Noise Specialist Report for the Proposed COZA Iron Ore Project on the Farm Driehoekspan in the Tsantsabane Local Municipality of the Northern Cape Province

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

Report compiled by:
Nicolette von Reiche

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Address: 480 Smuts Drive, Halfway Gardens | Postal: P O Box 5260, Halfway House, 1685
Tel: +27 (0)11 805 1940 | Fax: +27 (0)11 805 7010
www.airshed.co.za

Report Details

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Prepared by	Nicolette von Reiche, BEng Hons (Mech.) (University of Pretoria)
Notice	Airshed Planning Professionals (Pty) Ltd is a consulting company located in Midrand, South Africa, specialising in all aspects of air quality, ranging from nearby neighbourhood concerns to regional air pollution impacts as well as noise impact assessments. The company originated in 1990 as Environmental Management Services, which amalgamated with its sister company, Matrix Environmental Consultants, in 2003.
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Revision Record

Version	Date	Section(s) Revised	Summary Description of Revision(s)

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 7: Annex A – Specialist's Curriculum Vitae (page 33)
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) 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) 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 7)
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 20) Site alternatives were not considered.
Any mitigation measures for inclusion in the EMPr.	Section 5: Management, Mitigation and Recommendations (page 30)
Any conditions for inclusion in the environmental authorisation	Section 5: Management, Mitigation and Recommendations (page 30)
Any monitoring requirements for inclusion in the EMPr or environmental authorisation.	Section 5.3: Monitoring (page 31)
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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 (page 30)
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)
$L_{Req,d}$	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)
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

A noise impact assessment was conducted for the proposed activities at Driehoekspan which forms part of the COZA Iron Ore Project in addition to already assessed Doornpan activities. The main objective of this study was to establish baseline/pre-development noise levels in the study area and to quantify the extent to which ambient noise levels will change as a result of the project. The baseline and impact study then informed the air quality management and mitigation measures recommended for adoption as part of the project's Environmental Management Plan.

To achieve this objective, the following tasks were included in the scope of work (SoW):

1. A review of 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 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 conducted by SLR.
4. An impact assessment, including:
    a. The establishment of a source inventory for the operational phase of the project.
    b. Noise propagation simulations to determine environmental noise levels.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. 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:

- The nearest communities to the proposed operations include scattered farm residences/buildings. NSRs most likely to be affected by Driehoekspan activities include a farmstead on the Driehoekspan farm and one located less than 500 m directly downwind (to the south-west) of the Driehoekspan farm boundary (Palingpan).
- 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 night.
- Baseline noise levels are affected by traffic along the R325, birds and insects Representative day- and night-time as well as 24-hour baseline noise levels of 51.7 dBA, 44.3 dBA and 50.3 dBA respectively were calculated from survey results.

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 (CadnaA, ISO 9613). The propagation of noise was calculated over an area of 10 km east-west by 15 km north-south with the both Driehoekspan and Doornpan included in the simulation domain. The area was divided into a grid matrix with a 20 m resolution and NSRs were included as discrete receptors. The following was found:

- Although not quantified, 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.
- The operational phase will result in noise levels in exceedance of the selected impact criteria at the nearest NSR, Palingpan. Slight reaction with sporadic complaints from individuals at this location may be expected if impacts remain unmitigated.
- 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 6.3 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.

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 air quality impact assessment for the proposed COZA Mining (Pty) Ltd Iron Ore Project (the project) to be located within the Tsantsabane Local Municipality of the Northern Cape Province.

The project is a green-fields project that will comprise mining from three separate pits located on the farms Driehoekspan 435 (Remaining Extent), Doornpan 445 (Portion 1) and Jenkins. The three farms are situated between Postmasburg and Kathu, with Jenkins located furthest north (approximately 30 km south of Kathu), Doornpan furthest south and Driehoekspan in between (approximately 30 km south of Jenkins).

The product from open cast iron ore mining operations is estimated at 1.5 – 2 million tonnes per annum (Mt/a) Run of Mine (RoM). The mining method will consist of truck and shovel operations and beneficiation at a washing and screening plant to be located at the Jenkins portion. The Life of Mine (LoM), is estimated at 7 years, from 2017 to 2023. Pre-stripping of overburden is scheduled for the first half of 2017 and start of production aimed for the second half of 2017. The Jenkins portion will be mined for the duration of the LoM, while Driehoekspan will be mined in year 4 and Doornpan from year 5 to mine closure.

The focus of this assessment is on noise impacts associated with proposed activities at Driehoekspan and, due to its proximity to Doornpan also the potential for cumulative noise impacts. The Jenkins portion is considered too far north from Driehoekspan to add to cumulative impacts.

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 Driehoekspan portion in addition to Doornpan. The proposed Driehoekspan site layout plan is included in Figure 1. For completeness, the layout for Doornpan is shown in Figure 2.

1.2 Scope of Work

The following tasks were included in the Scope of Work (SoW):

1. A review of 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;
    b. A study of environmental noise attenuation potential by referring to available weather records, land use and topography data sources; and
    c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from a survey conducted by SLR.
4. An impact assessment, including:
    a. The establishment of a source inventory for the operational phase of the project.
    b. Noise propagation simulations to determine environmental noise levels.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. A specialist noise impact assessment report.

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

Open pit mining at Driehoekspan and Doornpan will be undertaken by means of truck and shovel. Topsoil will be stripped and stockpiled and the overburden will be placed on waste rock dumps located near to the pits within the infrastructure area. Ore will be trucked to a RoM stockpile area for crushing and screening. Ore will then be trucked from site using existing access roads that link to the R325. From the R325 ore will be trucked to the Jenkins portion for further processing.

The infrastructure that will be developed includes access roads with entrance controls, mine fencing, water management infrastructure (pollution control dams and water supply dams), power supply, offices, a change house, workshops, sewage treatment, temporary waste storage facilities and areas for the storage of explosives and fuel.

During the construction phase, workers will be accommodated at the temporary construction village on site. Once operations at the mine commence, staff will be accommodated within surrounding towns. Power for the mine will be sourced from diesel generators during the construction phase and later a power supply line will be constructed to link to an existing Eskom line.

Sources of noise during the operational phases of Driehoekspan and Doornpan 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); and
- Access road traffic.

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.

