Nozala Coal (Pty) Ltd

ENVIRONMENTAL NOISE IMPACT ASSESSMENT

for the

Proposed Gruisfontein Colliery near Lephalale, Limpopo

Study done for:

JACANA environmentals cc

Prepared by:

EAR Enviro Acoustic Research

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EXECUTIVE SUMMARY

INTRODUCTION AND PURPOSE

Enviro-Acoustic Research CC was contracted by Jacana Environmentals cc (the EAP) to conduct an Environmental Noise Impact Assessment (ENIA) to determine the potential noise impact on the surrounding environment due to the development of Gruisfontein Colliery west of Lephalale, Limpopo.

This report describes ambient sound levels in the area, potential worst case noise rating levels and the potential noise impact that the operation may have on the surrounding sound environment, highlighting the methods used, potential issues identified, findings and recommendations.

PROJECT DESCRIPTION

Nazala Coal (Pty) Ltd (the Applicant) proposes to mine coal on the farm Gruisfontein. The proposed Gruisfontein project includes the following mining and related infrastructure:

- An opencast pit;
- Processing plant (i.e. crushing, wash plant, screening, etc.);
- Product stockpiles;
- Administration office facilities (i.e. security building, administration and staff offices, reception area, ablution facilities, etc.);
- Production facilities (i.e. locker rooms, laboratory, workshops, stores, explosives magazine, ablution facilities, etc.);
- Access roads; and
- Clean and dirty water management infrastructure.

BASELINE ASSESSMENT

Ambient (background) sound levels were measured over a one night-time period from 21 to 22 January 2019, augmented with a number of short, 10-minute measurements. Measurements were sufficient to characterise the ambient sound level character and, together with measurements done in the area for other projects there is a very high confidence in the typical rating level determined for the area.

While there were a number of measurements where the ambient sound levels were high, this is mainly due to natural noises. Considering the ambient sound levels measured onsite, as well as the developmental character of the area, the acceptable zone rating

level would be typical of a **rural area** (35 dBA at night and 45 dBA during the day) as defined in SANS 10103:2008.

NOISE IMPACT DETERMINATION AND FINDINGS

The potential noise rating levels were calculated using a sound propagation model. Conceptual scenarios were developed for the construction and operational phase with the output of the modelling exercise indicating that there is low risk of a noise impact during all the phases of the project. Mitigation is not required, though generic measures are highlighted to ensure that noise levels are managed at all times.

NEED AND DESIRABILITY OF PROJECT

Due to economic advantages, mining does provide valuable employment, local taxes and foreign currency. It must be noted when mining projects are near to potential noise-sensitive receptors, consideration must be given to ensure a compatible co-existence. Potential sensitive receptors should not be adversely affected and yet, at the same time mining need to reach an optimal scale in terms of layout and production.

The proposed mining activities however will slightly raise the noise levels at a number of potential noise-sensitive developments. These noises can be disturbing and may impact on the quality of living for the receptors. Therefore, in terms of acoustics there is no benefit to the surrounding environment (closest receptors).

However, the project will greatly assist in the economic growth and development challenges South Africa is facing by means of assisting in providing employment and other business opportunities. Considering only noise[1], people in the area not directly affected by increased noise levels could have a positive perception of the project and could see the need and desirability of the project.

RECOMMENDATIONS (MANAGEMENT AND MITIGATION)

Generic measures are highlighted to ensure that noise levels are managed at all times. These measures include:

- Ensure a good working relationship between mine management and all potentially noise-sensitive receptors staying within 2,000 m from the mine.
- Ensure that equipment is well maintained and fitted with the correct and appropriate noise abatement measures. Engine bay covers over heavy equipment could be pre-fitted with sound absorbing material. Heavy equipment that fully

[1] Considering only noise as other environmental factors may affect other people.

encloses the engine bay should be considered, ensuring that the seam gap between the hood and vehicle body is minimised;

- The operation should investigate the use of white-noise alarms instead of tonal reverse alarms on heavy vehicles operating on roads, within the mining area and at stockpile areas;
- The mine must implement a line of communication (i.e. a helpline where complaints could be lodged). All potential sensitive receptors should be made aware of these contact numbers, or alternative means to communicate issues. The mine should maintain a commitment to the local community and respond to concerns in an expedient fashion. Sporadic and legitimate noise complaints could develop and if valid, should be investigated; and,
- All employees and contractors should receive induction that includes an environmental awareness component (noise). This is to allow employees and contractors to realize the potential noise risks that activities (especially night-time activities) pose to the surrounding environment.

It is concluded that the increases in noise levels does not constitute a fatal flaw. It is therefore the recommendation that the project should be authorized (from a noise impact perspective).

CONTENTS OF THE SPECIALIST REPORT – CHECKLIST

Contents of this report in terms of Regulation GNR 982 of 2014, Appendix 6 (as amended 2017)		**Relevant Section in Specialist study**
(1)	A specialist report prepared in terms of these Regulations must contain-	
	details of-	
	(i) the specialist who prepared the report; and	Section 1
	(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae	Section 1
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Section 2 *(also separate document to this report)*
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section 3.1
(cA)	an indication of the quality and age of base data used for the specialist report;	Section 5.1
(cB)	a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 5.1 and 9.1
(d)	the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 5.1
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 3.6
(f)	details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Sections 5.1, 6.1, 6.1.3, 9.2 and 9.3
(g)	an identification of any areas to be avoided, including buffers;	No buffers required. Noise rating levels calculated and illustrated.
(h)	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;	Sections 9.2 and 9.3
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 8
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Sections 9 and 10
(k)	any mitigation measures for inclusion in the EMPr;	Sections 11.3
(l)	any conditions for inclusion in the environmental authorisation;	Sections 11.3
(m)	any monitoring requirements for inclusion in the EMPr or	Section 13.1

Contents of this report in terms of Regulation GNR 982 of 2014, Appendix 6 (as amended 2017)		**Relevant Section in Specialist study**
	environmental authorisation;	
	a reasoned opinion -	Section 14
	whether the proposed activity, activities or portions thereof should be authorised;	Section 14
	regarding the acceptability of the proposed activity or activities; and	Section 14
	if the opinion is that the proposed activity, activities 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;	Sections 11.3
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	See Section 3.5
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	See Section 3.5
(q)	any other information requested by the competent authority.	None

This report should be sited as:

De Jager, M. (2019): "*Environmental Noise Impact Assessment for the Proposed Gruisfontein Colliery near Lephalale, Limpopo*". Enviro-Acoustic Research CC, Pretoria

Client:

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on behalf of
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Report no:

JA-GC/ENIA/201902-Rev 0

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Date:

February 2019

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GLOSSARY OF ABBREVIATIONS

ADT	Articulated Dump Trucks
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
EARES	Enviro Acoustic Research cc
ECA	Environment Conservation Act
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
ENIA	Environmental Noise Impact Assessment
ENM	Environmental Noise Monitoring
ENPAT	Environmental Potential Atlas for South Africa
EPs	Equator Principles
EPFIs	Equator Principles Financial Institutions
FEL	Front-end Loader
GN	Government Notice

IEC	International Electrotechnical Commission
IFC	International Finance Corporation
ISO	International Organization for Standardization
METI	Ministry of Economy, Trade, and Industry
NASA	National Aeronautical and Space Administration
NCR	Noise Control Regulations
NSD	Noise-sensitive Development
PWL	Sound Power Level
SABS	South African Bureau of Standards
SANS	South African National Standards
SPL	Sound Power Level
TPA	Tonnes per annum
UTM	Universal Transverse Mercator
WHO	World Health Organization

GLOSSARY OF UNITS

dB	Decibel (expression of the relative loudness of the un-weighted sound level in air)
dBA	Decibel (expression of the relative loudness of the A-weighted sound level in air)
Hz	Hertz (measurement of frequency)
kg/m^2	Surface density (measurement of surface density)
km	kilometre (measurement of distance)
m	Meter (measurement of distance)
m^2	Square meter (measurement of area)
m^3	Cubic meter (measurement of volume)
mamsl	Meters above mean sea level
m/s	Meter per second (measurement for velocity)
^oC	Degrees Celsius (measurement of temperature)
µPa	Micro pascal (measurement of pressure – in air in this document)

1 THE AUTHOR

The Author started his career in the mining industry as a bursar Learner Official (JCI, Randfontein), working in the mining industry, doing various mining related courses (Rock Mechanics, Surveying, Sampling, Safety and Health [Ventilation, noise, illumination etc] and Metallurgy. He did work in both underground (Coal, Gold and Platinum) as well as opencast (Coal) for 4 years. He changed course from Mining Engineering to Chemical Engineering after his second year of his studies at the University of Pretoria.

After graduation he worked as a Water Pollution Control Officer at the Department of Water Affairs and Forestry for two years (first year seconded from Wates, Meiring and Barnard), where duties included the perusal (evaluation, commenting and recommendation) of various regulatory required documents (such as EMPR's, Water Licence Applications and EIA's), auditing of licence conditions as well as the compilation of Technical Documents.

Since leaving the Department of Water Affairs, Morné has been in private consulting for the last 15 years, managing various projects for the mining and industrial sector, private developers, business, other environmental consulting firms as well as the Department of Water Affairs. During that period he has been involved in various projects, either as specialist, consultant, trainer or project manager, successfully completing these projects within budget and timeframe. During that period he gradually moved towards environmental acoustics, focusing on this field exclusively since 2007.

He has been interested in acoustics as from school days, doing projects mainly related to loudspeaker design. Interest in the matter brought him into the field of Environmental Noise Measurement, Prediction and Control. He has been doing work in this field for the past 8 years, and was involved with the following projects in the last few years:

Wind Energy Facilities	*Zen (Savannah Environmental – SE), Goereesoe (SE), Springfontein (SE), Garob (SE), Project Blue (SE), ESKOM Kleinzee (SE), iNCa Gouda (Aurecon SA), Kangnas (Aurecon), Walker Bay (SE), Oyster Bay (SE), Hidden Valley (SE), Happy Valley (SE), Deep River (SE), Saldanha WEF (Terramanzi), Loeriesfontein (SiVEST), Noupoort (SiVEST), Prieska (SiVEST), Plateau East and West (Aurecon), Saldanha (Aurecon), Veldrift (Aurecon), Tsitsikamma (SE), AB (SE), West Coast One (SE), Namakwa Sands (SE), Dorper (SE), VentuSA Gouda (SE), AmakhalaEmoyeni (SE), Klipheuwel (SE), Cookhouse (SE), Cookhouse II (SE), Canyon Springs (Canyon Springs), Rheboksfontein (SE), Suurplaat (SE), Karoo Renewables (SE), Outeniqwa (Aurecon), Koningaas (SE), Eskom Aberdene (SE), Spitskop (SE), Rhenosterberg (SiVEST), Bannf (Vidigenix), Wolf WEF (Aurecon)*

Mining and Industry	*BECSA – Middelburg (Golder Associates), Kromkrans Colliery (Geovicon Environmental), SASOL Borrow Pits Project (JMA Consulting), Lesego Platinum (AGES), Tweefontein Colliery (Cleanstream), EvrazVametco Mine and Plant (JMA), Goedehoop Colliery (Geovicon), Hacra Project (Prescali Environmental), Der Brochen Platinum Project (J9 Environment), Delft Sand (AGES), Brandbach Sand (AGES), Verkeerdepan Extension (CleanStream), Dwaalboom Limestone (AGES), Jagdlust Chrome (MENCO), WPB Coal (MENCO), Landau Expansion (CleanStream), Stuart Coal – Weltevreden (CleanStream), Otjikoto Gold (AurexGold), Klipfontein Colliery (MENCO), Imbabala Coal (MENCO), ATCOM East Expansion (Jones and Wagner), IPP Waterberg Power Station (SE), Kangra Coal (ERM), Schoongesicht (CleanStream), EastPlats (CleanStream), Chapudi Coal (Jacana Environmental), Generaal Coal (JE), Mopane Coal (JE), Boshoek Chrome (JMA), Langpan Chrome (PE), Vlakpoort Chrome (PE), Sekoko Coal (SE), Frankford Power (REMIG), Strahrae Coal (Ferret Mining), Transalloys Power Station (Savannah), Pan Palladum Smelter, Iron and PGM Complex (Prescali)*
Road and Railway	*K220 Road Extension (Urbansmart), Boskop Road (MTO), Sekoko Mining (AGES), Davel-Swaziland-Richards Bay Rail Link (Aurecon), Moloto Transport Corridor Status Quo Report and Pre-Feasibility (SiVEST), Postmasburg Housing Development (SE), Tshwane Rapid Transport Project, Phase 1 and 2 (NRM Consulting/City of Tshwane)*
Airport	*Oudtshoorn Noise Monitoring (AGES), Sandton Heliport (Alpine Aviation), Tete Airport Scoping*
Noise monitoring	*Peerboom Colliery (EcoPartners), Thabametsi (Digby Wells), DoxaDeo (DoxaDeo), Harties Dredging (Rand Water), Xstrata Coal – Witbank Regional, SephakuDelmas (AGES), AmakhalaEmoyeni WEF (Windlab Developments), Oyster Bay WEF (Renewable Energy Systems), Tsitsikamma WEF (Cennergi and SE), Hopefield WEF (Umoya), Wesley WEF (Innowind), Ncora WEF (Innowind), Boschmanspoort (Jones and Wagner), Nqamakwe WEF (Innowind), Dassiesfontein WEF Noise Analysis (BioTherm), Transnet Noise Analysis (Aurecon)*
Small Noise Impact Assessments	*TCTA AMD Project Baseline (AECOM), NATREF (Nemai Consulting), Christian Life Church (UrbanSmart), Kosmosdale (UrbanSmart), Louwlardia K220 (UrbanSmart), Richards Bay Port Expansion (AECOM), Babalegi Steel Recycling (AGES), Safika Slag Milling Plant (AGES), Arcelor Mittal WEF (Aurecon), RVM Hydroplant (Aurecon), Grootvlei PS Oil Storage (SiVEST), Rhenosterberg WEF, (SiVEST), Concerto Estate (BPTrust), Ekuseni Youth Centre (MENCO), Kranskop Industrial Park (Cape South Developments), Pretoria Central Mosque (NomanShaikh), Soshanguve Development (Maluleke Investments), Seshego-D Waste Disposal (Enviroxcellence), Zambesi Safari Equipment (Owner), Noise Annoyance Assessment due to the Operation of the Gautrain (Thornhill and Lakeside Residential Estate), Upington Solar (SE), Ilangalethu Solar (SE), Pofadder Solar (SE), Flagging Trees WEF (SE), Uyekraal WEF (SE), Ruuki Power Station (SE), Richards Bay Port Expansion (AECOM), Babalegi Steel Recycling (AGES), SafikaLadium (AGES), Safika Cement Isando (AGES), Natref (NEMAI), RareCo (SE), Struisbaai WEF (SE)*
Project reviews and amendment reports	*Loperberg (Savannah), Dorper (Savannah), Penhoek Pass (Savannah), Oyster Bay (RES), Tsitsikamma (Cennergi), AmakhalaEmoyeni (Windlab), Spreeukloof (Savannah), Spinning Head (Savannah), Kangra Coal (ERM), West Coast One (Moyeng Energy), Rheboksfontein (Moyeng Energy)*

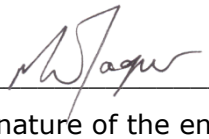
2 DECLARATION OF INDEPENDENCE

I, Morné de Jager declare that:

- I act as the independent environmental practitioner in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting environmental noise impact assessments, including knowledge of the National Environmental Management Act (107 of 1998), the Environmental Impact Assessment Regulations of 2014, and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in regulation 8 of the regulations when preparing the specialist study;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will ensure that the comments of all interested and affected parties are considered and recorded in reports that are submitted to the competent authority in respect of the application, provided that comments that are made by interested and affected parties in respect of a final report that will be submitted to the competent authority may be attached to the report without further amendment to the report;
- will perform all other obligations as expected from an environmental assessment practitioner in terms of the Regulations; and
- I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014.



Signature of the environmental practitioner:

Enviro-Acoustic Research cc

Name of company:

2019 – 08 - 30

Date:

3 INTRODUCTION

3.1 INTRODUCTION AND PURPOSE

Enviro-Acoustic Research (EARES) was contracted by Jacana Environmentals cc (the EAP) to determine the potential noise impact on the surrounding environment due to the proposed development of a coal mine by Gruisfontein (Pty) Ltd. This operation will be located approximately 50 km west of Lephalale in the Limpopo Province (see **Figure 3-1**).

This report describes ambient sound levels in the area, potential worst case noise rating levels and the potential noise impact that the operation may have on the surrounding sound environment, highlighting the methods used, potential issues identified, findings and recommendations. This report did not investigate vibrations and only briefly considers blasting.

This study considered local regulations and both local and international guidelines, using the terms of reference as proposed by SANS 10328:2008 to allow for a comprehensive Environmental Noise Impact Assessment.

3.2 BRIEF PROJECT DESCRIPTION

Nazala Coal (Pty) Ltd (the Applicant) proposes to mine coal on the farm Gruisfontein. The proposed project includes the following mining and related infrastructure:

- Opencast pits;
- Processing plant (i.e. crushing, wash plant, screening, etc.);
- Product stockpiles;
- Administration office facilities (i.e. security building, administration and staff offices, reception area, ablution facilities, etc.);
- Production facilities (i.e. locker rooms, laboratory, workshops, stores, explosives magazine, ablution facilities, etc.);
- Access roads; and
- Clean and dirty water management infrastructure.

3.2.1 Mining Method

The mining method would be an open pit, truck and shovel operation. During the first three years, discard, soft overburden, hard overburden and carbonaceous material will be stockpiled at a separate location. During this period long-term discard/carbonaceous dumps will be constructed using hard and soft overburden. A short-term discard dump will be constructed to the West of the plant. From year four the waste material (from the

open-pit, including the plant discard) will be stockpiled on the long-term dump. Topsoil will be stockpiled separately.

Once sufficient room has been established in the open-pit, in-pit stockpiling of carbonaceous material and discard will take place (estimated after year 16).

3.2.2 Plant process

The Run of Mine (RoM) coal will be hauled to the RoM tip (crushed by a primary and secondary sizer) where the material will be crushed and conveyed to the RoM stockpile from where the Coal Processing Plant (CPP) will be fed.

The CPP consists of dry screening (vibrating screens), crushers, de-sliming (cyclones, screens), dense medium separation (cyclones, baths, cones, drums and screens), classifying (cyclones), thickening and dewatering (filter press).

3.3 STUDY AREA

The proposed project is located approximately 50 km west of Lephalale, lying west of the existing Grootegeluk Coal Colliery and about 25 km from the Matimba (existing) and the Medupi (under construction) Power Stations. The study area is further described in terms of environmental components that may contribute or change the sound character in the area.

3.3.1 Topography

The area is relatively flat plains. There are little natural features that could act as noise barriers considering practical distances at which sound propagates.

3.3.2 Surrounding Land Use

The area in the vicinity of the proposed development is currently classified as Vacant or Unspecified. Previous site visits revealed that the area is mainly wilderness with game ranches forming a large part of the agricultural activities (cattle farming).

3.3.3 Roads

There are a number of gravel district roads that traverses the area. There are no other roads or railway lines within 2,000 m from the proposed development. Based on observations made during this and previous site visits, the gravel roads do not carry any traffic of acoustic significance.

3.3.4 Residential areas

Excluding farm dwellings, there are no residential areas within 5,000 m.

3.3.5 Other industrial and commercial processes

The Grootegeluk Coal Colliery is approximately 20 km east south-east from the proposed development. It is too far to influence the ambient sound levels in the vicinity of the proposed development. There are also a number of collieries planned directly adjacent to the proposed mine.

3.3.6 Ground conditions and vegetation

The area falls within the Savannah biome, with the vegetation type being bushveld. The ground is covered with grasses, shrubs and trees and would be considered as 50% acoustically absorbent. This influences the propagation of the sound from the mine, as the fraction of sound that is reflected from the ground would be influenced as certain frequencies would be partly absorbed by the ground surface.

3.3.7 Existing Ambient Sound Levels

Onsite measurements were collected 21 – 23 January 2019. The soundscape is discussed in more detail in **Section 5**.

3.4 POTENTIAL NOISE-SENSITIVE RECEPTORS (DEVELOPMENTS) AND NO-GO AREAS

Potentially sensitive receptors, also known as noise-sensitive developments (NSDs), located within or close to the proposed mining area was identified using Google Earth® by the Environmental Assessment Practitioner (EAP).

Normally noise is limited to within 2,000m from the project activities, with most of the potential NSDs located further than 2,000m from the operational activities. There is one residential structure (NSD01, see Location 1, **Figure 3-2**) located on the Gruisfontein property, though it is expected that this structure will be relocated once the project starts and this NSD will not be considered further in this assessment.

The closest potential NSDs within approximately 5km from the closest proposed infrastructure are illustrated in **Figure 3-2**.

3.5 COMMENTS REGARDING NOISE RECEIVED DURING THIS PROJECT

The issue of noise was raised by most of the surrounding land owners during the pre-application consultation. Land-owners and residents are concerned about the potential impact of noise which will be investigated in this report.

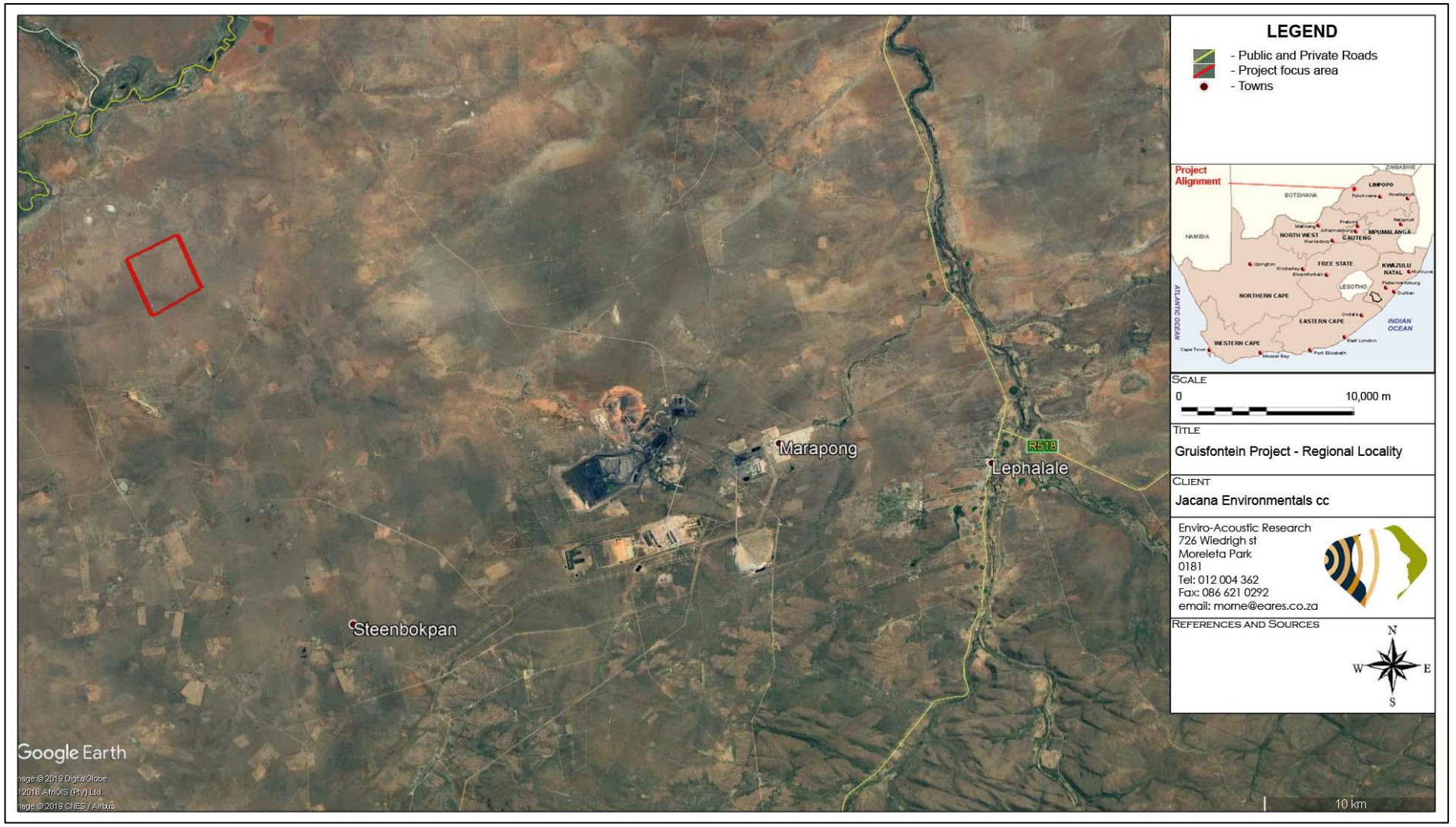


Figure 3-1: Locality map indicating the location of the proposed Gruisfontein Project

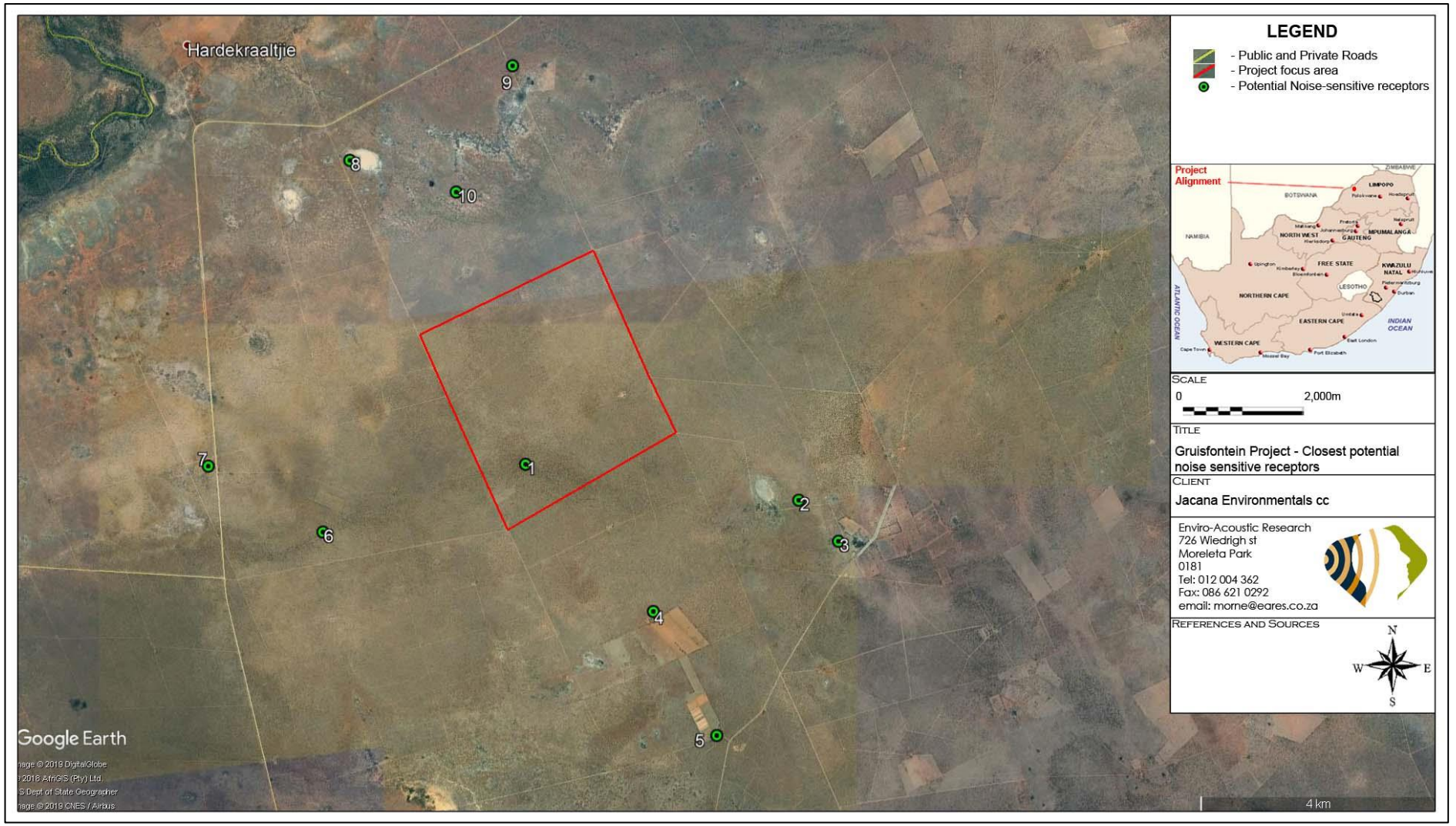


Figure 3-2: Aerial image indicating potentially noise-sensitive receptors close to mining area

3.6 AVAILABLE INFORMATION

The author has completed a number of projects in the direct vicinity of the project site (within 20 km), with the results of ambient sound levels, the project descriptions and findings covered in the following reports:

- De Jager, M. 2011: "*Noise impact study for Environmental Impact Assessment: Establishment of the Sekoko Coal Loading Siding on various farms near Lephalale, Limpopo*". M2 Environmental Connections cc, Pretoria.
- De Jager, M. 2012: "*Acoustical Baseline study on various farms near the town of Lephalale, Limpopo Province*". M2 Environmental Connections cc, Pretoria.
- De Jager, M. 2012: "*Noise Study for Environmental Impact Assessment: Establishment of the Thabametsi 1.200 MW Coal-fired Power Station near Lephalale, Limpopo*". Enviro Acoustic Research cc, Pretoria.

