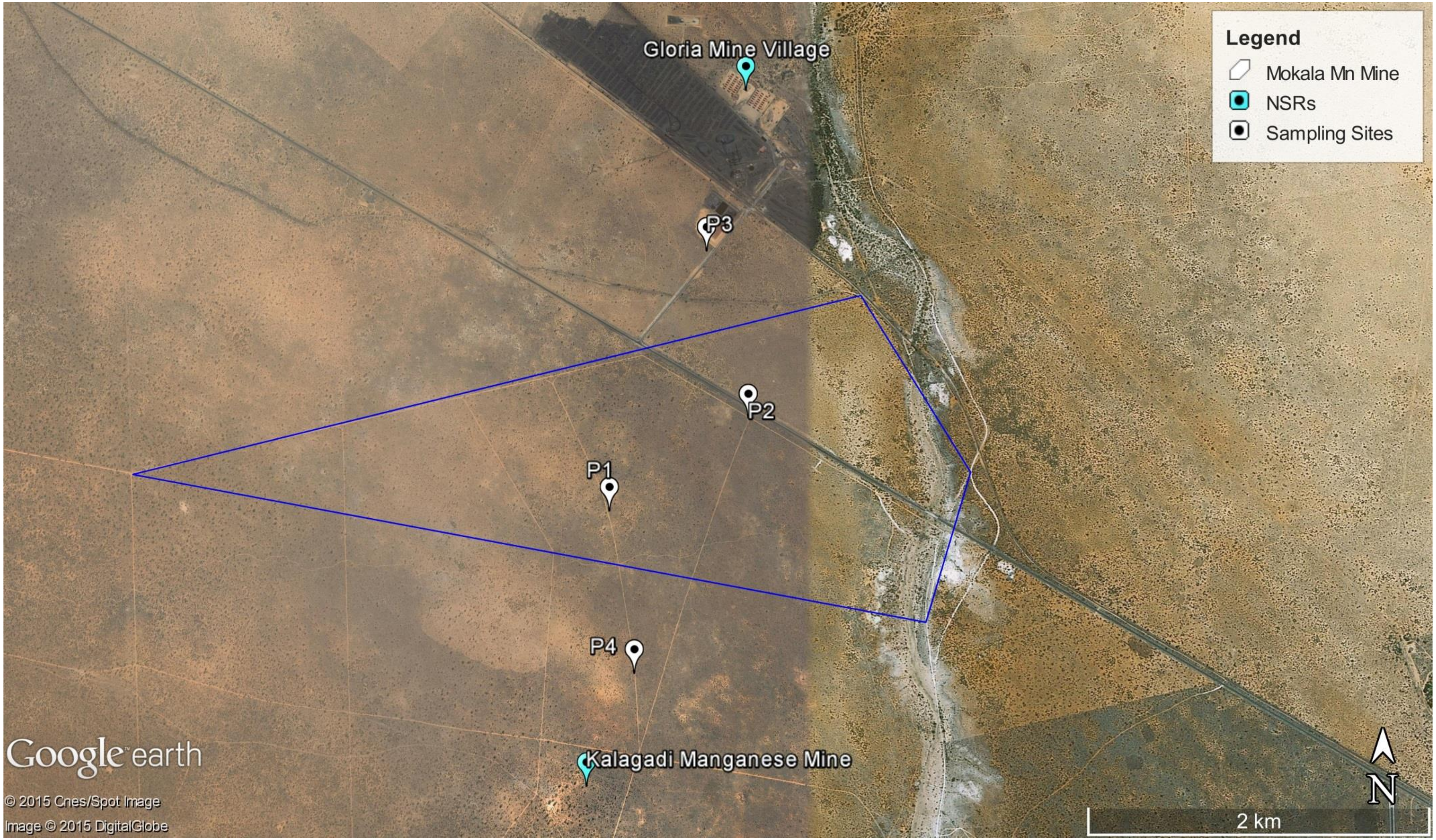



**Figure 5: Baseline noise survey sites**

# 4 IMPACT ASSESSMENT

The noise source inventory, noise propagation modelling and results for the construction and operational phases of the Project are discussed in Section 4.1 and Section 4.2 respectively. The results provided below are for the unmitigated scenario.

## 4.1 Construction Phase

### 4.1.1 Noise Sources and Sound Power Levels

The extent and character of construction phase noise will be highly variable as different activities with different equipment will take place at different times, over different periods, in different combinations, in different sequences and on different parts of the construction site. The following sources of noise were included in the study:

- Diesel mobile equipment for clearing the box cut area, plant area, roads etc. including the use of water bowsers, lighting masts, articulated dump trucks (ADT), loaders, dozers, graders, backhoes, light delivery vehicles (bakkies), and buses
- General construction/industrial noise, including the R380 realignment.
- Transport of overburden from initial box cut area to areas of construction where overburden will be used.

Construction related activities will be limited to day-time hours between 06:00 and 16:00.

#### *4.1.1.1 Diesel Mobile Equipment*

A list of equipment likely to be used during the construction phase was supplied by Mokala. $L_W$'s from the equipment were estimated through the application of the following equation recommended by Crocker (1998):

$$L_W = 99 + 10 \cdot \log kW$$

In the equation, $L_W$ is the overall sound power level in dB and kW is the power rating of the equipment's engine. In practice the sound power level will average about 4 dB lower than the calculated level since engines are not always operated in the maximum power condition (Crocker, 1998). Octave band sound power levels were obtained by applying adjustments recommended by Crocker (1998). Calculated $L_W$'s are included in Table 5, a summary of the construction phase source inventory.

#### *4.1.1.2 General Construction Noise*

General construction activities were estimated over an area wide basis by applying the European Commission (EC) Working Group on Assessment of Environmental noise (WG-AEN) proposed $L_W$ of 65 dBA/m$^2$ for heavy industrial activities (EC WG-AEN, 2003). Construction area footprints (obtained from site layout maps) and calculated $L_W$'s are included in Table 5, a summary of the construction phase source inventory.

#### *4.1.1.3 Traffic Noise*

It was assumed that roads would carry LDV and HDV at an average of two trips per hour. It was further assumed that vehicles travel at an average speed of 40 km/hr. The propagation of traffic noise was calculated in accordance with the procedure set out in SANS 10210 (2008).

**Table 5: Construction phase source noise inventory**

| Equipment Type | Qty. | Power Rating (kW) | Octave Band Sound Power Levels, $L_{Wi}$ (dB) | | | | | | | A-weighted Sound Power Level, $L_{WA}$ (dBA) |
|---|---|---|---|---|---|---|---|---|---|---|
| **DIESEL MOBILE EQUIPMENT** | | | | | | | | | | |
| | | | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | |
| 2.2 L diesel LDV, Ford | 2 | 110 | 104.4 | 109.4 | 112.4 | 107.4 | 105.4 | 102.4 | 96.4 | **110.6** |
| 25 000 L Water Bowser, CAT 730 | 1 | 280 | 108.5 | 113.5 | 116.5 | 111.5 | 109.5 | 106.5 | 100.5 | **114.7** |
| 40 t ADT, CAT 740 | 2 | 365 | 109.6 | 114.6 | 117.6 | 112.6 | 110.6 | 107.6 | 101.6 | **115.9** |
| 90 t Excavator, CAT 390 | 1 | 405 | 110.1 | 115.1 | 118.1 | 113.1 | 111.1 | 108.1 | 102.1 | **116.3** |
| Backhoe, CAT 428 | 1 | 56 | 101.5 | 106.5 | 109.5 | 104.5 | 102.5 | 99.5 | 93.5 | **107.7** |
| Dozer, CAT D8 | 2 | 245 | 107.9 | 112.9 | 115.9 | 110.9 | 108.9 | 105.9 | 99.9 | **114.1** |
| Grader, CAT 140K | 2 | 155 | 105.9 | 110.9 | 113.9 | 108.9 | 106.9 | 103.9 | 97.9 | **112.1** |
| Lighting Masts | 2 | 7.4 | 92.7 | 97.7 | 100.7 | 95.7 | 93.7 | 90.7 | 84.7 | **98.9** |
| Loader, CAT 966 | 2 | 213 | 107.3 | 112.3 | 115.3 | 110.3 | 108.3 | 105.3 | 99.3 | **113.5** |
| **GENERAL CONSTRUCTION** | | | | | | | | | | |
| Construction Site | Total Area ($m^2$) | | Octave Band Sound Power Levels, $L_{Wi}$ (dB) | | | | | | | A-weighted Sound Power Level, $L_{WA}$ (dBA) |
| | | | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | |
| Processing Plant | 14 500 | | 100.6 | 105.6 | 108.6 | 103.6 | 101.6 | 98.6 | 92.6 | **106.8** |
| Offices | 23 500 | | 102.7 | 107.7 | 110.7 | 105.7 | 103.7 | 100.7 | 94.7 | **109.0** |
| Road Section | 1 720 | | 91.4 | 96.4 | 99.4 | 94.4 | 92.4 | 89.4 | 83.4 | **97.6** |

### 4.1.2 Noise Propagation and Simulated Noise Levels

The propagation of noise generated during the construction phase was calculated in accordance with SANS 10357 (2004) and SANS 10210 (2008). Meteorological and site specific acoustic parameters as discussed in Section 3.2.1 along with source data discussed in 4.1.1, were applied in the model.

Results are presented isopleth form. An isopleth is a line on a map connecting points at which a given variable (in this case $L_P$) 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.

During the day, construction phase related noise is expected to exceed the day-time IFC guideline of 55 dBA up to approximately 200 m from the Project boundary (Figure 6). The nearest NSR will however not be exposed to construction phase noise at levels higher than the IFC guideline. At a day-time baseline noise level of 48.8 dBA in increase of 3 dBA is expected up to 750 m from the Project boundary (Figure 7). An increase of less than 1 dBA is predicted at the nearest NSR which is within the relevant guidelines.