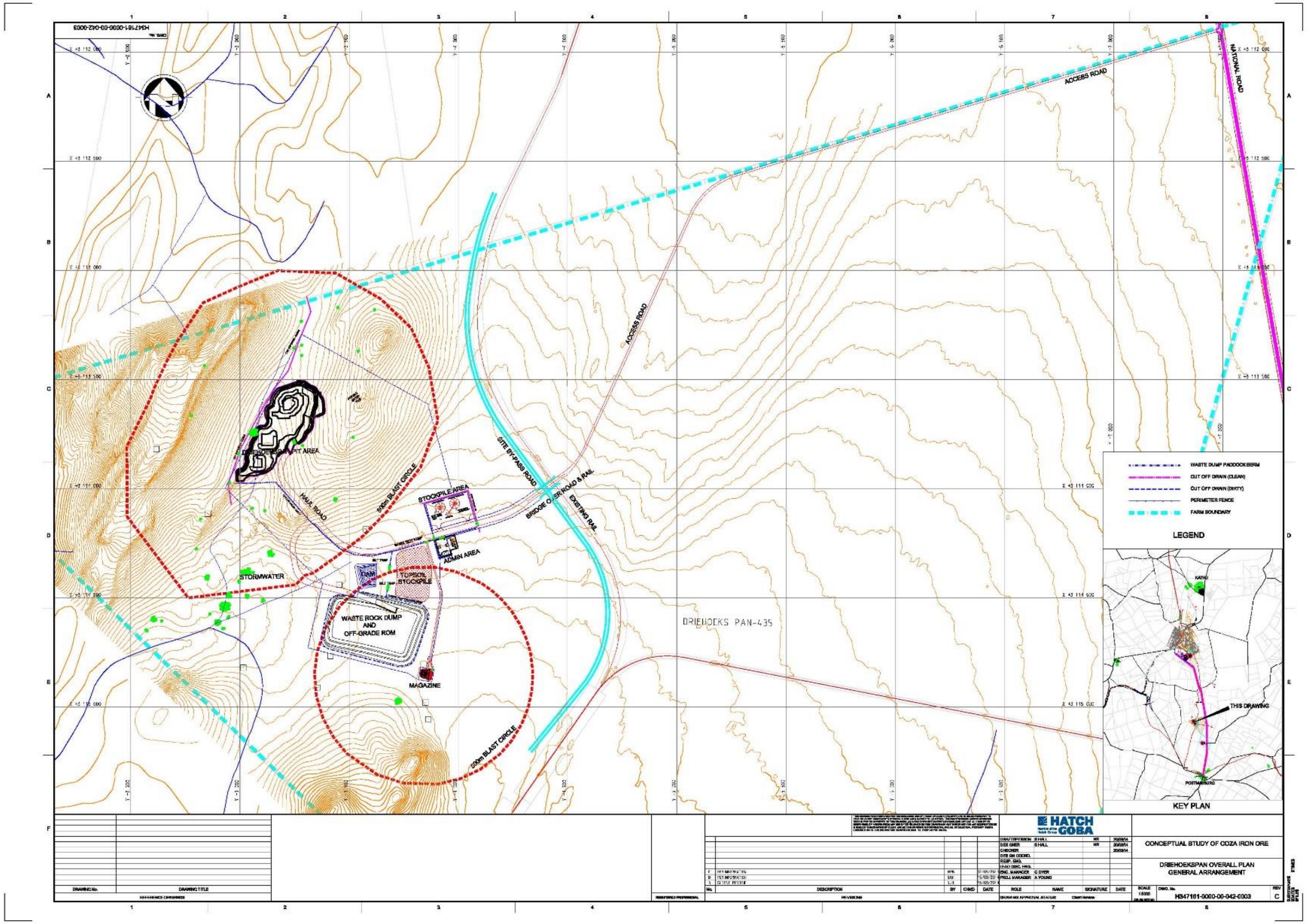


Figure 1: Driehoekspan portion layout (layout provided by SLR)

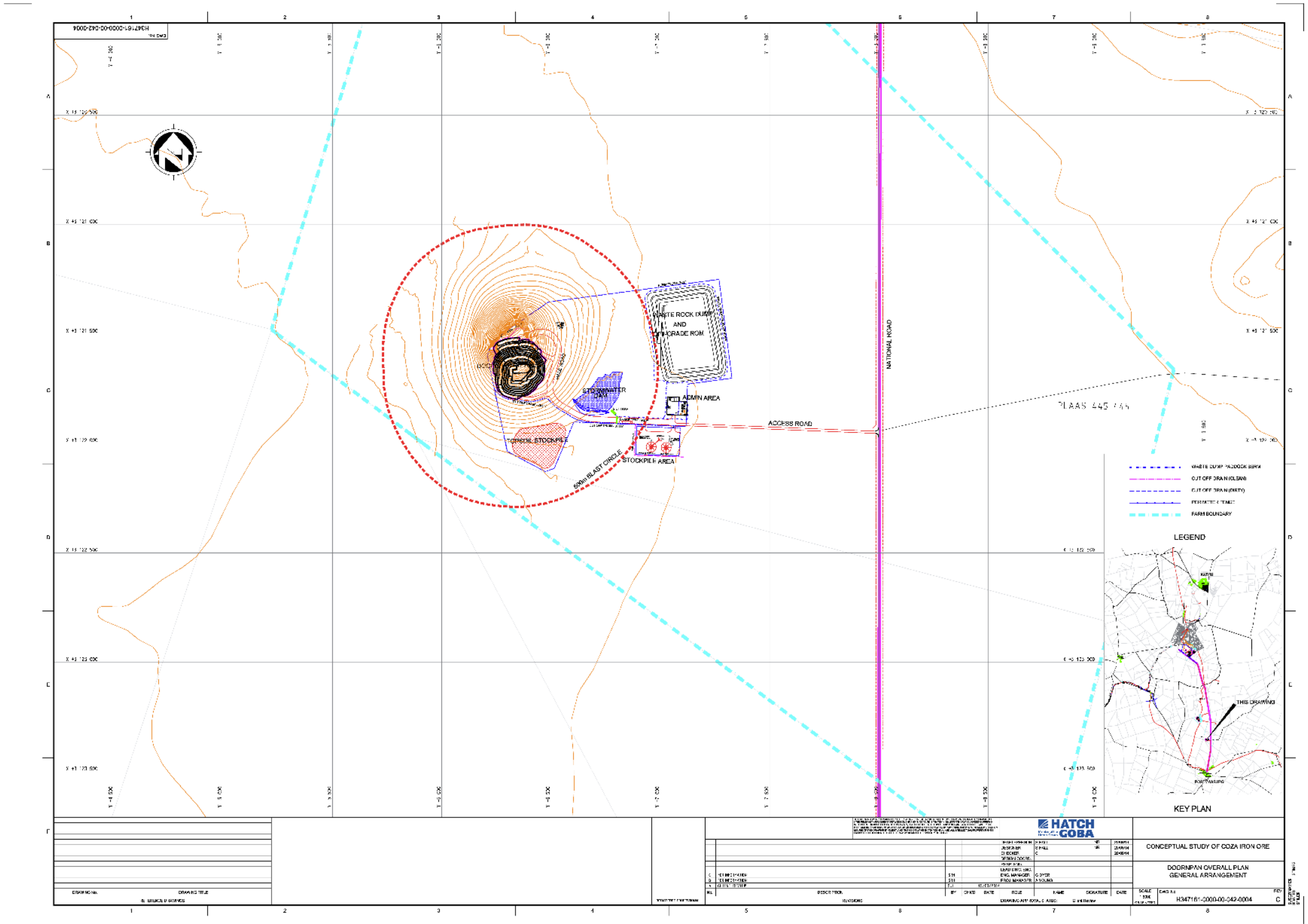


Figure 2: Doornpan portion layout (layout provided by SLR)