3.7 TERMS OF REFERENCE

A noise impact assessment must be completed for the following reasons:

- If there are potential noise-sensitive receptors staying within 1,000 m from industrial activities (SANS 10328:2008).
- It is a controlled activity in terms of the NEMA regulations and an ENIA is required, because:
    - It may cause a disturbing noise that is prohibited in terms of section 18(1) of the Government Notice 579 of 2010.
- It is generally required by the local or district authority as part of the environmental authorization or planning approval in terms of Regulation 2(d) of GN R154 of 1992.
- If noise is raised as a potential concern by interested and affected parties during the Environmental Impact Assessment (EIA) process.

In addition, Appendix 6 of GN 982 of December 2014 (Gov. Gaz. 38282), issued in terms of the National Environmental Management Act, No. 107 of 1998, also defines minimum information requirements for specialist reports.

In South Africa the document that addresses the issues specifically concerning environmental noise is SANS 10103:2008. It has recently been thoroughly revised and brought in line with the guidelines of the World Health Organisation (WHO). It provides the maximum average ambient noise levels during the day and night to which different types of developments indoors may be exposed.

This standard specifies the methodology to assess the potential noise impacts on the environment due to a proposed activity that might impact on the environment. This standard also stipulates the minimum requirements to be investigated for Scoping purposes. These minimum requirements are:

1. The purpose of the investigation;
2. A brief description of the planned development or the changes that are being considered;
3. A brief description of the existing environment;
4. The identification of the noise sources that may affect the particular development, together with their respective estimated sound pressure levels or sound power levels (or both);
5. The identified noise sources that were not taken into account and the reasons why they were not investigated;
6. The identified noise-sensitive developments and the estimated impact on them;
7. Any assumptions made with regard to the estimated values used;
8. An explanation, either by a brief description or by reference, of the methods that were used to estimate the existing and predicted rating levels;
9. The location of the measurement or calculation points, i.e. a description, sketch or map;
10. Estimation of the environmental noise impact;
11. Alternatives that were considered and the results of those that were investigated;
12. A list of all the interested or affected parties that offered any comments with respect to the environmental noise impact investigation;
13. A detailed summary of all the comments received from interested or affected parties as well as the procedures and discussions followed to deal with them;
14. Conclusions that were reached;
15. Recommendations, i.e. if there could be a significant impact, or if more information is needed, a recommendation that an environmental noise impact assessment be conducted; and
16. If remedial measures will provide an acceptable solution, which would prevent a significant impact, these remedial measures should be outlined in detail and included in the final record of decision if the approval is obtained from the relevant authority. If the remedial measures deteriorate after a certain time and a follow-up auditing or maintenance programme (or both) is instituted, this programme should be included in the final recommendations and accepted in the record of decision if the approval is obtained from the relevant authority.

4 LEGAL CONTEXT, POLICIES AND GUIDELINES

4.1 THE REPUBLIC OF SOUTH AFRICA CONSTITUTION ACT ("THE CONSTITUTION")

The environmental rights contained in section 24 of the Constitution provide that everyone is entitled to an environment that is not harmful to his or her well-being. In the context of noise, this requires a determination of what level of noise is harmful to well-being. The general approach of the common law is to define an acceptable level of noise as that which the reasonable person can be expected to tolerate under the particular circumstances. The subjectivity of this approach can be problematic, which has led to the development of noise standards (see **Section 4.3**).

"Noise pollution" is specifically included in Part B of Schedule 5 of the Constitution, which means that noise pollution control is a local authority competence, provided that the local authority concerned has the capacity to carry out this function.

4.2 THE ENVIRONMENT CONSERVATION ACT (ACT 73 OF 1989)

The Environment Conservation Act ("ECA") allows the Minister of Environmental Affairs and Tourism ("now the Ministry of Environmental Affairs") to make regulations regarding noise, among other concerns. See also **section 4.2.1**.

4.2.1 Noise Control Regulations (GN R154 of 1992)

In terms of section 25 of the ECA, the national Noise Control Regulations (NCRs) (GN R154 in *Government Gazette* No. 13717 dated 10 January 1992) were promulgated. The NCRs were revised under Government Notice Number R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations.

Subsequently, in terms of Schedule 5 of the Constitution of South Africa of 1996 legislative responsibility for administering the noise control regulations was devolved to provincial and local authorities. Provincial Noise Control Regulations exist in the Free State, Gauteng and Western Cape provinces but not in Limpopo and the National Regulations will be in effect.

The National Noise Control Regulations (GN R154 1992) defines:

"**disturbing noise**" as:
noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dBA or more.

"**zone sound level**" as:
a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. *This is the same as the Rating Level as defined in SANS 10103.*

In addition:
In terms of Regulation 2 -
"A local authority may –
(c): if a noise emanating from a building, premises, vehicle, recreational vehicle or street is a disturbing noise or noise nuisance, or may in the opinion of the local authority concerned be a disturbing noise or noise nuisance, instruct in writing the person causing such noise or who is responsible therefor, or the owner or occupant of such building or premises from which or from where such noise emanates or may emanate, or all such persons, to discontinue or cause to be discontinued such noise, or to take steps to lower the lever of the noise to a level conforming to the requirements of these Regulations within the period stipulated in the instruction: Provided that the provisions of this paragraph shall not apply in respect of a disturbing noise or noise nuisance caused by rail vehicles or aircraft which are not used as recreational vehicles;
(d): before changes are made to existing facilities or existing uses of land or buildings, or before new buildings are erected, in writing require that noise impact assessments or tests are conducted to the satisfaction of that local authority by the owner, developer, tenant or occupant of the facilities, land or buildings or that, for the purposes of regulation 3(b); or (c), reports or certificates in relation to the noise impact to the satisfaction of that local authority are submitted by the owner, developer, tenant or occupant to the local authority on written demand".

In terms of Regulation 4 of the Noise Control Regulations:
"No person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, machine, device or apparatus or any combination thereof".

4.3 NOISE STANDARDS

There are a few South African scientific standards (SABS) relevant to noise from mines, industry and roads. They are:

- SANS 10103:2008. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication';
- SANS 10328:2008. 'Methods for environmental noise impact assessments'.

The relevant standards use the equivalent continuous rating level as a basis for determining what is acceptable. The levels may take single event noise into account, but single event noise by itself does not determine whether noise levels are acceptable for land use purposes. With regards to SANS 10103:2008, the recommendations are likely to inform decisions by authorities, but non-compliance with the standard will not necessarily render an activity unlawful *per se.*

4.4 INTERNATIONAL GUIDELINES

While a number of international guidelines and standards exist, those selected below are used by numerous countries for environmental noise management.

4.4.1 Guidelines for Community Noise (WHO, 1999)

The World Health Organization's (WHO) document on the *Guidelines for Community Noise* is the outcome of the WHO- expert task force meeting held in London, United Kingdom, in April 1999. It is based on the document entitled "Community Noise" that was prepared for the World Health Organization and published in 1995 by the Stockholm University and Karolinska Institute.

The scope of WHO's effort to derive guidelines for community noise is to consolidate actual scientific knowledge on the health impacts of community noise and to provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments.

Guidance on the health effects of noise exposure of the population has already been given in an early publication of the series of Environmental Health Criteria. The health risk to humans from exposure to environmental noise was evaluated and guidelines values derived. The issue of noise control and health protection was briefly addressed.

The document uses the L_{Aeq} and $L_{A,max}$ noise descriptors to define noise levels. It should be noted that a follow-up document focusing on Night-time Noise Guidelines for Europe (WHO, 2009).

4.4.2 Night Noise Guidelines for Europe (WHO, 2009)

Refining previous Community Noise Guidelines issued in 1999, and incorporating more recent research, the World Health Organization has released a comprehensive report on the health effects of night time noise, along with new (non-mandatory) guidelines for use in Europe. Rather than a maximum of 30dB inside at night (which equals 45-50dB max

outside), the WHO now recommends a maximum year-round outside night-time noise average of 40dB to avoid sleep disturbance and its related health effects. The report notes that only below 30dB (outside annual average) are "*no significant biological effects observed*," and that between 30 and 40dB, several effects are observed, with the chronically ill and children being more susceptible; however, "*even in the worst cases the effects seem modest*." Elsewhere, the report states more definitively, "*There is no sufficient evidence that the biological effects observed at the level below 40 dB (night, outside) are harmful to health*." At levels over 40dB, "*Adverse health effects are observed*" and "*many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected*."

The 184-page report offers a comprehensive overview of research into the various effects of noise on sleep quality and health (including the health effects of non-waking sleep arousal), and is recommended reading for anyone working with noise issues. The use of an outdoor noise standard is in part designed to acknowledge that people do prefer to leave windows open when sleeping, though the year-long average may be difficult to obtain (it would require longer-term sound monitoring than is usually budgeted for by either industry or neighbourhood groups).

While recommending the use of the average level, the report notes that some instantaneous effects occur in relation to specific maximum noise levels, but that the health effects of these "cannot be easily established."

4.4.3 Equator Principles

The **Equator Principles** (EPs) are a voluntary set of standards for determining, assessing and managing social and environmental risk in project financing. Equator Principles Financial Institutions (EPFIs) commit to not providing loans to projects where the borrower will not or is unable to comply with their respective social and environmental policies and procedures that implement the EPs.

The Equator Principles were developed by private sector banks and were launched in June 2003. The banks chose to model the Equator Principles on the environmental standards of the World Bank and the social policies of the International Finance Corporation (IFC). 67 financial institutions (October 2009) have adopted the Equator Principles, which have become the de facto standard for banks and investors on how to assess major development projects around the world. The environmental standards of the World Bank have been integrated into the social policies of the IFC since April 2007 as the International Finance Corporation Environmental, Health and Safety (EHS) Guidelines.

4.4.4 IFC: General EHS Guidelines – Environmental Noise Management

These guidelines are applicable to noise created beyond the property boundaries of a development that conforms to the Equator Principle.

It states that noise prevention and mitigation measures should be applied where predicted or measured noise impacts from a project facility or operations exceed the applicable noise level guideline at the most sensitive point of reception. The preferred method for controlling noise from stationary sources is to implement noise control measures at source.

It goes as far as to propose methods for the prevention and control of noise emissions, including:

- Selecting equipment with lower sound power levels;
- Installing silencers for fans;
- Installing suitable mufflers on engine exhausts and compressor components;
- Installing acoustic enclosures for equipment causing radiating noise;
- Improving the acoustic performance of constructed buildings, apply sound insulation;
- Installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m^2 in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective;
- Installing vibration isolation for mechanical equipment;
- Limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas;
- Re-locating noise sources to less sensitive areas to take advantage of distance and shielding;
- Placement of permanent facilities away from community areas if possible;
- Taking advantage of the natural topography as a noise buffer during facility design;
- Reducing project traffic routing through community areas wherever possible;
- Planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas; and
- Developing a mechanism to record and respond to complaints.

It sets noise level guidelines (see **Table 4-1**) as well as highlighting the certain monitoring requirements pre- and post-development. It adds another criterion in that the existing background ambient noise level should not rise by more than 3 dBA. This criterion will effectively sterilize large areas of any development. It is, therefore, the considered

opinion that this criterion was introduced to address cases where the existing ambient noise level is already at, or in excess of the recommended limits.

Table 4-1: IFC Table 7.1-Noise Level Guidelines

Receptor type	One hour L_{Aeq} (dBA)	
	Daytime 07:00 - 22:00	Night-time 22:00 – 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

The document uses the $L_{Aeq,1hr}$ noise descriptors to define noise levels. It does not determine the detection period, but refers to the IEC standards, which requires the fast detector setting on the Sound Level Meter during measurements for Europe.

5 CURRENT ENVIRONMENTAL SOUND CHARACTER

5.1 EFFECT OF SEASON ON SOUND LEVELS

Natural sounds are a part of the environmental noise surrounding humans. In rural areas the sounds from insects and birds would dominate the ambient sound character, with noises such as wind flowing through vegetation increasing as wind speed increase. Work by Fégeant (2002) stressed the importance of wind speed and turbulence causing variations in the level of vegetation generated noise. In addition, factors such as the season (e.g. dry or no leaves versus green leaves), the type of vegetation (e.g. grass, conifers, deciduous), the vegetation density and the total vegetation surface all determine both the sound level as well as spectral characteristics.

Ambient sound levels are significantly affected by the area where the sound measurement location is situated. When the sound measurement location is situated within an urban area, close to industrial plants or areas with a constant sound source (ocean, rivers, etc.), seasons and even increased wind speeds could have a significant impact on ambient sound levels.

Sound levels in undeveloped rural areas (away from occupied dwellings) however are impacted by changes in season for a number of complex reasons. The two main reasons are:

- Faunal communication during the warmer spring and summer months as various species communicate in an effort to find mates; and
- Seasonal changes in weather patterns, mainly wind (also see **section 5.1.1**).

For environmental noise, weather plays an important role; the greater the separation distance, the greater the influence of the weather conditions; so, from day to day, a road 1,000 m away can sound very loud or can be completely inaudible.

Other, environmental factors that impact on sound propagation includes wind, temperature and humidity, as discussed in the following sections.

5.1.1 Environmental factors that influence the propagation of sound

Sound is a sequence of waves of pressure that propagate through a compressible medium such as air. In air, there are three main properties that can affect the behaviour of sound propagation, namely:

1. The motion of the medium itself, e.g. wind in air. In the case of wind, if the air movement is in the direction of the sound wave, the sound can be transported further;

2. The relationship between density and pressure. This relationship, affected by temperature, determines the speed of sound within the medium;
3. The viscosity of the medium. This determines the rate at which sound is attenuated.

During this propagation, the sound waves can be reflected, refracted or attenuated by this medium. Atmospheric absorption depends on frequency, relative humidity, temperature and atmospheric pressure.

5.1.2 Effect of wind on ambient sound levels

Wind speed can be a significant factor for ambient sound levels at most rural locations. With no wind, there is little vegetation movement that could generate noises, however, as wind speeds increase, the rustling of leaves increases which subsequently can increase sound levels. This directly depends on the type of vegetation in a certain area. The impact of increased wind speeds on sound levels depends on the vegetation type (deciduous versus conifers), the density of vegetation in an area, seasonal changes (in winter deciduous trees are bare) as well as the height of this vegetation. This excludes the effect of faunal communication as vegetation may create suitable habitats and food sources for fauna, attracting more animals in number and species diversity as may be found in the natural veldt.

5.1.3 Effect of wind on sound propagation

Excluding wind-induced noises relating to increased wind speeds, wind alters sound propagation by the mechanism of refraction; that is, wind bends sound waves. Wind nearer to the ground moves more slowly than wind at higher altitudes, due to surface characteristics such as hills, trees, and man-made structures that interfere with the wind. This wind gradient, with faster wind at higher elevation and slower wind at lower elevation, causes sound waves to bend downward when they are traveling to a location downwind of the source and to bend upward when traveling toward a location upwind of the source. Waves bending downward means that a listener standing downwind of the source will hear louder noise levels than the listener standing upwind of the source. This phenomenon can significantly impact sound propagation over long distances and when wind speeds are high.

5.1.4 Effect of temperature on sound propagation

On a typical sunny afternoon, air is warmest near the ground and temperature decreases at higher altitudes. This temperature gradient causes sound waves to refract upward, away from the ground and results in lower noise levels being heard at a measurement location. In the evening, this temperature gradient will reverse, resulting in cooler

temperatures near the ground. This condition, often referred to as a temperature inversion will cause sound to bend downward toward the ground and results in louder noise levels at the listener's position. Like wind gradients, temperature gradients can influence sound propagation over long distances and can significantly complicate noise propagation modelling.

5.2 AMBIENT SOUND LEVEL AND CHARACTER MEASUREMENTS

Ambient (background) sound levels were measured over a one night-time period from 21 to 22 January 2019, augmented with a number of short, 10-minute measurements. Measurements were sufficient to characterise the ambient sound level character and, together with measurements done in the area for other projects (see Available Information, section 3.6) there is a very high confidence in the typical rating level determined for the area.

The measurements were completed in accordance with the South African National Standard SANS 10103:2008 "***The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication***". The standard specifies the acceptable techniques for sound measurements including:

- type of equipment;
- minimum duration of measurement;
- microphone positions;
- calibration procedures and instrument checks; and
- weather conditions.

The sound measurement locations are illustrated in **Figure 5-1** as a blue square, with a summary of the sound levels determined.

The sound level measuring equipment was referenced at 1,000 Hz directly before and after the measurements were taken. In all cases drift was less than 0.2 dBA. Instruments used to measure the longer-term sound levels would measure "average" sound levels over 10 minute periods, save the data and start with a new 10 minute measurement till the instrument was stopped.

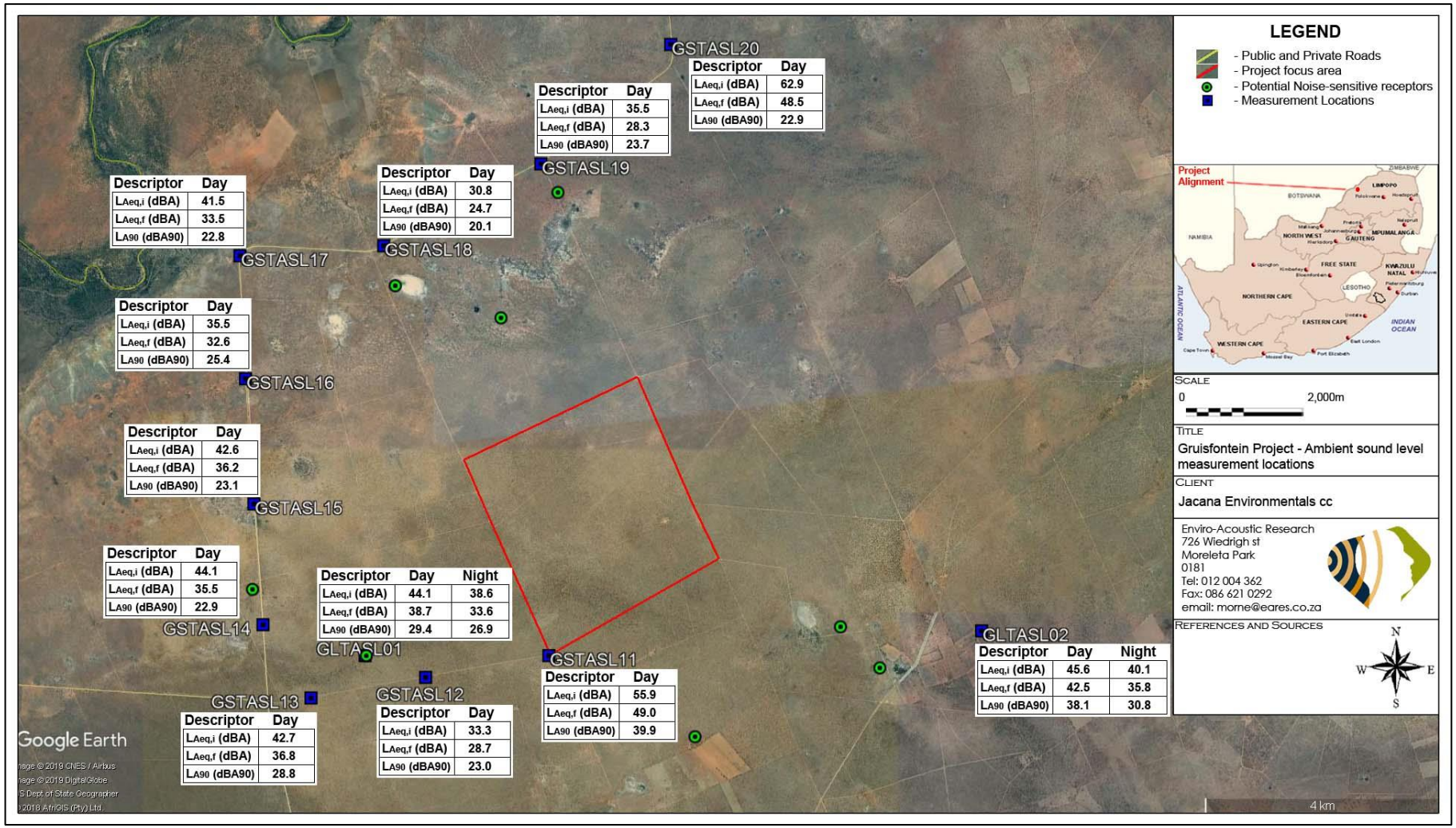


Figure 5-1: Localities of where ambient sound levels were measured

5.2.1 Ambient Sound Measurements at GLTASL01

The microphone was deployed at the house, away from any identifiable potential noise sources. There were no large trees within 20m from the microphone though there were some wind-induced noises at times. A photo of the measurement location is presented in **Appendix B**. Sounds heard onsite are described in the following table.

Table 5-1: Noises/sounds heard during site visits at receptor GLTASL01

Ambient Sound Character – Sounds of significance heard onsite	
	Faunal and Natural
	Deployment: Bird sounds dominant. Insects at times. Wind-induced noises at times Collection: Bird sounds dominant. Insects at times.
	Residential and other Anthropogenic
	Deployment: None Collection: None
	Industries, Commercial and Road Traffic
	Deployment: None Collection: None

Table 5-2: Equipment used to gather data at GLTASL01

Equipment	Model	Serial no	Calibration
SLM	SVAN 977	36176	December 2017
Microphone	ACO Pacific 7052E	49596	December 2017
Calibrator	Quest CA-22	J 2080094	July 2018
Weather Station	WH3081PC	-	-

- Microphone fitted with the appropriate windshield.

Impulse equivalent sound levels (South African legislation): Figure 5-2 illustrates how the impulse-weighted 10-minute equivalent values changes over time with **Table 5-3** defining the average values for the time period. This sound descriptor is mainly used in South Africa to define sound and noise levels. The instrument is set to measure the impulse time-weighted sound levels.

Fast equivalent sound levels (International guidelines): Fast-weighted 10-minute equivalent (average) sound levels for the day and night-time periods are shown on **Figure 5-2** with **Table 5-3** defining the average values for the time period. Fast-weighted equivalent sound levels are included in this report as this is the sound descriptor used in most international countries to define the Ambient Sound Level.

Statistical sound levels ($L_{A90,f}$): The L_{A90} level is presented in this report as it is used to define the "background ambient sound level", or the sound level that can be expected if there were little single events (loud transient noises) that impacts on the average sound

level. **L_{A90}** is a statistical indicator that describes the noise level that is exceeded 90% of the time and is frequently used to define the background sound level internationally. The instrument is set to fast time-weighting. It is illustrated against time on **Figure 5-3**.

Measured maximum and minimum sound levels: These are statistical sound descriptors that can be used to characterise the sound levels in an area along with the other sound descriptors. These sound level descriptors are defined in **Figure 5-3** and **Table 5-3**.

Table 5-3: Sound levels considering various sound level descriptors at GLTASL01

	$L_{Amax,i}$ (dBA)	**$L_{Aeq,i}$ (dBA)**	**$L_{Aeq,f}$ (dBA)**	**$L_{A90,f}$ (dBA90)**	**$L_{Amin,f}$ (dBA)**	**Comments**
Day arithmetic average	-	44	39	29	-	-
Night arithmetic average	-	39	34	27	-	-
Day minimum	-	32	29	-	24	-
Day maximum	71	59	55	-	-	-
Night minimum	-	31	27	-	23	-
Night maximum	73	54	49	-	-	-
Day 1 equivalent	-	44	38	-	-	Late afternoon and evening
Night 1 Equivalent	-	44	38	-	-	8 hour night equivalent average
Day 2 equivalent	-	51	43	-	-	Morning only

The **$L_{Aeq,i}$**, **$L_{Aeq,f}$** and **$L_{A90,f}$** sound level descriptors indicate a location that are generally quiet to very quiet. **L_{Amax}** levels exceeded 65 dBA less than 10 times at night with the source unknown. When more than 10 sound events occur at night (where the noise level exceeds 65 dBA) it may disturb the sleep of people. Ambient sound levels are typical of a rural noise district (the existing rating level).

Figure 5-2 and **Figure 5-3** illustrate an area with a high potential to be quiet ($L_{Amin,f}$ values), and, based on the observations made onsite, natural sound are the reason for higher ambient sound level. As typical for most areas, dawn chorus (waking of birds) significantly raise the ambient sound levels from 5 am in the morning.

Considering the character of the area, sounds heard as well as the average **$L_{Aeq,f}$** values, both day- and night-time ambient sound levels are typical of a **rural noise district** (SANS 10103:2008 – see **Table 7-1**).

Third octaves were measured and are displayed in the following figures.

Lower frequency (20 – 250 Hz) – Noise sources of significance in this frequency band would include nature (wind and surf especially – indicated by a relative smooth curve) and sounds of anthropogenic origin and vehicles (engine sounds and electric motors – erratic bumps at certain frequencies). Lower frequencies tend to travel further through the atmosphere than higher frequencies. People generally do not hear these frequencies unless very quiet due to the low response of the ear to these low frequencies. Sounds from wind-induced noises generally have significant acoustic energy in this frequency range (normally identified by a smooth curve).

Night-time data indicated a site with very little acoustic energy in this frequency range (average of approximately 9 dBA).
Daytime data shows a site with insignificant acoustic energy in this frequency band with a character similar of the night-time spectral data (average of approximately 13 dBA).

Third octave surrounding the 1,000 Hz (200 – 2,000 Hz) – This range contains energy mostly associated with human speech (350 Hz – 2,000 Hz) and dwelling noises (including sounds from larger animals such as chickens, dogs, goats, sheep and cattle). Road-tyre interaction (from vehicular traffic) normally peaking in 630 – 1,600 Hz range (depending on vehicular speed and road characteristics).

Night-time data indicated a site with a bit of acoustic energy in this frequency range (average of approximately 28 dBA). Early morning measurements show a clearly discernible peak at 1,000 Hz (likely birds).
Daytime data shows a site with some acoustic energy in this frequency range (average of approximately 34 dBA). Most measurements show a clearly discernible peak at 800 – 1,000 Hz.

Higher frequency (2,000 Hz upwards) – Smaller faunal species such as birds, crickets and cicada use this range to communicate and hunt etc.

Night-time data indicated a site with a bit of acoustic energy in this frequency range (average of approximately 27 dBA) with no clear character (different sources).
Daytime data shows some acoustic energy in this frequency band due to various different sources, likely birds and insects (average of approximately 37 dBA - no clear character).