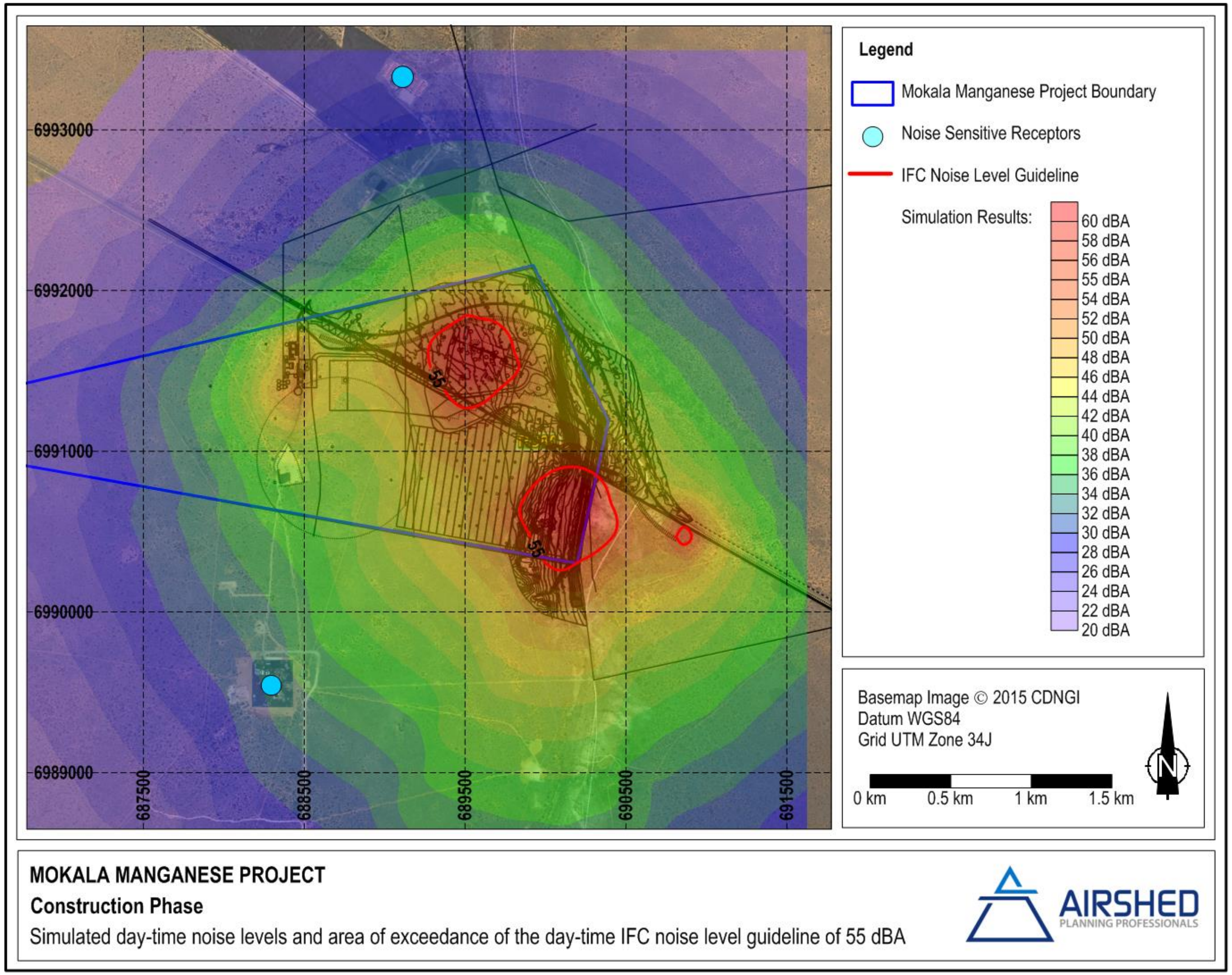



**Figure 6: Simulated day-time noise levels as a result of the Mokala Manganese Project's construction phase**

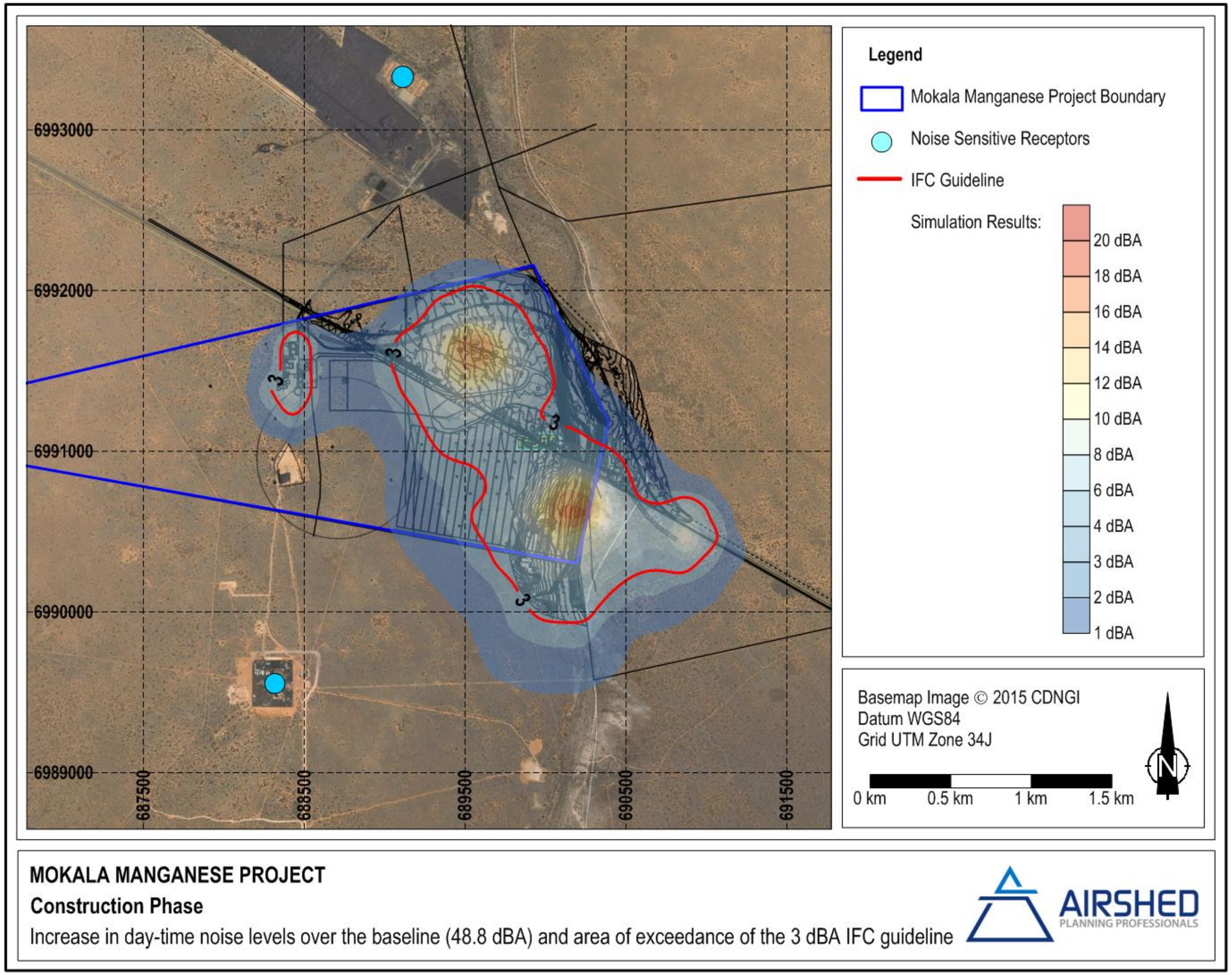



**Figure 7: Increase in day-time noise levels over the baseline as a result of the Mokala Manganese Project's construction phase**

## 4.2 Operational Phase

### 4.2.1 Noise Sources and Sound Power Levels

As with the construction phase, the extent and character of operational phase noise, especially mining, will be variable as the mine progresses. The following operational phase sources of noise were included in the study:

- Diesel mobile equipment, operational within the pit, along haul routes and within the plant;
- Ore processing through crushing and screening;
- Diesel power generation; and
- Transport of ore and waste materials.

#### *4.2.1.1 Diesel Mobile Equipment*

The fleet size during the operational phase and calculated $L_W$'s are given in Table 6, the summary of the operational phase source inventory. $L_W$'s were estimated using the method described in Section 4.1.1.1.

#### *4.2.1.2 Ore Processing*

$L_W$'s of crushing and screening operations are given in Table 6. These $L_W$'s were obtained from a reference database for such operations (Francois Malherbe Acoustic Consulting).

#### *4.2.1.3 Diesel Power Generation*

Noise as a result of power generation with one Caterpillar 3516, 1 600 KVA diesel generator was included in the source inventory for the Project's operational phase. The overall $L_W$'s of the generator was estimated with the following equation recommended by Crocker (1998) for V-type diesel fuelled engines operation at speeds of 1 500 rpm and higher, with or without turbocharging:

$$L_W = 93 + 10 \cdot \log kW$$

In the equation, $L_W$ is the overall sound power level in dB and kW is the power rating of the engine. Octave band sound power levels were obtained by applying adjustments recommended by Crocker (1998). Calculated $L_W$'s are included in Table 6, the summary of the operational phase source inventory.

#### *4.2.1.4 Traffic Noise*

On-site traffic noise accounted for in the assessment of operational phase noise include the transport of mine materials inside active box-cuts, ore transport to and within the plant area, the transport of product to the Project's boundary, and the transport of waste to stockpile areas. Traffic volumes included return trips required for trucks to transport ore, waste or product to its destinations and accounted for two LDV trips per hour on all roads. Traffic information as included in the source inventory included in Table 6.

Table 6: Operational phase source noise inventory

| **Diesel Mobile Equipment and Power Generation** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Equipment Type | Qty. | Power Rating (kW) | Octave Band Sound Power Levels, $L_{Wi}$ (dB) | | | | | | | $AL_{WA}$ (dBA) |
| | | | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | |
| 2.2 L Diesel LDV, Ford | 4 | 110 | 104.4 | 109.4 | 112.4 | 107.4 | 105.4 | 102.4 | 96.4 | **110.6** |
| 25 000 L Water Bowser, CAT 730 | 2 | 280 | 108.5 | 113.5 | 116.5 | 111.5 | 109.5 | 106.5 | 100.5 | **114.7** |
| 40 t ADT, CAT 740 | 3 | 365 | 109.6 | 114.6 | 117.6 | 112.6 | 110.6 | 107.6 | 101.6 | **115.9** |
| 5 000 L Diesel Bowser | 1 | 261 | 108.2 | 113.2 | 116.2 | 111.2 | 109.2 | 106.2 | 100.2 | **114.4** |
| 70 t Excavator, CAT 374 | 2 | 362 | 109.6 | 114.6 | 117.6 | 112.6 | 110.6 | 107.6 | 101.6 | **115.8** |
| 90 t Excavator, CAT 390 | 1 | 405 | 110.1 | 115.1 | 118.1 | 113.1 | 111.1 | 108.1 | 102.1 | **116.3** |
| Dozer, CAT D8 | 1 | 245 | 107.9 | 112.9 | 115.9 | 110.9 | 108.9 | 105.9 | 99.9 | **114.1** |
| Drill Rig, Ingersoll Rand DM 30 | 1 | 391 | 109.9 | 114.9 | 117.9 | 112.9 | 110.9 | 107.9 | 101.9 | **116.2** |
| Grader, CAT 140K | 2 | 155 | 105.9 | 110.9 | 113.9 | 108.9 | 106.9 | 103.9 | 97.9 | **112.1** |
| Lighting Masts | 4 | 7.4 | 92.7 | 97.7 | 100.7 | 95.7 | 93.7 | 90.7 | 84.7 | **98.9** |
| Loader, CAT 966 | 2 | 213 | 107.3 | 112.3 | 115.3 | 110.3 | 108.3 | 105.3 | 99.3 | **113.5** |
| Tyre Handler, TLB CAT 428 | 2 | 56 | 101.5 | 106.5 | 109.5 | 104.5 | 102.5 | 99.5 | 93.5 | **107.7** |
| CAT 5316 1600 kVA diesel generator | 1 | 1 640 | | | | | | | | |

| **Ore Processing** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Activity | Octave Band Sound Power Levels, $L_{Wi}$ (dB) | | | | | | | $L_{WA}$ (dBA) |
| | 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | |
| Primary crushing, secondary crushing and screening | 100.6 | 105.6 | 108.6 | 103.6 | 101.6 | 98.6 | 92.6 | **106.8** |

| **Traffic** | | | |
|---|---|---|---|
| Activity | Trips per hour | Average vehicle speed (km/h) | % Heavy vehicles |
| In-pit ore transport | 13 | 40 | 83% |
| Ore to plant and stockpiles | 12 | 40 | 91% |

| Traffic (Continued) | | | |
| --- | --- | --- | --- |
| **Activity** | **Trips per hour** | **Average vehicle speed (km/h)** | **% Heavy vehicles** |
| Product from plant to access gate | 10 | 40 | 89% |
| Fines to storage | 4 | 40 | 67% |
| In-pit waste transport | 9 | 40 | 88% |
| Waste towards plant area and roads | 9 | 40 | 83% |
| Waste to stockpile area | 10 | 40 | 89% |

### 4.2.2 Noise Propagation and Simulated Noise Levels

The propagation of noise generated during the operational phase was calculated in accordance with SANS 10357 (2004) and SANS 10210 (2008). Meteorological and site specific acoustic parameters as discussed in Section 3.2.1 along with source data discussed in 4.2.1, were applied in the model. As for the construction phase, results are presented as isopleths in Figure 8 to Figure 11.

During the day, operational phase related noise is expected to exceed the day-time IFC guideline of 45 dBA up to approximately 250 m from the Project boundary (Figure 8). The nearest NSR will however not be exposed to noise at levels higher than the IFC guideline. At a day-time baseline noise level of 48.8 dBA in increase of 3 dBA is expected up to 500 m from the Project boundary (Figure 9). An increase of less than 1 dBA is predicted at the nearest NSR is within the relevant guidelines.

As a result of atmospheric conditions less conducive to noise attenuation and stricter guidelines, night-time noise impacts are more notable. The area over which the night-time IFC guideline of 45 dBA is expected to be exceeded as a result of noise from operational phase activities extends up to 1 000 m from the Project boundary (Figure 10). At a baseline noise level of 44.4 dBA, an increase of 3 dBA can be expected up to 1 100 m from the Project boundary (Figure 11). Simulations indicate a night-time noise level of 42.2 dBA at the nearest NSR and an increase of between 2 dBA and 3 dBA over the baseline. The IFC guidelines will therefore not be exceeded at the nearest NSR.