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

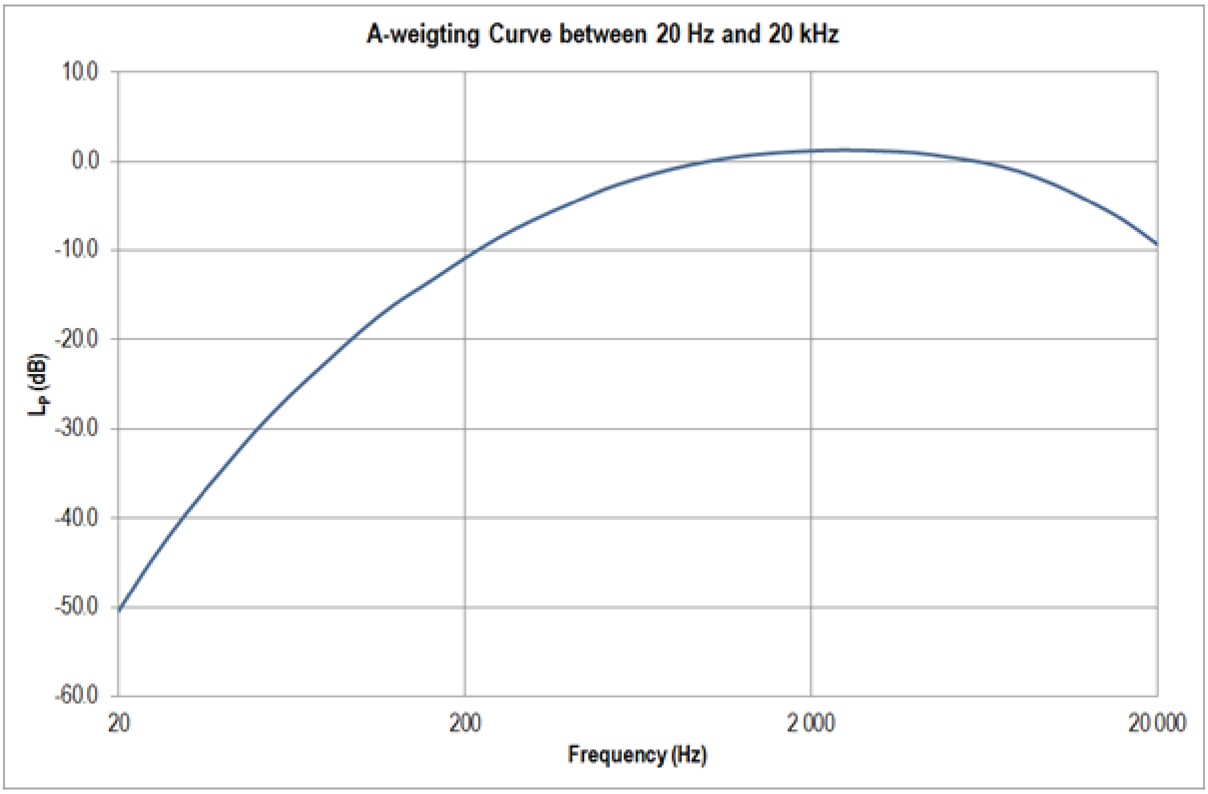


Figure 3: A-weighting curve

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 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.

1.5.1 Information Review

All project related information referred to in this study was provided by SLR. It included Chapter 4 of COZA Iron Ore Concept Phase Report compiled by COZA Mining (Pty) Ltd as well as site layout maps and mine production calculations supplied by SLR. Gaps or limitations in the information supplied were identified. These were addressed by making suitable technical assumptions which were approved by SLR.

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

1.5.3 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 satellite imagery.

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 data recorded near Postmasburg by Anglo American's Kolomela Mine in cooperation with the Northern Cape Province for a period between 2011 and 2014. 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 an area. Higher ambient noise levels will result in less noticeable noise impacts and a smaller impact area. The opposite also holds true. Increases in noise will be more noticeable in areas with low ambient noise levels. The data from a baseline noise survey conducted by SLR was studied to determine representative baseline noise levels for use in the assessment of cumulative impacts.

1.5.4 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
- Haul truck traffic data.

1.5.5 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 outdoors in order 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 midband 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. 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 reflection from surfaces*
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. It does however not apply to blast waves from mining.

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.

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 or areas 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/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 10 km east-west by 15 km north-south with the both Driehoekspan and Doornpan included in the simulation domain. The area was divided into a grid matrix with a 20 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.

1.5.6 Presentation of Results

Noise impacts were calculated in terms of:

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

1.5.7 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 blast assessment.
- All mining activities were conservatively assumed to be at the surface of pit areas. The mitigating effect of pit walls and waste rock dumps were not accounted for.
- Although the focus of this assessment is on mining activities at Driehoekspan, the COZA Iron Ore Project includes mining on the farms Doornpan and Driehoekspan. The potential for cumulative impacts as a result of mining activities at their peak on both farm portions were considered.
- The quantification of sources of noise was restricted to proposed operations at Driehoekspan and Doornpan. Although other existing sources of emission within the area were identified, such sources were not quantified.
- All project information required to calculate noise impacts were provided by SLR.
- Routine noise impacts from mining operations were estimated and modelled.
- In the absence of on-site meteorological data, use was made of data recorded near Postmasburg.

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

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

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

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

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

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

[1] $L_{Aeq,T}$ 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. Δ = 3 dBA is, therefore, a useful significance indicator for a noise impact.

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

Table 2: IFC noise level guidelines

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

2.3 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. For that reason, the 24-hour limit of 55 dBA was also used. 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

NSRs generally include places of residence and areas where members of the public may be affected by noise generated by mining/industrial activities. The nearest towns to the proposed Driehoekspan pit include Postmasburg, Lohathla and Beeshoek all more than 10 km away.

More likely NSRs in the project area include scattered farmsteads/homesteads (Table 3). These are indicated in Figure 4 in relation to the farms Driehoekspan and Doornpan. The closest of these to proposed activities on the farm Driehoekspan lie approximately 600 m to the south-east and 1.4 km to the south-west of the mine perimeter fence (no. 3 and no. 4).

Table 3: Sensitive receptors

Receptor	Description	Longitude	Latitude
1	Farmstead/homestead	23° 00' 23.61"	28° 10' 15.56"
2 (Palingpan)	Farmstead/homestead	23° 00' 50.79"	28° 10' 28.42"
3	Farmstead/homestead	23° 01' 12.16"	28° 09' 04.10"
4	Farmstead/homestead	23° 02' 38.15"	28° 09' 14.32"
5	Farmstead/homestead	23° 02' 56.21"	28° 06' 41.95"
6	Farmstead/homestead	23° 05' 13.35"	28° 07' 59.47"
7	Farmstead/homestead	23° 06' 19.08"	28° 08' 45.33"
8 (Manganore)	Farmstead/homestead	23° 06' 12.77"	28° 09' 19.91"
9	Farmstead/homestead	23° 05' 34.00"	28° 12' 51.85"
10	Farmstead/homestead	23° 01' 56.98"	28° 14' 16.48"

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. Anglo American operates a weather and ambient air quality monitoring station in Postmasburg as part of their Kolomela operations. Reference is made to data recorded between 11 November 2011 and 13 October 2014.

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 5. 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 the night.