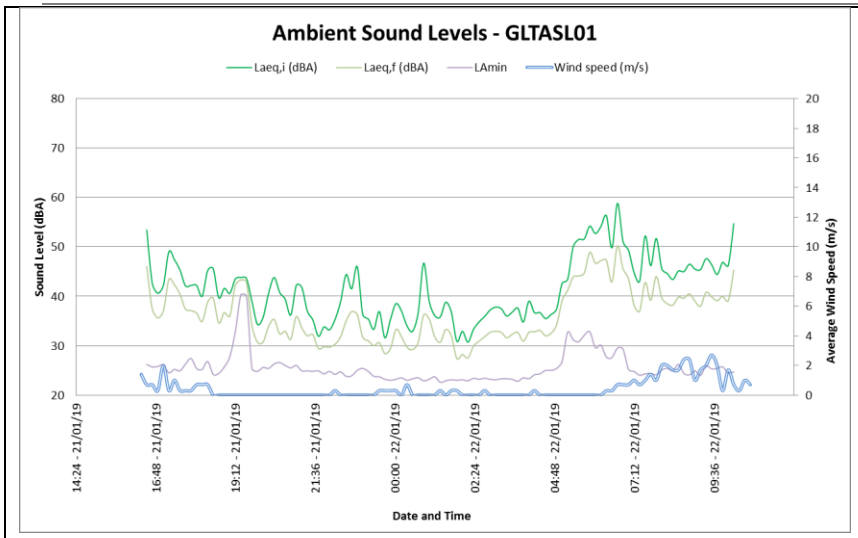


Figure 5-2: Ambient Sound Levels at GLTASL01

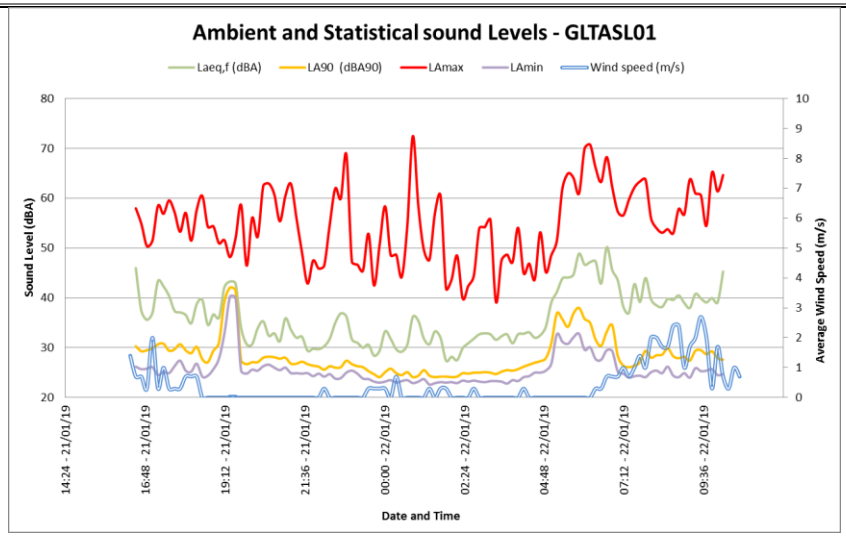


Figure 5-3: Maximum, minimum and statistical values

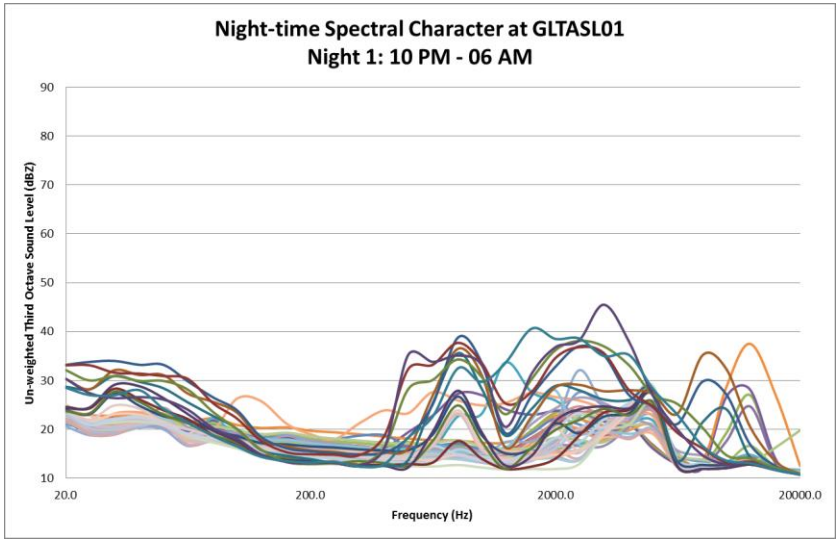


Figure 5-4: Spectral frequencies - GLTASL01, Night 1

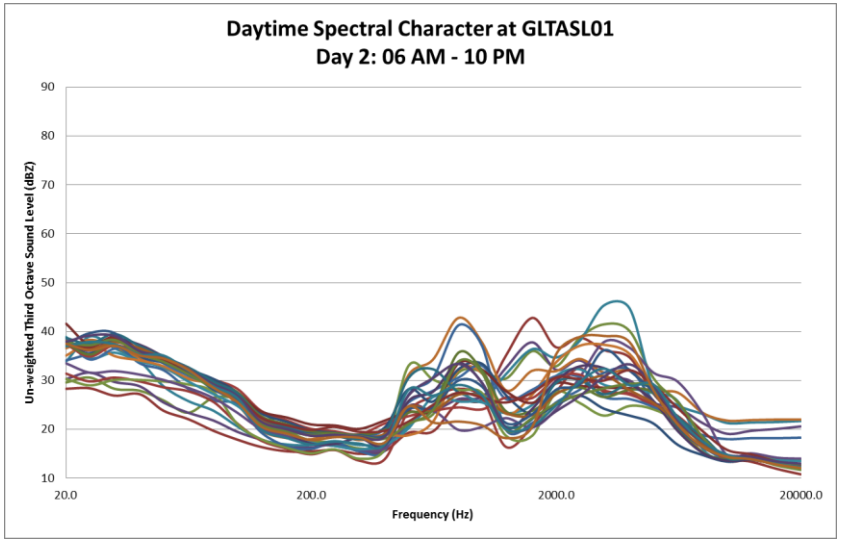


Figure 5-5: Spectral frequencies - GLTASL01, Day 2

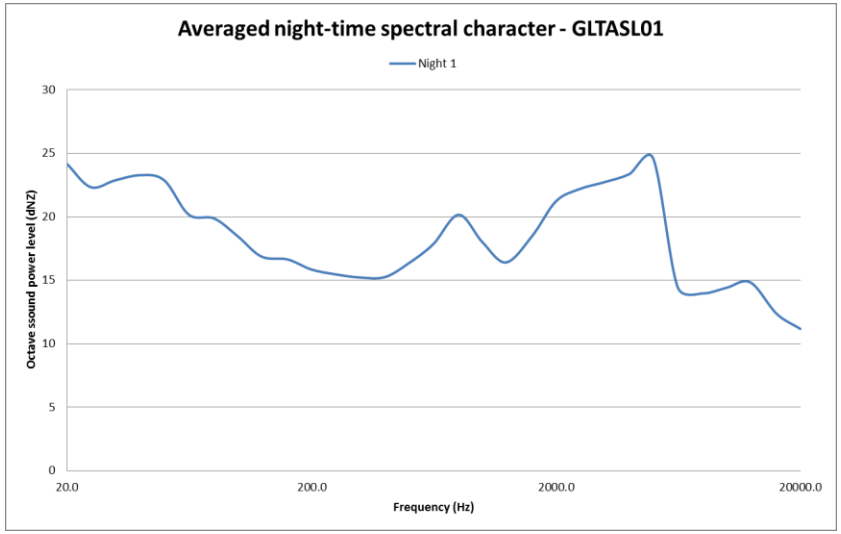


Figure 5-6: Average spectral frequencies –Night

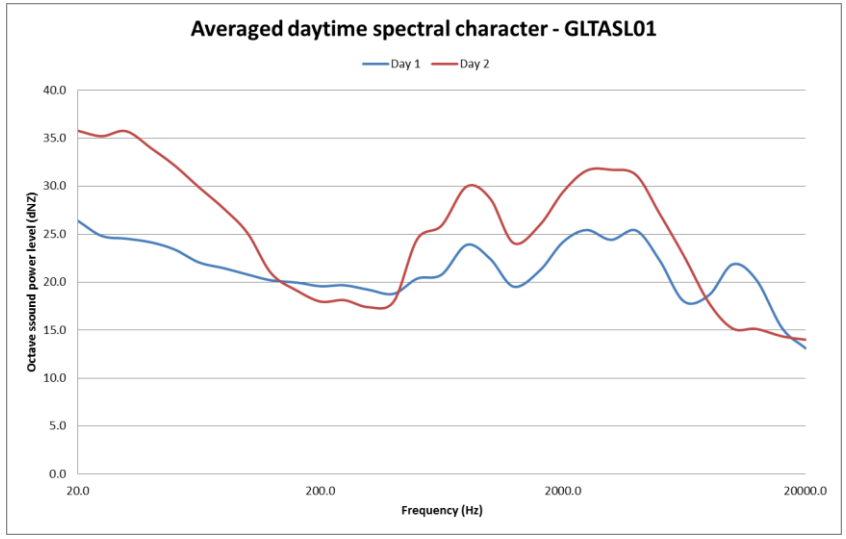


Figure 5-7: Average spectral frequencies - Day

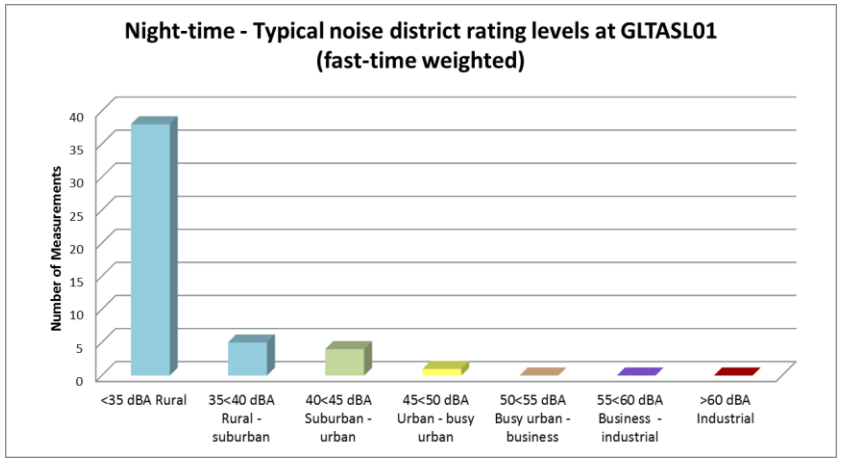


Figure 5-8: Classification of night-time measurements

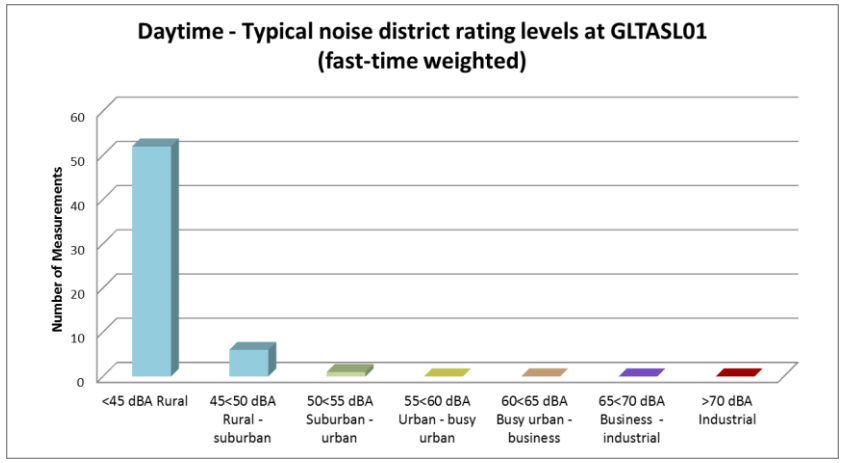


Figure 5-9: Classification of daytime measurements

5.2.2 Ambient Sound Measurements at GLTASL02

The microphone was deployed at the house, away from any identifiable potential noise sources. There were large trees within 20m from the microphone with some wind-induced noises at times. A photo of the measurement location is presented in **Appendix B**. Sounds heard onsite are described in the following table.

Table 5-4: Noises/sounds heard during site visits at receptor GLTASL02

Ambient Sound Character – Sounds of significance heard onsite	
	Faunal and Natural
	Deployment: Bird sounds dominant. Insects clearly audible. Wind-induced noises at times Collection: Bird sounds dominant. Frogs audible.
	Residential and other Anthropogenic
	Deployment: Air-conditioner audible. Collection: None
	Industries, Commercial and Road Traffic
	Deployment: None Collection: None

Table 5-5: Equipment used to gather data at GLTASL02

Equipment	Model	Serial no	Calibration
SLM	SVAN 955	27637	October 2018
Microphone	ACO Pacific 7052E	52437	October 2018
Calibrator	Quest CA-22	J 2080094	July 2018

- Microphone fitted with the appropriate windshield.

Impulse equivalent sound levels (South African legislation): Figure 5-10: Ambient Sound Levels at GLTASL02 illustrates how the impulse-weighted 10-minute equivalent values changes over time with **Table 5-6** defining the average values for the time period. This sound descriptor is mainly used in South Africa to define sound and noise levels. The instrument is set to measure the impulse time-weighted sound levels.

Fast equivalent sound levels (International guidelines): Fast-weighted 10-minute equivalent (average) sound levels for the day and night-time periods are shown on **Figure 5-10** with **Table 5-6**: Sound levels considering various sound level descriptors at GLTASL01defining the average values for the time period. Fast-weighted equivalent sound levels are included in this report as this is the sound descriptor used in most international countries to define the Ambient Sound Level.

Statistical sound levels ($L_{A90,f}$): The L_{A90} level is presented in this report as it is used to define the "background ambient sound level", or the sound level that can be expected if there were little single events (loud transient noises) that impacts on the average sound

level. **L_{A90}** is a statistical indicator that describes the noise level that is exceeded 90% of the time and frequently used to define the background sound level internationally. The instrument is set to fast time-weighting. It is illustrated against time on **Figure 5-11**.

Measured maximum and minimum sound levels: These are statistical sound descriptors that can be used to characterise the sound levels in an area along with the other sound descriptors. These sound level descriptors are defined in **Figure 5-11** and **Table 5-6**: Sound levels considering various sound level descriptors at GLTASL01.

Table 5-6: Sound levels considering various sound level descriptors at GLTASL01

	$L_{Amax,i}$ (dBA)	**$L_{Aeq,i}$ (dBA)**	**$L_{Aeq,f}$ (dBA)**	**$L_{A90,f}$ (dBA90)**	**$L_{Amin,f}$ (dBA)**	**Comments**
Day arithmetic average	-	46	42	38	-	-
Night arithmetic average	-	40	36	31	-	-
Day minimum	-	38	36	-	27	-
Day maximum	82	57	55	-	-	-
Night minimum	-	34	30	-	<18	-
Night maximum	72	60	53	-	-	-
Day 1 equivalent	-	45	40	-	-	Late afternoon and evening
Night 1 Equivalent	-	48	42	-	-	8 hour night equivalent average
Day 2 equivalent	-	45	39	-	-	Morning only

The **$L_{Aeq,i}$**, **$L_{Aeq,f}$** and **$L_{A90,f}$** sound level descriptors indicate a location that are generally quiet to very quiet. **L_{Amax}** levels exceeded 65 dBA less than 10 times at night with the source unknown. When more than 10 sound events occur at night (where the noise level exceeds 65 dBA) it may disturb the sleep of people. Ambient sound levels are typical of a rural noise district (the existing rating level).

Figure 5-10 and **Figure 5-11** illustrate an area with a high potential to be quiet ($L_{Amin,f}$ values), and based on the observations made onsite, natural sound are the reason for higher ambient sound level. As typical for most areas, dawn chorus (waking of birds) significantly raise the ambient sound levels from 5 am in the morning.

Considering the character of the area, sounds heard as well as the average **$L_{Aeq,f}$** values, both day- and night-time ambient sound levels are typical of a **rural noise district** (SANS 10103:2008 – see **Table 7-1**).

Third octaves were measured and are displayed in the following figures.

Lower frequency (20 – 250 Hz) – Noise sources of significance in this frequency band would include nature (wind and surf especially – indicated by a relative smooth curve) and sounds of anthropogenic origin and vehicles (engine sounds and electric motors – erratic bumps at certain frequencies). Lower frequencies tend to travel further through the atmosphere than higher frequencies. People generally do not hear these frequencies unless very quiet due to the low response of the ear to these low frequencies. Sounds from wind-induced noises generally have significant acoustic energy in this frequency range (normally identified by a smooth curve).

Night-time data indicated a site with insignificant acoustic energy in this frequency range (average of approximately 14 dBA) with a slight peak at 50 and 100Hz, likely from the air conditioner in the area.
Daytime data shows a site with insignificant acoustic energy in this frequency band with a character similar of the night-time spectral data (average of approximately 15 dBA).

Third octave surrounding the 1,000 Hz (200 – 2,000 Hz) – This range contains energy mostly associated with human speech (350 Hz – 2,000 Hz) and dwelling noises (including sounds from larger animals such as chickens, dogs, goats, sheep and cattle). Road-tyre interaction (from vehicular traffic) normally peaking in 630 – 1,600 Hz range (depending on vehicular speed and road characteristics).

Night-time data indicated a site with some acoustic energy in this frequency range (average of approximately 25 dBA). Early morning measurements show a clearly discernible peak at 500 and 1,000 Hz (likely birds).
Daytime data shows a site with some acoustic energy in this frequency range (average of approximately 28 dBA). Most measurements show a clearly discernible peak at 500 – 1,000 Hz.

Higher frequency (2,000 Hz upwards) – Smaller faunal species such as birds, crickets and cicada use this range to communicate and hunt etc.

Night-time data indicated a site with some acoustic energy in this frequency range (average of approximately 36 dBA) with morning peaks at 3,150 Hz (birds) and night-time peaks at 6,300 Hz (crickets).
Daytime data shows significant acoustic energy in this frequency band, mainly from birds and insects (average of approximately 41 dBA).

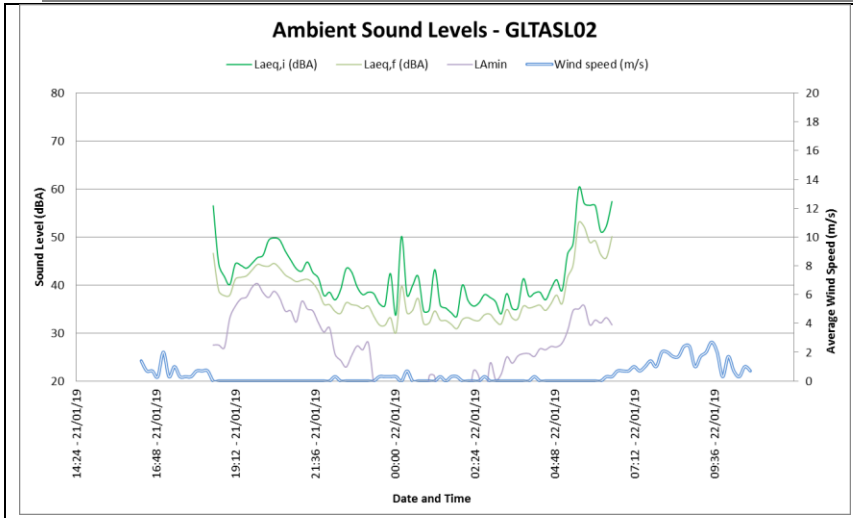


Figure 5-10: Ambient Sound Levels at GLTASL02

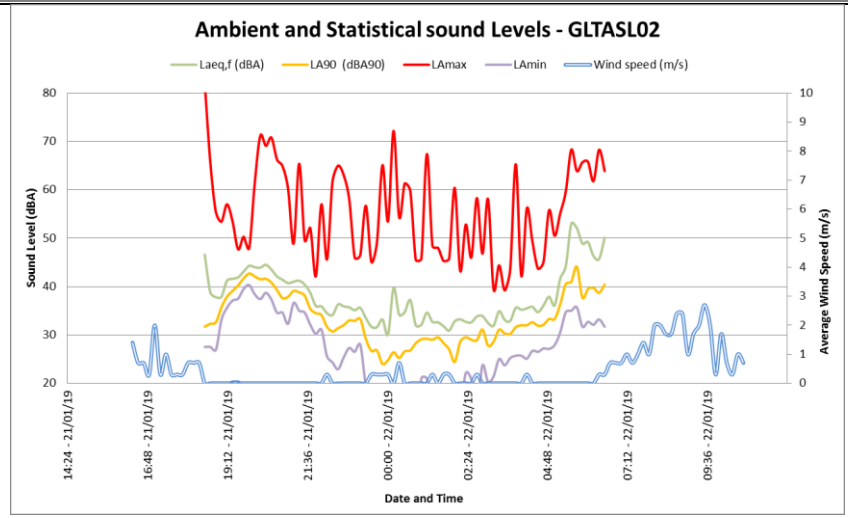


Figure 5-11: Maximum, minimum and statistical values

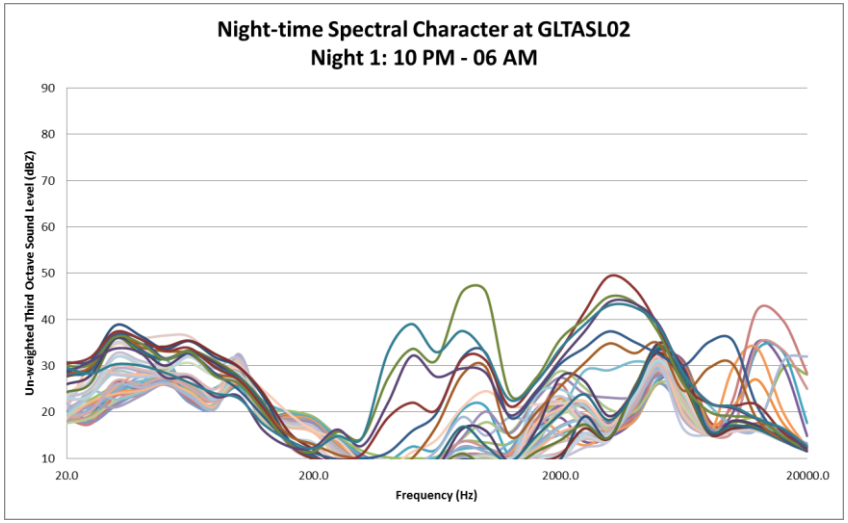


Figure 5-12: Spectral frequencies - GLTASL02, Night 1

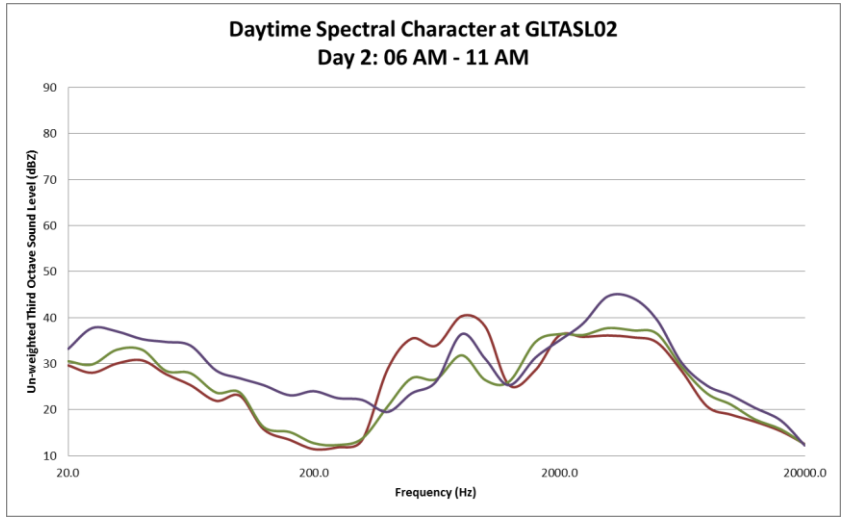


Figure 5-13: Spectral frequencies - GLTASL02, Day 2

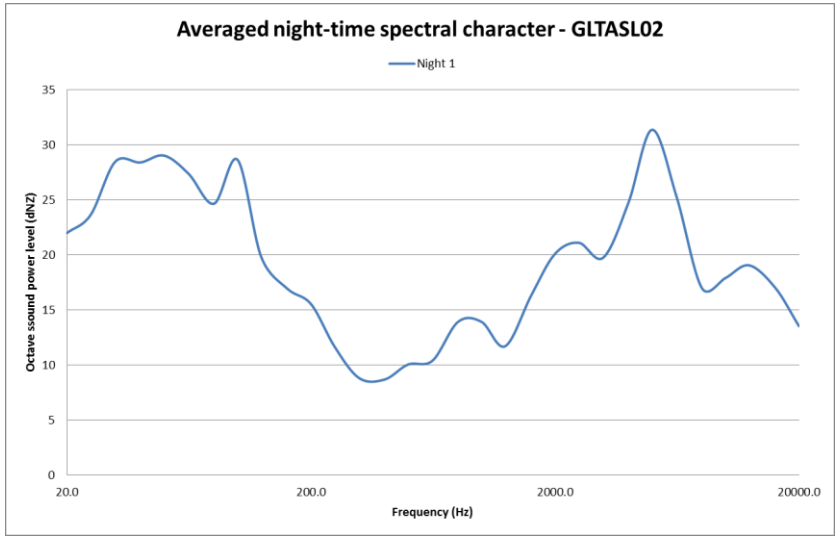


Figure 5-14: Average spectral frequencies –Night (GLTASL02)

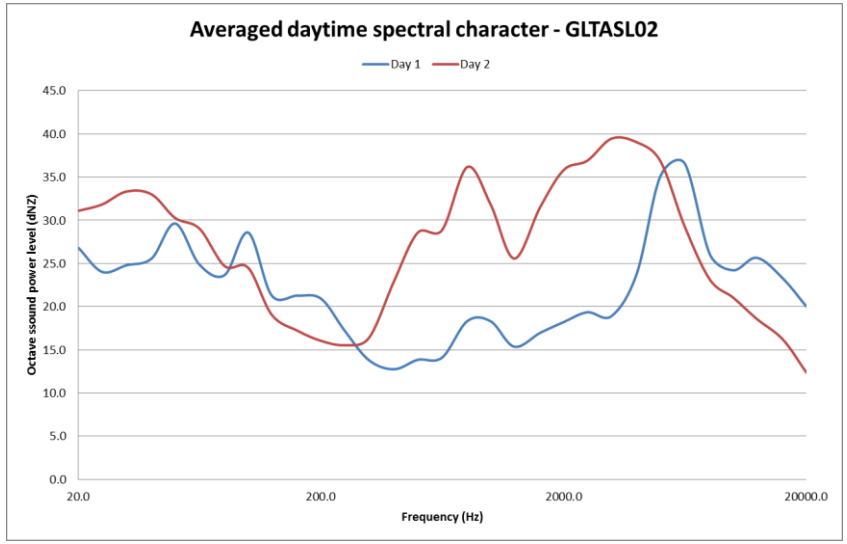


Figure 5-15: Average spectral frequencies – Day (GLTASL02)

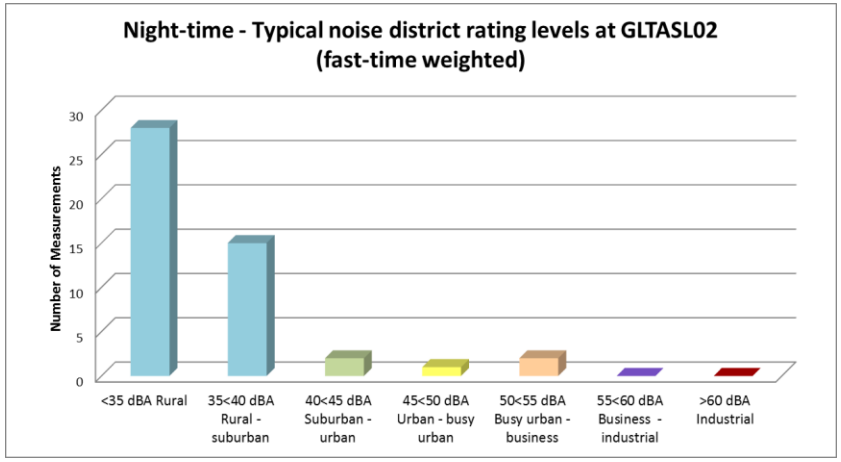


Figure 5-16: Classification of night-time measurements (GLTASL02)

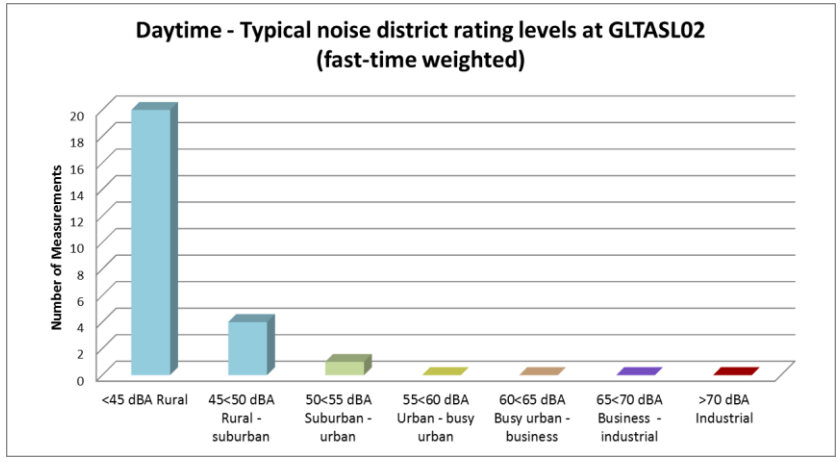


Figure 5-17: Classification of daytime measurements (GLTASL02)

5.2.3 Single Measurements – In vicinity of focus area

A number of single measurements were collected to augment the longer-term ambient sound levels measured at GLTASL01 and GLTASL02. The equipment used at these locations is defined in the following table. Refer to **Appendix B** for a photo of this measurement location.