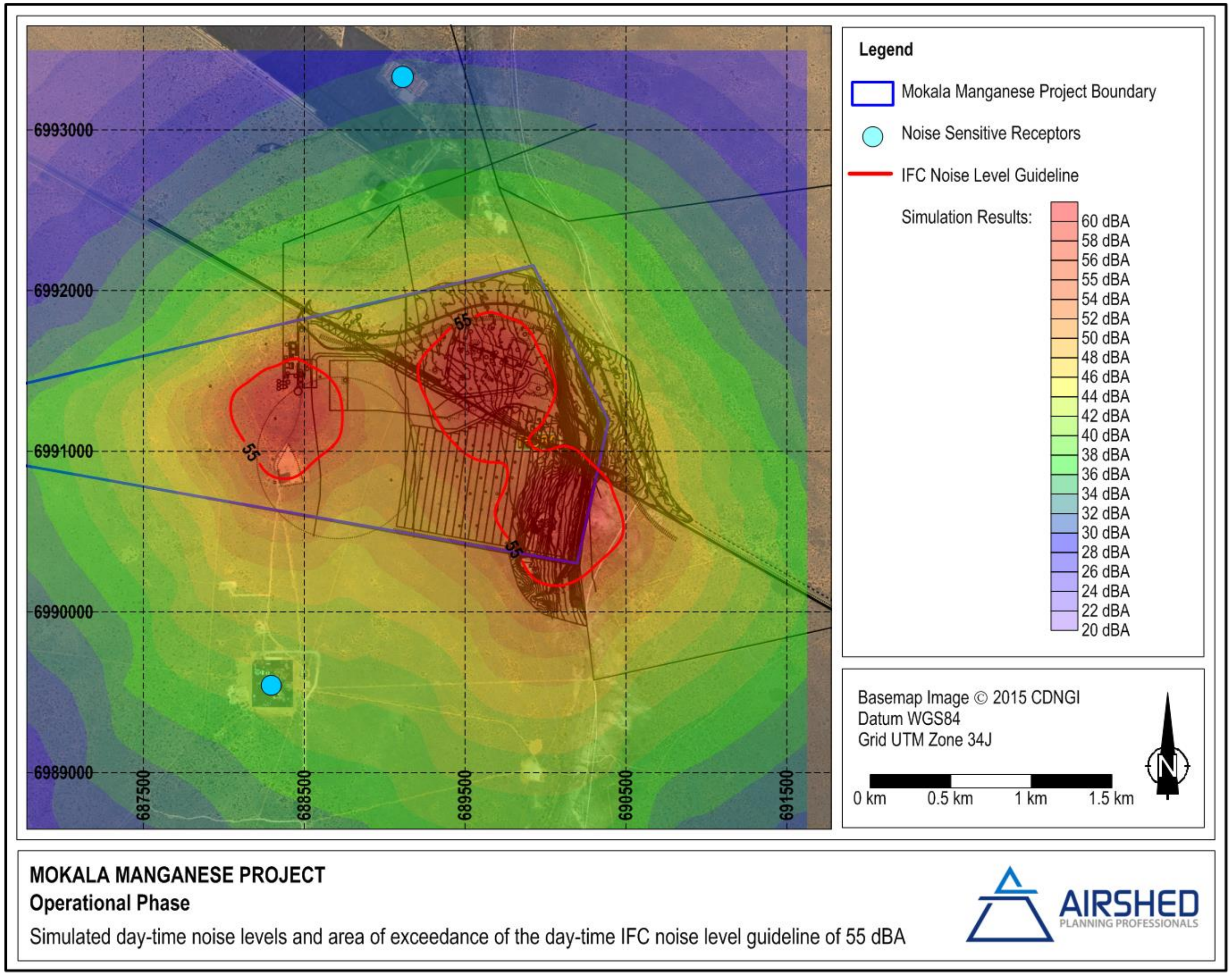



**Figure 8: Simulated day-time noise levels as a result of the Mokala Manganese Project's operational phase**

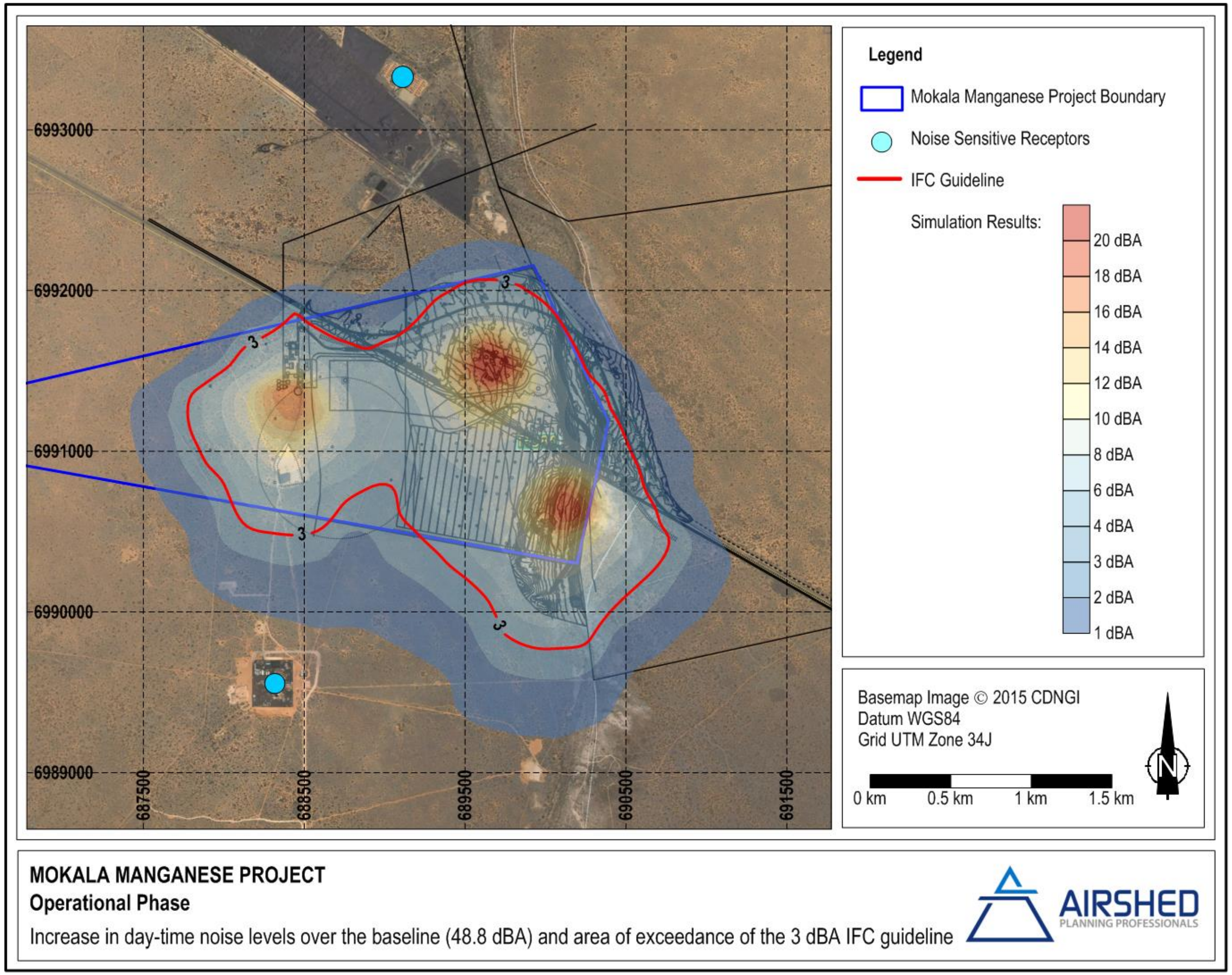



**Figure 9: Increase in day-time noise levels over the baseline as a result of the Mokala Manganese Project's operational phase**

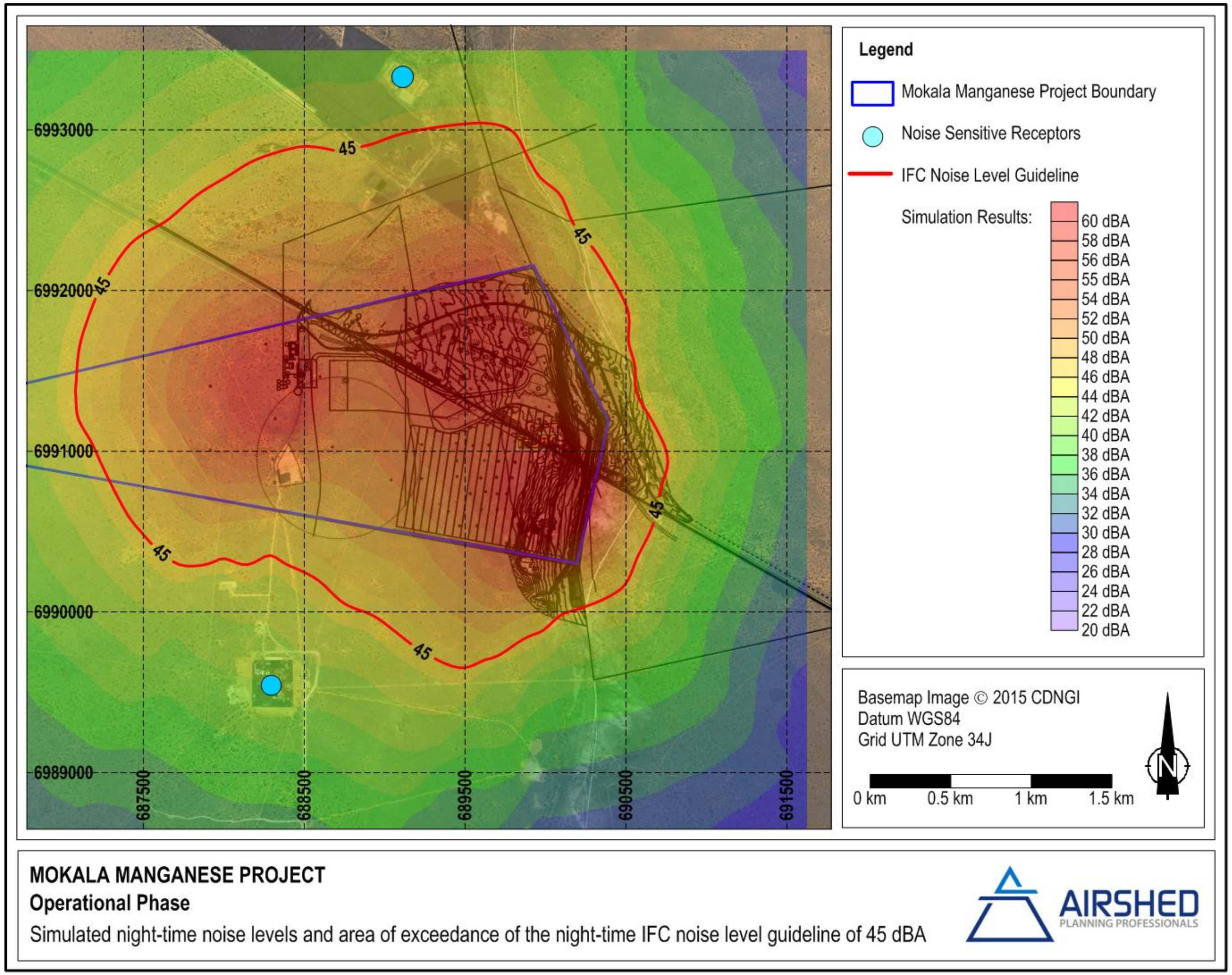



**Figure 10: Simulated night-time noise levels as a result of the Mokala Manganese Project's operational phase**

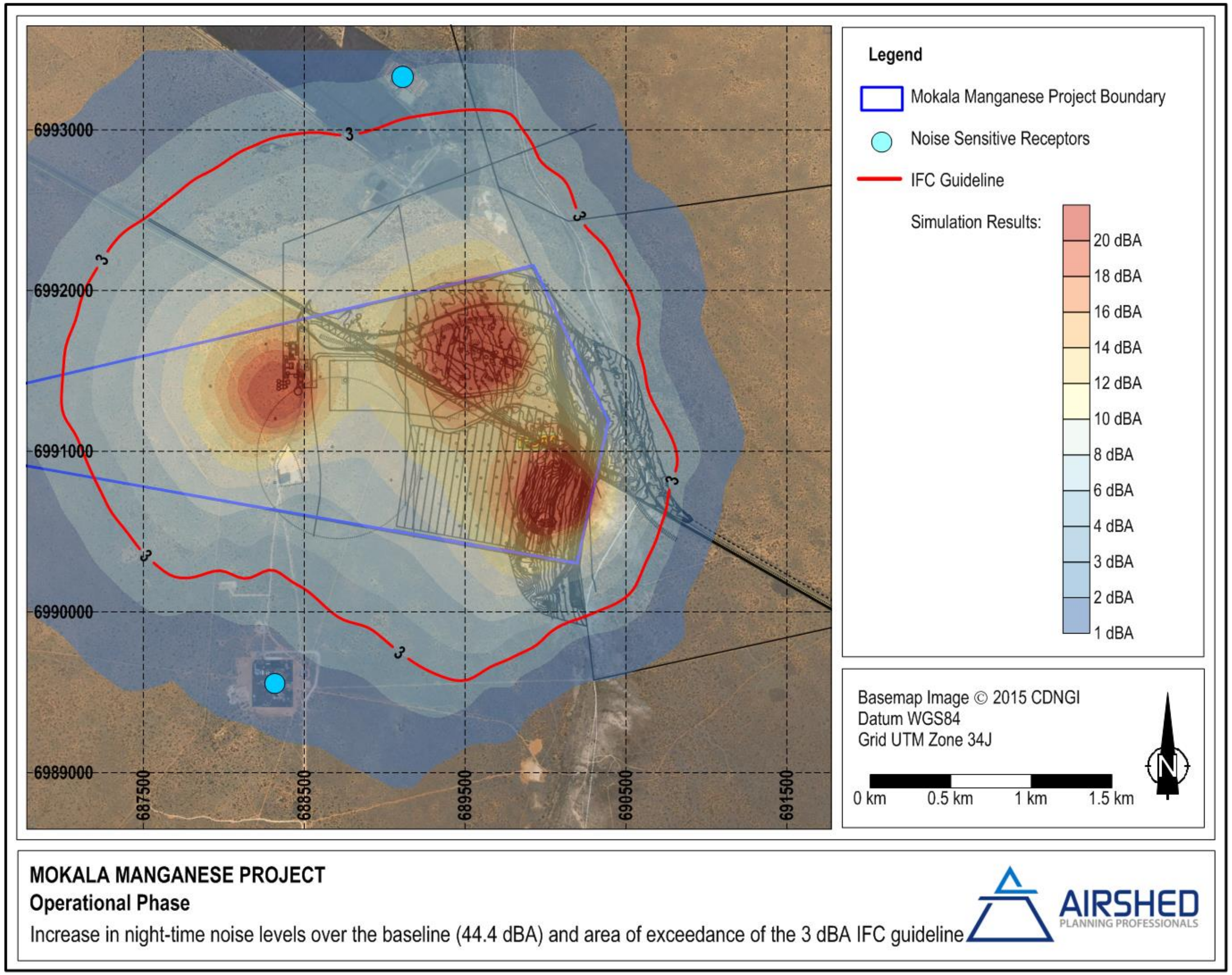



**Figure 11: Increase in night-time noise levels over the baseline as a result of the Mokala Manganese Project's operational phase**