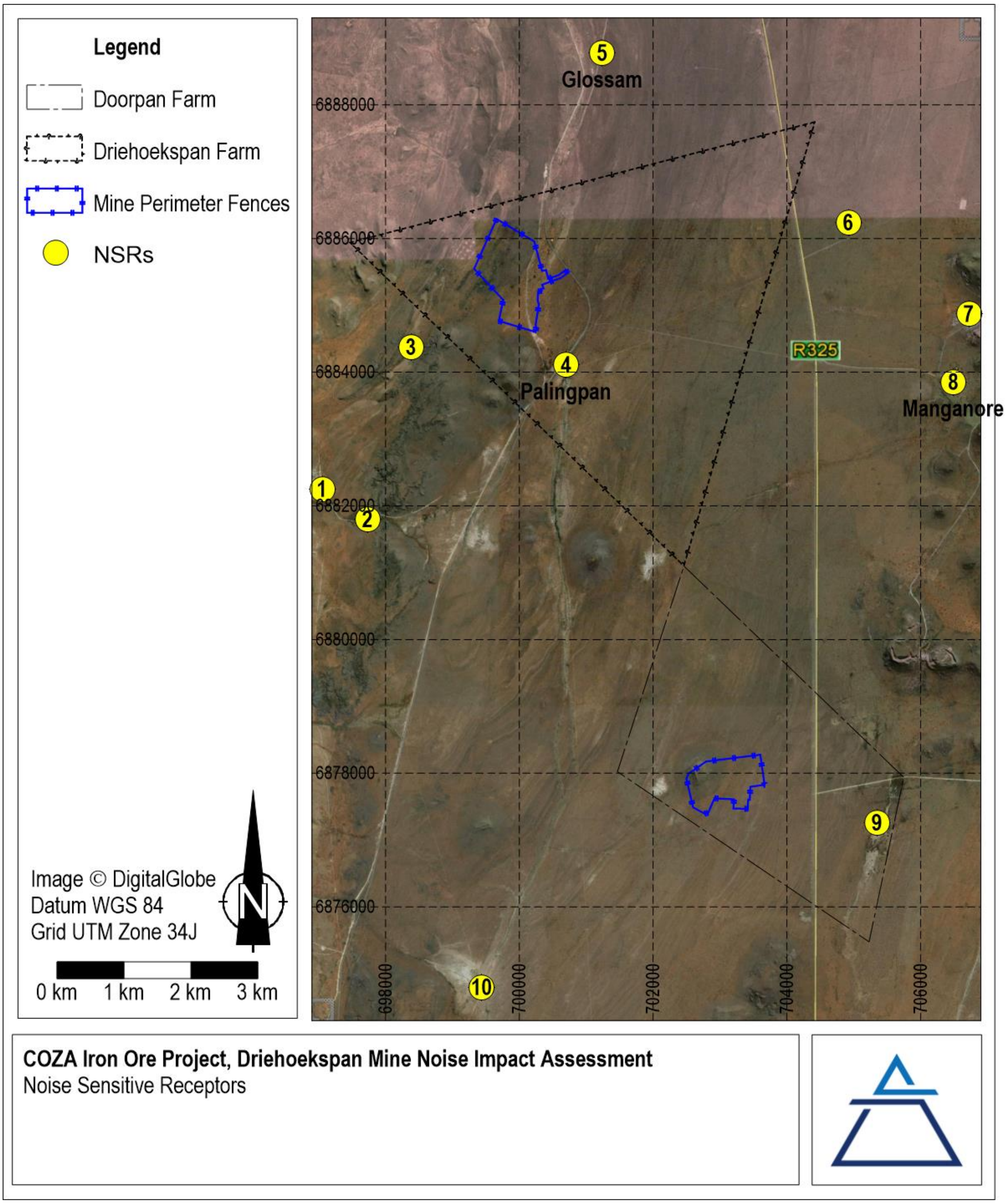
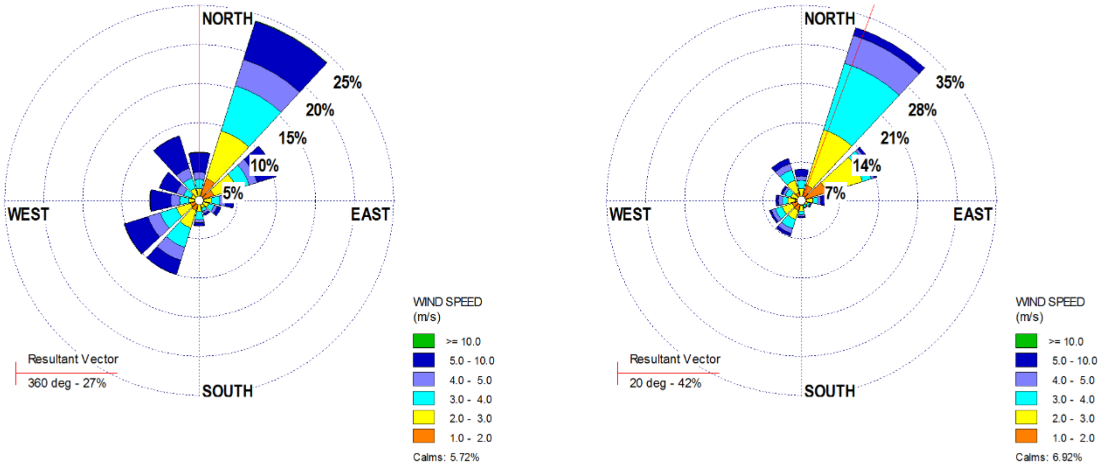


Figure 4: Location of NSRs



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

Figure 5: 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. An average temperature of 17°C and a humidity of 47% were applied in simulations.

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. The terrain of the study area was however included.

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

SLR conducted a baseline noise survey at the three locations shown in Figure 6, in December of 2013. The survey consisted of attended 30 to 60 minute samples during the day and night (results summarised in Table 4).

Ambient noise levels are affected by traffic on the R385 and R325 and natural noise sources such as birds and insects. During very quiet conditions the distant low frequency noise of mining/industrial activities is audible. Sampled noise levels vary between what SANS 10103 states is typically found in rural or suburban areas. Insect noise at night often results in night-time noise levels that are slightly higher than during the day.

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

- $L_{Req,d}$ – 51.7 dBA;
- $L_{Req,n}$ – 44.3 dBA; and
- $L_{R,dn}$ – 50.3 dBA.

Table 4: Summary of the noise survey conducted by SLR on 4 and 5 December 2013

	1A		2A		P3	
Latitude	S 28°12'57.3"		S 28°10'40.4"		S 28°08'25.5"	
Longitude	E 22°57'12.4"		E 22°55'58.0"		E 23°04'36.7"	
Time of Day	Day	Night	Day	Night	Day	Night
Start Date and Time	5-Dec-13 16:40:00	4-Dec-13 22:35:00	4-Dec-13 12:33:00	5-Dec-13 23:19:00	4-Dec-13 14:41:00	6-Dec-13 00:54:00
Duration	01:00:00	00:35:00	01:00:00	00:30:00	01:00:00	00:30:00
Weather Conditions	Clear sunny day with westerly wind speeds up to 2.1 m/s.	Clear, wind still conditions.	Clear sunny day with westerly wind speeds up to 3.7 m/s.	Clear, wind still conditions.	Clear sunny day with westerly wind speeds up to 4.1 m/s.	Clear night with westerly wind speeds up to 2.3 m/s
Acoustic Observations	Birds, insects and wind constantly audible. Occasional vehicle passing by.	Insects, occasional vehicles passing by, goats bleating.	Birds, insects and wind constantly audible. Occasional vehicle passing by.	Insects, distant mining/industrial noise.	Traffic along R325, birds, insects and wind rustling grass.	Intermittent traffic along R325, insects and wind rustling grass.
L_{AFmin} (dBA)	22.5	22.8	29.6	22.2	25.2	25.7
L_{AFmax} (dBA)	73.3	66.8	66.8	66.5	60.3	67.8
L_{Aeq} (dBA) Comparable to IFC Noise Level Guidelines	45.4	31.0	56.0	32.8	38.4	48.9