Table 5-7: Equipment used to do singular measurements around Hernic

Equipment	Model	Serial no	Calibration
SLM	RION NA-28	00901489	February 2017
Microphone	UC-59	02087	February 2017
Calibrator	Quest CA-22	J 2080094	July 2018

Note: SLM fitted at all times with appropriate windshield

Note:

$L_{Aeq,i}$ - Equivalent A-weighted noise level, similar to an average noise level – Impulse-detector

$L_{Aeq,f}$ - Equivalent A-weighted noise level, similar to an average noise level – Fast-detector

L_{A90} - Noise level that is exceeded 90% or more of the time – Fast-detector

The data collected and information about the measurement locations are presented in the following tables.

5.3 SUMMARY OF AMBIENT SOUND LEVEL MEASUREMENTS

Considering the ambient sound levels measured onsite, as well as the developmental character of the area, the acceptable zone rating level would be typical of a **rural area** (35 dBA at night and 45 dBA during the day) as defined in SANS 10103:2008.

Table 5-8: Summary of singular noise measurements

Measurement location	$L_{Aeq,i}$ level (dBA)	$L_{Aeq,i}$ level (dBA)	$L_{Aeq,i}$ level (dBA)	$L_{Aeq,f}$ level (dBA)	L_{A90} Level (dBA90)	Spectral character	Comments
GSTASL11	66	56	27	49	40	**Figure 5-18**	Birds dominating, with birds in trees close to microphone generating significant noise. Frogs (suspected) clearly audible and significant. Some wind gusts at times with minimal influence on sound levels.
GSTASL12	43	33	18	29	23	**Figure 5-19**	Birds dominating with frogs clearly audible. Some minor wind induced noises at times.
GSTASL13	58	43	22	37	29	**Figure 5-20**	Birds dominating. Birds in tree close to microphone.
GSTASL14	58	44	19	36	23	**Figure 5-21**	Birds dominating.
GSTASL15	52	43	20	36	23	**Figure 5-22**	Birds dominating.
GSTASL16	50	36	22	33	25	**Figure 5-23**	Birds dominating. Insects clearly audible (bees).
GSTASL17	56	42	20	33	23	**Figure 5-24**	Birds dominating. Voices from people in area. Insects. Some wind induced noises.
GSTASL18	47	31	17	25	20	**Figure 5-25**	Birds and insects.
GSTASL19	46	36	21	28	24	**Figure 5-26**	Birds dominant. Insects audible. Some wind induced noises with Aeolian sounds at times from power lines. Wind induced noises from tree.
GSTASL20	81	63	19	48	23	**Figure 5-27**	Birds dominating. Bird in tree close to microphone generating high noise levels. Insects audible. Slight wind induced noises at times.

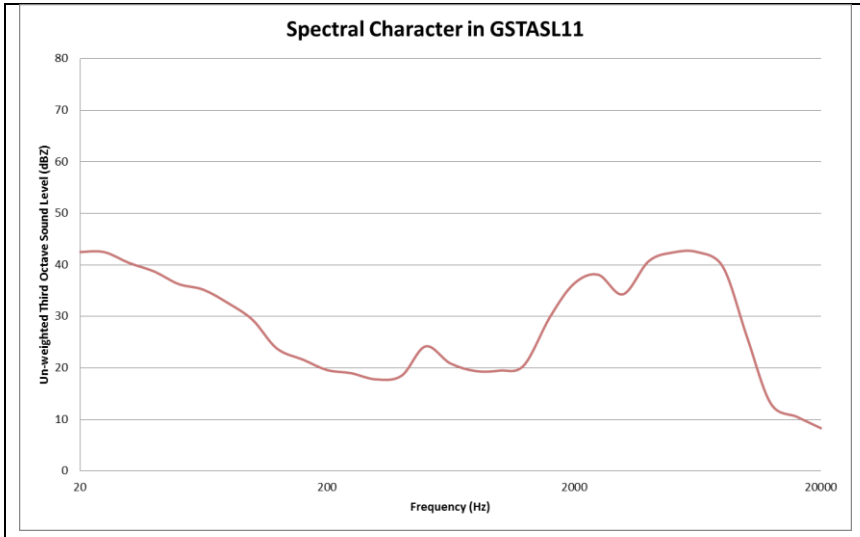


Figure 5-18: Spectral frequencies recorded at GSTASL11

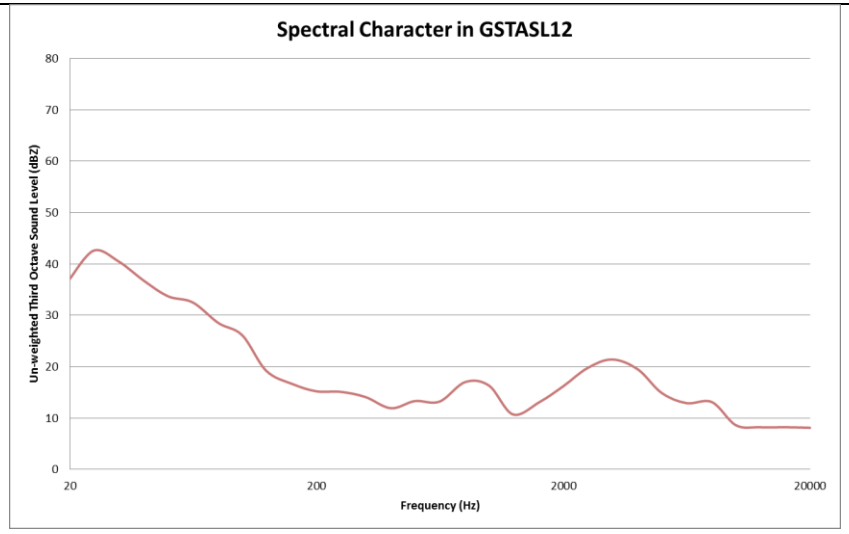


Figure 5-19: Spectral frequencies recorded at GSTASL12

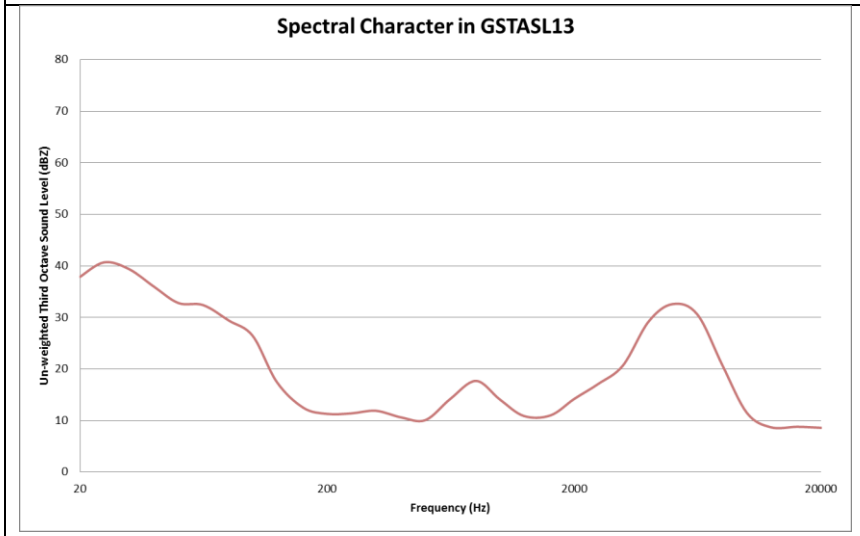


Figure 5-20: Spectral frequencies recorded at GSTASL13

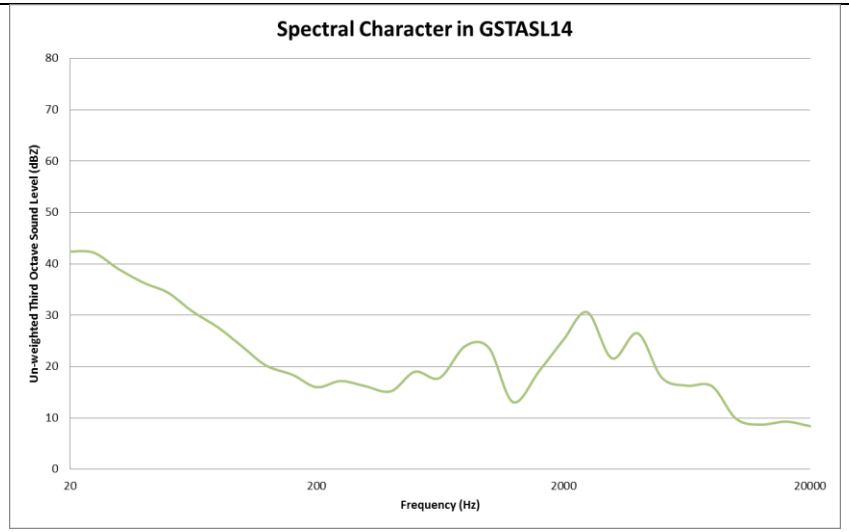


Figure 5-21: Spectral frequencies recorded at GSTASL14

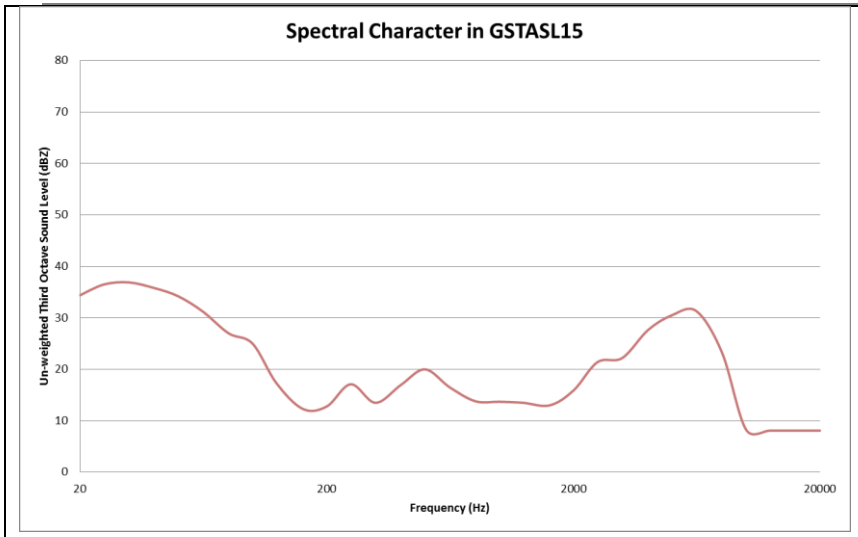


Figure 5-22: Spectral frequencies recorded at GSTASL15

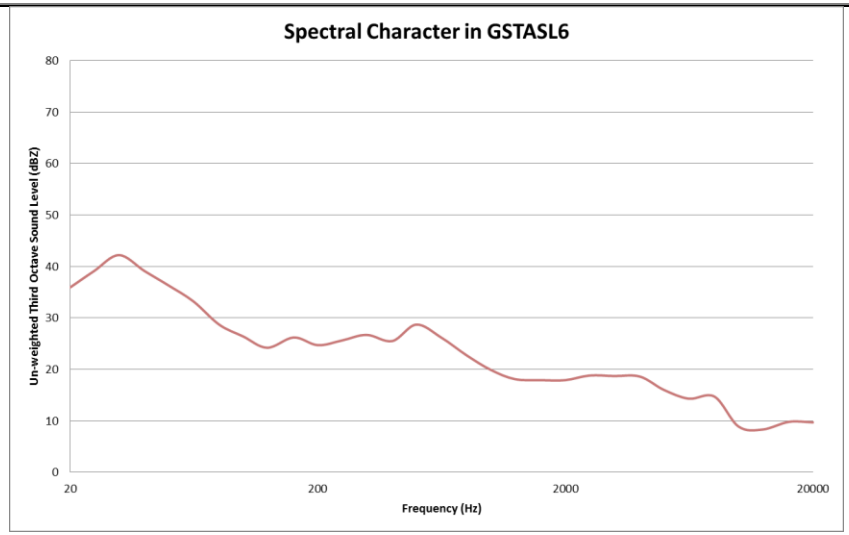


Figure 5-23: Spectral frequencies recorded at GSTASL16

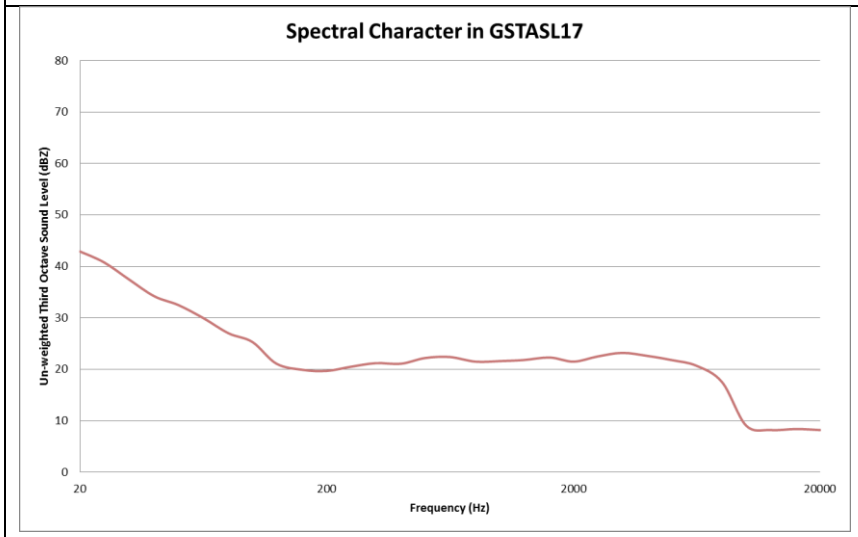


Figure 5-24: Spectral frequencies recorded at GSTASL17

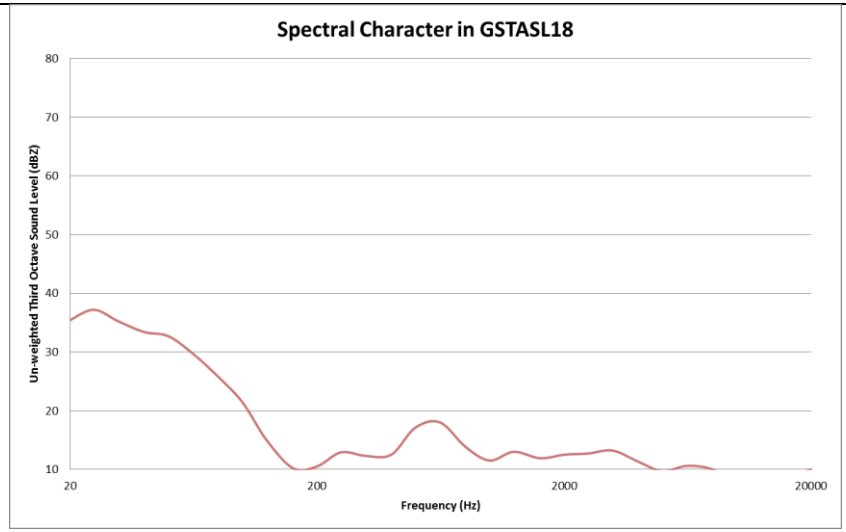


Figure 5-25: Spectral frequencies recorded at GSTASL18

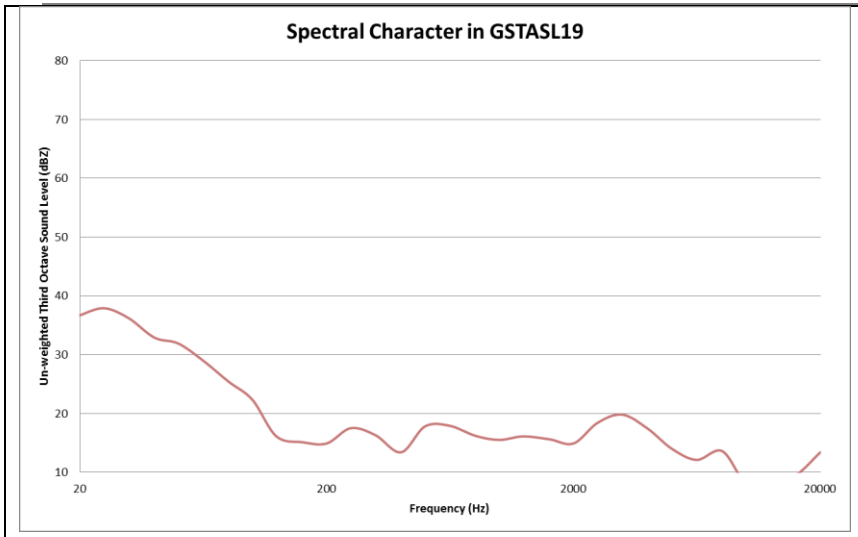


Figure 5-26: Spectral frequencies recorded at GSTASL19

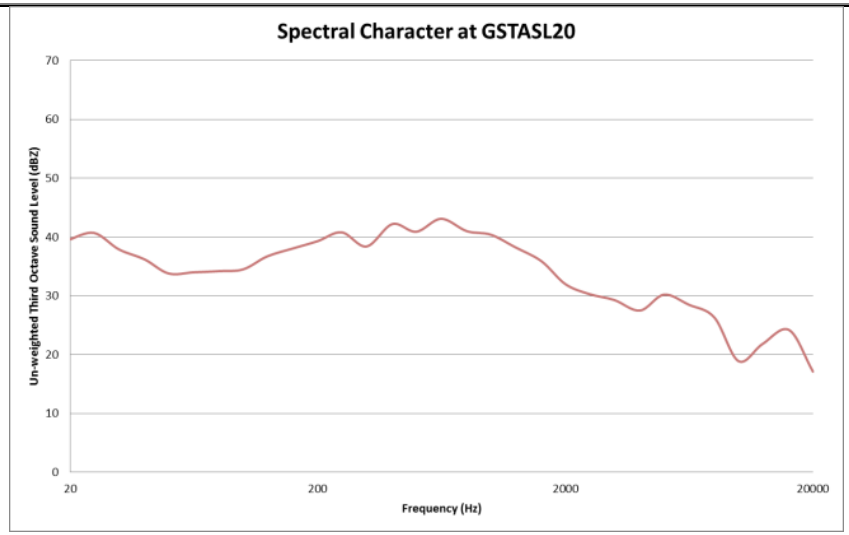


Figure 5-27: Spectral frequencies recorded at GSTASL20

6 POTENTIAL NOISE SOURCES

Increased noise levels are directly linked with the various activities associated with the construction of the proposed mine and related infrastructure, as well as the operational phase of the activity.

6.1 CONSTRUCTION NOISES

6.1.1 Construction of Mining Infrastructure

The following are likely the main construction related sources:

- Site survey and development of a contractors camp and storage;
- Transport of workers, components & equipment to site – brought to site by means of flatbed trucks (60 peak trips during the day, 20 trips at night);
- Development of the internal and access roads – bulldozers, graders;
- Vegetation removal and the stripping of topsoil at open cast pit, dumps and stockpile areas as well as certain infrastructure by means of bulldozers, excavators, front end loaders (FEL), articulated dump trucks (ADT), water dozers, etc. Typical practice is to stockpile stripped topsoil close to the mining or project areas as a berm, to be used for backfilling or to be hauled to specific stockpiles/dumps – 5 articulated dump trucks (ADTs) trips per hour to the soft overburden dump;
- Development of the topsoil, hards- and soft overburden dumps/stockpiles (around mining pits) - bulldozers, ADTs, etc.;
- Drilling of the overburden;
- Development of the initial boxcut - excavators, ADTs, drill rigs, etc. The model will evaluate a scenario where overburden was blasted and excavators are loading the overburden on ADTs for moving to the hard overburden dump (10 ADTs per hour);
- Digging of foundations for certain structures. Due to the volume of concrete that will be required, an on-site batching plant will be required to ensure a continuous concreting operation. The source of aggregate is as yet undefined but is expected to be derived from an offsite source or brought in as ready-mix; and
- Civil construction activities.

Potential maximum noise levels generated by construction equipment, as well as the potential extent are presented in **Table 6-1**. The potential extent depends on a number of factors, including the prevailing ambient sound levels during the instance the maximum noise event occurred, as well as the spectral characteristics of the noise and the ambient soundscape in the surroundings.

Average or equivalent sound levels are another factor that impacts on the ambient sound levels and is the constant sound level that the receptor can experience. Typical sound power levels associated with various activities that may be found at a construction site is presented in **Table 6-2**.

The level and character of the construction noise will be highly variable as different activities with different equipment take place at different times, for different periods of time (operating cycles), in different combinations/sequences and on different parts of the construction site.

6.1.2 Delivery/Access roads, design, specifications & information

The main source of traffic noise during the construction phase relates to traffic to the project site as well as on the site due to material delivery as well construction crew vehicle movement. The access route's acoustical contribution to the surrounding sound environment depends on a host of factors ranging from road traffic volumes, vehicle specifications (tyre design, light or heavy etc.), road tyre interaction specifications (including road paving design such as surface porosity, surface texture etc.), road traffic speeds and a host of other considerations.

Construction traffic is expected to be generated throughout the entire construction period; however, the volume and type of traffic generated will be dependent upon the construction activities being conducted, which will vary during the construction period.

It has been estimated that the construction activities at the mine site will on average generate no more than about 230 vehicle trips (two-way) daily. The main percentage of the trips will be concentrated in the morning and evening peak periods. There will also be a peak of traffic during the start of the project when equipment and material will be delivered to the project site.

For the purpose of this assessment, construction traffic will be assumed at 500 trips per day, with most of the trips taking place during the day, with half of the traffic being heavy vehicles. All vehicles travel at 60 km/h with 140 vehicles per hour during the morning and evening peak periods on the main access road, and 40 km/h on the mine.

Table 6-1: Potential maximum noise levels generated by construction equipment

Equipment Description[2]	Impact Device?	Maximum Sound Power Levels (dBA)	Operational Noise Level at given distance considering potential maximum noise levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
			5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Backhoe	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Chain Saw	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Compactor (ground)	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Compressor (air)	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Concrete Batch Plant	No	117.7	92.7	86.7	80.6	72.7	66.7	63.1	60.6	57.1	52.7	49.2	46.7	40.6
Concrete Mixer Truck	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Concrete Pump Truck	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Crane	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Dozer	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Drill Rig Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Drum Mixer	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Dump Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Excavator	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Flat Bed Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Front End Loader	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Generator	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Grader	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Impact Pile Driver	Yes	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6
Jackhammer	Yes	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Man Lift	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Mounted Impact	Yes	124.7	99.7	93.7	87.6	79.7	73.7	70.1	67.6	64.1	59.7	56.2	53.7	47.6

[2]Equipment list and Sound Power Level source: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

Hammer														
Paver	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Pickup Truck	No	89.7	64.7	58.7	52.6	44.7	38.7	35.1	32.6	29.1	24.7	21.2	18.7	12.6
Pumps	No	111.7	86.7	80.7	74.6	66.7	60.7	57.1	54.6	51.1	46.7	43.2	40.7	34.6
Rivet Buster/Chipping Gun	Yes	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Rock Drill	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Roller	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Sand Blasting (single nozzle)	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Scraper	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Slurry Plant	No	112.7	87.7	81.7	75.6	67.7	61.7	58.1	55.6	52.1	47.7	44.2	41.7	35.6
Slurry Trenching Machine	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Soil Mix Drill Rig	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Tractor	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Vacuum Excavator (Vac-Truck)	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vacuum Street Sweeper	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Ventilation Fan	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vibrating Hopper	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vibratory Concrete Mixer	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Vibratory Pile Driver	No	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6
Warning Horn	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Welder/Torch	No	107.7	82.7	76.7	70.6	62.7	56.7	53.1	50.6	47.1	42.7	39.2	36.7	30.6

Table 6-2: Potential equivalent noise levels generated by various equipment

Equipment Description	Equivalent (average) Sound Levels (dBA)	Operational Noise Level at given distance considering equivalent (average) sound power emission levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
		5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Bulldozer CAT D11	113.3	88.4	82.3	76.3	68.4	62.3	58.8	56.3	52.8	48.4	44.8	42.3	36.3
Bulldozer CAT D6	108.2	83.3	77.3	71.2	63.3	57.3	53.7	51.2	47.7	43.3	39.8	37.3	31.2
Bulldozer Komatsu 375	114.0	89.0	83.0	77.0	69.0	63.0	59.5	57.0	53.4	49.0	45.5	43.0	37.0
Crusher/Screen (MTC Mobile)	109.6	84.6	78.6	72.6	64.6	58.6	55.1	52.6	49.0	44.6	41.1	38.6	32.6
Crushing plant (50 tons/h)	114.5	89.5	83.5	77.5	69.5	63.5	60.0	57.5	54.0	49.5	46.0	43.5	37.5
Conveyor transfer	103.2	78.3	72.2	66.2	58.3	52.2	48.7	46.2	42.7	38.3	34.7	32.2	26.2
Drilling Machine	109.6	84.6	78.6	72.6	64.6	58.6	55.1	52.6	49.1	44.6	41.1	38.6	32.6
Dumper/Haul truck - CAT 700	115.9	91.0	85.0	78.9	71.0	65.0	61.4	58.9	55.4	51.0	47.5	45.0	38.9
Dumper/Haul truck - Terex 30 ton	112.2	87.2	81.2	75.2	67.2	61.2	57.7	55.2	51.7	47.2	43.7	41.2	35.2
Excavator - Hitachi EX1200	113.1	88.1	82.1	76.1	68.1	62.1	58.6	56.1	52.6	48.1	44.6	42.1	36.1
Excavator - Hitachi 870 (80 t)	108.1	83.1	77.1	71.1	63.1	57.1	53.6	51.1	47.5	43.1	39.6	37.1	31.1
FEL - Bell L1806C	102.7	77.7	71.7	65.7	57.7	51.7	48.2	45.7	42.1	37.7	34.2	31.7	25.7
FEL - CAT 950G	102.1	77.2	71.2	65.1	57.2	51.2	47.6	45.1	41.6	37.2	33.7	31.2	25.1
FEL - Komatsu WA380	100.7	75.7	69.7	63.7	55.7	49.7	46.2	43.7	40.1	35.7	32.2	29.7	23.7
General noise	108.8	83.8	77.8	71.8	63.8	57.8	54.2	51.8	48.2	43.8	40.3	37.8	31.8
Grader - Operational Hitachi	108.9	83.9	77.9	71.9	63.9	57.9	54.4	51.9	48.4	43.9	40.4	37.9	31.9
Grader	110.9	85.9	79.9	73.9	65.9	59.9	56.4	53.9	50.3	45.9	42.4	39.9	33.9
Screening plant	105.5	80.6	74.6	68.5	60.6	54.6	51.0	48.5	45.0	40.6	37.0	34.6	28.5
Water Dozer, CAT	113.8	88.8	82.8	76.8	68.8	62.8	59.3	56.8	53.3	48.8	45.3	42.8	36.8

6.1.3 Blasting Noises

Rock blasting will be required to break down rock and the coal resource. Blasting generates significant acoustic energy over a very short period of time and noise-sensitive receptors often raise blasting noises as a first concern. However, blasting will not be considered as part of the noise impact assessment for the following reasons:

- This will the subject of a separate study;
- Blasting is highly regulated and control of blasting to protect human health, equipment and infrastructure will ensure that any blasts will use minimum explosives and will occur in a controlled manner;
- Blasting is a highly specialised field, and various management options are available to the blasting specialist. Options available to minimise the risk to equipment, people and infrastructure includes:
    - The use of different explosives that have a lower detonation speed, which reduces vibration, sound pressure levels as well as air blasts.
    - Blasting techniques such as blast direction and/or blast timings (both blasting intervals and sequence).
    - Reducing the total size of the blast.
    - Damping materials used to cover the explosives.
- People are generally more concerned over ground vibration and air blast levels that might cause building damage than the impact of the noise from the blast. This is normally associated with close proximity mining/quarrying.