### 4.3 Site Alternatives

Two site layout alternatives were considered. Option 1 included the location of the proposed infrastructure to the south of the existing R380. Option 2 includes the realignment of the R380 and the location of the proposed infrastructure to the north and south of the current R380. This assessment considered proposed Option 2. The position of the open pit is fixed as this is dictated by the location of the ore body.

From a noise impact perspective the difference in potential impact on NSRs between Option 1 and 2 are minor given that relative distances between proposed activities and NSRs are similar

# 5 MANAGEMENT, MITIGATION AND RECOMMENDATIONS

In the quantification of noise emissions and simulation of noise levels as a result of the proposed Mokala Manganese Project it was predicted that IFC and SANS evaluation criteria for human receptors will not be exceeded at the nearest NSR to site.

From a noise perspective the project may proceed provided that the management and mitigation measures are implemented as part of the conditions of environmental authorisation.

## 5.1 Good Engineering and Operational Practices

For general activities the following good engineering practice should be applied:

- All diesel powered equipment and plant vehicles should be kept at a high level of maintenance. This should particularly include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment should serve as trigger for withdrawing it for maintenance.
- To minimise noise generation, vendors should be required to guarantee optimised equipment design noise levels.
- A mechanism to monitor noise levels, record and respond to complaints and mitigate impacts should be developed.
- Blasting at the surface will be audible over long distances and may cause a startling reaction at receptors in close proximity. This can be mitigated by adhering to blast schedules that have been communicated to the affected parties.

## 5.2 Traffic

The measures described below are considered good practice in reducing traffic related noise.

In general, road traffic noise is the combination of noise from individual vehicles in a traffic stream and is considered as a line source if the density of the traffic is high enough to distinguish it from a point source. The following general factors are considered the most significant with respect to road traffic noise generation:

- Traffic volumes i.e. average daily traffic.
- Average speed of traffic.
- Traffic composition i.e. percentage heavy vehicles.
- Road gradient.
- Road surface type and condition.
- Individual vehicle noise including engine noise, transmission noise, contact noise (the interaction of tyres and the road surface, body, tray and load vibration and aerodynamic noise

In managing transport noise specifically related to trucks, efforts should be directed at:

- Minimizing individual vehicle engine, transmission and body noise/vibration. This is achieved through the implementation of an equipment maintenance program.
- Minimize slopes by managing and planning road gradients to avoid the need for excessive acceleration/deceleration.
- Maintain road surface regularly to avoid corrugations, potholes etc.
- Avoid unnecessary idling times.

- Minimizing the need for trucks/equipment to reverse. This will reduce the frequency at which disturbing but necessary reverse warnings will occur. Alternatives to the traditional reverse 'beeper' alarm such as a 'self-adjusting' or 'smart' alarm could be considered. These alarms include a mechanism to detect the local noise level and automatically adjust the output of the alarm is so that it is 5 to 10 dB above the noise level in the vicinity of the moving equipment. The promotional material for some smart alarms does state that the ability to adjust the level of the alarm is of advantage to those sites 'with low ambient noise level' (Burgess & McCarty, 2009).

## 5.3 Monitoring

In the event that Mokala receives noise related complaints during either construction or operation, then Mokala should consider conducting short term (24-hour) ambient noise measurements as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions.

The following procedure should be adopted for all noise surveys:

- Any surveys should be designed and conducted by a trained specialist.
- Sampling should be carried out using a Type 1 sound level meter (SLM) that meets all appropriate International Electrotechnical Commission (IEC) standards and is subject to annual calibration by an accredited laboratory.
- The acoustic sensitivity of the SLM should be tested with a portable acoustic calibrator before and after each sampling session.
- Samples of at least 24 hours in duration and sufficient for statistical analysis should be taken with the use of portable SLM's capable of logging data continuously over the time period. Samples representative of the day- and night-time acoustic climate should be taken.
- The following acoustic indices should be recoded and reported:
  - $L_{Aeq}$ (T)
  - Statistical noise level $L_{A90}$,
  - $L_{Amin}$ and $L_{Amax}$
  - 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 climate of each site.

# 6 REFERENCES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SANS 10210, 2008. *Calculating and Predicting Road Traffic Noise,* Pretoria: Standards South Africa.

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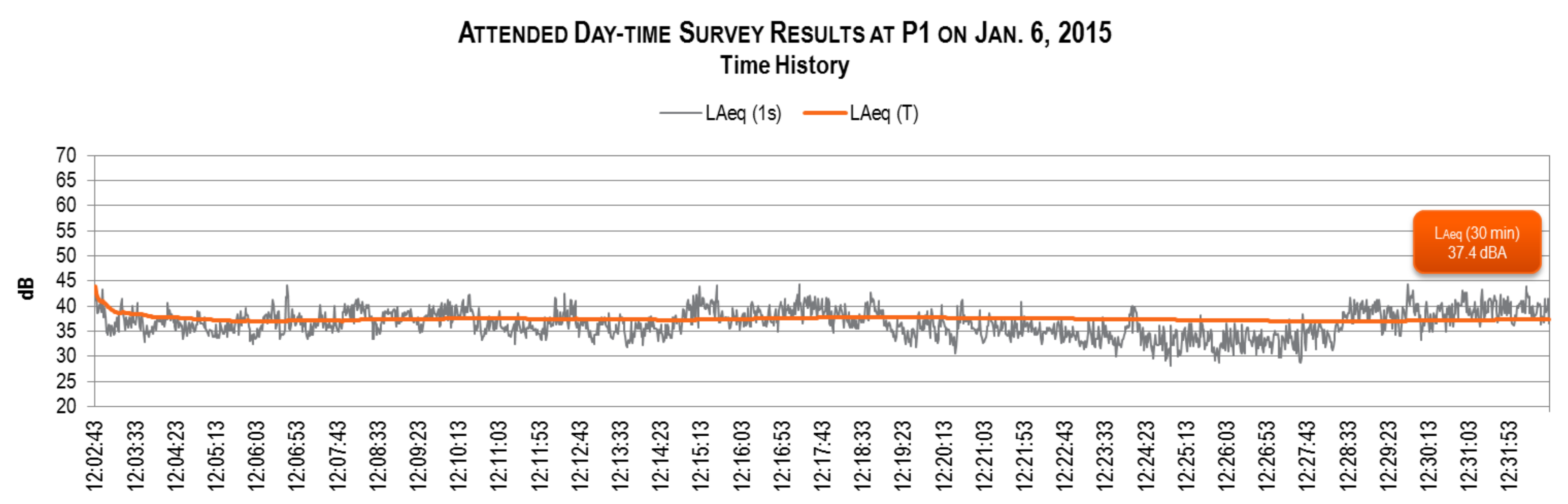
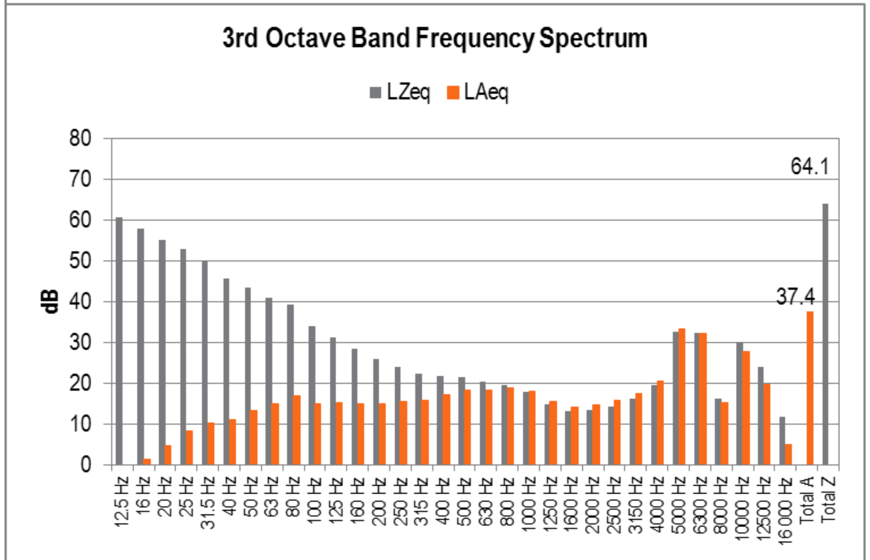
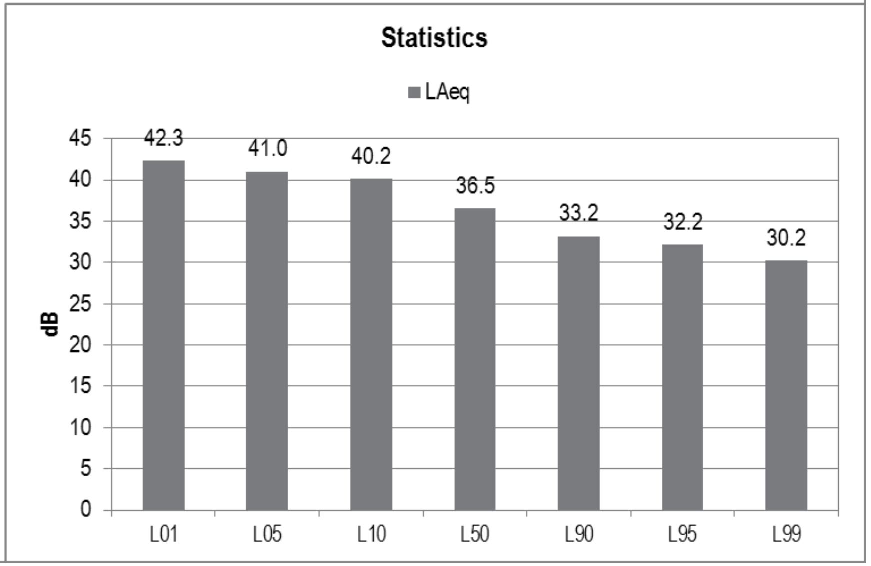
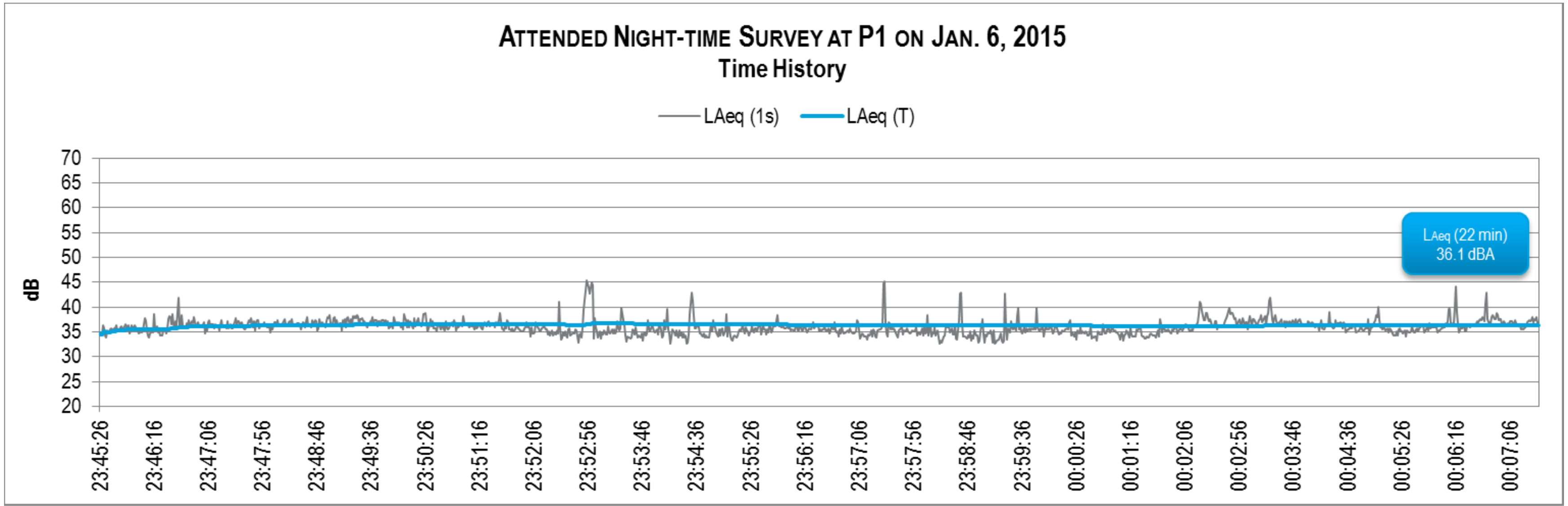
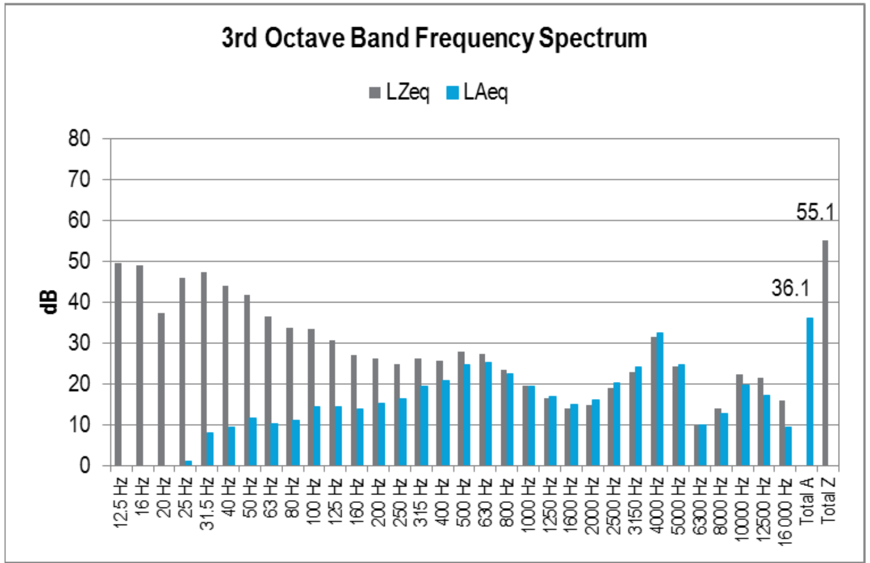
# 7 ANNEX A - DETAILED BASELINE SAMPLING RESULTS

