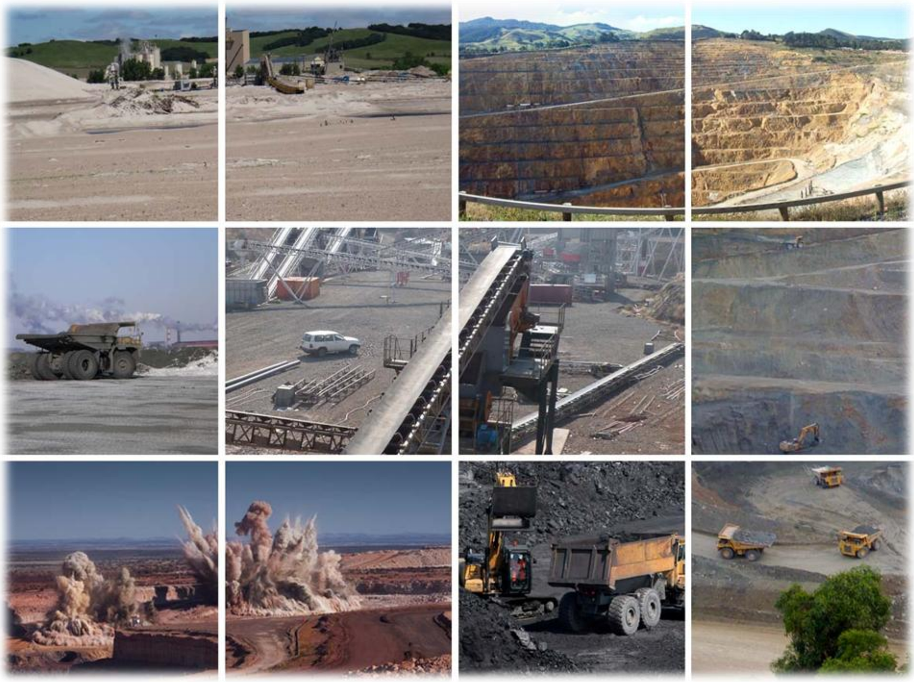
Vandabyte (Pty) Ltd

ENVIRONMENTAL NOISE IMPACT ASSESSMENT

for the

Proposed Dunbar Coal Project

West of Hendrina, Mpumalanga



Study done for:

Enviro INSIGHT
www.enviro-insight.co.za

Prepared by:

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EXECUTIVE SUMMARY

INTRODUCTION AND PURPOSE

Enviro-Acoustic Research (EARES) was contracted by Enviro-Insight CC (Enviro-Insight in this report) to determine the potential noise impact on the surrounding environment due to the proposed development of the Dunbar Coal Project west of Hendrina.

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

PROJECT DESCRIPTION

INSA Coal Holdings (the Applicant) is the owner of a Mineral Right west of Hendrina. They propose to mine coal by means of conventional opencast methods to a depth of between 10 and 50 meters below surface (mbs).

BASELINE ASSESSMENT

The site was visited 3 and 5 September 2019, with two sound level analysers deployed at two different locations in the vicinity of the project. This information was used to define ambient sound levels, and, considering the developmental nature of the area as well as the onsite sound levels with sound levels measured in similar areas, it can be summarized that:

- **EIDSLLT01 - Measurement representing sound levels typical of a dwelling:**
  - Considering the average $L_{Aeq,f}$ daytime data, sound levels are typical of a rural noise district (average daytime levels of 43.1 dBA, mean of the three daytime periods of the equivalent level is 45.1 dBA). Considering the developmental character of the area, daytime ambient sound levels should be typical of a rural noise district;
  - Considering the average $L_{Aeq,f}$ night-time data, sound levels are typical of a sub-urban noise district (average night-time levels of 37.9 dBA, mean of the two night-time periods of the equivalent level is 39.3 dBA). Considering the developmental character of the area, night-time ambient sound levels should be typical of a rural noise district.
- **EIDSLLT02 - Measurement representing sound levels typical of a dwelling:**

- Considering the average $L_{Aeq,f}$ daytime data, sound levels are typical of a rural noise district (average daytime levels of 42.0 dBA, mean of the three daytime periods of the equivalent level is 45.2 dBA). Considering the developmental character of the area, daytime ambient sound levels should be typical of a rural noise district;
- Considering the average $L_{Aeq,f}$ night-time data, sound levels are typical of a sub-urban noise district (average night-time levels of 38.0 dBA, mean of the two night-time periods of the equivalent level is 43.2 dBA). Considering the developmental character of the area, night-time ambient sound levels should be typical of a rural noise district.