Blasts will be an infrequent occurrence, with a loud but a relative instantaneous character. Potentially affected parties will receive sufficient notice (siren and blasting schedule) and the knowledge that the blast will be over relatively fast result in a higher acceptance of the noise associated with the blast.

6.2 OPERATIONAL NOISES – GENERAL

6.2.1 Mining and Processing Activities

Coal will be mined through an opencast bench mining method. The benches will be mined at a height of 20 metres with the final mining depth determined by the coal resource (starting at 40 m).

The following mining method will be assumed for the noise model:

- Vegetation and topsoil will be stripped ahead of mining using a bulldozer. At least one cut will already be stripped and available for drilling between the active topsoil stripping operation and the open void. This will be limited to day-time activities;
- The topsoil will be loaded onto dump trucks by excavators and hauled to stockpiles or areas that require rehabilitation using articulated dump trucks. This will be mainly limited to the day-time period (estimated at no more than 400,000 tpa). It will be assumed that the topsoil will be used to develop berms around the mining site up to a height of 3 m;
- Soft overburden will be loaded onto dump trucks by excavators and hauled to stockpiles or areas that require rehabilitation. This could take place 24 hours per day (estimated at no more than 1,200,000 tpa);
- Drilling operations will commence in the front of the second bench after the topsoil and soft overburden has been removed. This will take place 24 hours per day 2 m below the ground surface (depth assumed). The hard overburden will be mined on two benches of 20 m each;
- Drilling operations will commence in the front of the advancing pit after the overburden of the first bench was removed. This will take place 24 hours per day 20 m below the ground surface;
- After the hard overburden was broken by means of blasting, it will be loaded onto ADTs by excavators and hauled to stockpiles or areas that require rehabilitation. Loading will take place 20 and 40 m below the surface level. This will be repeated until the coal resource is reached. Excavation and the hauling of overburden will continue at night (moving 1,400,000 tpa);
- Drilling and blasting of the coal resource with the Run of Mine (RoM) crushed and screened in the pit before being loaded and hauled to the plant (40 m below ground surface). This will take place 24 hours per day (moving approximately 6,700,000 tpa);
- Topsoil and soft material will be placed on the edge of the mining area to act in as a noise protection berm. These berms will be located between the active mining activities and the closest receptors and will be at least 3 m high;
- Processing of the RoM, with the discard hauled to the discard dump (moving 3,700,000 tpa discard) ; and
- Various plant activities to beneficiate the resource, stockpiling and loading onto road trucks to allow transport to the market or to a Rapid Load Out Facility (south of the project area – product estimated to be 50% of RoM).

The level and character of the noise during this phase is more constant than with the construction phase, but can be significantly higher and more intrusive, especially if there

is an impulsive[3] component involved (such as from tipping, crushing and equipment banging on other equipment) and these noise generating activities takes place at night. A list of proposed mobile production equipment that may be required is presented in **Table 6-3**.

Table 6-3: List of mobile production equiment

PRODUCTION EQUIPMENT	TYPE	MAX	AREA
Front Shovel	290 Tonnes Shovel (CAT 6030)	1	OB
Wheel Loader (FEL)	24 Tonnes FEL (CAT 992)	3	Coal
Haulers	90 Tonnes Hauler (CAT 777)	16	Coal/OB
Drill Rigs	DM 45 Diesel	1	HOB
Drill Rigs	DM30 Diesel	2	Coal/OB
Soil Trucks	Bell B40	3	Soil
Soil Loader	CAT 390	1	Soil
Wheel Loader	CAT 988 Class	3	Stockpile loading
SUPPORT FLEET			
	TTT CAT D10 Class	1	Dump
	TTT CAT D10 Class	2	Dump/stockpile
	TTT CAT D9 Class	1	Stockpile/In Pit
	WTT CAT 834H Class	2	Stockpile/In Pit
	GRAD CAT 16M Class	2	Road maintenance
	120KL WT	3	Road maintenance
	12t COMPACTOR	2	Road maintenance
	Telehandler CAT TH514	1	Multi-Purpose
	CAT 980 Tyre Handler	1	Tyre Handler
	Fuel & Lube Truck	4	Service and Diesel

At this preliminary stage of the project, there are no lists of the equipment that will be used at the plant, though the processes that would be required include:

- RoM stockpile, vibrating feeders and primary sizer (crusher);
- Sizing building feed conveyor, secondary sizer and vibrating screens prior to primary and secondary sizers, screen to bypass RoM raw coal, Plant feed vibrating screen;
- Plant feed conveyor, plant bypass conveyor, product feed conveyor, product stockpiles slewing conveyor, discard conveyor to a rejects bin (loaded on trucks);
- Coal preparation modules (dense medium separation or DMS) with a high gravity separation utilising a dense-medium cyclones (DMC);

[3] A sound characterized by brief excursions of sound pressure (transient signal) that significantly exceed the ambient sound level.

- Product and discard drain & rinse screens, magnetic separator;
- Fine coal dewatering and ultra-fine coal (0.15 mm) dewatering in a tailings thickener. Filter plant to dewater thickener underflow;
- Ancillary services including compressed air supply and reticulation, magnetite pit, flocculent preparation system, water clarification and reticulation system.

As with all noises (and with the construction phase), the audibility, as well as the potential of a noise impact on receptors, is determined by factors such as the sound character, spectral frequencies, number and magnitude of maximum noise events, the average noise levels etc. Potential maximum noise levels generated by various equipment and the potential extent of these sounds are presented in **Table 6-1** with **Table 6-2** illustrating the equivalent (average) noise levels and potential extent.

Sound power emission levels as defined in **Table 6-4** will be used in the noise modelling for both the construction and operational phase. Due to various other activities, processes and equipment that are present on a typical project site, area where activities will take place will be included as a noise source (area source generating 65 dBA/m^2)[4].

Table 6-4: Sound power emission levels used for operational phase modelling

Equipment	**Sound power level, dB re1 pW, in octave band, Hz**							**SPL**
Centre frequency	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**(dBA)**
ADT truck – CAT 700 series	107.9	113.2	116.9	114.4	110.6	106.8	100.2	115.9
Bulldozer CAT D11	121.2	112.2	111.4	110.9	110.4	101.5	93.7	113.3
Cement truck (with cement)	104.0	107.0	106.0	108.0	107.0	105.0	102.0	111.7
Diesel Generator (mobile)	107.2	104.0	102.4	102.7	100.2	99.5	97.4	106.1
Coal beneficiation plant	110.6	111.2	110.9	111.2	110.8	107.0	100.6	117.5
Crusher (primary / secondary)	121.1	122.3	120.1	120.0	117.3	112.5	106.3	121.7
Cyclones (hard rock)	100.0	102.9	101.7	103.0	103.2	103.0	101.1	108.8
Drilling Machine (max)	121.6	123.3	118.3	115.3	114.2	113.9	111.3	120.8
Excavator - Hitachi EX1200	112.9	114.3	116.7	107.9	107.6	102.9	102.5	113.1
FEL - CAT 988	105.0	117.0	113.0	114.0	111.0	107.0	101.0	115.6
General noise	95.0	100.0	103.0	105.0	105.0	100.0	100.0	108.8
Grader	100.0	111.0	108.0	108.0	106.0	104.0	98.0	110.9
Mobile Crusher	121.1	122.3	120.1	120.0	117.3	112.5	106.3	109.6
Road Truck average	90.0	101.0	102.0	105.0	105.0	104.0	99.0	109.6
Vibrating Screens	115.0	109.7	105.7	104.2	103.5	103.1	99.9	109.1

[4]Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure (EC WG-AEN, 2006)

6.2.2 Traffic

A source of noise during the operational phase will be traffic to and from the project site, traffic in and around the colliery, ROM and product transport and activities associated with waste management. Estimated round trips are summarized in **Table 6-5**.

Table 6-5: Estimated transport at Gruisfontein (Eksteen, 2018)

Type of Vehicle	Estimated Daily Movements (round trips both)	Peak hourly used for noise model
Work Trips – Cars	52	26
Work Trips – Busses	28	14
Business Trips / Deliveries	40	20
Product transport to ESKOM – 50 ton Tippers	400	28
Product transport to Rail Siding – 50 ton Tippers	400	28

All vehicles will travel at an average speed of 60 km/h on access roads and 40 km/h within the mine boundary. Coal hauling will only take place during the daylight hours.

6.2.3 Blasting

Blasting will not be considered in this report for the reasons defined in **section 6.1.3**.

6.3 POTENTIAL NOISE SOURCES: FUTURE NOISE SCENARIO – DECOMMISSIONING

The Decommissioning Phase is considered as the phase which begins after the last coal is removed from the mine area and ends when the mine receives a Closure certificate from the DMR.

Rehabilitation normally takes place concurrently with mining, and final rehabilitation allows for the backfilling of all the remaining material and building rubble into the open pit area and the sloping of the high-wall areas.

Activities that can take place include:

- Decommissioning and rehabilitation of the remaining infrastructure unless it is required for post-mining impact management or for the final end land use. This includes the following:
    - Removal of all remaining redundant infrastructure.
    - Removal of any contaminated soil.

- The rehabilitation of disturbed areas including the necessary ripping of compacted soils and the shaping of rehabilitated areas to ensure free drainage.
- Placement of topsoil on rehabilitated surface areas followed by seeding (if necessary to re-establish vegetation).
- Monitoring and maintenance of the rehabilitated areas.
- Application for a Closure Certificate for the site.

However, while there are numerous activities that can take place during the decommissioning stage, the potential noise impact will only be discussed in general. This is because the noise impacts associated with the decommissioning phase is normally less than both the construction and operational phases for the following reasons:

- Final decommissioning normally takes place only during the day, a time period when existing ambient sound levels are higher, generally masking most external noises for surrounding receptors; and
- There is a lower urgency of completing this phase and less equipment remains onsite (and are used simultaneously) to affect the final decommissioning.

7 METHODS: NOISE IMPACT ASSESSMENT AND SIGNIFICANCE

7.1 NOISE IMPACT ON ANIMALS[5]

A significant amount of research was undertaken during the 1960's and 70's on the effects of aircraft noise on animals. While aircraft noise has a specific characteristic that might not be comparable with industrial noise, the findings should be relevant to most noise sources. A general animal behavioural reaction to aircraft noise is the startle response with the strength and length of the startle response to be dependent on the following:

- which species is exposed;
- whether there is one animal or a group of animals, and
- whether there have been some previous exposures.

Overall, the research suggests that species differ in their response to noise depending on the duration, magnitude, characteristic and source of the noise, as well as how accustomed the animals are to the noise (previous exposure).

Extraneous noises impact on animals as it can increase stress levels and even impact on their hearing. Masking sounds may affect their ability to react to threats, compete and seek mates and reproduce, hunt and forage, communicate and generally to survive.

Unfortunately, there are numerous other factors in the faunal environment that also influence the effects of noise. These include predators, weather, changing prey/food base and ground-based disturbance, especially anthropogenic. This hinders the ability to define the real impact of noise on animals.

The only animal species studied in detail are humans, and studies are still continuing in this regard. These studies also indicate that there is considerable variation between individuals, highlighting the loss of sensitivity to higher frequencies as human's age. Sensitivity also varies with frequency with humans. Considering the variation in the sensitivity to frequencies and between individuals, this is likely similar with all faunal species. Some of these studies are repeated on animals, with behavioural hearing tests being able to define the hearing threshold range for some animals as indicated on **Figure 7-1** below.

Only a few faunal (animal) species have been studied in a bit more detail so far, with the potential noise impact on marine animals most likely the most researched subject, with a few studies that discuss behavioural changes in other faunal species due to increased

[5]Report to Congressional Requesters, 2005; USEPA, 1971; Autumn, 2007; Noise quest, 2010; Manci, 1988

noises. Few studies indicate definitive levels where noises start to impact on animals, with most based on laboratory level research that subject animals to noise levels that are significantly higher than the noise levels these animals may experience in their environment (excluding the rare case where bats and avifauna fly extremely close to an anthropogenic noise, such as from a moving car or the blades of a wind turbine).

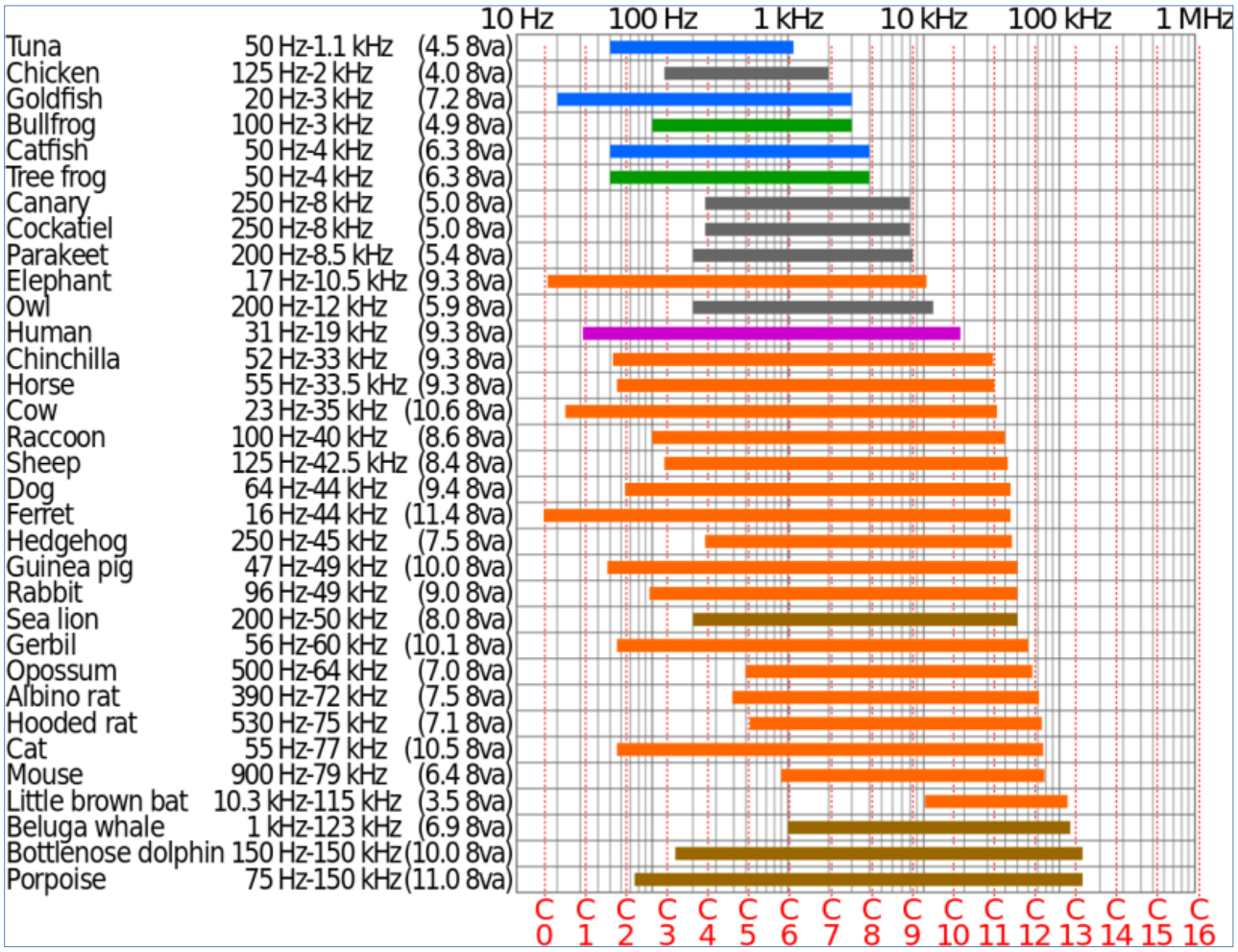


Figure 7-1: Logarithmic Chart of the Hearing Ranges of Some Animals[6]

7.1.1 Domestic Animals

It may be that domesticated animals are more accustomed to noise sources of an industrial, commercial or other anthropogenic nature, although exposure to high noise levels may affect domestic animals' well-being. Sound levels in animal shelters can exceed 100 dB, much more than what can be expected at a domestic dwelling from an industrial, commercial or transportation noise source (10 minute equivalent)[7&8].The high noise levels

[6] https://en.wikipedia.org/wiki/Hearing_range
[7] Crista L. Coppola. Noise in the Animal Shelter Environment: Building Design and the Effects of Daily Noise Exposure.
[8] David Key, Essential Kennel Designs.

may see negative influences on animals' cardiovascular systems and behaviour, and may be damaging to the hearing of dogs in the kennel facility[9].

Domesticated animals may also respond differently to noises than animals in the wild. Domesticated dogs are pack animals and may respond excitedly or vocally to other noises, smells, visual and other stimulants, in contrast to wild animals that may flee due to any slight unfamiliar sounds or noises. Animals that are transported at least once in their life (such as pigs to an abattoir) would endure high noise levels for the duration of the delivery period. A change in the heart rate, renal blood flow and blood pressure of study subjects were noted in the above studies. How small changes (in environmental noise levels) may impact on domesticated animals has not been studied.

Accordind to Šottník, 2011, noise as high as 80 dB had no negative effect on dairy cows. As noise levels increased (up to 105 dB), feed consumption, milk yield and intensity of milk release decreased. Gygax and Nosal (2006) investigated the effect of vibration and noise on somatic cell counts (SCC) in milk, highlighting that SCC increased with an increasing intensity of vibration but not with acoustic noise. The study reported vibration as m/s^2, with SCC increasing as vibration increases above 0.1 m/s^2.

Unexpected high intensity noise (above 110 dB), such as low altitude jet aircraft overflights at milking time could reduce effectiveness of the milk ejection reflex, decrease efficiency of milk removal, increase residual milk, and lead to overall reduction in milk yield. However, a majority of the studies reviewed suggests that there is little or no effect of aircraft noise on cattle. Adverse effects of low-altitude flights have been noted in some studies but have not been uniformly reproduced in other reports (Manci, 1988).

7.1.2 Wildlife

Many natural based acoustics themselves may be loud or impulsive. Examples include thunder, wind induced noises that could easily exceed 35 dBA ($L_{A90,fast}$) above wind speeds averaging 6 m/s, noise levels during early morning dawn chorus or loud cicada noises during late evening or early morning.

Potential noise impacts on wildlife are very highly species dependent. Studies showed that most animals adapt to noises and would even return to a site after an initial disturbance, even if the noise continues. The more sensitive animals that might be impacted by noise would most likely relocate to a quieter area. Stress levels can increase in animals restricted to areas where the sound levels are impacting on them (due to the level,

[9]Wei, B. L. (1969). Physiological effects of audible sound. AAAS Symposium Science, 166(3904), 533-535.

character or both). Sound levels above about 90 dB are likely to be adversive to mammals and are associated with a number of behaviours such as retreat from the sound source, freezing, or a strong startle response. Manci (1988) highlighted that sound levels below about 90 dB usually causes much less adversive behaviour. Laboratory studies of domestic mammals have indicated that behavioural responses vary with noise types and levels, and that domestic animals appear to acclimate to some sound disturbances (see also Annexure C).

7.1.3 Avifauna[10]

Noise impacts on birds include:

- It can cause hearing damage (very loud or loud impulsive sounds);
- It can increase stress levels (directly and indirectly);
- Masking (directly or indirectly) the sounds of their food, predators or mates;
- Their typical food sources may move;
- Relocation to less suitable habitats; and
- other behavioral reactions.

As with the impact on other wildlife, the impact of noise on avifauna depends on the character of the noise (including the impulsive character), the magnitude or intensity of the noise as well as the familiarity the birds have with the sound.

Similarly, different birds change their response to these sounds differently. Some may not be impacted while more sensitive species may relocate, some birds –

- may start to sing at different times;
- may change the frequency, pitch or character of their calls/singing/signals; or/and
- increase the volume of their calls/singing/signals.

As with other animals, there are no guidelines or even studies highlighting acceptable sound levels or other criteria before noise may start to impact on birds.

7.1.4 Laboratory Animal Studies

Although many laboratory animals have wild counterparts (rats, mice) the laboratory test subjects differ in many aspects (genetics, behaviour etc.). Also noise levels of studies are conducted at generally very high levels at over 100 dB, much more than what would be experienced in environmental settings around industrial, commercial or transportation activities.[11] Other dissimilarities to laboratory tests and a natural environment include the

[10] Ortega, 2012; Halfwerk, 2011; Francis, 2012; Francis, 2011; Parris, 2009, Brumm, 2004.
[11]USEPA, 1971.

time exposure (duration of noise), the spectral and noise character (impulsive noise vs. constant noise) etc. Although there exists dissimilarities in tests conducted and noise levels around commercial and industrial environments, laboratory rodents exposed to high noise levels did indicated physiological, behavioural changes, hearing loss and other such effects[12].

7.1.5 Summary: Impact of noises on Animals

From these and other studies the following can be concluded that:

- Animals respond to impulsive (sudden) noises (higher than 90 dB) by running away. If the noises continue, animals would try to relocate (Brouček, 2014).
- Animals start to respond to increased noise levels with elevated stress hormone levels and hypertension. These responses begin to appear at exposure levels of 55 to 60 dBA (Barber, 2010).
- Animals of most species exhibit adaptation with noise (Brouček, 2014), including impulsive noises, by changing their behaviour.
- More sensitive species would relocate to a more quiet area, especially species that depend on hearing to hunt or evade prey, or species that makes use of sound/hearing to locate a suitable mate (Dooling, 2007).
- Noises associated with helicopters, motor- and quad bikes does significantly impact on animals. This is due to the sudden and significant increase in noise levels due to these activities.

To date there are, however, no guidelines or sound limits with regards to noise levels that can be used to estimate the potential significance of noises on animals.

7.2 WHY NOISE CONCERNS COMMUNITIES[13]

Noise can be defined as "unwanted sound", and an audible acoustic energy that adversely affects the physiological and/or psychological well-being of people, or which disturbs or impairs the convenience or peace of any person. One can generalise by saying that sound becomes unwanted when it:

- Hinders speech communication;
- Impedes the thinking process;
- Interferes with concentration;
- Obstructs activities (work, leisure and sleeping); and

[12] Baldwin, 2007.
[13]World Health Organization, 1999; Noise quest, 2010; Journal of Acoustical Society of America, 2009

- Presents a health risk due to hearing damage.

However, it is important to remember that whether a given sound is "noise" depends on the listener or hearer. The driver playing loud rock music on their car radio hears only music, but the person in the traffic behind them hears nothing but noise.

Response to noise is unfortunately not an empirical absolute, as it is seen as a multi-faceted psychological concept, including behavioural and evaluative aspects. For instance, in some cases, annoyance is seen as an outcome of disturbances, in other cases it is seen as an indication of the degree of helplessness with respect to the noise source.

Noise does not need to be loud to be considered "disturbing". One can refer to a dripping tap in the quiet of the night, or the irritating "thump-thump" of the music from a neighbouring house at night when one would like to sleep.

Severity of the annoyance depends on factors such as:

- Background sound levels, and the background sound levels the receptor is used to;
- The manner in which the receptor can control the noise (helplessness);
- The time, unpredictability, frequency distribution, duration, and intensity of the noise;
- The physiological state of the receptor; and
- The attitude of the receptor about the emitter (noise source).

7.3 IMPACT ASSESSMENT CRITERIA

7.3.1 Overview: The common characteristics

The word "noise" is generally used to convey a negative response or attitude to the sound received by a listener. There are four common characteristics of sound, any or all of which determine listener response and the subsequent definition of the sound as "noise". These characteristics are:

- Intensity;
- Loudness;
- Annoyance; and
- Offensiveness.

Of the four common characteristics of sound, intensity is the only one which is not subjective and can be quantified. Loudness is a subjective measure of the effect sound has

on the human ear. As a quantity it is therefore complicated, but has been defined by experimentation on subjects known to have normal hearing.

The annoyance and offensive characteristics of noise are also subjective. Whether or not a noise causes annoyance mostly depends upon its reception by an individual, the environment in which it is heard, the type of activity and mood of the person and how acclimatised or familiar that person is to the sound.

7.3.2 Noise criteria of concern

The criteria used in this report were drawn from the criteria for the description and assessment of environmental impacts considering the latest EIA Regulations, SANS 10103:2008 as well as guidelines from the World Health Organization.

There are a number of criteria that are of concern for the assessment of noise impacts. These can be summarised in the following manner:

- *Increase in noise levels:* People or communities often react to an increase in the ambient noise level they are used to, which is caused by a new source of noise. With regards to the Noise Control Regulations (promulgated in terms of the ECA), an increase of more than 7 dBA is considered a disturbing noise. See also **Figure 7-2**.
- *Zone Sound Levels:* Previously referred to as the acceptable rating levels, it sets acceptable noise levels for various areas. See also **Table 7-1**.
- *Absolute or total noise levels:* Depending on their activities, people generally are tolerant to noise up to a certain absolute level, e.g. 65 dBA. Anything above this level will be considered unacceptable.

In South Africa, the document that addresses the issues concerning environmental noise is SANS 10103:2008 (See also **Table 7-1**). It provides the equivalent ambient noise levels (referred to as Rating Levels), $L_{Req,d}$ and $L_{Req,n}$, during the day and night respectively to which different types of developments may be exposed.

Acoustical measurements indicated an area where the ambient sound levels are typically of a rural noise district, and the potential noise impact was evaluated in terms of (i.t.o.) the following Zone Sound Levels (proposed rating levels):

- "Rural District suitable for residential use" (45 and 35 dBA day/night-time Rating i.t.o. SANS 10103:2008).
- "Equator principles" (55 and 45 dBA day/night-time Rating i.t.o. IFC Noise Limits).

Considering the information contained in **section 7.1** and **7.1.5**, animals start to respond to increased noise levels of 55 to 60 dBA (Barber, 2010). This report will use the projected noise level of 55 dBA to define the extent of potential influence on animals.