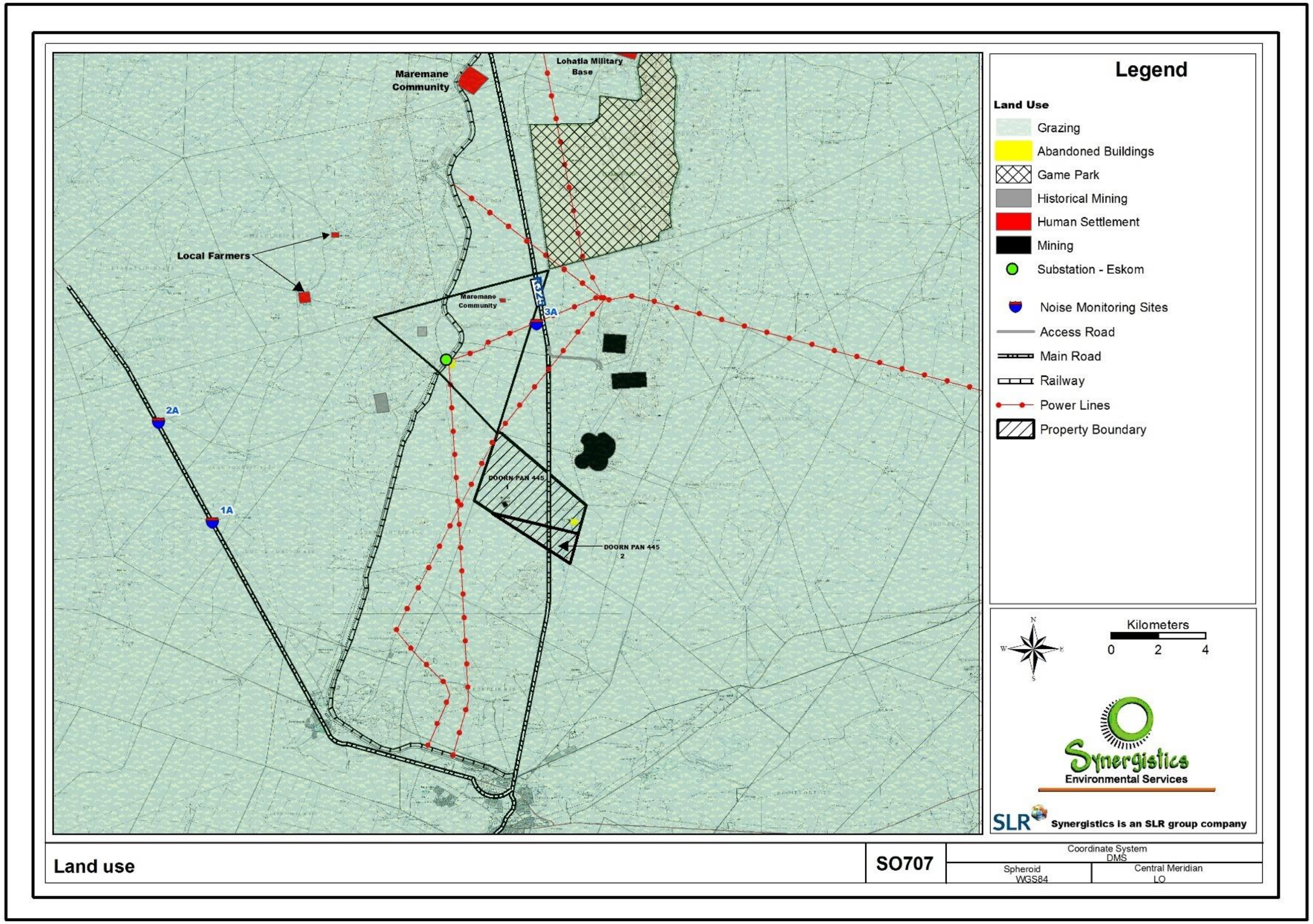


Figure 6: Baseline noise survey sites

4 Impact Assessment

The noise source inventory, noise propagation modelling and results for the operational phase of Driehoekspan are discussed in Section 4.1and Section 4.2 respectively.

4.1 Noise Sources and Sound Power Levels

The extent and character of operational phase noise, especially mining, will be variable as the mining 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;
- Transport of ore and waste materials; and
- Personnel transport.

Except for personnel transport, all activities were assumed to be continuous i.e. 24 hours/day.

Table 5: Operational phase source noise inventory for Doornpan and Driehoekspan

Equipment	Qty. Doornpan	Qty. Driehoekspan	Octave band LW frequency spectra (dB)								
			63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	A (dBA)
Komatsu PC600 Shovel	1	1	109.1	114.1	117.1	112.1	110.1	107.1	101.1	95.1	115.4
Komatsu PC800 Shovel	1	1	109.7	114.7	117.7	112.7	110.7	107.7	101.7	95.7	116.0
CAT 777 Truck	2	2	112.8	117.8	120.8	115.8	113.8	110.8	104.8	98.8	119.1
Hitachi AH500 ADT	2	2	109.8	114.8	117.8	112.8	110.8	107.8	101.8	95.8	116.1
Drill Rig	2	2	110.2	115.2	118.2	113.2	111.2	108.2	102.2	96.2	116.5
Wheeled Loader	1	1	108.8	113.8	116.8	111.8	109.8	106.8	100.8	94.8	115.1
Track Dozer	1	1	107.7	112.7	115.7	110.7	108.7	105.7	99.7	93.7	114.0
Wheeled Dozer	1	1	108.8	113.8	116.8	111.8	109.8	106.8	100.8	94.8	115.1
Truck	4	4	109.6	114.6	117.6	112.6	110.6	107.6	101.6	95.6	115.9
Motor Grader	1	1	105.2	110.2	113.2	108.2	106.2	103.2	97.2	91.2	111.5
Wheeled Loader	1	1	110.4	115.4	118.4	113.4	111.4	108.4	102.4	96.4	116.7
Rock Breaker	1	1	109.1	114.1	117.1	112.1	110.1	107.1	101.1	95.1	115.4
Lighting Plant	3	3	91.8	96.8	99.8	94.8	92.8	89.8	83.8	77.8	98.1
Bakkie	5	5	104.0	109.0	112.0	107.0	105.0	102.0	96.0	90.0	110.3
85 Seater Bus	1	1	107.5	112.5	115.5	110.5	108.5	105.5	99.5	93.5	113.8
Ore and Waste Handling	3	3	80.0	90.0	98.8	97.6	100.7	101.4	95.4	0.0	105.8
Primary Crushing	1	1	121.1	122.3	120.1	120.0	117.3	112.5	106.3	0.0	121.7

Table 6: Operational phase traffic for Doornpan and Driehoekspan

Transport Activity	Equipment type	Vehicle trips per hour	Vehicle speed (km/h)	Hours per day
Doornpan				
RoM transport	Hitachi AH500 ADT	3.7	30	24
Waste rock transport	CAT 777 Truck	9.9	30	24
Personnel bus transport	unknown	2	60	4
Product transport via R325	unknown	3.7	80	24
Driehoekspan				
RoM transport	Hitachi AH500 ADT	8.4	30	24
Waste rock transport	CAT 777 Truck	18.9	30	24
Personnel bus transport	unknown	2	60	4
Product transport via R325	unknown	8.4	80	24

4.2 Noise Propagation and Simulated Noise Levels

The propagation of noise generated during the operational phase was calculated with CandaA in accordance with ISO 9613. Meteorological and site specific acoustic parameters as discussed in Section 3.2.1 along with source data discussed in 4.1, were applied in the model.

Results are presented in tabular form (Table 7) and isopleth form (Figure 7 to Figure 12). 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 (06:00 to 22:00), operational phase related noise is not expected to exceed the day-time guideline of 55 dBA at NSRs. Although low, the highest day-time impact is expected at Palingpan (NSR04) with an increase above the baseline of 2 dBA.

As a result of atmospheric conditions less conducive to noise attenuation and stricter guidelines, night-time noise impacts (22:00 to 06:00) are more notable. The night-time guideline of 45 dBA is expected to be exceeded only at Palingpan. Driehoekspan operations are expected to result in a $L_{Req,n}$ of 49.4 dBA and an increase of 6.3 dBA above the baseline at Palingpan. This is in exceedance of the IFC 3 dBA guideline and, according to SANS 10103 (2008), 'little' reaction with 'sporadic complaints' can be expected.

Over 24-hours, the guideline of 55 dBA will also only be exceeded at Palingpan. An increase on 6.3 dBA above the baseline, which is more than the 3 dBA limit recommended by the IFC, is expected. According to SANS 10103 (2008), 'little' reaction with 'sporadic complaints' from residents of- or visitors to Palingpan are likely.

Table 7: Noise propagation simulation results at NSRs

NSR	$L_{Req,d}$ (dBA)	$\Delta L_{Req,d}$ (dBA)	$L_{Req,n}$ (dBA)	$\Delta L_{Req,n}$ (dBA)	$L_{R,dn}$ (dBA)	$\Delta L_{R,dn}$ (dBA)
NSR01	Not affected	0	Not affected	0	Not affected	0
NSR02	Not affected	0	Not affected	0	Not affected	0
NSR03	39.7	0.3	40.2	1.4	46.2	1.4
NSR04 (Palingpan)	49.3	2.0	49.4[(a)]	6.3[(a)]	55.4[(a)]	6.3[(a)]
NSR05 (Gossam)	24.0	0	24.1	0	30.1	0
NSR06	30.7	0	30.5	0.2	36.6	0.2
NSR07	Not affected	0	Not affected	0	Not affected	0
NSR08 (Manganore)	Not affected	0	Not affected	0	Not affected	0
NSR09	31.2	0	31.1	0.2	37.1	0.2
NSR10	Not affected	0	Not affected	0	Not affected	0

Notes:

(a) Exceeds selected noise criterion.