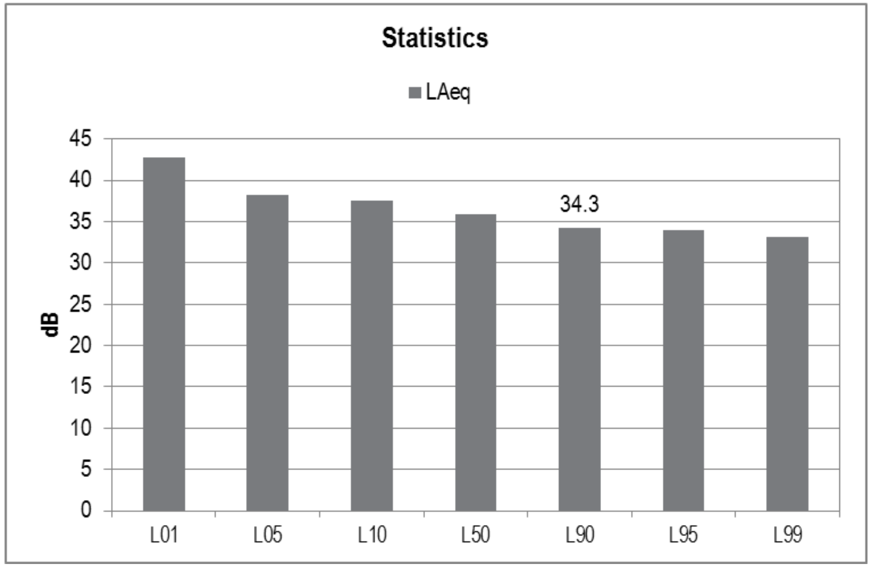

ATTENDED DAY-TIME SURVEY RESULTS AT P1 ON JAN. 6, 2015
Time History
LAeq (1s)
LAeq (T)
LAeq (30 min) 37.4 dBA
dB

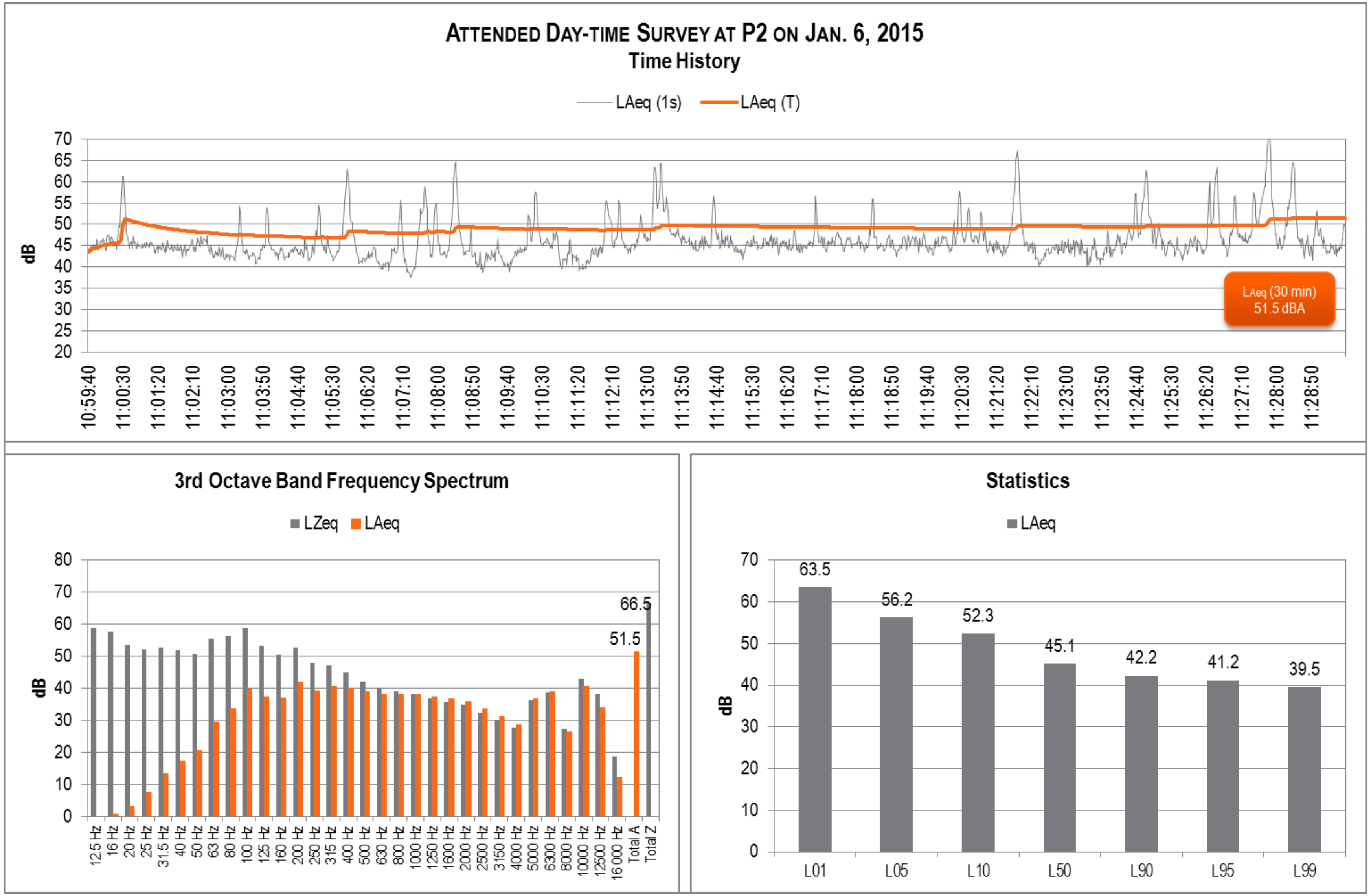

3rd Octave Band Frequency Spectrum
LZeq
LAeq
dB
64.1
37.4

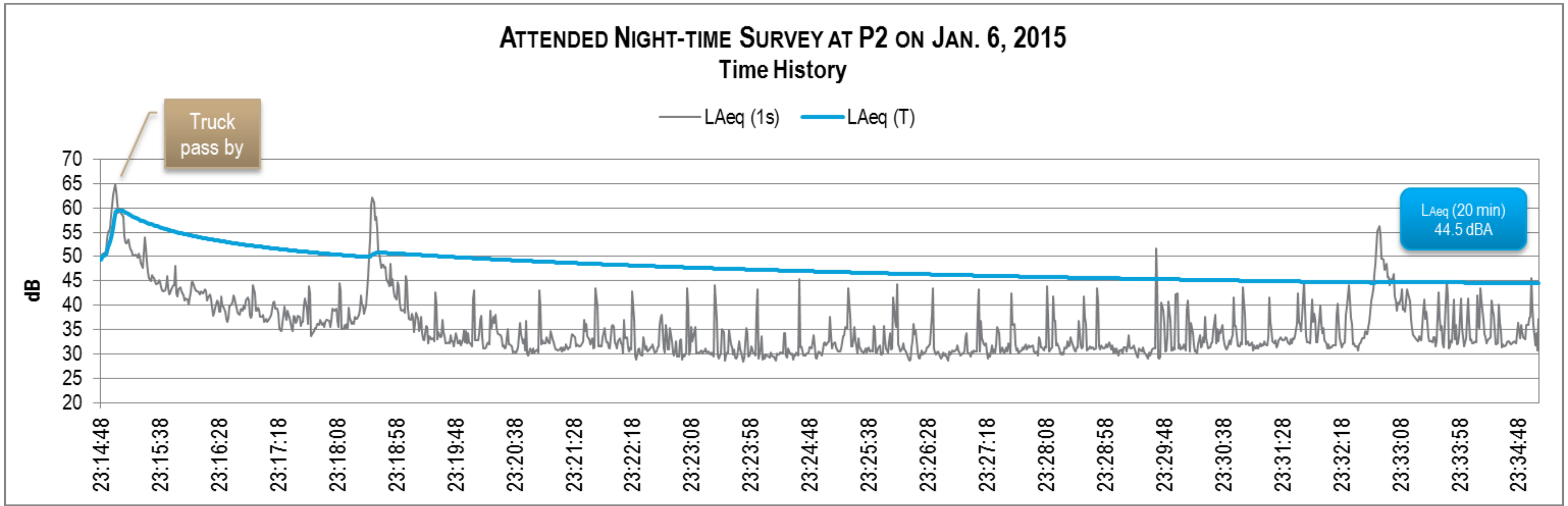

Statistics
LAeq
dB
42.3
41.0
40.2
36.5
33.2
32.2
30.2
L01
L05
L10
L50
L90
L95
L99

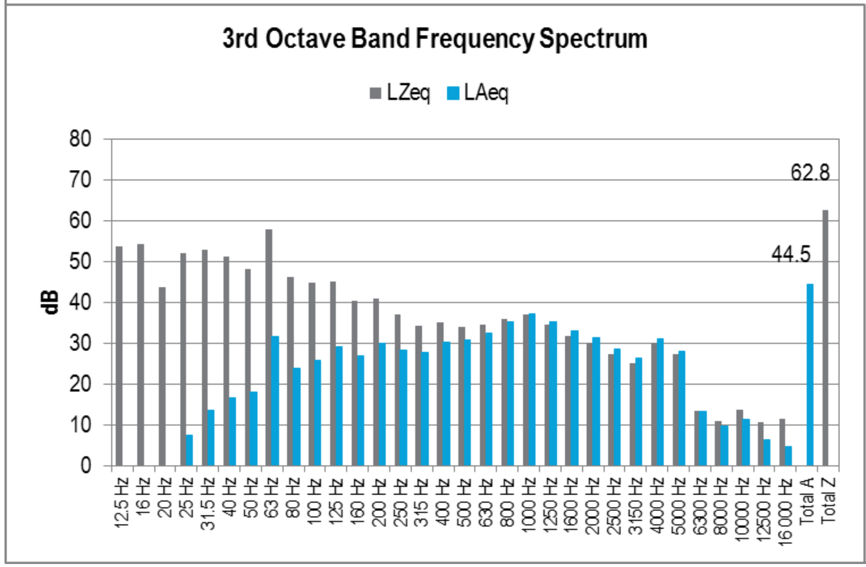

ATTENDED NIGHT-TIME SURVEY AT P1 ON JAN. 6, 2015
Time History
LAeq (1s)
LAeq (T)
LAeq (22 min)
36.1 dBA
dB
70
65
60
55
50
45
40
35
30
25
20
23:45:26
23:46:16
23:47:06
23:47:56
23:48:46
23:49:36
23:50:26
23:51:16
23:52:06
23:52:56
23:53:46
23:54:36
23:55:26
23:56:16
23:57:06
23:57:56
23:58:46
23:59:36
00:00:26
00:01:16
00:02:06
00:02:56
00:03:46
00:04:36
00:05:26
00:06:16
00:07:06