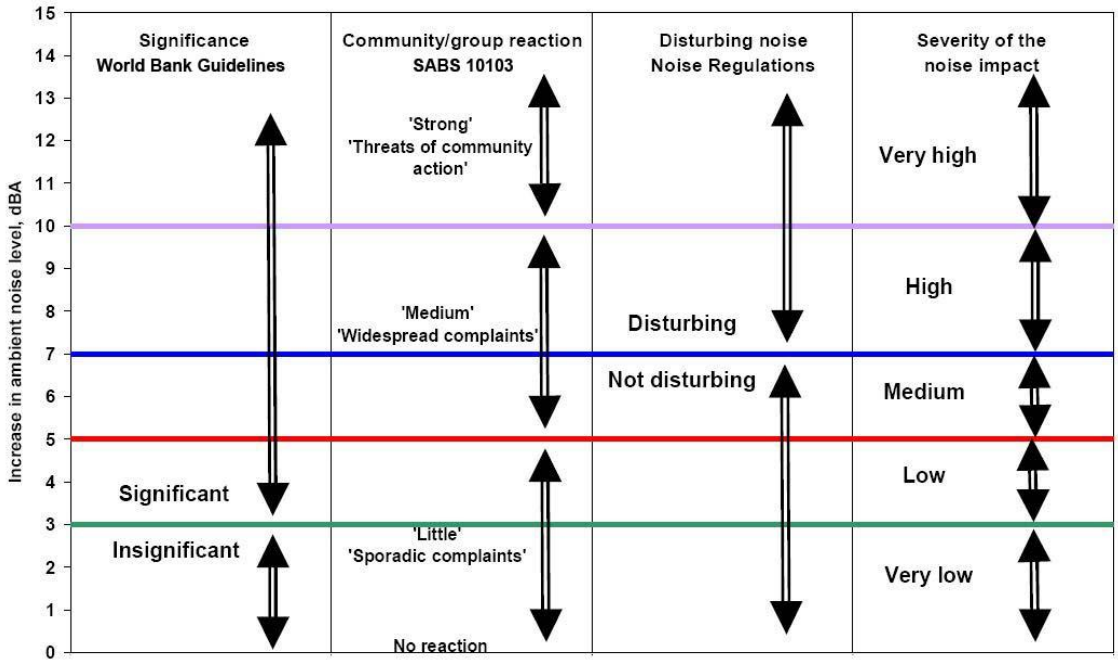


Figure 7-2: Criteria to assess the significance of impacts stemming from noise

SANS 10103:2008 also provides a guideline for estimating community response to an increase in the general ambient noise level caused by an intruding noise. If Δ is the increase in sound level, the following criteria are of relevance:

- **Δ ≤ 3 dBA:** An increase of 3 dBA or less will not cause any response from a community. It should be noted that for a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level would not be noticeable.
- **3 < Δ ≤ 5 dBA:** An increase of between 3 dBA and 5 dBA will elicit 'little' community response with 'sporadic complaints'. People will just be able to notice a change in the sound character in the area.
- **5 < Δ ≤ 15 dBA:** An increase of between 5 dBA and 15 dBA will elicit a 'medium' community response with 'widespread complaints'. In addition, an increase of 10 dBA is subjectively perceived as a doubling in the loudness of a noise. For an increase of more than 15 dBA the community reaction will be 'strong' with 'threats of community action'.

Note that an increase of more than 7 dBA is defined as a disturbing noise and prohibited (National and Provincial Noise Control Regulations).

Table 7-1: Acceptable Zone Sound Levels for noise in districts (SANS 10103:2008)

1	2	3	4	5	6	7
Type of district	**Equivalent continuous rating level ($L_{Req,T}$) for noise** dBA					
	Outdoors			**Indoors, with open windows**		
	Day/night $L_{R,dn}$[a]	**Daytime $L_{Req,d}$**[b]	**Night-time $L_{Req,n}$**[b]	**Day/night $L_{R,dn}$**[a]	**Daytime $L_{Req,d}$**[b]	**Night-time $L_{Req,n}$**[b]
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts with one or more of the following: workshops; business premises; and main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

7.3.3 Other noise sources of significance

In addition, other noise sources that may be present should also be considered. During the day, people are generally bombarded with the sounds from numerous sources considered "normal", such as animal sounds, conversation, amenities and appliances (TV/Radio/CD playing in background, computer(s), freezers/fridges, etc.). This excludes activities that may generate additional noise associated with normal work.

At night, sounds that are present are natural sounds from animals, wind as well as other sounds we consider "normal", such as the hum from a variety of appliances (magnetostriction) drawing standby power, freezers and fridges.

7.3.4 Determining the Significance of the Noise Impact

Regulation 50(c), of the MPRDR (2004) under the MPRDA (2002) requires an assessment of the nature (status), extent, duration, probability and significance of the identified potential environmental impacts of the proposed mining operation.

The level of detail as depicted in the EIA regulations was fine-tuned by assigning specific values to each impact. In order to establish a coherent framework within which all impacts could be objectively assessed, it was necessary to establish a rating system, which was applied consistently to all the criteria. For such purposes each aspect was assigned a value as defined in the third column in the tables below.

The impact consequence is determined by summing the scores of Magnitude (**Table 7-2**), Duration (**Table 7-3**) and Spatial Extent (**Table 7-4**). The impact significance (see **Sections 7.3.5** and **Section 7.3.6**) is determined by multiplying the Consequence result with the Probability score (**Table 7-5**). An explanation of the impact assessment criteria is defined in the following tables.

Table 7-2: Impact Assessment Criteria – Magnitude

This defines the impact as experienced by any receptor. In this report the receptor is defined as any resident in the area, but excludes faunal species.		
Rating	**Description**	**Score**
Low	Increase in average sound pressure levels between 0 and 3 dB from the expected ambient sound levels. Ambient sound levels are defined by the lower of the measured $L_{AIeq,8hr}$ or $L_{AIeq,16hr}$ during measurement dates. Total projected noise level is less than the Zone Sound Level and/or IFC noise limits in wind-still conditions.	2
Low Medium	Increase in average sound pressure levels between 3 and 5 dB from the expected ambient sound levels. Total projected noise levels between 3 and 5 above the Zone Sound Level and/or IFC noise limits (wind-less conditions).	4
Medium	Increase in average sound pressure levels between 5 and 7 dB from the ambient sound levels. Increase in sound pressure levels between 5 and 7 above the Zone Sound Level and/or IFC noise limits (wind-less conditions). Sporadic complaints expected.	6
High	Increase in average sound pressure levels between 7 and 10 from the ambient sound level. Total projected noise levels between 7 and 10 dBA above the Zone Sound Level and/or IFC noise limits (wind-less condition). Medium to widespread complaints expected.	8
Very High	Increase in average ambient sound pressure levels higher than 10 dBA. Total projected noise levels higher than 10 dB above the Zone Sound Level and/or IFC noise limits (wind less-conditions). Change of 10 dBA is perceived as 'twice as loud', leading to widespread complaints and even threats of community or group action. Any point where instantaneous noise levels exceed 65 dBA at any receptor.	10

Table 7-3: Impact Assessment Criteria - Duration

The lifetime of the impact that is measured in relation to the lifetime of the proposed development (construction, operational and closure phases). Will the receptors be subjected to increased noise levels for the lifetime duration of the project, or only infrequently.		
Rating	**Description**	**Score**
Temporary	Impacts are predicted to be of short duration (portion of construction period) and intermittent/occasional.	1
Short term	Impacts that are predicted to last only for the duration of the construction period.	2
Long term	Impacts that will continue for the life of the Project, but ceases when the Project stops operating.	4
Permanent	Impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially	5

	beyond the Project lifetime.	

Table 7-4: Impact Assessment Criteria – Spatial extent

Classification of the physical and spatial scale of the impact		
Rating	**Description**	**Score**
Site	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.	1
Local	The impact could affect the local area (within 1,000 m from site).	2
Regional	The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns (further than 1,000 m from site).	3
National	The impact could have an effect that expands throughout the country (South Africa).	4
International	Where the impact has international ramifications that extend beyond the boundaries of South Africa.	5

Table 7-5: Impact Assessment Criteria - Probability

This describes the likelihood of the impacts actually occurring, and whether it will impact on an identified receptor. The impact may occur for any length of time during the life cycle of the activity, and not at any given time. The classes are rated as follows:		
Rating	**Description**	**Score**
Improbable	The possibility of the impact occurring is none, due either to the circumstances, design or experience. The chance of this impact occurring is zero (0%).	1
Possible	The possibility of the impact occurring is very low, due either to the circumstances, design or experience. The chances of this impact occurring is defined to be up to 25%.	2
Likely	There is a possibility that the impact will occur to the extent that provisions must therefore be made. The chances of this impact occurring is defined to be between 25% and 50%.	3
Highly Likely	It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up before carrying out the activity. The chances of this impact occurring is defined between 50% and 75%.	4
Definite	The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied on. The chance of this impact occurring is defined to be between 75% and 100%.	5

In order to assess each of these factors for each impact, the following ranking scales as contained in **Table 7-6** were used.

7.3.5 Identifying the Potential Impacts without Mitigation Measures (WOM)

Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned probabilities, resulting in a Significance Rating (SR) value for each impact (prior to the implementation of mitigation measures).

7.3.6 Identifying the Potential Impacts with Mitigation Measures (WM)

In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it was necessary to re-evaluate the impact. Significance with mitigation is rated on the following scale:

Table 7-6: Assessment Criteria: Ranking Scales

PROBABILITY		**MAGNITUDE**	
Description / Meaning	**Score**	**Description / Meaning**	**Score**
Definite/don't know	5	Very high/don't know	10
Highly likely	4	High	8
Likely	3	Medium	6
Possible	2	Low Medium	4
Improbable	1	Low	2
DURATION		**SPATIAL SCALE**	
Description / Meaning	**Score**	**Description / Meaning**	**Score**
		International	5
Permanent	5	National	4
Long Term	4	Regional	3
Short term	2	Local	2
Temporary	1	Footprint	1

Table 7-7: Significance without mitigation

SR<30	Low (L)	Impacts with little real effect and which should not have an influence on or require modification of the project design or alternative mitigation. No mitigation is required.
30<**SR** <60	Medium (M)	Where it could have an influence on the decision unless it is mitigated. An impact or benefit which is sufficiently important to require management. Of moderate significance - could influence the decisions about the project if left unmanaged.
SR>60	High (H)	Impact is significant, mitigation is critical to reduce impact or risk. Resulting impact could influence the decision depending on the possible mitigation. An impact which could influence the decision about whether or not to proceed with the project.

Table 7-8: Significance with mitigation

SR<30	Low (L)	The impact is mitigated to the point where it is of limited importance.
30<**SR** <60	Medium (M)	Notwithstanding the successful implementation of the mitigation measures, to reduce the negative impacts to acceptable levels, the negative impact will remain of significance. However, taken within the overall context of the project, the persistent impact does not constitute a fatal flaw.
SR>60	High (H)	The impact is of major importance. Mitigation of the impact is not possible on a cost-effective basis. The impact is regarded of high importance and taken within the overall context of the project, is regarded as a fatal flaw. An impact regarded as high significance, after mitigation could render the entire development option or entire project proposal unacceptable.

8 ASSUMPTIONS AND LIMITATIONS

8.1 MEASUREMENTS OF AMBIENT SOUND LEVELS

- Ambient sound levels are the cumulative effects of innumerable sounds generated at various instances both far and near. High measurements may not necessarily mean that noise levels in the area are high. Similarly, a low sound level measurement will not necessarily mean that the area is always quiet, as sound levels will vary over seasons, time of the day, faunal characteristics, vegetation in the area and meteorological conditions (especially wind). This is excluding the potential effect of sounds from anthropogenic origin. It is impossible to quantify and identify the numerous sources that influenced a measurement using the reading result at the end of the measurement. Therefore trying to define ambient sound levels using the result of one 10-minute measurement will be very inaccurate (very low confidence level in the results) for the reasons mentioned above (one of the reasons why long-term measurements were collected). The more measurements that can be collected at a location the higher the confidence levels in the ambient sound level determined. When short-term measurements was collected, one should be cautious and consider other sound descriptors (such as L_{A90} values), together with an opinion of the character of the area.
- It is assumed that the measurement locations represent other residential dwellings in the area (similar environment), yet, in practice this can be highly erroneous as there are numerous factors that can impact on ambient sound levels, including:
    - the distance to closest trees, number and type of trees as well as the height of trees;
    - available habitat and food for birds and other animals;
    - distance to residential dwelling, type of equipment used at dwelling (compressors, air-cons);
    - general maintenance condition of house (especially during windy conditions); and
    - number and type of animals kept in the vicinity of the measurement locations (typical land use taking place around the dwelling).
- Exact location of a sound level meter in an area in relation to structures, infrastructure, vegetation and external noise sources will influence measurements. It may determine whether one is measuring anthropogenic sounds from a receptors dwelling, or environmental ambient soundscape contributors of significance (faunal, road traffic, railway line movement etc.). At times there are extraneous noises that cannot be heard during deployment, or not operational, that can significantly impact on readings (such as water pumps, transformers, faunal communication, etc.).

- Determination of existing road traffic and other noise sources of significance are important (traffic counts etc.). Traffic however is highly dependent on the time of day as well as general agricultural activities taking place during the site investigation. Traffic noise is one of the major components in urban areas and could be a significant source of noise during busy periods. Traffic may be audible at distances up to 3,000 m during quiet periods (little faunal and other noises), especially if the wind blows from the road to the receptors. The Gruisfontein Focus area is located in an area with a rural developmental character and existing traffic noises are minimal and of no concern.
- Measurements over wind speeds of 3 m/s could provide data influenced by wind-induced noises. While the windshields used limits the effect of fluctuating pressure across the microphone diaphragm, the effect of wind-induced noises in the trees in the vicinity of the microphone did impact on the ambient sound levels. The site visit coincided with relatively low winds.
- Ambient sound levels are dependant not only on time of day and meteorological conditions, but also change due to seasonal differences. Ambient sound levels are generally higher in summer months when faunal activity is higher and lower during the winter due to reduced faunal activity. Many faunal species are more active during warmer periods than colder periods. Certain cicada species can generate noise levels up to 120 dB for mating or distress purposes, sometimes singing in synchronisation magnifying noise levels they produce from their tymbals[14]. Winter months unfortunately also coincide with lower temperatures and very stable atmospheric conditions, ideal conditions for propagation of noise though faunal activity (and sounds) may be significantly lower.
- Ambient sound levels recorded near rivers, streams, wetlands, trees and bushy areas can be high. This is due to faunal activity which can dominate the sound levels around the measurement location. This generally is still considered naturally quiet and understood and accepted as features of the natural soundscape, and in various cases sought after and pleasing.
- Considering one or more sound descriptor or equivalent can improve an acoustical assessment. Parameters such as L_{AMin}, L_{AIeq}, L_{AFeq}, L_{Ceq}, L_{AMax}, L_{A10}, L_{A90} and spectral analysis forms part of the many variables that can be considered.
- As a residential area develops the presence of people will result in increased sounds. These are generally a combination of traffic noise, voices, animals and equipment (incl. TV's and Radios). The result is that ambient sound levels will increase as an area matures.

[14]Clyne, D. *"Cicadas: Sound of the Australian Summer, Australian Geographic"* Oct/Dec Vol 56. 1999.

8.2 CALCULATING NOISE EMISSIONS – ADEQUACY OF PREDICTIVE METHODS

The noise emissions into the environment from the various sources as defined were calculated for the construction and operational phases in detail, using the sound propagation model described in ISO 9613-2.

The following was considered:

- The octave band sound pressure emission levels of processes and equipment;
- The distance of the receiver from the noise sources;
- The impact of atmospheric absorption;
- The operational details of the proposed project, such as projected areas where activities will be taking place;
- Topographical layout; and
- Acoustical characteristics of the ground. 50% soft ground conditions were modelled, as the area where the mining activity would be taking place is well vegetated and sufficiently uneven to allow the consideration of relatively soft ground conditions. This is because the use of hard ground conditions could represent a too precautionary situation.

The noise emission into the environment due to additional traffic was calculated using the sound propagation model described in RLS-90 used in Germany. Corrections such as the following were considered:

- Distance of receptor from the road;
- Road construction material;
- Average speeds of travel;
- Types of vehicles used; and
- Ground acoustical conditions.

Model development and noise mapping were done considering the guideline provided by the EPA (2011). The potential worst-case is considered at all times. In this project noise maps illustrates the potential extent of the calculated noises at a potential moment in time. The extent of noises is used to define potential issues of concern and not to predict a noise level at a potential noise-sensitive receptor. For this the selected model is internationally recognised and considered adequate.

8.3 ADEQUACY OF UNDERLYING ASSUMPTIONS

Noise experienced at a certain location is the cumulative result of innumerable sounds emitted and generated both far and close, each in a different time domain, each having a different spectral character at a different sound level. Each of these sounds are also

impacted differently by surrounding vegetation, structures and meteorological conditions that result in a total cumulative noise level represented by a few numbers on a sound level meter.

As previously mentioned, it is not the purpose of noise modelling to accurately determine a likely noise level at a certain receptor, but to calculate a noise rating level that is used to identify potential issues of concern.

8.4 UNCERTAINTIES ASSOCIATED WITH MITIGATION MEASURES

Any noise impact can be mitigated to have a low significance; however, the cost of mitigating this impact may be prohibitive, or the measure may not be socially acceptable (such as the relocation of a NSD). These mitigation measures may be engineered, technological or due to management commitment.

For the purpose of the determination of the significance of the noise impact mitigation measures were selected that is feasible, mainly focussing on management of noise impacts using rules, policy and require a management commitment. This however does not mean that noise levels cannot be reduced further, only that to reduce the noise levels further may require significant additional costs (whether engineered, technological or management).

It was assumed the mitigation measures proposed for the construction phase will be implemented and continued during the operational phase.

8.5 UNCERTAINTIES OF INFORMATION PROVIDED

While it is difficult to define the character of a measured noise in terms of numbers (third octave sound power levels), it is difficult to accurately model noise levels at a receptor from any operation. The projected noise levels are the output of a numerical model with the accuracy depending on the assumptions made during the setup of the model. The assumptions include the following:

- That octave sound power levels selected for processes and equipment accurately represent the sound character and power levels of these processes and equipment. The determination of octave sound power levels in itself is subject to errors, limitations and assumptions with any potential errors carried over to any model making use of these results;

- Sound power emission levels from processes and equipment changes depending on the load the process and equipment is subject to. While the octave sound power level is the average (equivalent) result of a number of measurements, this measurement relates to a period that the process or equipment was subject to a certain load (work required from the engine or motor to perform action). Normally these measurements are collected when the process or equipment is under high load. The result is that measurements generally represent a worse-case scenario;
- As it is unknown which processes and equipment will be operational (when and for how long), modelling considers a scenario where processes and equipment are under full load for a set time period. Modelling assumptions complies with the precautionary principle and operational time periods are frequently overestimated. The result is that projected noise levels would be likely over-estimated;
- Modelling cannot capture the potential impulsive character of a noise that can increase the potential nuisance factor;
- The XYZ topographical information is derived from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global DEM data, a product of Japan's Ministry of Economy, Trade, and Industry (METI) and the National Aeronautical and Space Administration (NASA). There are known inaccuracies and artefacts in the data set, yet this is still one of the most accurate data sets to obtain 3D-topographical information;
- The impact of atmospheric absorption is simplified and very uniform meteorological conditions are considered. This is an over-simplification and the effect of this in terms of sound propagation modelling is difficult to quantify, and
- Acoustical characteristics of the ground are over-simplified with ground conditions accepted as uniform. Fifty percent (50%) soft ground conditions will be modelled as the area where the construction activities are proposed is well vegetated and sufficiently uneven to allow the consideration of soft ground conditions.

9 PROJECTED NOISE RATING LEVELS

9.1 CURRENT NOISE LEVELS (CONCEPTUAL)

The focus area is located far from busy roads, railway lines and industrial activities and the existing ambient sound levels are low and typical of an undeveloped, natural soundscape.

9.2 PROPOSED CONSTRUCTION PHASE NOISE IMPACT

This section investigates the proposed construction activities as discussed in **section 6.1**. There may be a number of smaller equipment operating in the area, but the addition of a general noise source (at each location where activities can take place) covers most of these noise sources.

Potential activities were conceptualised as illustrated in **Figure 9-1** with the sound power levels used defined in **Table 6-4**. All noise sources generate the noises 2 m above the ground surface. This is a worst-case scenario and the projected noise levels will be higher than the actual noise levels that will occur.

The potential extent of the noise from construction activities are presented in the figures as follows:

- **Figure 9-2**: Contours of equal noise rating levels as calculated for the conceptual daytime activities; and,
- **Figure 9-3**: Contours of equal noise rating levels as calculated for the conceptual night-time activities.

Projected construction noise levels are less than 35 dBA at all NSDs. Noise levels only exceed 55 dBA close to the projected activities (within 250 m).

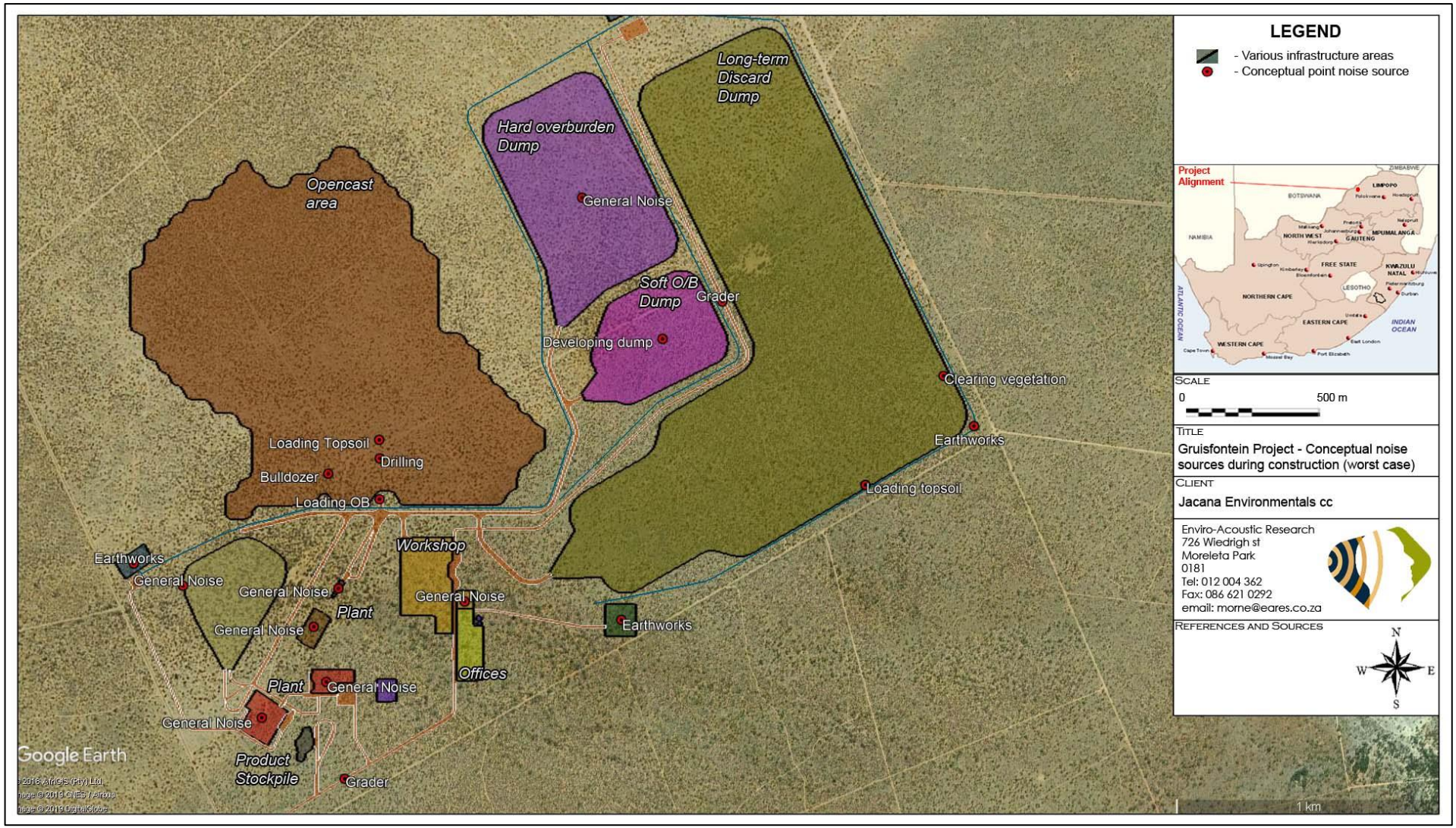


Figure 9-1: Conceptual construction noise sources

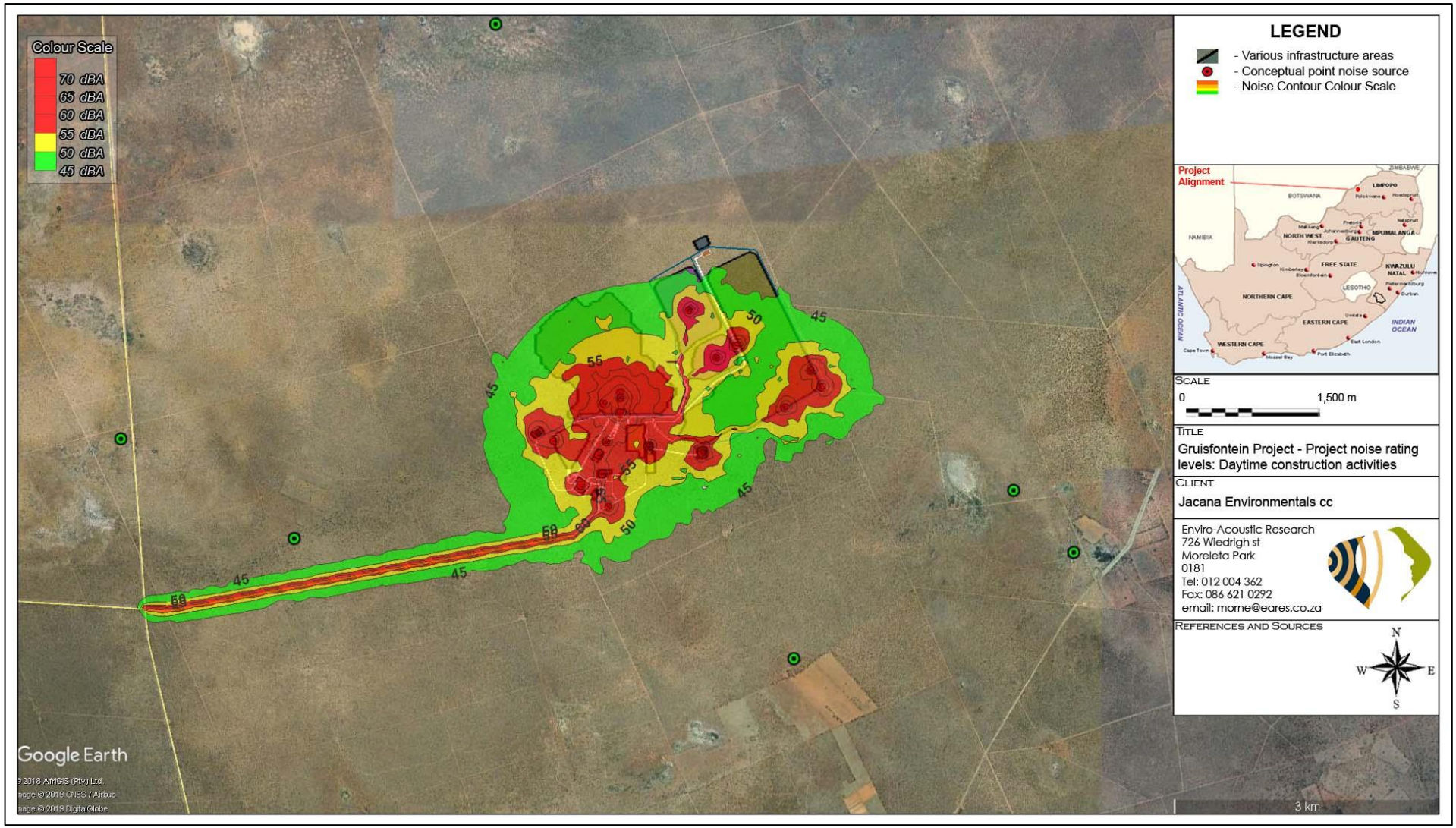


Figure 9-2: Projected conceptual daytime noise rating level contours due to construction activities