Day- and night-time ambient sound levels were higher than measurements collected in other areas with a rural sound character. Ideally, the activities of the proposed mining activity should not change the existing ambient sound levels with more than 7 dBA. Considering average night-time ambient sound levels, mining activities should not increase the noise levels higher than 45 dBA (similar to the WHO / IFC noise limit for residential use).

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:

- The significance of the noise impact will be low for daytime construction activities;
- The significance of the noise impact could be medium-high for night-time construction activities. Mitigation is available to reduce the significance to low;
- The significance of the noise impact will be low for daytime operational activities;
- The significance of the noise impact could be medium-high for night-time operational activities. Mitigation is available to reduce the significance to low.

NEED AND DESIRABILITY OF PROJECT

Due to economic advantages, mining does provide valuable employment, local taxes and foreign currency. It must be noted that when mining projects are near to potential noise-sensitive receptors, consideration must be given to ensure a compatible co-existence. The 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 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, 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)

The proximity of potential noise-sensitive receptors to the project area necessitates the selection of appropriate mitigation measures and the following is recommended:

- 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.
- The mine should use the topsoil and soft material to develop noise berms between the mining opencast area (including haul roads) and the closest NSD. This berm should only be constructed during the daytime period.
- It is recommended that a noise monitoring programme is developed.
- 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.
- Compliance with the Noise conditions of the Environmental Management Plan.

It is concluded that, if the mine considers the recommendations in this report (incorporated in the Environmental Management Plan), that the increases in noise levels do not constitute a fatal flaw. It is, therefore, the recommendation that the Dunbar Coal project is 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 of Specialist study
(1)	A specialist report prepared in terms of these Regulations must contain-	
(a)	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
(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 5.3
(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 specifically 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, 6.2, 9.1 and 9.2
(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 9.1 and 9.2
(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 11.1.2 and 11.2.2
(l)	any conditions for inclusion in the environmental authorisation;	Sections 11.1.2 and 11.2.2

Contents of this report in terms of Regulation GNR 982 of 2014, Appendix 6 (as amended 2017)		**Relevant Section of Specialist study**
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 13.1
(n)	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 11.1.2 and 11.2.2
(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 cited as:

De Jager, M. (2019): "*Environmental Noise Impact Assessment for the Proposed Dunbar Coal Project West of Hendrina, Mpumalanga*". Enviro-Acoustic Research CC, Pretoria

Client:

Enviro-Insight
on behalf of
Vandabyte (Pty) Ltd

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Wapadrand Security Village
Pretoria

Report no:

EI-ICHD/ENIA/201909-Rev 0

Author:

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Review:

Johan Maré *(M.Sc. (Microbiology), PrSci. Nat – SACNASP No: 400092/91)*

Date:

September 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
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)
^{o}C	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 the 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	*BECSA – Middelburg (Golder Associates), Kromkrans Colliery (Geovicon*

Industry	*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, Sephaku Delmas (AGES), Amakhala Emoyeni 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 an independent specialist 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 and I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have expertise in conducting environmental impact assessments, including knowledge of the National Environmental Management Act (107 of 1998), the Environmental Impact Assessment Regulations of 2014 (as amended), and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- 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 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 in the proposed activity proceeding other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014 (as amended).

____

Signature of the environmental practitioner:

Name of company:

Enviro-Acoustic Research cc

Date:

2019 – 09 - 05

3 INTRODUCTION

3.1 INTRODUCTION AND PURPOSE

Enviro-Acoustic Research (EARES) was contracted by Enviro-Insight CC (Enviro-Insight in this report) to determine the potential noise impact on the surrounding environment due to the proposed development of a coal mine. This operation will be located around 20km west of the town of Hendrina in Mpumalanga.