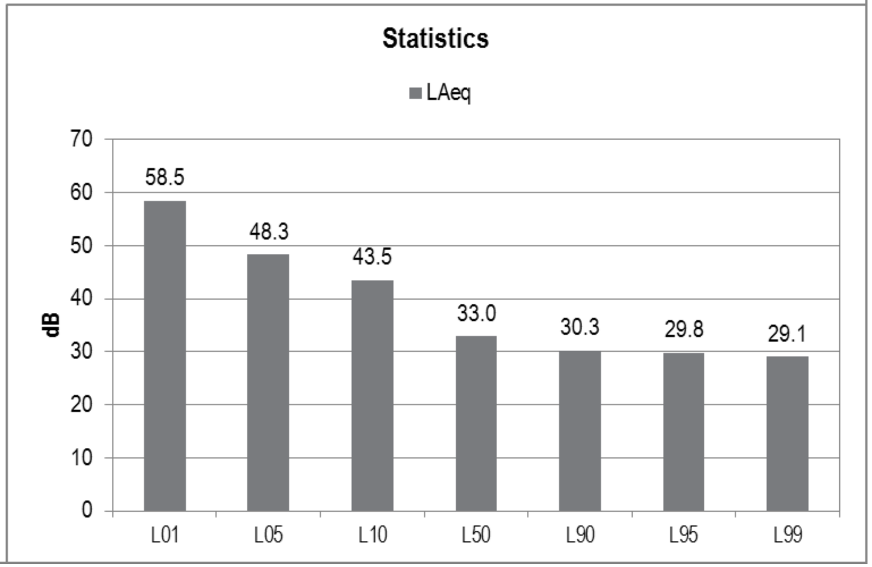

3rd Octave Band Frequency Spectrum
LZeq
LAeq
dB
80
70
60
50
40
30
20
10
0
55.1
36.1
12.5 Hz
16 Hz
20 Hz
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1000 Hz
1250 Hz
1600 Hz
2000 Hz
2500 Hz
3150 Hz
4000 Hz
5000 Hz
6300 Hz
8000 Hz
10000 Hz
12500 Hz
16 000 Hz
Total A
Total Z

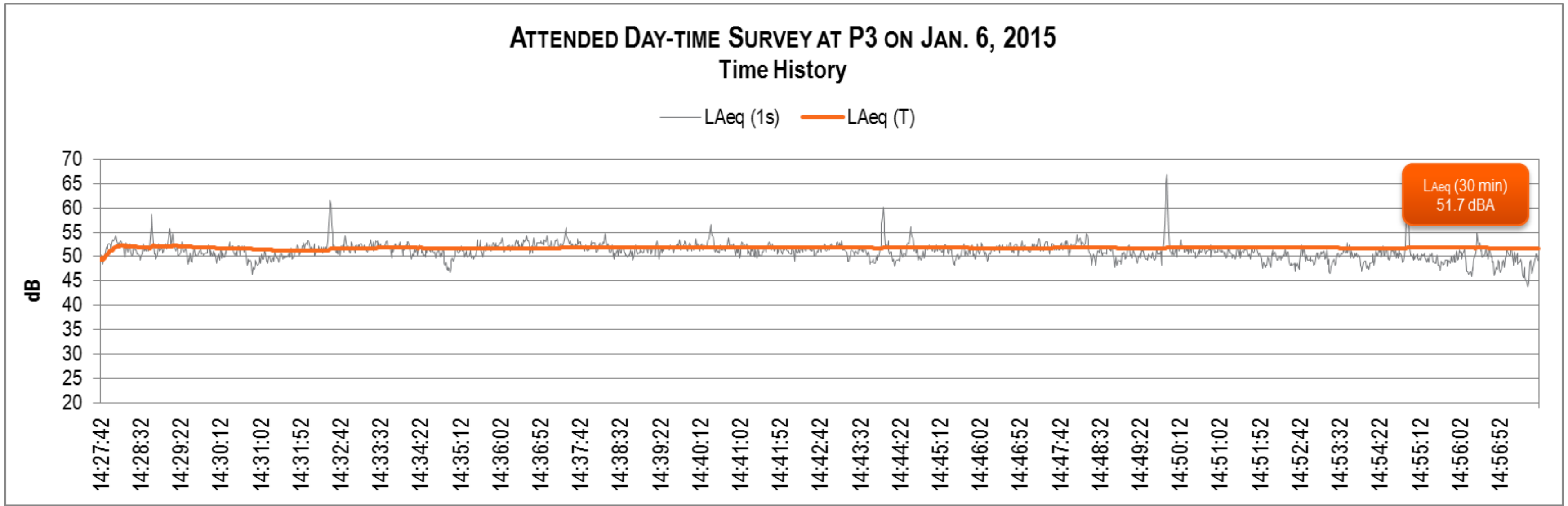

Statistics
LAeq
dB
45
40
35
30
25
20
15
10
5
0
34.3
L01
L05
L10
L50
L90
L95
L99


ATTENDED DAY-TIME SURVEY AT P2 ON JAN. 6, 2015
Time History
LAeq (1s)
LAeq (T)
dB
70
65
60
55
50
45
40
35
30
25
20
LAeq (30 min) 51.5 dBA
10:59:40
11:00:30
11:01:20
11:02:10
11:03:00
11:03:50
11:04:40
11:05:30
11:06:20
11:07:10
11:08:00
11:08:50
11:09:40
11:10:30
11:11:20
11:12:10
11:13:00
11:13:50
11:14:40
11:15:30
11:16:20
11:17:10
11:18:00
11:18:50
11:19:40
11:20:30
11:21:20
11:22:10
11:23:00
11:23:50
11:24:40
11:25:30
11:26:20
11:27:10
11:28:00
11:28:50
3rd Octave Band Frequency Spectrum
LZeq
LAeq
dB
80
70
60
50
40
30
20
10
0
66.5
51.5
12.5 Hz
16 Hz
20 Hz
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1000 Hz
1250 Hz
1600 Hz
2000 Hz
2500 Hz
3150 Hz
4000 Hz
5000 Hz
6300 Hz
8000 Hz
10000 Hz
12500 Hz
16 000 Hz
Total A
Total Z
Statistics
LAeq
dB
70
60
50
40
30
20
10
0
63.5
56.2
52.3
45.1
42.2
41.2
39.5
L01
L05
L10
L50
L90
L95
L99


ATTENDED NIGHT-TIME SURVEY AT P2 ON JAN. 6, 2015
Time History
LAeq (1s)
LAeq (T)
Truck pass by
LAeq (20 min) 44.5 dBA
dB
23:14:48
23:15:38
23:16:28
23:17:18
23:18:08
23:18:58
23:19:48
23:20:38
23:21:28
23:22:18
23:23:08
23:23:58
23:24:48
23:25:38
23:26:28
23:27:18
23:28:08
23:28:58
23:29:48
23:30:38
23:31:28
23:32:18
23:33:08
23:33:58
23:34:48


3rd Octave Band Frequency Spectrum
LZeq
LAeq
dB
62.8
44.5
12.5 Hz
16 Hz
20 Hz
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1000 Hz
1250 Hz
1600 Hz
2000 Hz
2500 Hz
3150 Hz
4000 Hz
5000 Hz
6300 Hz
8000 Hz
10000 Hz
12500 Hz
16 000 Hz
Total A
Total Z


Statistics
LAeq
dB
58.5
48.3
43.5
33.0
30.3
29.8
29.1
L01
L05
L10
L50
L90
L95
L99


ATTENDED DAY-TIME SURVEY AT P3 ON JAN. 6, 2015
Time History
LAeq (1s)
LAeq (T)
LAeq (30 min) 51.7 dBA
dB
70
65
60
55
50
45
40
35
30
25
20
14:27:42
14:28:32
14:29:22
14:30:12
14:31:02
14:31:52
14:32:42
14:33:32
14:34:22
14:35:12
14:36:02
14:36:52
14:37:42
14:38:32
14:39:22
14:40:12
14:41:02
14:41:52
14:42:42
14:43:32
14:44:22
14:45:12
14:46:02
14:46:52
14:47:42
14:48:32
14:49:22
14:50:12
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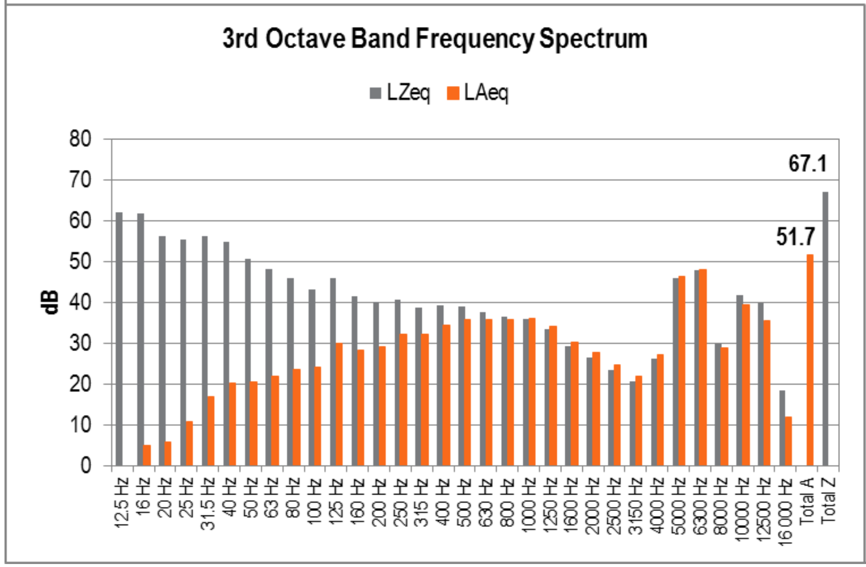
14:54:22
14:55:12
14:56:02
14:56:52