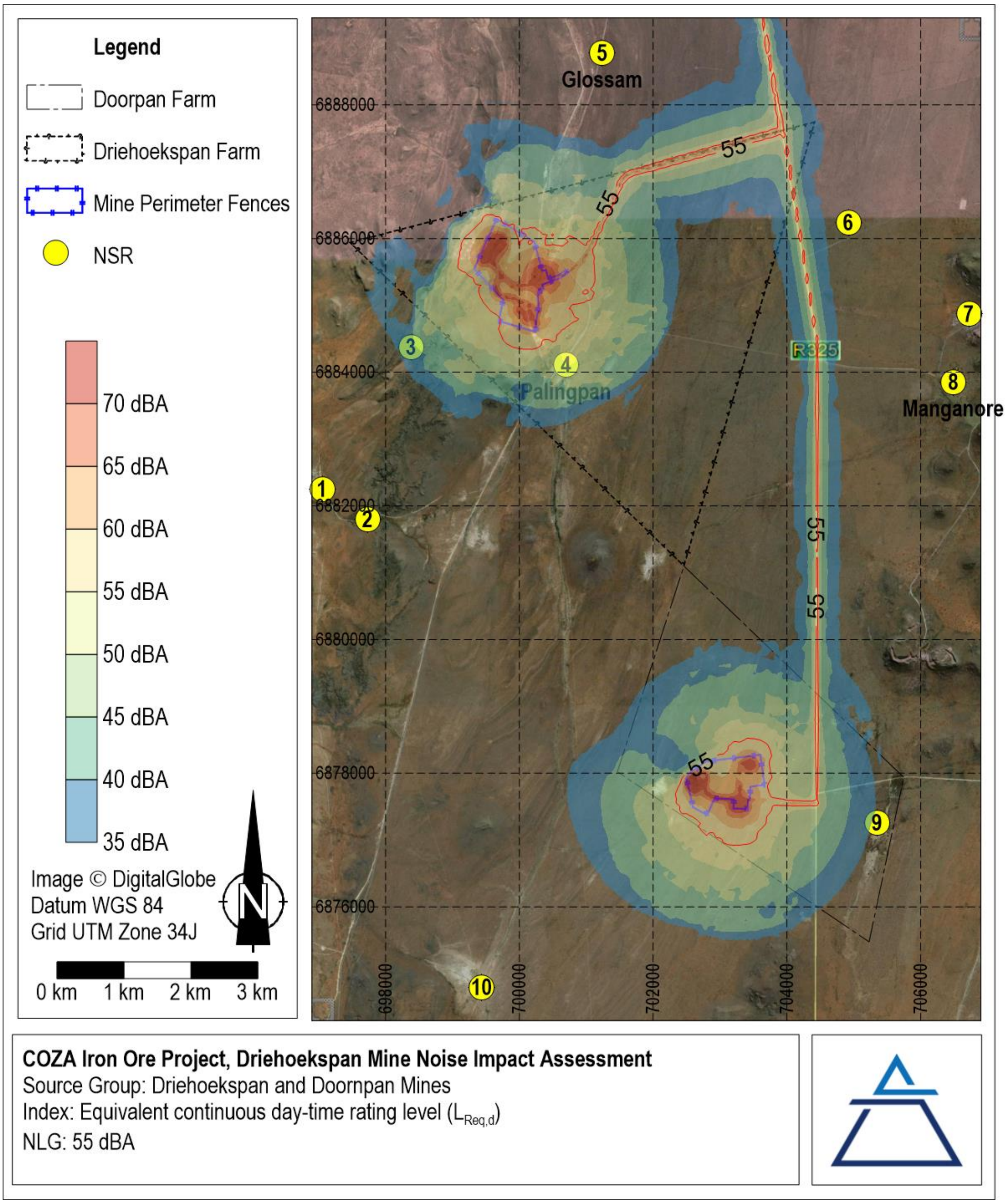


Figure 7: Simulated equivalent continuous day-time rating level ($L_{Req,d}$)

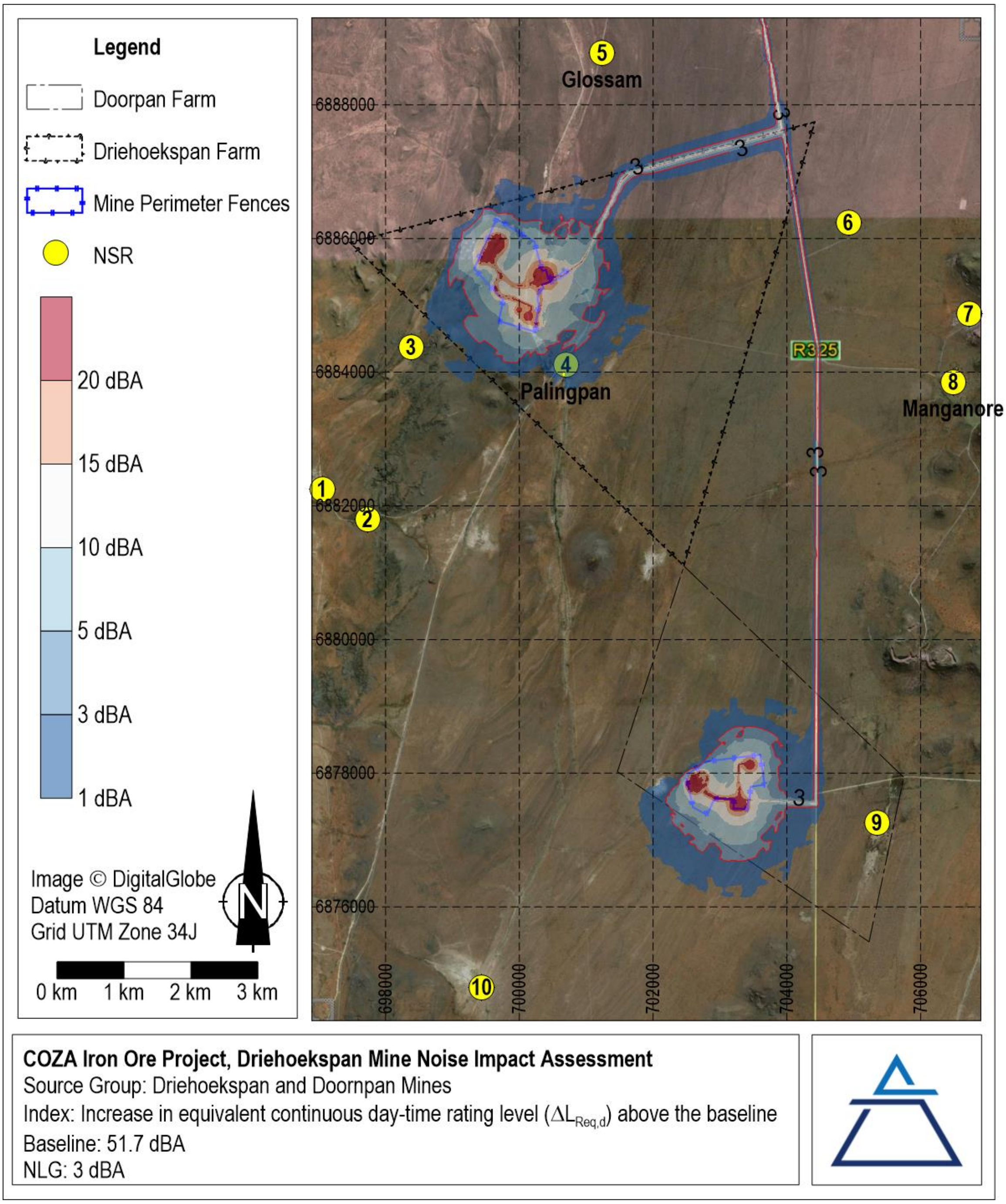


Figure 8: Simulated increase in equivalent continuous day-time rating level ($\Delta L_{Req,d}$) above the baseline