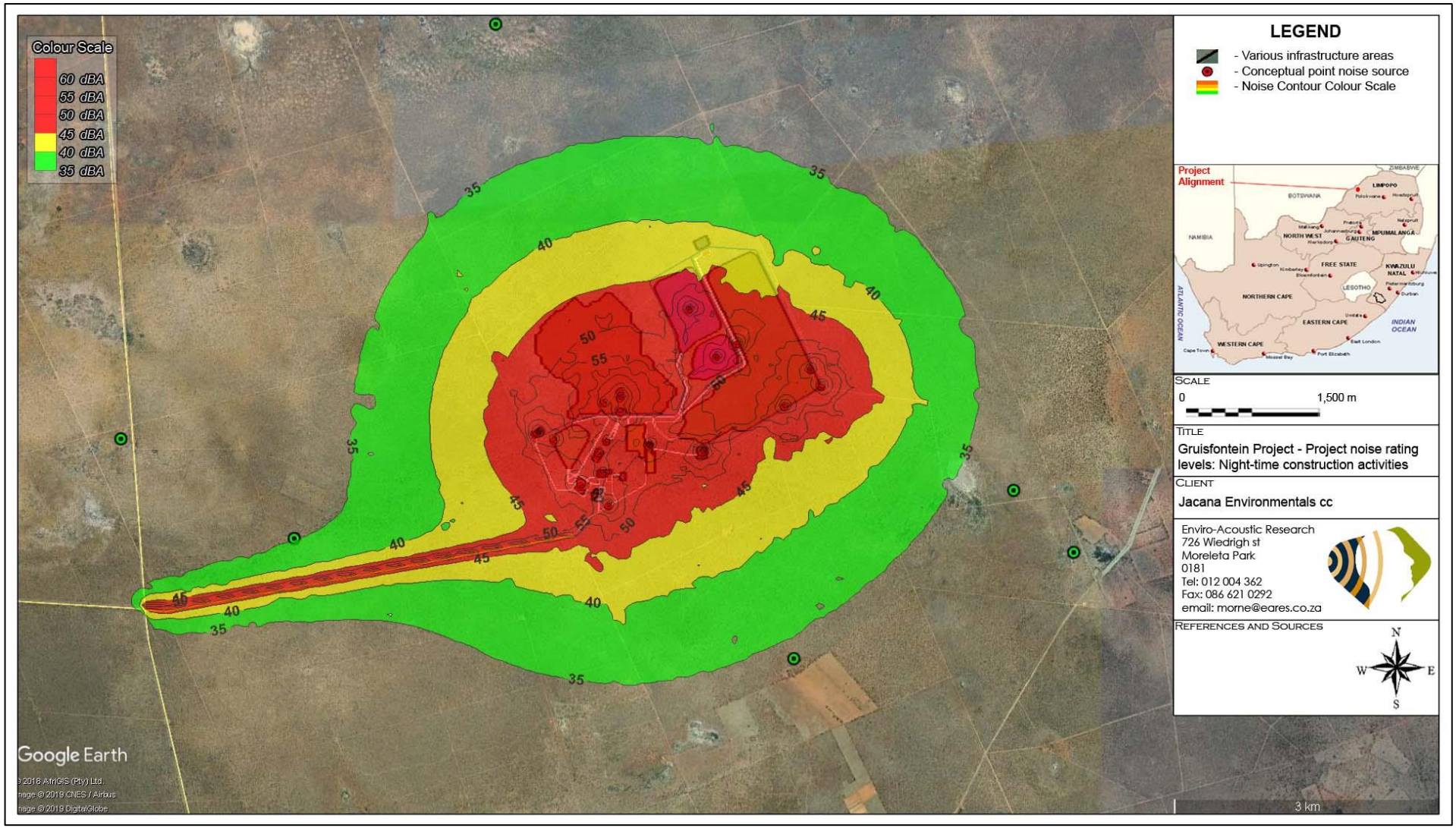


Figure 9-3: Projected conceptual night-time noise rating level contours due to construction activities

9.3 OPERATIONAL PHASE NOISE IMPACT

This section investigates the proposed operational activities as discussed in **Section 6.2**. A worst case scenario will be evaluated, with all equipment operating under full load, 24 hours per day.

These activities were conceptualised as illustrated in **Figure 9-4** with the octave sound power levels used in the model defined in **Table 6-4**. All noise sources generate the noises 2 m above the ground surface.

The potential extent of the noise from operational activities is presented in the figures as follows:

- **Figure 9-5**: Contours of equal noise rating levels as calculated for the conceptual daytime activities; and,
- **Figure 9-6**: Contours of equal noise rating levels as calculated for the conceptual night-time activities.

Projected operational noise levels may exceed 35 dBA at NSD04 and 06.

9.4 DECOMMISSIONING AND CLOSURE PHASE NOISE IMPACT

The potential for a noise impact to occur during the decommissioning and closure phase is much lower than the construction and operational phases. The noise impact during this phase is generally significantly less than the operational phase, as there is a lower urgency to complete the phase. It was therefore not investigated further.

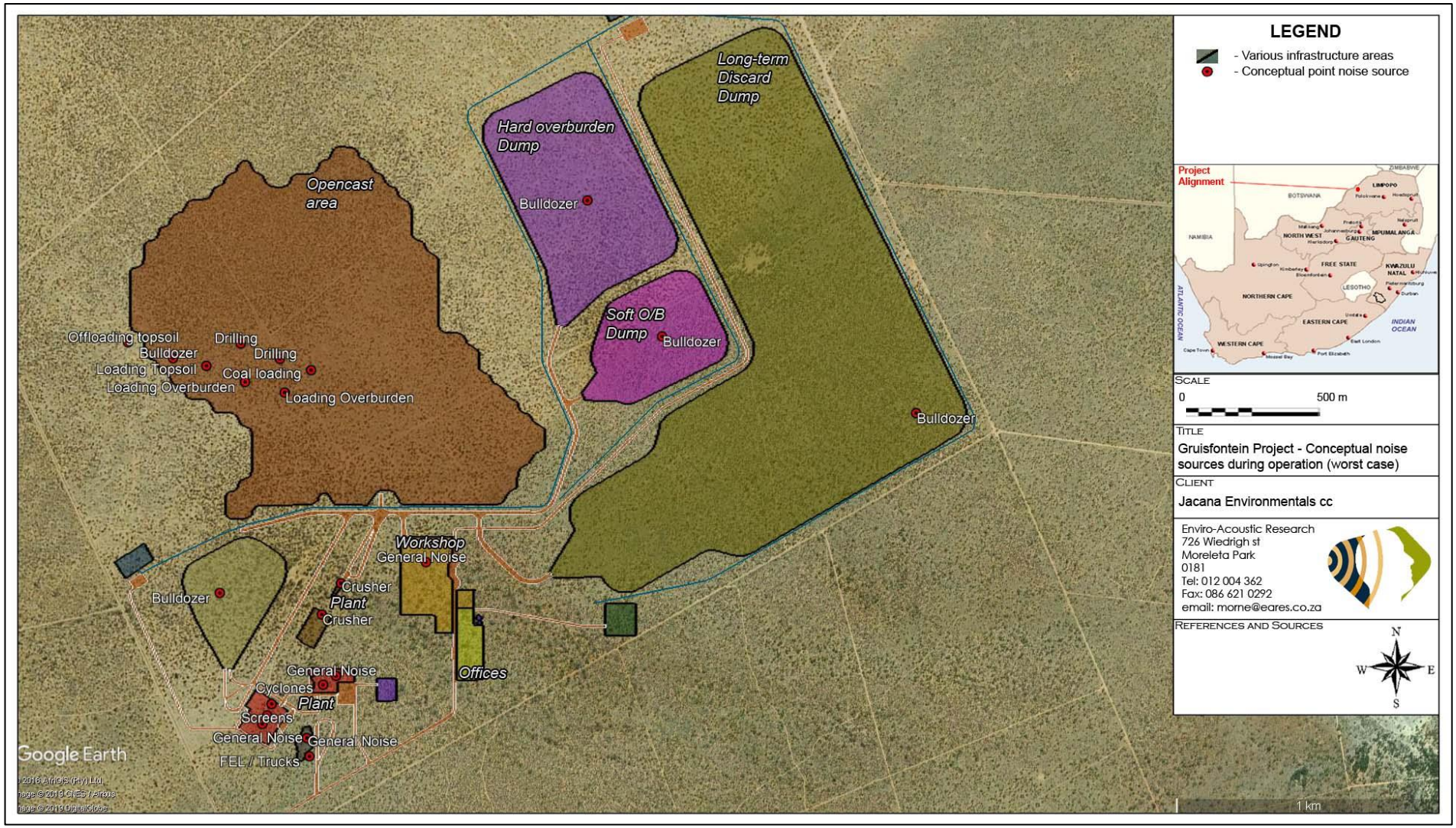


Figure 9-4: Conceptual Noise Generating Activities – Operational phase

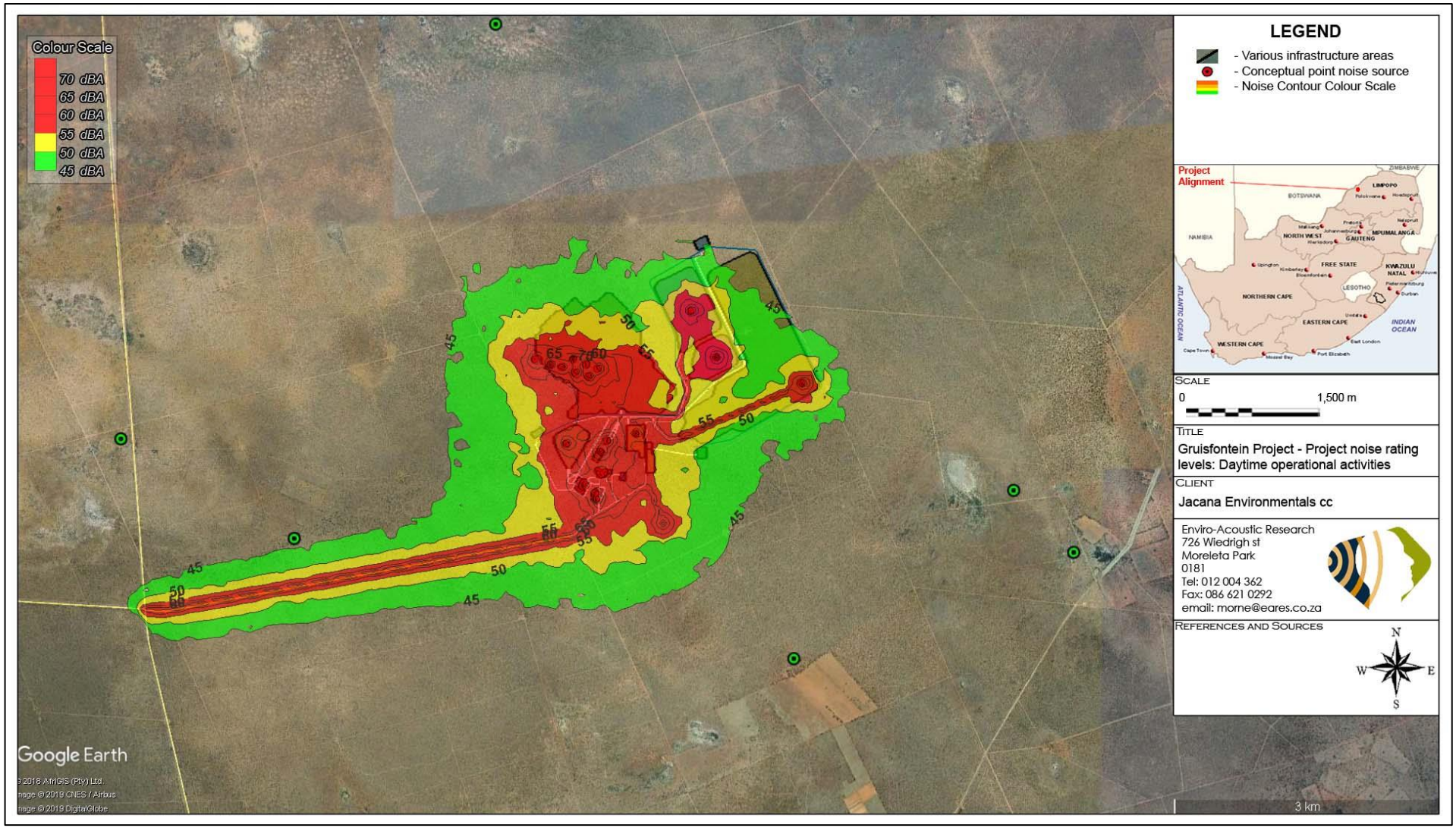


Figure 9-5: Projected conceptual daytime noise rating level contours due to operational activities

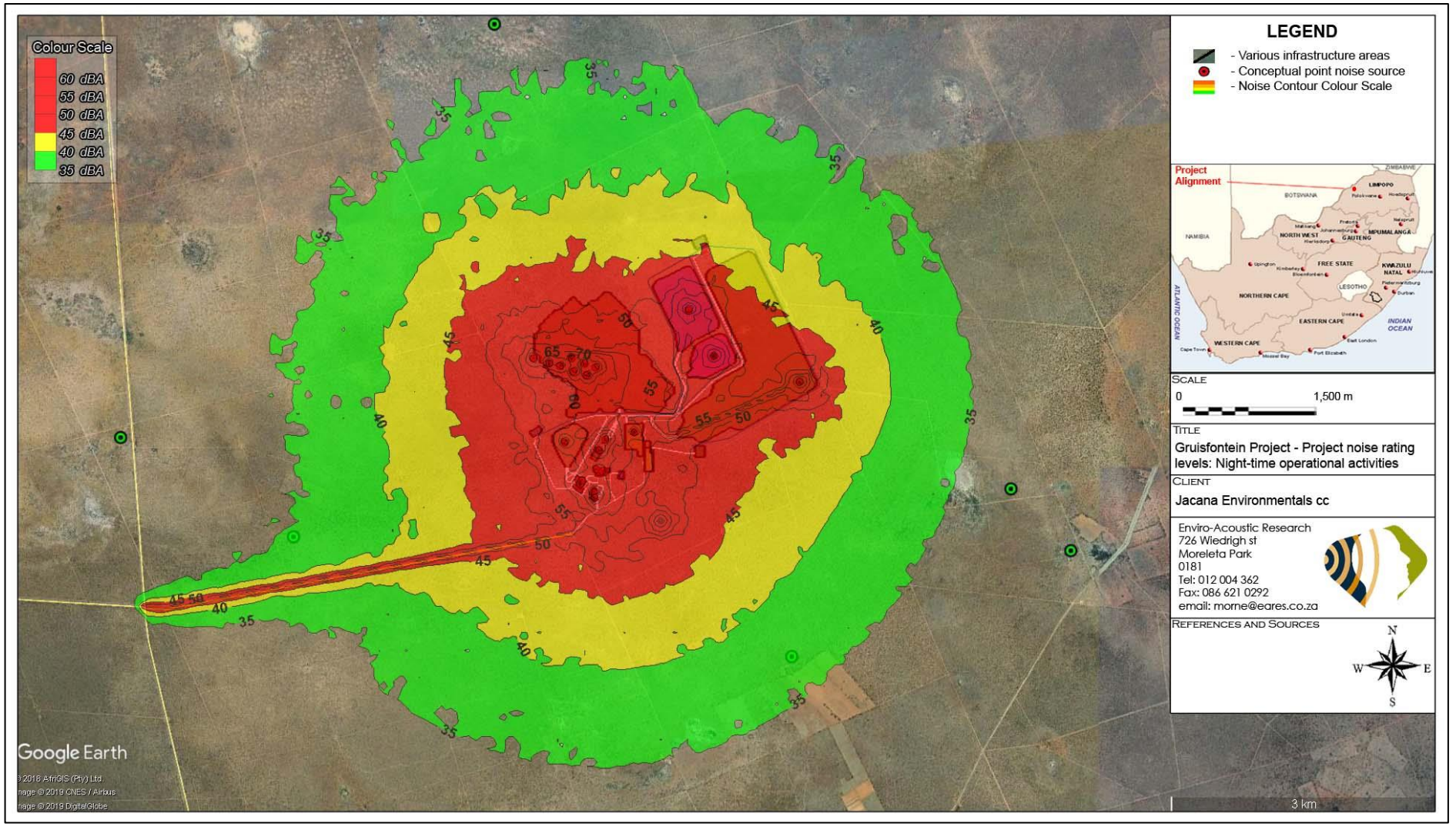


Figure 9-6: Projected conceptual night-time noise rating level contours due to operational activities

10 SIGNIFICANCE OF THE NOISE IMPACT

10.1 PLANNING PHASE NOISE IMPACT

Noises associated with the planning phase are generally of very short duration and located far from people. As such the magnitude of noise levels are low and the probability of a noise impact occurring is very low. The significance is very low and this will not be investigated in detail in this section.

As highlighted in **Section 3.4**, it is accepted that NSD01 will be relocated as this receptor stays directly on the footprint of the Gruisfontein project.

10.2 CONSTRUCTION PHASE NOISE IMPACT

The potential noise impacts for the various activities defined in **Section 6.1**, conceptualised and calculated in **Section 9.2**. The potential significance of the noise impacts is summarized in **Table 10-1** and **Table 10-2** for the day and night-time scenarios respectively.

Table 10-1: Impact Assessment: Construction Activities during the day

Nature:	***Numerous simultaneous construction activities***	
Acceptable Rating Level	Area has a rural development character, confirmed by onsite ambient sound level measurements. Use $L_{Req,D}$ of 45 dBA (rural).	
	Without Mitigation	***With Mitigation***
Magnitude (Table 7-2)	Noise levels will be less than 45 dBA at all receptors. Low (All NSD) - 2	Noise levels will be less than 45 dBA at all receptors. Low (All NSD) - 2
Duration (Table 7-3)	Noises will continue for the construction phase. (Short – 2)	Noises will continue for the construction phase. (Short – 2)
Extent ($\Delta L_{Aeq,D}$>7dBA) (Table 7-4)	Daytime construction activities will generate noise but it will mainly be limited to the project site and directly adjacent properties. (Local – 2)	Daytime construction activities will generate noise but it will mainly be limited to the project site and directly adjacent properties. (Local – 2)
Probability (Table 7-5)	Improbable (1)	Improbable (1)
Significance of Impact	Low (6)	Low (6)
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No loss of resources.	No loss of resources.
Comments	Worst case scenario with numerous simultaneous construction activities	
Degree of Confidence	**High**	
Mitigation:	Mitigation is not required	

Cumulative impacts	Once other proposed mines are developed there will be a slight potential (less than 3 dB change) of a cumulative impact. Cumulative impacts onsite is of a low concern, but cumulative impacts may raise noise levels in the larger area as the area develops. This impact cannot be quantified at this early stage.
Residual Impacts:	This impact will only disappear after mine decommissioning and closure is completed.

Table 10-2: Impact Assessment: Construction Activities at night

Nature:	***Numerous simultaneous construction activities***	
Acceptable Rating Level	Area has a rural development character, confirmed by onsite ambient sound level measurements. Ambient sound levels at times may be less than 35 dBA that will allow the mining noises to be audible 2 – 3 km from the mine during quiet periods Use $L_{Req,N}$ of 35 dBA (rural).	
	Without Mitigation	***With Mitigation***
Magnitude (Table 7-2)	Noise levels will be less than 45 dBA at all receptors. Low (All NSD)	Noise levels will be less than 45 dBA at all receptors. Low (All NSD)
Duration (Table 7-3)	Noises will continue for the construction phase. (Short – 2)	Noises will continue for the construction phase. (Short – 2)
Extent ($\Delta L_{Aeq,D}$>7dBA) (Table 7-4)	Night-time construction activities will generate noise but it will mainly be limited to the project site and directly adjacent properties. The noises may change ambient sound levels further than 1,000m from the mining activities. (Regional – 3)	Night-time construction activities will generate noise but it will mainly be limited to the project site and directly adjacent properties. The noises may change ambient sound levels further than 1,000m from the mining activities. (Regional – 3)
Probability (Table 7-5)	Improbable (1)	Improbable (1)
Significance of Impact	Low (7)	Low (7)
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No loss of resources.	No loss of resources.
Comments	Worst case scenario with numerous simultaneous construction activities	
Degree of Confidence	**High**	
Mitigation:	Mitigation is not required	
Cumulative impacts	Once other proposed mines are developed there will be a slight potential (less than 3 dB change) of a cumulative impact. Cumulative impacts onsite is of a low concern, but cumulative impacts may raise noise levels in the larger area as the area develops. This impact cannot be quantified at this early stage.	
Residual Impacts:	This impact will only disappear after mine decommissioning and closure is completed.	

10.3 OPERATIONAL PHASE NOISE IMPACT

The impact assessment for the various activities defined in **section 6.2**, conceptualised and calculated in **section 9.3**. The potential significance of the noise impacts are summarized in **Table 10-3** and **Table 10-4** for the day and night-time scenarios respectively.

Table 10-3: Impact Assessment: Operational Activities during the day

Nature:	***Numerous simultaneous operational activities***	
Acceptable Rating Level	Area has a rural development character, confirmed by onsite ambient sound level measurements. Use $L_{Req,D}$ of 45 dBA (rural).	
	Without Mitigation	***With Mitigation***
Magnitude (Table 7-2)	Noise levels will be less than 45 dBA at all receptors. Low (All NSD)	Noise levels will be less than 45 dBA at all receptors. Low (All NSD)
Duration (Table 7-3)	Noises will continue for the full operational phase. (Long – 4)	Noises will continue for the full operational phase. (Long - 4)
Extent ($\Delta L_{Aeq,D}$>7dBA) (Table 7-4)	Daytime activities will generate noise but it will mainly be limited to the project site and directly adjacent properties. (Local – 2)	Daytime activities will generate noise but it will mainly be limited to the project site and directly adjacent properties. (Local – 2)
Probability (Table 7-5)	Improbable (1)	Improbable (1)
Significance of Impact	Low (8)	Low (8)
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No loss of resources.	No loss of resources.
Comments	Worst case scenario with numerous simultaneous construction activities	
Degree of Confidence	**High**	
Mitigation:	Mitigation is not required	
Cumulative impacts	Once other proposed mines are developed there will be a slight potential (less than 3 dB change) of a cumulative impact. Cumulative impacts onsite is of a low concern, but cumulative impacts may raise noise levels in the larger area as the area develops. This impact cannot be quantified at this early stage.	
Residual Impacts:	This impact will only disappear after mine decommissioning and closure is completed.	

Table 10-4: Impact Assessment: Operational Activities at night

Nature:	***Numerous simultaneous operational activities***	
Acceptable Rating Level	Area has a rural development character, confirmed by onsite ambient sound level measurements. Use $L_{Req,N}$ of 35 dBA (Rural)	
	Without Mitigation	***With Mitigation***
Magnitude (Table 7-2)	Noise levels will be less than 35 dBA at all receptors but NSD04 and 06. Low-medium (NSD04 and 06)	Noise levels will be less than 35 dBA at all receptors but NSD04 and 06. Low-medium (NSD04 and 06)
Duration (Table 7-3)	Noises will continue for the full operational phase. (Long – 4)	Noises will continue for the full operational phase. (Long - 4)
Extent ($\Delta L_{Aeq,D}$>7dBA) (Table 7-4)	Night-time construction activities will generate noise but it will mainly be limited to the project site and directly adjacent properties. The noises may change ambient sound levels further than 1,000m from the mining activities. (Regional – 3)	Night-time construction activities will generate noise but it will mainly be limited to the project site and directly adjacent properties. The noises may change ambient sound levels further than 1,000m from the mining activities. (Regional – 3)

Probability (Table 7-5)	Possible (2)	Possible (2)
Significance of Impact	Low (22)	Low (22)
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No loss of resources.	No loss of resources.
Comments	Worst case scenario with numerous simultaneous construction activities	
Degree of Confidence	**High**	
Mitigation:	Mitigation is not required	
Cumulative impacts	Once other proposed mines are developed there will be a slight potential (less than 3 dB change) of a cumulative impact. Cumulative impacts onsite is of a low concern, but cumulative impacts may raise noise levels in the larger area as the area develops. This impact cannot be quantified at this early stage.	
Residual Impacts:	This impact will only disappear after mine decommissioning and closure is completed.	

10.4 DECOMMISSIONING PHASE NOISE IMPACT

Final decommissioning activities will have a noise impact lower than either the construction or operational phases. This is because decommissioning and closure activities normally take place during the day using minimal equipment (due to the decreased urgency of the project). While there may be various activities, there is a very small risk for any additional noise impact.

10.5 EVALUATION OF ALTERNATIVES

10.5.1 Alternative 1: No-go option

The ambient sound levels will remain as is. The noise levels experienced by the surrounding receptors will remain naturally quiet.

10.5.2 Alternative 2: Proposed mining activities

The proposed mining activities (worse-case evaluated) will slightly raise the noise levels at a number of closest potential noise-sensitive developments. These noises may be disturbing and may impact on the quality of living for the receptors. Therefore, in terms of acoustics there is no real benefit to the surrounding environment (closest receptors). However, provided that the proposed mitigation measures are implemented, the impact will be reduced to a more acceptable medium significance.

However, the project will greatly assist in the economic growth and development challenges South Africa is facing by means of assisting in providing employment and

other business opportunities. Considering only noise[15], people in the area not directly affected by increased noise levels may have a positive perception of the project and could see the need and desirability of the project.

[15] Considering only noise as other environmental factors may affect other people.

11 MITIGATION OPTIONS

11.1 CONSTRUCTION PHASE MITIGATION MEASURES

The study considers the potential noise impact on the surrounding environment due to construction activities during the day- and night-time periods. It was determined that the potential noise impact would be of low significance and mitigation is not required. General measures are proposed to ensure that noise levels are not excessive.

11.1.1 Mitigation options available to reduce Construction Noise Impact

Mitigation options included both management measures as well as technical changes. Potential measures to manage noise generation include:

- Ensure a good working relationship between mine management and all potentially noise-sensitive receptors staying closer than 2,000 m from the mine.
- Ensure that equipment is well maintained and fitted with the correct and appropriate noise abatement measures. Engine bay covers over heavy equipment could be pre-fitted with sound absorbing material. Heavy equipment that fully encloses the engine bay should be considered, ensuring that the seam gap between the hood and vehicle body is minimised.
- The operation should investigate the use of white-noise alarms instead of tonal reverse alarms on heavy vehicles operating on roads, within the mining area and at stockpile areas[16][17]. The advantages of white noise alarms above tonal alarms are:
    - It is as safe as a tonal alarm[18].
    - Highly audible close to the alarm (or revering truck)[19].
    - It generates a more uniform sound field behind a reversing vehicle[20].
    - Greater directional information, workers can locate the source faster.
    - Significantly less environmental noise and it creates significantly less annoyance far away.
    - When properly installed, white noise alarms of a similar sound power emission level are more likely to comply with the ISO 9533 standard.