3rd Octave Band Frequency Spectrum
LZeq
LAeq
dB
80
70
60
50
40
30
20
10
0
67.1
51.7
12.5 Hz
16 Hz
20 Hz
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1000 Hz
1250 Hz
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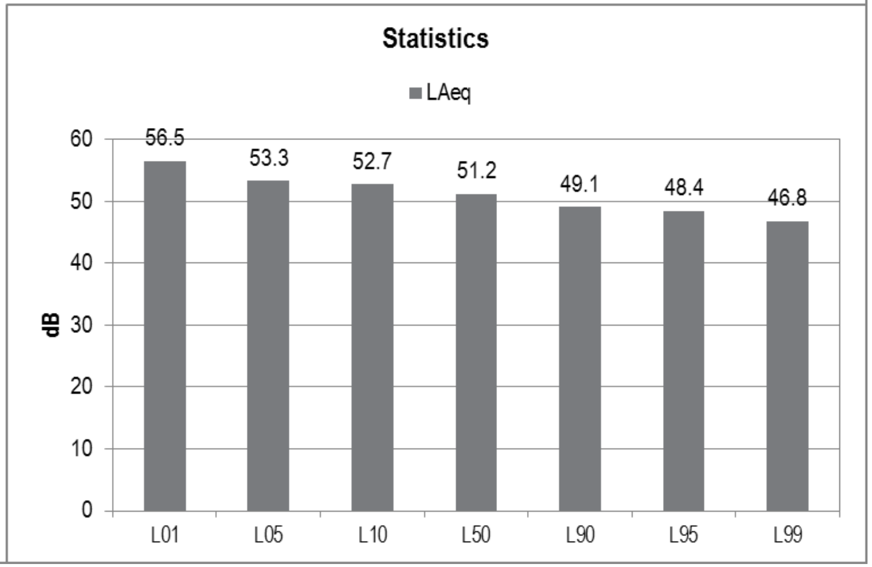
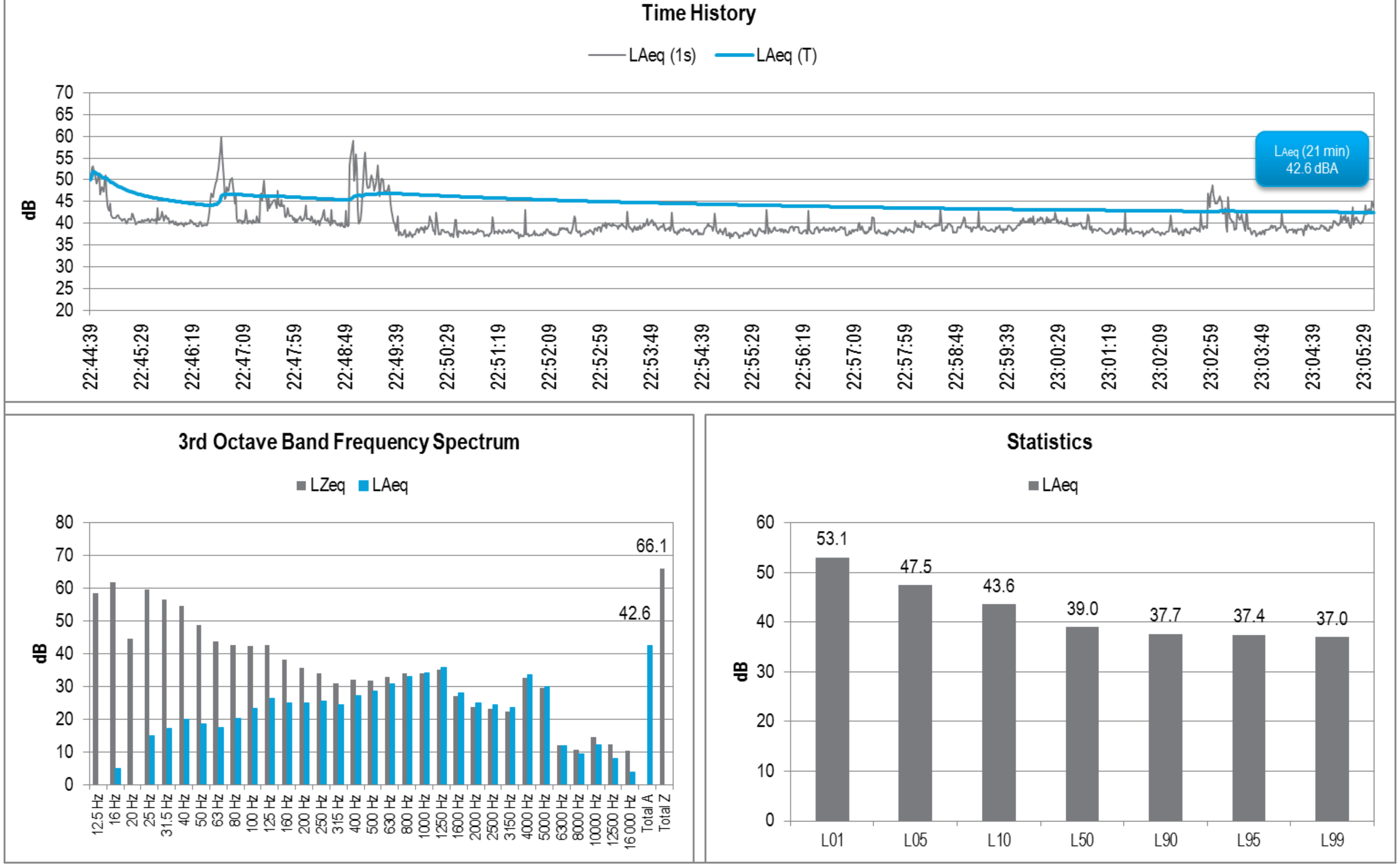
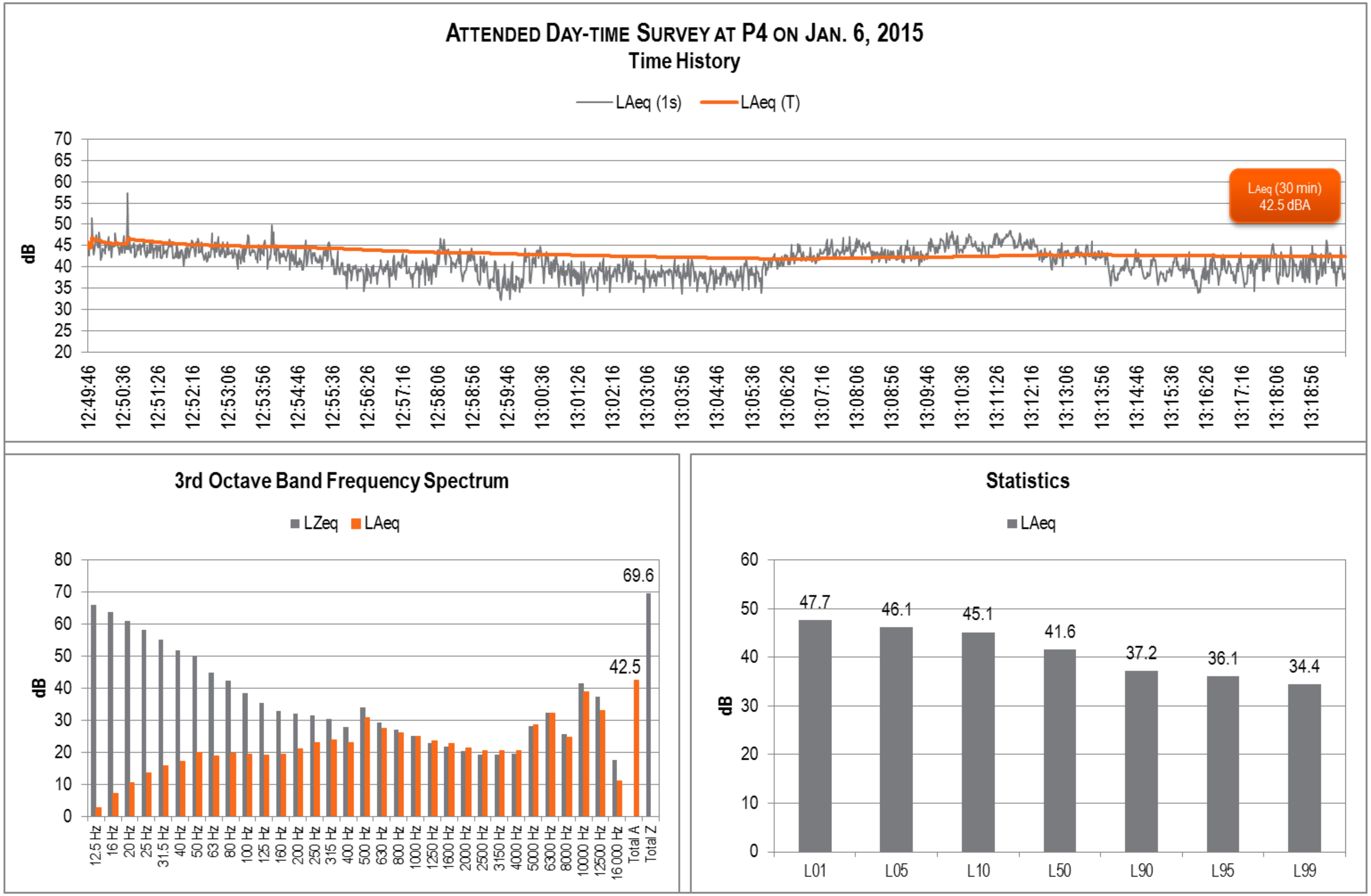
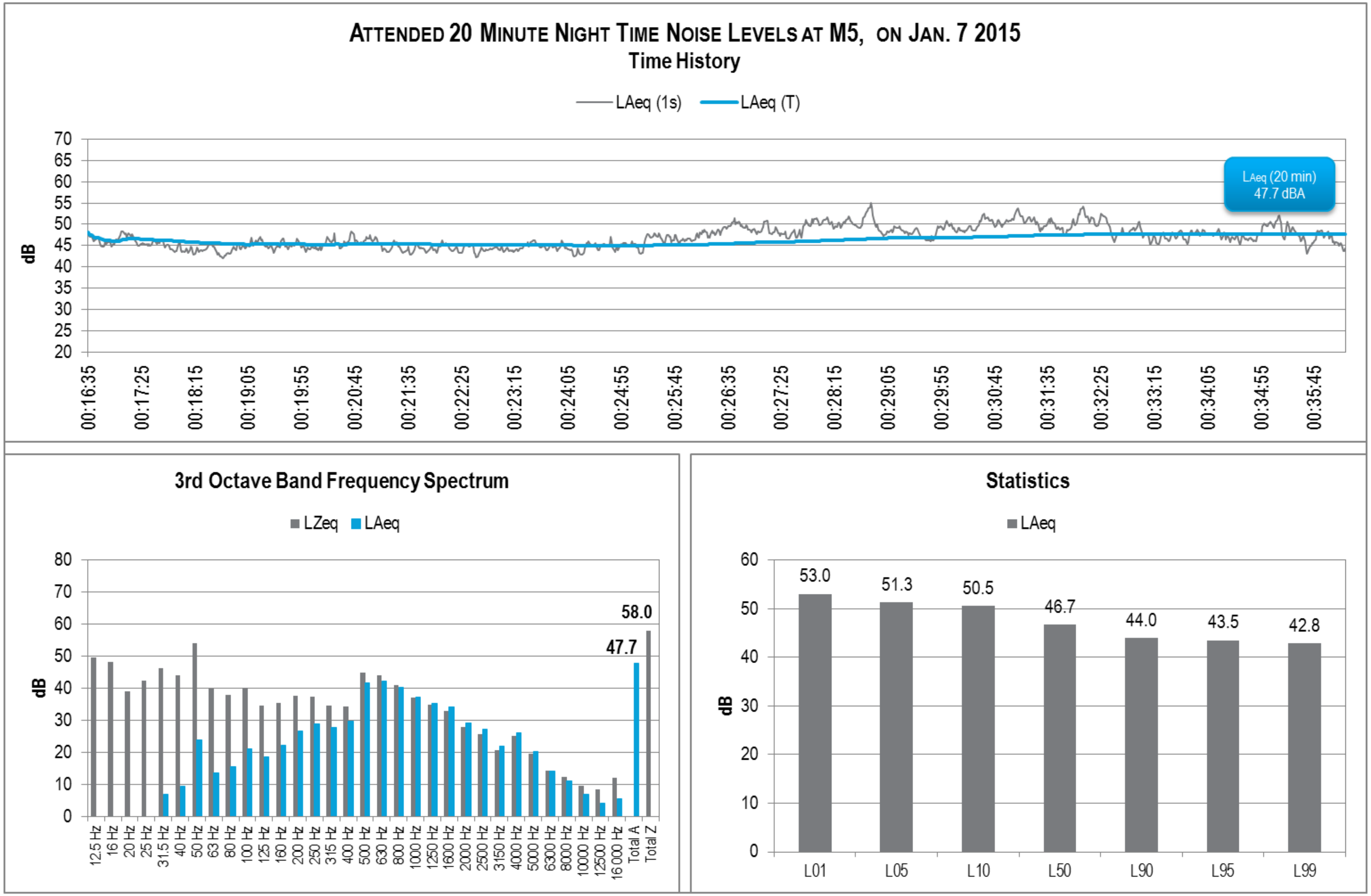
6300 Hz
8000 Hz
10000 Hz
12500 Hz
16000 Hz
Total A
Total Z


Statistics
LAeq
dB
60
50
40
30
20
10
0
56.5
53.3
52.7
51.2
49.1
48.4
46.8
L01
L05
L10
L50
L90
L95
L99

## Attended Night-time Survey at P3 on Jan. 6, 2015




ATTENDED DAY-TIME SURVEY AT P4 ON JAN. 6, 2015
Time History
LAeq (1s)
LAeq (T)
LAeq (30 min) 42.5 dBA
dB
3rd Octave Band Frequency Spectrum
LZeq
LAeq
69.6
42.5
Statistics
LAeq
47.7
46.1
45.1
41.6
37.2
36.1
34.4
L01
L05
L10
L50
L90
L95
L99



ATTENDED 20 MINUTE NIGHT TIME NOISE LEVELS AT M5, ON JAN. 7 2015
Time History
LAeq (1s)
LAeq (T)
LAeq (20 min)
47.7 dBA
dB
3rd Octave Band Frequency Spectrum
LZeq
LAeq
58.0
47.7
Statistics
LAeq
53.0
51.3
50.5
46.7
44.0
43.5
42.8
L01
L05
L10
L50
L90
L95
L99

# 8 ANNEX B – SPECIALIST'S CURRICULUM VITAE

# CURRICULUM VITAE

| | |
|---|---|
| **Name** | Nicolette von Reiche (nee Krause) |
| **Date of Birth** | 22 October 1982 |
| **Nationality** | South African |
| **Employer** | Airshed Planning Professionals (Pty) Ltd |
| **Position** | Principal Consultant and Project Manager |
| **Profession** | Mechanical Engineer employed as a Air Quality and Environmental Noise Assessment Consultant |
| **Years with Firm** | 9 Years |

## MEMBERSHIP OF PROFESSIONAL SOCIETIES

- South African Acoustic Institute (SAAI), 2006 to present
- National Association for Clean Air (NACA), 2006 to present
- International Institute for Acoustics and Vibration (IIAV), 2014 to present

## EXPERIENCE

Nicolette has over nine years of experience in both air quality and noise impact assessment and management. She is an employee of Airshed Planning Professionals (Pty) Ltd and is involved in the compilation of emission inventories, atmospheric dispersion modelling, air pollution mitigation and management, and air pollution impact work. Airshed Planning Professionals is affiliated with Francois Malherbe Acoustic Consulting cc and in assisting with numerous projects she has gained experience in environmental noise measurement, modelling and assessment as well.