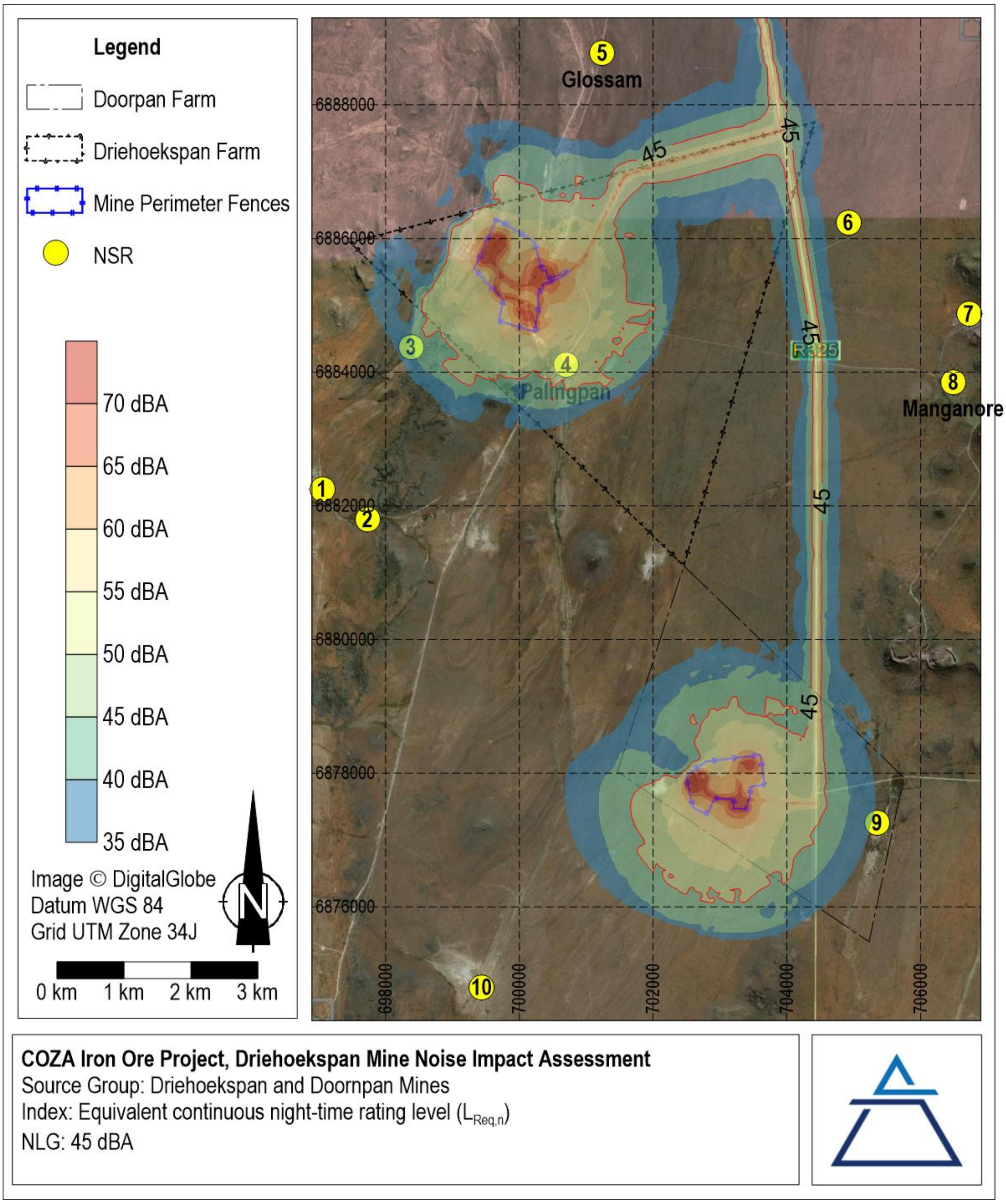


Figure 9: Simulated equivalent continuous night-time rating level ($L_{Req,n}$)

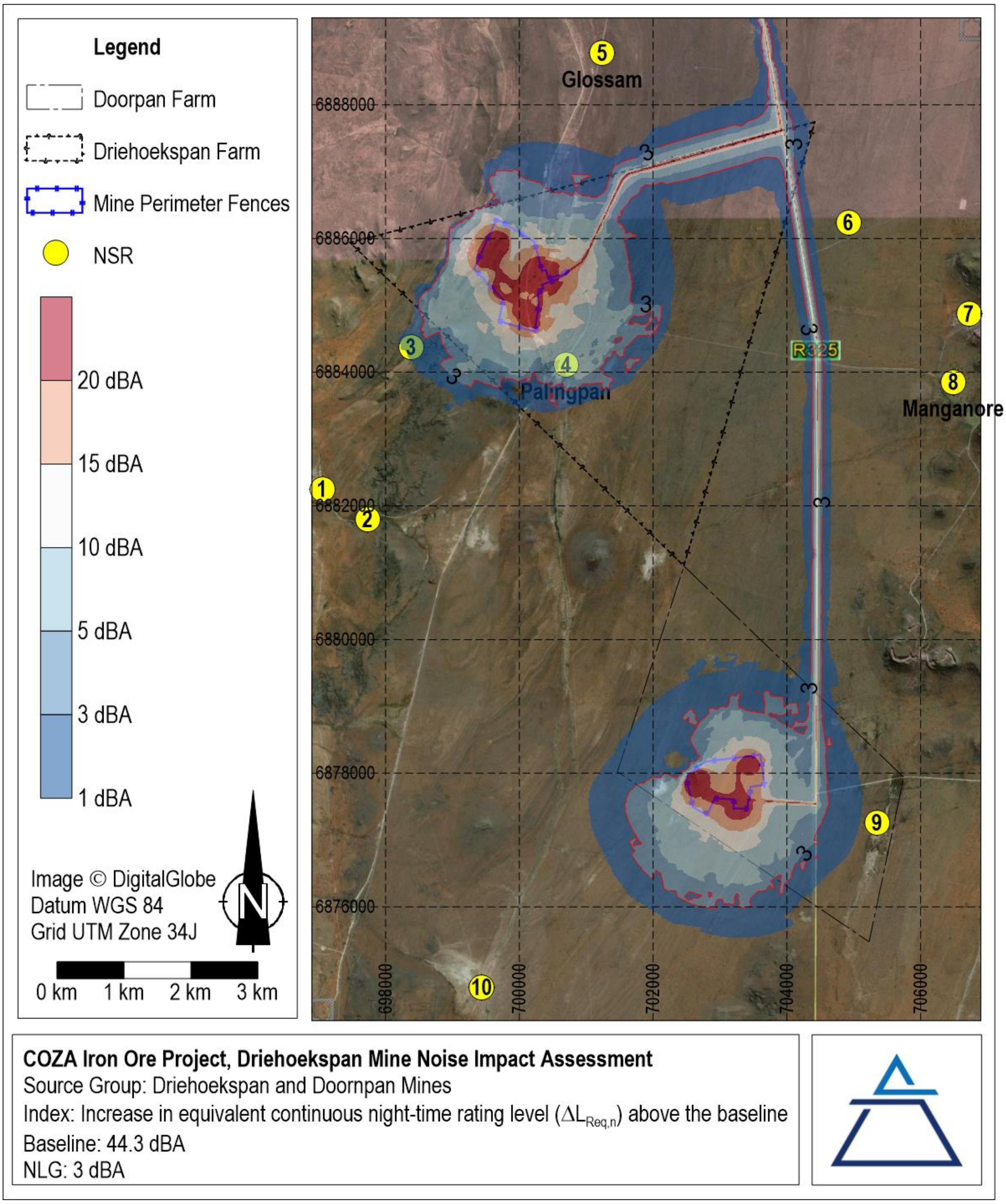


Figure 10: Simulated increase in equivalent continuous night-time rating level ($\Delta L_{Req,n}$) above the baseline