The mine must know that community involvement needs to continue throughout the project. Annoyance is a complicated psychological phenomenon; as with many industrial

[16]White Noise Reverse Alarms: http://www.brigade-electronics.com/products.
[17] https://www.constructionnews.co.uk/home/white-noise-sounds-the-reversing-alarm/885410.article - White noise sounds the reversing alarm
[18]https://www.acoustics.asn.au/conference_proceedings/AAS2012/papers/p126.pdf - Which is Safer – Tonal or Broadband Reversing Alarms
[19] http://www.irsst.qc.ca/media/documents/PubIRSST/R-833.pdf - Safety of workers behind heavy vehicles
[20] https://www.vaultintel.com/blog/reversing-beeps-could-be-a-thing-of-the-past
https://brigade-electronics.com/white-sound-reversing-alarms-improving-safety-environment/

operations, expressed annoyance with sound can reflect an overall annoyance with the project, rather than a rational reaction to the sound itself. At all stages surrounding receptors should be informed about the project, providing them with factual information without setting unrealistic expectations. It is counterproductive to suggest that the activities (or facility) will be inaudible due to existing high ambient sound levels. The magnitude of the sound levels will depend on a multitude of variables and will vary from day to day and from place to place with environmental and operational conditions. Audibility is distinct from the sound level, because it depends on the relationship between the sound level from the activities, the spectral character and that of the surrounding soundscape (both level and spectral character).

11.2 OPERATIONAL PHASE MITIGATION MEASURES

The significance of the noise impact is low (during the operational phase) and additional mitigation measures are not required. Potential measures to manage noise generation include:

- Ensure that equipment is well maintained and fitted with the correct and appropriate noise abatement measures;
- The mine should investigate the use of white-noise alarms instead of tonal reverse alarms;
- Compliance with the Noise conditions of the Environmental Management Plan that covers:
    - Potential mitigation measures as defined in this report;
    - Formal register where receptors can lodge any noise complaints;
    - Noise measurement protocol to investigate any noise complaints; and
    - The commitment from the mine to consider reasonable mitigation if the noise complaint investigation indicate the validity of a noise complaint. These measures could include steps ranging from process changes, development of barriers or enclosure of the noise source and even relocation (if no other feasible alternatives exist).

11.3 OPERATION MITIGATION OPTIONS THAT SHOULD BE INCLUDED IN THE EMP

i. The mine must implement a line of communication (i.e. a helpline where complaints could be lodged). All potential sensitive receptors should be made aware of these contact numbers, or alternative means to communicate issues. The mine should maintain a commitment to the local community and respond to concerns in an expedient fashion. Sporadic and legitimate noise complaints could develop and if valid, should be investigated. Feedback must be provided to the

affected stakeholder(s) with details of any steps taken to mitigate the impact (if valid complaint) or preventative steps to minimise this from happening again.

ii. All employees and contractors should receive induction that includes an environmental awareness component (noise). This is to allow employees and contractors to realize the potential noise risks that activities (especially night-time activities) pose to the surrounding environment.

12 ENVIRONMENTAL MANAGEMENT OBJECTIVES

The DMR guideline for EMP development requires the formulation of Objectives for Mine Closure as influenced by the Environmental Base Line description. This demonstrates the importance of considering the post closure land use, relative to the pre-mining land use, when formulating the closure objectives.

Environmental Management Objectives is difficult to be defined for noise because ambient sound levels would slowly increase as developmental pressures increase in the area. This is due to increased traffic and human habitation and is irrespective whether the mining activity starts. The moment the mine stops noise levels will drop similar to the pre-mining levels (typical of other areas with a similar developmental character).

However, as there are a number of potential noise-sensitive receptors in the area, Environmental Management Objectives will be proposed. These objectives are based on the sound levels criteria for Residential Use (International Best Practice) while considering the National Noise Control Regulations.

As such, the operation may not increase the existing ambient sound levels with more than **7 dB** (a disturbing noise and prohibited by the National Noise Control Regulations).

13 ENVIRONMENTAL MONITORING PLAN

Environmental Noise Monitoring can be divided into two distinct categories, namely:

- Passive monitoring – the registering of any complaints (reasonable and valid) regarding noise; and
- Active monitoring – the measurement of noise levels at identified locations.

No active environmental noise monitoring is recommended due to the low significance for a noise impact to develop. However, should a valid complaint be registered, the mine must investigate this complaint as per the following sections. It is recommended that the noise investigation be done by an independent acoustic consultant.

It should be noted that this section should be used as a guideline as site specific conditions may require that the monitoring locations, frequency or procedure be adapted.

13.1 MEASUREMENT LOCALITIES AND PROCEDURES

13.1.1 Measurement Localities

Noise measurements must be conducted at the location of the person that registered a valid and reasonable noise complaint (receptors staying within 1,000m from the mining infrastructure). The measurement location should consider the direct surroundings to ensure that other sound sources cannot influence the reading. A second instrument must be deployed at the mine infrastructure area (close to the source of noise) during the measurement.

13.1.2 Measurement Frequencies

After valid and reasonable noise complaint was registered.

13.1.3 Measurement Procedures

Ambient sound measurements should be collected as defined in SANS 10103:2008. Due to the variability that naturally occurs in sound levels at most locations, it is recommended that semi-continuous measurements are conducted over a period of at least 24 hours, covering at least a full day- (06:00 – 22:00) and night-time (22:00 – 06:00) period.

Measurements should be collected in 10-minute bins defining the 10-minute descriptors such as $L_{Aeq,I}$ (National Noise Control Regulation requirement), $L_{A90,f}$ (background noise level as used internationally) and $L_{Aeq,f}$ (Noise level used to compare with IFC noise limit).

Spectral frequencies should also be measured to define the potential origin of noise. When a noise complaint is being investigated, measurements should be collected during a period or in conditions similar to when the receptor experienced the disturbing noise event.

13.2 RELEVANT STANDARD FOR NOISE MEASUREMENTS

Noise measurements must be conducted as required by the National Noise Control Regulations (GN R154 of 1992) and SANS 10103:2008. It should be noted that the SANS standard also refers to a number of other standards.

13.3 STANDARD OPERATING PROCEDURES FOR REGISTERING A COMPLAINT

When a noise complaint is registered, the following information must be obtained:

- Full details (names, contact numbers, location) of the complainant;
- Date and approximate time when this non-compliance occurred;
- Description of the noise or event; and
- Description of the conditions prevalent during the event (if possible).

14 RECOMMENDATIONS AND CONCLUSION

This ENIA covers the proposed development of a coal mine west of Lephalale, Limpopo. Conceptual scenarios were developed for the construction and operational phase with the potential noise rating levels calculated using a sound propagation model. The output indicated a potential noise impact of low significance during all phases of the project.

Mitigation is not required, though generic measures are highlighted to ensure that noise generation is always managed. These measures may include:

- Ensure a good working relationship between mine management and all potentially noise-sensitive receptors staying within 2,000m from the mine.
- Ensure that equipment is well maintained and fitted with the correct and appropriate noise abatement measures. Engine bay covers over heavy equipment could be pre-fitted with sound absorbing material. Heavy equipment that fully encloses the engine bay should be considered, ensuring that the seam gap between the hood and vehicle body is minimised;
- The operation should investigate the use of white-noise alarms instead of tonal reverse alarms on heavy vehicles operating on roads, within the plant and stockpile areas as well as the dumps;
- The mine must implement a line of communication (i.e. a help line where complaints could be lodged). All potential sensitive receptors should be made aware of these contact numbers, or alternative means to communicate issues. The mine should maintain a commitment to the local community and respond to concerns in an expedient fashion. Sporadic and legitimate noise complaints could develop and if valid, should be investigated; and
- All employees and contractors should receive induction that includes an environmental awareness component (noise). This is to allow employees and contractors to realize the potential noise risks that activities (especially night-time activities) pose to the surrounding environment.

It is the opinion of the Author that the increase in noise levels does not constitute a fatal flaw. It is therefore the recommendation that the project should be authorized (from a noise impact perspective).

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APPENDIX A

Glossary of Acoustic Terms, Definitions and General Information

1/3-Octave Band	A filter with a bandwidth of one-third of an octave representing four semitones, or notes on the musical scale. This relationship is applied to both the width of the band, and the center frequency of the band. See also definition of octave band.
A – Weighting	An internationally standardised frequency weighting that approximates the frequency response of the human ear and gives an objective reading that therefore agrees with the subjective human response to that sound.
Air Absorption	The phenomena of attenuation of sound waves with distance propagated in air, due to dissipative interaction within the gas molecules.
Alternatives	A possible course of action, in place of another, that would meet the same purpose and need (of proposal). Alternatives can refer to any of the following, but are not limited hereto: alternative sites for development, alternative site layouts, alternative designs, alternative processes and materials. In Integrated Environmental Management the so-called "no go" alternative refers to the option of not allowing the development and may also require investigation in certain circumstances.
Ambient	The conditions surrounding an organism or area.
Ambient Noise	The all-encompassing sound at a point being composed of sounds from many sources both near and far. It includes the noise from the noise source under investigation.
Ambient Sound	The all-encompassing sound at a point being composite of sounds from near and far.
Ambient Sound Level	Means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such a meter was put into operation. In this report the term Background Ambient Sound Level will be used.
Amplitude Modulated Sound	A sound that noticeably fluctuates in loudness over time.
Applicant	Any person who applies for an authorisation to undertake a listed activity or to cause such activity in terms of the relevant environmental legislation.
Assessment	The process of collecting, organising, analysing, interpreting and communicating data that is relevant to some decision.
Attenuation	Term used to indicate reduction of noise or vibration, by whatever method necessary, usually expressed in decibels.
Audible frequency Range	Generally assumed to be the range from about 20 Hz to 20,000 Hz, the range of frequencies that our ears perceive as sound.
Ambient Sound Level	The level of the ambient sound indicated on a sound level meter in the absence of the sound under investigation (e.g. sound from a particular noise source or sound generated for test purposes). Ambient sound level as per Noise Control Regulations.
Broadband Noise	Spectrum consisting of a large number of frequency components, none of which is individually dominant.
C-Weighting	This is an international standard filter, which can be applied to a pressure signal or to a *SPL* or *PWL* spectrum, and which is essentially a pass-band filter in the frequency range of approximately 63 to 4000 Hz. This filter provides a more constant, flatter, frequency response, providing significantly less adjustment than the A-scale filter for frequencies less than 1000 Hz.
Controlled area (as per National Noise Control Regulations)	a piece of land designated by a local authority where, in the case of- (a) road transport noise in the vicinity of a road- (i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period extending from 06:00 to 24:00 while such meter is in operation, exceeds 65dBA; or (ii) the equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2metres, but not more than 1,4 metres, above the ground for a period extending from06:00 to 24:00 as calculated in accordance with SABS 0210-1986, titled: "Code of Practice for calculating and predicting road traffic noise", published under Government Notice No. 358 of 20 February 1987, and projected for a

	period of 15 years following the date on which the local authority has made such designation, exceeds 65 dBA; (b) aircraft noise in the vicinity of an airfield, the calculated noisiness index, projected for a period of 15 years following the date on which the local authority has made such designation, exceeds 65 dBA; or (c) industrial noise in the vicinity of an industry- (i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter is in operation, exceeds 61 dBA; or (ii) the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 metres, but not more than 1,4 metres, above the ground for a period of 24 hours, exceeds 61 dBA;
dB(A)	Sound Pressure Level in decibel that has been A-weighted, or filtered, to match the response of the human ear.
Decibel (db)	A logarithmic scale for sound corresponding to a multiple of 10 of the threshold of hearing. Decibels for sound levels in air are referenced to an atmospheric pressure of 20 μ Pa.
Diffraction	The process whereby an acoustic wave is disturbed and its energy redistributed in space as a result of an obstacle in its path, Reflection and refraction are special cases of diffraction.
Direction of Propagation	The direction of flow of energy associated with a wave.
Disturbing noise	Means a noise level that exceeds the zone sound level or, if no zone sound level has been designated, a noise level that exceeds the ambient sound level at the same measuring point by 7 dBA or more.
Environment	The external circumstances, conditions and objects that affect the existence and development of an individual, organism or group; these circumstances include biophysical, social, economic, historical, cultural and political aspects.
Environmental Control Officer	Independent Officer employed by the applicant to ensure the implementation of the Environmental Management Plan (EMP) and manages any further environmental issues that may arise.
Environmental impact	A change resulting from the effect of an activity on the environment, whether desirable or undesirable. Impacts may be the direct consequence of an organisation's activities or may be indirectly caused by them.
Environmental Impact Assessment	An Environmental Impact Assessment (EIA) refers to the process of identifying, predicting and assessing the potential positive and negative social, economic and biophysical impacts of any proposed project, plan, programme or policy that requires authorisation of permission by law and that may significantly affect the environment. The EIA includes an evaluation of alternatives, as well as recommendations for appropriate mitigation measures for minimising or avoiding negative impacts, measures for enhancing the positive aspects of the proposal, and environmental management and monitoring measures.
Environmental issue	A concern felt by one or more parties about some existing, potential or perceived environmental impact.
Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$)	The value of the average A-weighted sound pressure level measured continuously within a reference time interval *T*, which have the same mean-square sound pressure as a sound under consideration for which the level varies with time.
Equivalent continuous A-weighted rating level ($L_{Req,T}$)	The Equivalent continuous A-weighted sound exposure level *($L_{Aeq,T}$)* to which various adjustments has been added. More commonly used as ($L_{Req,d}$) over a time interval 06:00 – 22:00 (T=16 hours) and ($L_{Req,n}$) over a time interval of 22:00 – 06:00 (T=8 hours). It is a calculated value.
F (fast) time weighting	(1) Averaging detection time used in sound level meters. (2) Fast setting has a time constant of 125 milliseconds and provides a fast reacting display response allowing the user to follow and measure not too rapidly fluctuating sound.
Footprint area	Area to be used for the construction of the proposed development, which does

	not include the total study area.
Free Field Condition	An environment where there is no reflective surfaces.
Frequency	The rate of oscillation of a sound, measured in units of Hertz (Hz) or kilo Hertz (kHz). One hundred Hz is a rate of one hundred times per second. The frequency of a sound is the property perceived as pitch: a low-frequency sound (such as a bass note) oscillates at a relatively slow rate, and a high-frequency sound (such as a treble note) oscillates at a relatively high rate.
Green field	A parcel of land not previously developed beyond that of agriculture or forestry use; virgin land. The opposite of Greenfield is Brownfield, which is a site previously developed and used by an enterprise, especially for a manufacturing or processing operation. The term Brownfield suggests that an investigation should be made to determine if environmental damage exists.
G-Weighting	An International Standard filter used to represent the infrasonic components of a sound spectrum.
Harmonics	Any of a series of musical tones for which the frequencies are integral multiples of the frequency of a fundamental tone.
I (impulse) time weighting	(1) Averaging detection time used in sound level meters as per South African standards and Regulations. (2) Impulse setting has a time constant of 35 milliseconds when the signal is increasing (sound pressure level rising) and a time constant of 1,500 milliseconds while the signal is decreasing.
Impulsive sound	A sound characterized by brief excursions of sound pressure (transient signal) that significantly exceed the ambient sound level.
Infrasound	Sound with a frequency content below the threshold of hearing, generally held to be about 20 Hz. Infrasonic sound with sufficiently large amplitude can be perceived, and is both heard and felt as vibration. Natural sources of infrasound are waves, thunder and wind.
Integrated Development Plan	A participatory planning process aimed at developing a strategic development plan to guide and inform all planning, budgeting, management and decision-making in a Local Authority, in terms of the requirements of Chapter 5 of the Municipal Systems Act, 2000 (Act 32 of 2000).
Integrated Environmental Management	IEM provides an integrated approach for environmental assessment, management, and decision-making and to promote sustainable development and the equitable use of resources. Principles underlying IEM provide for a democratic, participatory, holistic, sustainable, equitable and accountable approach.
Interested and affected parties	Individuals or groups concerned with or affected by an activity and its consequences. These include the authorities, local communities, investors, work force, consumers, environmental interest groups and the general public.
Key issue	An issue raised during the Scoping process that has not received an adequate response and that requires further investigation before it can be resolved.
L_{A90}	the sound level exceeded for the 90% of the time under consideration
Listed activities	Development actions that is likely to result in significant environmental impacts as identified by the delegated authority (formerly the Minister of Environmental Affairs and Tourism) in terms of Section 21 of the Environment Conservation Act.
L_{AMin} and L_{AMax}	Is the RMS (root mean squared) minimum or maximum level of a noise source.
Loudness	The attribute of an auditory sensation that describes the listener's ranking of sound in terms of its audibility.
Magnitude of impact	Magnitude of impact means the combination of the intensity, duration and extent of an impact occurring.
Masking	The raising of a listener's threshold of hearing for a given sound due to the presence of another sound.
Mitigation	To cause to become less harsh or hostile.
Negative impact	A change that reduces the quality of the environment (for example, by reducing species diversity and the reproductive capacity of the ecosystem, by

	damaging health, or by causing nuisance).
Noise	a. Sound that a listener does not wish to hear (unwanted sounds). b. Sound from sources other than the one emitting the sound it is desired to receive, measure or record. c. A class of sound of an erratic, intermittent or statistically random nature.
Noise Level	The term used in lieu of sound level when the sound concerned is being measured or ranked for its undesirability in the contextual circumstances.
Noise-sensitive development	developments that could be influenced by noise such as: a) districts (see table 2 of SANS 10103:2008) 1. rural districts, 2. suburban districts with little road traffic, 3. urban districts, 4. urban districts with some workshops, with business premises, and with main roads, 5. central business districts, and 6. industrial districts; b) educational, residential, office and health care buildings and their surroundings; c) churches and their surroundings; d) auditoriums and concert halls and their surroundings; e) recreational areas; and f) nature reserves. In this report Noise-sensitive developments is also referred to as a Potential Sensitive Receptor
Octave Band	A filter with a bandwidth of one octave, or twelve semi-tones on the musical scale representing a doubling of frequency.
Positive impact	A change that improves the quality of life of affected people or the quality of the environment.
Property	Any piece of land indicated on a diagram or general plan approved by the Surveyor-General intended for registration as a separate unit in terms of the Deeds Registries Act and includes an erf, a site and a farm portion as well as the buildings erected thereon
Public Participation Process	A process of involving the public in order to identify needs, address concerns, choose options, plan and monitor in terms of a proposed project, programme or development
Reflection	Redirection of sound waves.
Refraction	Change in direction of sound waves caused by changes in the sound wave velocity, typically when sound wave propagates in a medium of different density.
Reverberant Sound	The sound in an enclosure which results from repeated reflections from the boundaries.
Reverberation	The persistence, after emission of a sound has stopped, of a sound field within an enclosure.
Significant Impact	An impact can be deemed significant if consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provides reasonable grounds for mitigating measures to be included in the environmental management report. The onus will be on the applicant to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account.
S (slow) time weighting	(1) Averaging times used in sound level meters. (2) Time constant of one [1]second that gives a slower response which helps average out the display fluctuations.
Sound Level	The level of the frequency and time weighted sound pressure as determined by a sound level meter, i.e. A-weighted sound level.
Sound Power	Of a source, the total sound energy radiated per unit time.
Sound Pressure Level (SPL)	Of a sound, 20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level. International values for the reference sound pressure level are 20 micropascals in air and 100 millipascals in water. SPL is reported as L_p in dB (not weighted) or in various other weightings.

Soundscape	Sound or a combination of sounds that forms or arises from an immersive environment. The study of soundscape is the subject of acoustic ecology. The idea of soundscape refers to both the natural acoustic environment, consisting of natural sounds, including animal vocalizations and, for instance, the sounds of weather and other natural elements; and environmental sounds created by humans, through musical composition, sound design, and other ordinary human activities including conversation, work, and sounds of mechanical origin resulting from use of industrial technology. The disruption of these acoustic environments results in noise pollution.
Study area	Refers to the entire study area encompassing all the alternative routes as indicated on the study area map.
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland Commission, 1987).
Tread braked	The traditional form of wheel brake consisting of a block of friction material (which could be cast iron, wood or nowadays a composition material) hung from a lever and being pressed against the wheel tread by air pressure (in the air brake) or atmospheric pressure in the case of the vacuum brake.
Zone of Potential Influence	The area defined as the radius about an object, or objects beyond which the noise impact will be insignificant.
Zone Sound Level	Means a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. This is similar to the Rating Level as defined in SANS10103:2008.

APPENDIX B

Site Investigation – Photos of monitoring locations

Photo B.1: Measurement location GLTASL01

Photo B.2: Measurement location GLTASL02

Photo B.3: Measurement location GSTASL11

Photo B.4: Measurement location GLTASL14

APPENDIX C

Some negative effects of noise and sonic booms on animals

Table C. 1: Some possitive negative effects of noise on faunal some species

SPECIES	TYPE OF NOISE	EFFECT
Domestic livestock:		
Various species	Sonic boom (80-370 mN/m2); low-level subsonic flights (50-200 m) (Nixon et al. 1968; Bond et al. 1974; Espmark et al. 1974).	Startle reaction
Dairy cow	Exploding paper bags (Ely and Petersen 1941)	Cessation of milk ejection
	General noise (105 dB) (Kovalcik and Sottnik 1971)	Reduces feed consumption, milk yield, and rate of milk release
	Tractor engine sound (97 dB) (Broucek et al. 1983)	Increased glucose concentration and leukocyte counts in the blood; reduced level of hemoglobin
	General noise (1 kHz, 110 dB) (Broucek et al. 1983)	Increase in glycemia, nonesterified fatty acids, creatin; decrease in hemoglobin and, thyroxin concentration
Goat	Jet noise (Sugawara et al, 1979)	Reduced milk yield
Swine	General noise (108-120 dB) (Borg 1981)	Influence on hormonal system: increase of plasma 11-OH-corticosterone and catecholamines; decreased corticosteroid level
	General noise (93 dB) (Dufour 1980)	Aldosteronism (excess secretion of aldosterone from the adrenals)
	Recorded aircraft noise (120-135 dB) (Bond et al. 1963)	Increased heart rate
Sheep	White noise (100 dB) (Ames and Arehart 1972)	Higher heart rate and respiration rate; lower feeding efficiency
	White noise (90 dB) (Ames 1978)	Decreased thyroid activity
	General noise (4 kHz, 100 dB) (Ames 1978)	Increased number of corpora lutea; more lambs/ewe
Wild ungulates:		
Reindeer	Sonic booms (35-702 Pa) (Espmark 1972)	Slight startle responses: raising of head, pricking the ears, scenting the air
Caribou	Low-altitude aircraft (<200 ft): fixed-wing, helicopter (Klein 1973)	Running and panic behavior
	Low-altitude aircraft (<500 ft): fixed-wing, helicopter (Calef et al. 1976)	Escape or strong panic reactions
	General noise (Calef 1974)	Increased incidence of miscarriages; lower birth rates
Pronghorn	Low-altitude helicopters (150 ft, slant range of 500 ft; 77 dBA) (Luz and Smith 1976)	Running
Laboratory rodents and rabbits:		
Various species	General noise (150 Hz-40 kHz, 132-140 dB) (Anthony and Ackerman 1957)	"Anxiety-like" behavior
Guinea pig	General noise (128 dB SPL) (Beagley 1965); simulated sonic booms (130 dB) (Hajeau-Chargois et al. 1970)	Anatomical hearing damage; hearing loss
Mouse	Simulated sonic booms (Reinis 1976)	Auditory damage; inner ear bleeding
	Intermittent noise (l10 dB) (Anthony and Ackerman 1955)	Decrease in circulating eosinophils; adrenal activation
	Recorded subway noise (105 dB SPL) (Busnel and Holin 1978)	Longer time interval between litters; lower weight gain of young; increased incidence of miscarriage, resorption

		and malformations
	Continuous, high-intensity jet engine noise (127 dB); random onset noise (103-ll0 dB); high-frequency noise (l13 dB) (Nawrot et al. 1980)	Decreased pregnancy rate (all groups); decrease in number of implantation sites per litter and fetolethal effects (high-intensity jet noise)
	General noise (106 dB) (Ishii and Yokobori 1960)	Teratogenic effects
Rat	General noise (105 dB SPL) (Moller 1978; Borg 1979, 1981)	Hearing loss; damage to inner ear structure
	General noise (80 dB SPL) (Borg 1978a,b,c)	Vasoconstriction
	General intermittent sound (Buckley and Smookler 1970)	Rise in blood pressure; hypertension
	Recorded thunderclaps (98-100 dB SPL, 50-200 Hz) (Ogle and Lockett 1966)	Increased urinary excretion of sodium and potassium; excretion of oxytocin and vasopressin
	Electric buzzer (110 dB) (Sackler et al. 1959)	Decreased adrenal , body, thymus, spleen, liver, pituitary, ovary, and uterine weights; slight gain in thyroid weight; increased production of ACTH; inhibition of gonadotrphin, ovarian hormones, and possible inhibition of the thyrotrophic and thyroid hormones
	General noise (1 kHz, 95 dB) (Fell et al. 1976)	Suppressed thyroid activity
	General noise (120 Hz, 95-105 dB) (Jurtshuk et al. 1959)	Reduced glutathione levels in blood, increased adrenal weights and ascorbic acid; decrease in total adrenal cholesterol
	Intermittent noise(95 dB)(Hrubes and Benes 1965)	Increased secretion of catecholamines in the urine; increased free fatty acids in the blood plasma; increased weight of the adrenals; inhibition of growth
	General noise (92 dB) (Gamble 1982)	Persistent vaginal estrus prolonged vaginal cornification; higher preweaning mortality of young
	White noise (102-l14 dB) (Friedman et al. 1967)	Change in the hypothalymus
	Electric bell (95-100 dB) (Zondek and Isacher 1964)	Enlarged ovaries; persistent estrus; follicular hematomas
	General noise (Zondek 1964)	Decreased fertility
Domestic rabbit	White noise (107-112 dB) (Nayfield and Besch 1981)	Increased adrenal weights; decreased spleen and thymus weights
	White noise (102-114 dB) (Friedman et al. 1967)	Change in the hypothalymus; higher plasma cholesterol and plasma triglycerides; fat deposits in the irises of the eyes; more aortic atherosclerosis and higher cholesterol content in the aortas
	Electric bell (95-100 dB) (Zondek and Isacher 1964)	Enlarged ovaries; persistent estrus; follicular hematomas
Chinchilla	Simulated sonic booms; general noise (65-105 dB) (Carder and Miller 1971, 1972; Reinis 1976)	Hearing loss; outer cell damage of the cochlea
Wild rodents:		
Desert kangaroo rat	ORV noise (78-110 dB SPL) (Brattstrom and Bondello 1983)	Temporary threshold shift in hearing
House mouse (feral)	Aircraft (110-120 dB) (Chesser et al. 1975)	Increased adrenal weights
Cotton rat	Recorded aircraft noise (110 dB SPL)	Increased body weights; increased

	(Pritchett et al. 1978)	secretion of ACTH
	High-pitched whistles (Hepworth 1966)	Enlarged ovaries; persistent estrus; follicular hematomas
Carnivores:		
Domestic cat	Noisy laboratory (Liberman and Beil 1979)	Hearing threshold shifts; loss or damage to hair cells of inner ear
	General noise (100-1,000 Hz) (Miller et al. 1963)	Hearing threshold shifts
Domestic dog	Sudden loud noises (Stephens 1980)	Increase in plasma corticosteroid concentrations
Farm-raised mink	Simulated sonic booms (167-294 mN/m2) (Travis et al. 1974)	Brief startle reaction
Wolf/grizzly bear	Low-altitude fixed-wing aircraft and helicopters (Klein 1973)	Startle reaction; running
Aquatic mammals:		
Beluga whale	Boat traffic (Acoustical Society of America 1980)	Easily displaced
Pinnepeds	Sonic booms (80-89 dBA SPL) (Jehl and Cooper 1980)	Startle reactions
Elephant seal	Impulse noise created by a carbide pest control cannon (115.6-145.5 dBA) (Stewart 1982)	Alert behavior
Sea lion	Simulated boom (Stewart 1982)	Left beach during non-breeding season and went into surf
Other mammal groups:		
Rhesus monkey	General noise (Leq (24): 85 dB) (Peterson et al. 1981)	Increased blood pressure

Reference list available at:

http://www.nonoise.org/library/animals/litsyn.htm#REFERENCES

End of Report