A list of projects competed in various sectors is given below:

### Power Generation, Oil and Gas

eni East Africa S.p.A Rovuma Area 4 baseline for offshore gas (Mozambique), Staatsolie Power Company Suriname (Suriname), Benga Coal Fired Power Station (Mozambique), Zuma Energy Project (Nigeria), Anglo Coal Bed Methane Project, Eskom Ash Disposal Projects for Kusile Power Station, Camden Power Station and Kendal Power Station, Hwange Thermal Coal Fired Power Station Project (Zimbabwe), Eskom Ankerlig Gas Power Station.

### Industrial Sector

Scantogo Cement Project (Togo), Boland Bricks, Brits Ferrochrome Smelter Project, Samancor Chrome's Ferrometals, Middelburg Ferrochrome and Tubatse Ferrochrome, BHP Billiton Metalloys Ferromanganese Projects and Mamatwan Sinter Plant Projects, Tharisa Minerals Concentrator Plant Project, Obuasi Gold Processing Plant (Ghana), Obuasi Gold Mine Pompora Treatment Plant Project (Ghana), Afrisam Saldanha Project, Scaw Metals Projects, including a Co-generation Plant and Steel Wire Rope Plant Project, Delta EMD Project, Dense Medium Separation (DMS) Powders Project, Transalloys Silica Manganese, Dundee Precious Metals Tsumeb (Namibia), Rössing Uranium Desalination Plant (Namibia), Otavi Steel Project (Namibia)

### Air Quality and Environmental Noise Management

- Saldanha Industrial Development Zone (IDZ) – Part of an integrated team of specialists that developed the proposed development and management strategies for the IDZ. Air quality guidelines were developed and a method of determining emissions for potential developers. The investigation included the establishment of the current air emissions and air quality impacts (baseline) with the objective to further development in the IDZ and to allow equal opportunity for development without exceeding unacceptable air pollution levels.
- Gauteng Department of Transport air quality and noise management plan - The plan involved the identification of main traffic related sources of noise and air pollution, the identification of intervention strategies to reduce traffic related noise and emissions to air and the theoretical testing of intervention strategies through emission quantification and dispersion modelling of selected case studies.
- Erongo Strategic Environmental Impact Assessment (Namibia) and Air Quality Management Plan

### Mining Sector

- **Coal mining:** Elders Colliery, Grootgeluk Colliery, Inyanda Colliery, Boschmanspoort Colliery, Benga Mine (Mozambique), Vangatfontein Colliery Dust Monitoring, T-Project Underground Coal Mine, Lusthof Colliery
- **Metalliferous mines:** Samancor Chrome's Eastern and Western Chrome Mines, Kinsenda Copper Mine (DRC), Bannerman Uranium Mine (Namibia), Sadiola Gold Mine Deep Sulphides Project (Mali), Kolomela Iron Ore Mine Noise Monitoring, Mamatwan Manganese Mine, Ntsimbintle Manganese Mine, Tharisa Minerals Chrome and Platinum Group Metals Open-pit Mine Project, Obuasi Gold Mine (Ghana), Omitiomire Copper Mine (Namibia), Perkoa Zinc Project (Burkina Faso), Tschudi Copper Mine (Namibia), Rössing Uranium Mine (Namibia), WCL Iron Ore Mines (Liberia), Fekola Gold Project (Mali), Esaase Gold Project (Ghana), Xstrata Paardekop and Amersfoort Underground Coal Mines, Mampon Gold Mine (Ghana), Husab Uranium Mine (Namibia), Mkuju River Uranium Project (Tanzania), Impala Platinum Mine, Angola Exploration Mining Resources Project (Angola), Kanyika Niobium Mine (Malawi)
- **Quarries:** Scantogo Limestone Quarry, Lion Park Quarries Dustfall Monitoring

### Waste Disposal and Treatment Sector

Aloes Hazardous Waste Disposal Site, Holfontein Hazardous Waste Disposal Site, Shongweni Hazardous Waste Disposal Site, Coega General and Hazardous Waste Disposal Site, Umdloti Waste Water Treatment Works, Waltloo Medical Waste Incinerator

### Transport and Logistics Sector

Saldanha Iron Ore Port Projects and Railway Line, Gautrain Environmental Noise Monitoring Project, Guinea Port and Railway Project (Guinea), Kenneth Kaunda International Airport Expansion (Zambia), Zambia Dry Port Project in Walvis Bay (Namibia)

### Ambient Air Quality and Noise Sampling

- Gravimetric Particulate Matter (PM) and dustfall sampling
- Passive diffusive gaseous pollutant sampling
- Environmental noise sampling
- Source noise measurements

## SOFTWARE PROFICIENCY

- Atmospheric Dispersion Models: AERMOD, ISC, CALPUFF, ADMS (United Kingdom), CALINE, GASSIM, TANKS
- Noise Propagation Modeling: Integrated Noise Model (for airport noise), CONCAWE, South African National Standards (SANS 10210) for Calculating and Predicting Road Traffic Noise
- Graphical Processing: Surfer, ArcGIS (basic proficiency)
- Other: MS Word, MS Excel, MS Outlook

## EDUCATION

- BEng: (Mechanical Engineering), 2005, *University of Pretoria*
- BEng (Hons): (Mechanical Engineering) 2010, *University of Pretoria*; specializing in:
  - Advance Heat and Mass Transfer
  - Advanced Fluid Mechanics
  - Numerical Thermo-flow
  - Tribology

## COURSES COMPLETED AND CONFERENCES ATTENDED

- Course: Air Quality Management. Presented by the University of Johannesburg (March 2006)
- Course: AERMET/AERMAP/AERMOD Dispersion Model. Presented by the University of Johannesburg (March 2010)
- Conference: NACA (October 2007), Attended and presented a paper
- Conference: NACA (October 2008), Attended and presented a paper
- Conference: NACA (October 2011), Attended and presented a poster
- Conference: NACA (October 2012), Attended and presented a paper
- Conference: IUAPPA (October 2013), Attended and presented a paper

## COUNTRIES OF WORK EXPERIENCE

South Africa, Mozambique, Zimbabwe, Zambia, Namibia, the Democratic Republic of the Congo, Botswana, Ghana, Liberia, Togo, Mali, Burkina Faso, Tanzania, Malawi, Angola, Nigeria and Suriname

## LANGUAGES

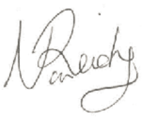
| | Speak | Read | Write |
|---|---|---|---|
| **English** | Excellent | Excellent | Excellent |
| **Afrikaans** | Excellent | Excellent | Excellent |

## REFERENCES

| Name | Position | Contact Number |
|---|---|---|
| Dr. Gerrit Kornelius | Associate of Airshed Planning Professionals | +27 (82) 925 9569<br>gerrit@airshed.co.za |
| François Malherbe | Owner of François Malherbe Acoustic Consulting | +27 (82) 469 8063<br>malherf@mweb.co.za |
| Dr. Hanlie Liebenberg Enslin | Managing Director at Airshed Planning Professionals | +27 (83) 416 1955<br>hanlie@airshed.co.za |

## CERTIFICATION

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



28/03/2015

# *FULL CURRICULUM VITAE*

| | |
|---|---|
| **Name of Firm** | Airshed Planning Professionals (Pty) Ltd |
| **Name of Staff** | Oladapo Akinshipe |
| **Profession** | Environmental Impact Specialist |
| **Date of Birth** | 27 September 1984 |
| **Years with Firm/ entity** | 2 years |
| **Nationalities** | Nigerian |

## MEMBERSHIP OF PROFESSIONAL SOCIETIES

- Member of the National Association for Clean Air (NACA)

## KEY QUALIFICATIONS

Oladapo has developed professional and technical experience in the following areas:

- Air Quality Impact Assessment,
- AEL and AIR Applications
- Noise monitoring and impact assessment
- Air Quality Monitoring
- Environmental research and Reporting
- Emission Quantification and Inventories (Mining and Ore Handling, Metal Recovery, Petrochemical Industry, Power Generation, Waste Disposal and Recycling etc.)

Oladapo has developed technical and specialist skills in various dispersion modelling packages including the industrial source complex models (SCREEN3), EPA Regulatory Models (AERMOD and AERMET), UK Gaussian plume model (ADMS), GasSim (for the quantification of landfill emissions).

He has also developed specialist skills in the following packages for simulation of noise propagation: SANS 10357:2004 and SANS 10103:2008 (South African National Standards).

## RELEVANT EXPERIENCE

### Mining and Ore Handling

Oladapo has undertaken numerous air quality impact assessments and management plans for coal, manganese, uranium, copper, cobalt and andalusite mines. These include air quality impact assessments for Alexander Coal Mine (Mpumalanga), Delmas coal mine (Delmas), Pumpi copper and cobalt mine (Congo DR), Vlakfontein coal mine (Mpumalanga). Ongoing projects include Mokala manganese project, Panda Hill Niobium project, Rhino Andalusite project, hattinspruit siding project.

### Metal Recovery

Air quality impact assessment has been carried out for the Transalloys ferromanganese furnace (eMalahleni).

### Chemical Industry

Air quality impact assessment and Atmospheric impact report has been completed for the Flexilube refinery plant (Meyerton).

### Petrochemical Industry

Air quality impact assessments have been completed for Sasol's Petroleum Sharing Agreement Development Project and Liquefied Petroleum Gas in Mozambique – Inhassoro Early Oil Project (Mozambique).

### Noise Impact Assessment

Noise impact assessments have been completed for Pumpi copper and cobalt mine (Congo DR), Mokala manganese Project (Hotazel), Panda Hill Niobium Project (Tanzania).

### Power Generation

Air quality impact assessment has been completed for the Transalloys coal fired power station (eMalahleni).

### Clay brick Industry

Research project and studies conducted in the clay brick industry include: The Development of an 'emission inventory tool' for Brickmaking Clamp Kilns; application of Atmospheric Emission Licences (AEL) for over 20 clay brick factories in South Africa.

### Monitoring Projects

Various ambient and stack monitoring projects have been undertaken in the following industries: clay brick, mining (coal, copper and cobalt, uranium etc.)

## EDUCATION

| | |
|---|---|
| **PhD Environmental Technology** | University of Pretoria, Pretoria, South Africa (Ongoing)<br>Title: *Atmospheric emissions from clamp kilns in the South African clay brick industry* |
| **M.Sc. Environmental Technology** | University of Pretoria, Pretoria, South Africa (2013)<br>Title: *The Development of an 'emission inventory tool' for Brickmaking Clamp Kilns* |
| **B.Sc. Honours** | University of Pretoria, Pretoria South Africa (2011)<br>Environmental Technology |
| **B.Sc.(Hons)** | Olabisi Onabanjo University, Nigeria (2008)<br>Microbiology |

## COUNTRIES OF WORK EXPERIENCE

South Africa, Nigeria, Mozambique, Democratic Republic of Congo, Tanzania and Namibia.

## EMPLOYMENT RECORD

### July 2013 - Present

**Airshed Planning Professionals (Pty) Ltd,** Air Quality Specialist, Midrand, South Africa.

### February 2012 – June 2013

**University of Pretoria,** Research Associate and Teaching Assistant, Pretoria, South Africa.

### October 2009 – December 2010

**Akfield Oil and Gas Ltd.,** Environmental/Logistics Officer**,** Port-Harcourt, Nigeria

## LANGUAGES

| | Speak | Read | Write |
|---|---|---|---|
| **English** | Excellent | Excellent | Excellent |

## CONFERENCE AND WORKSHOP PRESENTATIONS AND PAPERS

- The Development of an 'emission inventory tool' for Brickmaking Clamp Kilns. Akinshipe O., Kornelius G. International Union of Air Pollution Prevention and Environmental Protection Associations (IUAPPA) World Clean Air conference, Cape Town South Africa (2013). Peer reviewed.

## CERTIFICATION

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

27/08/2015

Full name of staff member: Oladapo Akinshipe