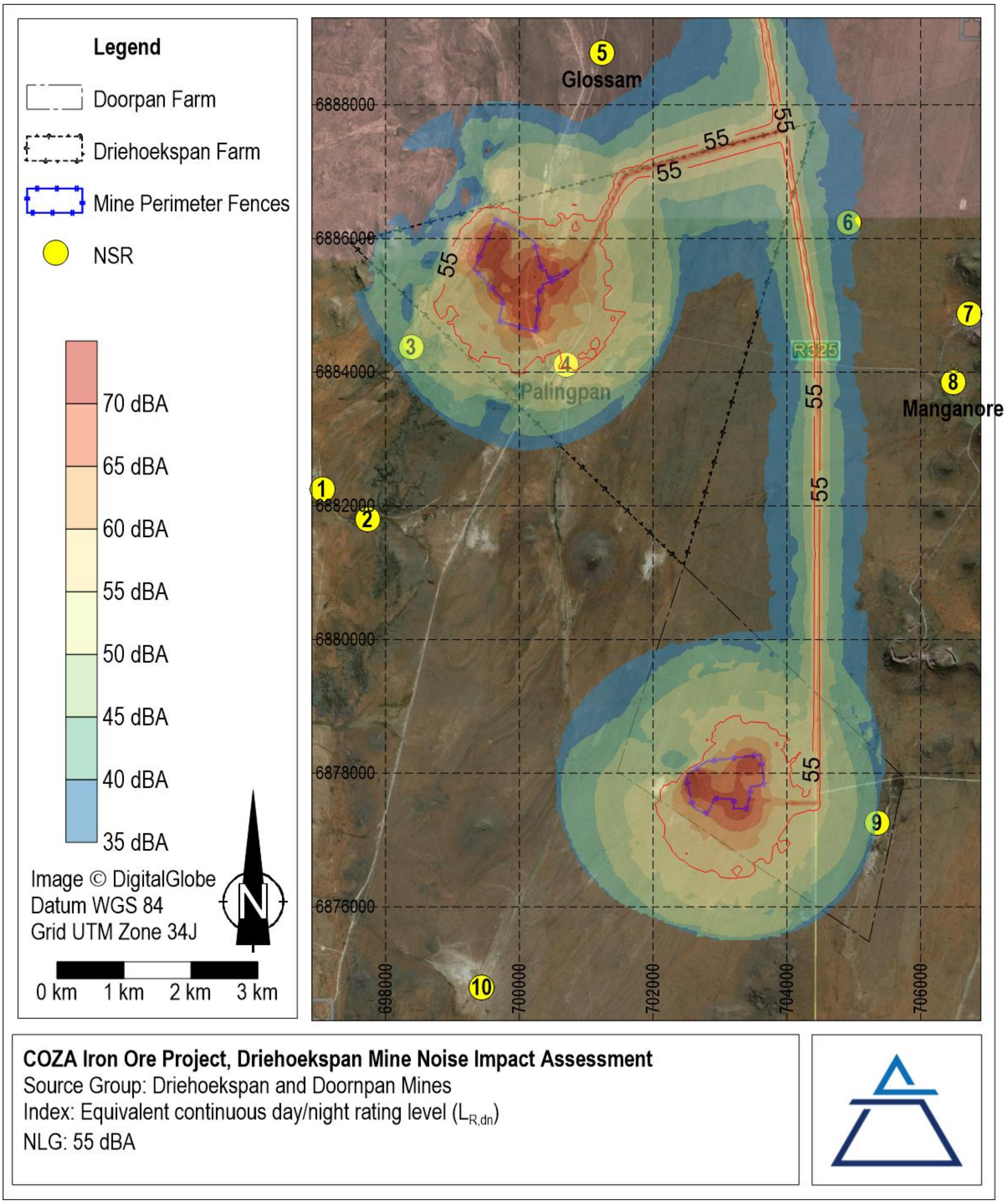


Figure 11: Simulated equivalent continuous day-night rating level ($L_{R,dn}$)

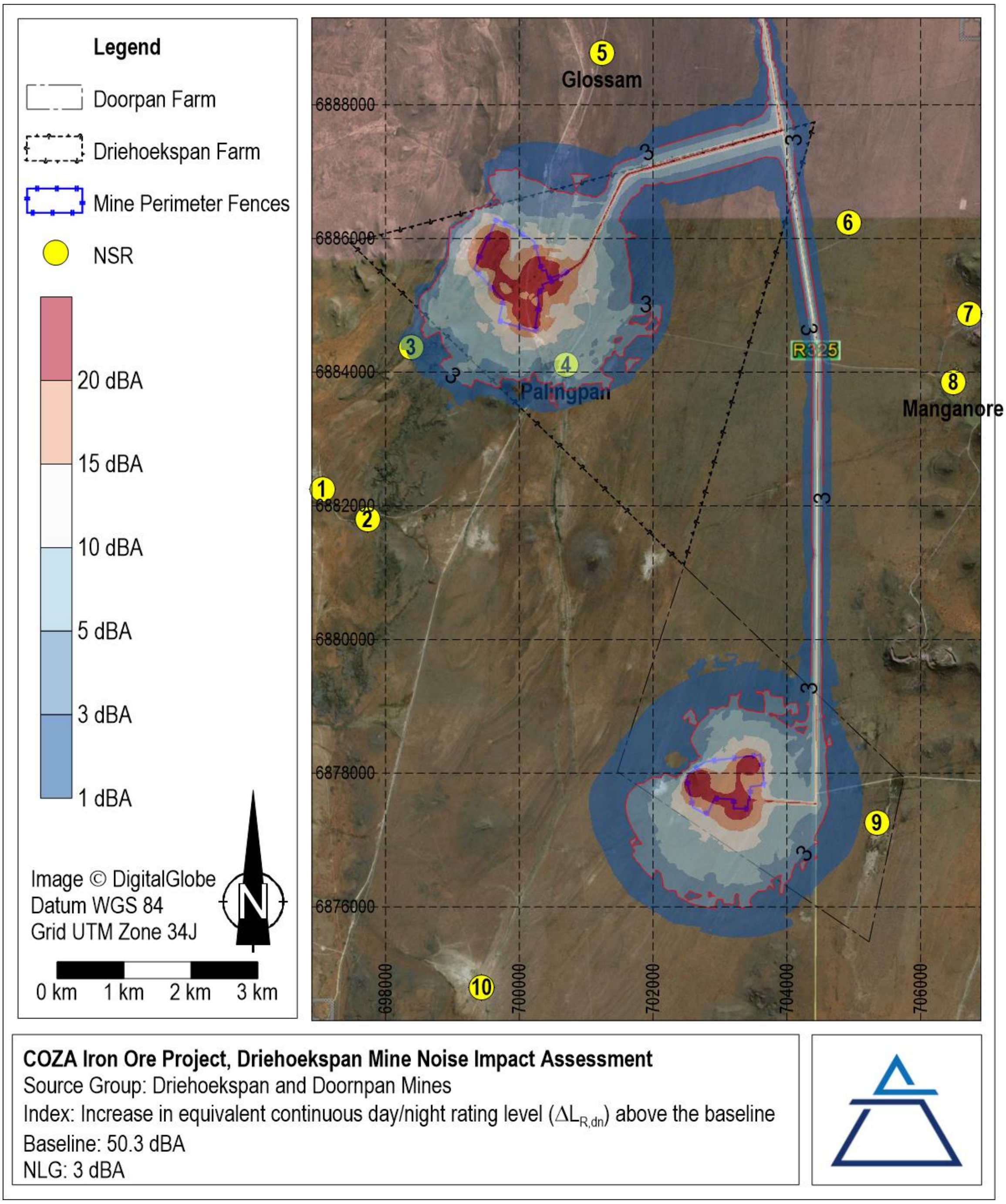


Figure 12: Simulated increase in equivalent continuous day-night rating level ($\Delta L_{R,dn}$) above the baseline

5 MANAGEMENT, MITIGATION AND RECOMMENDATIONS

In the quantification of noise emissions and simulation of noise levels as a result of the proposed COZA Iron Ore Project and specifically the Driehoekspan portion, it was calculated that ambient noise evaluation criteria for human receptors will only be exceeded in close proximity to activities and at the closest downwind NSR. Palingpan (NSR04) may be exposed to noise level in exceedance of night-time and 24-hour criteria.

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 to ensure minimal impacts on the surrounding environment.

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.
- Vibration isolators should be considered to reduce noise and vibration from crushers and screens.
- 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 noise related complaints are received short term (24-hour) ambient noise measurements should be conducted as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions.

The 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)
  - L_{AIeq} (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.

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7 ANNEX A – 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

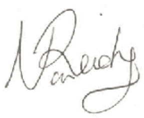
	Speak	Read	Write
English	Excellent	Excellent	Excellent
Afrikaans	Excellent	Excellent	Excellent

REFERENCES

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



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