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

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

3.2.1 Overview of the Project

Vandabyte (Pty) Ltd (the Applicant) propose the mining of a coal resource on a Portion of Portion 1, Portion 2 and the remaining extent of the Farm Dunbar 189 IS, Portion 1 of the Farm Middelkraal 50 IS and Portion 6 of the Farm Halfgewonnen 190 IS west of Hendrina (regional location presented in **Figure 3-1**). They propose to mine up to 150,000 tons of coal per month by means of conventional opencast methods to a depth of between 10 and 50 meters below surface (mbs).

The proposed project includes the following mining and related infrastructure:

- Opencast pits;
- Crushing, Screening and Washing facility (Beneficiation plant);
- Product stockpiles;
- Administration office facilities (i.e. security building, administration and staff office, ablution facilities, etc.);
- Production facilities (i.e. workshop, store, explosives magazine, ablution facilities, etc.);
- Potentially a conveyor belt to convey the coal ROM to the plant;
- Access and haul roads; and
- Clean and dirty water management infrastructure.

3.3 STUDY AREA

The study area is further described in terms of environmental components that may contribute to or change the sound character in the area.

3.3.1 Topography

The Environmental Potential Atlas of South Africa (ENPAT) (Van Riet *et al*, 1998) describes the topography as *"slightly to moderately irregular undulating plains and hills"*. The project is situated at approximately 1,600 meters above sea level (mamsl). 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 direct vicinity of the proposed mine section is mainly agriculture with significant mining activities located in the larger area.

3.3.3 Roads

The D622 (Mpumalanga Road Asset Management System[1]) pass the project site to the south-east. Based on the traffic volumes available on this database, the D622 road is a paved road with low traffic volumes (between 0 – 500 vehicles per day). The traffic noises from this road will not be considered.

3.3.4 Ground conditions and vegetation

The area falls within the Grassland biome, with the vegetation type being Moist Sandy Highveld Grassland. The natural veldt has been impacted significantly due to anthropogenic activities. Most of the surface area is well vegetated with grasses, shrubs, sedges and trees.

Taking into consideration available information it is the opinion of the author that the ground surface is sufficiently covered to assume 50% hard ground conditions for modelling purposes. It should be noted that this factor is only relevant for air-borne waves being reflected from the ground surface, with certain frequencies slightly absorbed by the vegetation.

[1] http://mp-rams.co.za/rams/rams.html

3.3.5 Existing Ambient Sound Levels

Ambient sound levels were measured from 3 – 5 September 2019 and discussed in **Section 5.3**. While the developmental character of the area is rural, ambient sound levels are slightly elevated due to increased activities associated with agricultural activities as well as faunal sounds. The increased faunal sounds are associated with the improved habitat and feeding opportunities provided by antropogenic activities (dwellings, gardens).

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

Residential areas and potential noise-sensitive developments/receptors/communities (NSDs) were identified using tools such as Google Earth®. Normally noises from mining activities:

- are limited to a distance of less than 500m from active mining access roads, though this would normally be less than 200m due to low traffic volumes and speeds associated with such roads. This can be increased to a distance of 1,000m, normally associated with very busy roads (such as a busy national road where average speeds exceed 100km/h);
- are limited to a distance of approximately 1,000m from the active mining areas. Ambient sound levels are increased due to noises from mining activities, with the potential noise impact measurable;
- audible up to a distance of 2,000m at night, and may be audible up to 4,000m during very quiet periods at night with certain meteorological conditions. Noise levels from mining activities are generally less than 45 dBA further than 1,000m from the mining activities.

Considering these potential buffer distances, all potential NSDs were identified within 1,000m of the proposed opencast pit, with the closest houses selected to represent potential noise levels in these areas (see **Figure 3-2**).

It should be noted that these NSDs could represent a small community, as there are a number of structures at each of these NSD locations.

3.5 COMMENTS REGARDING NOISE RECEIVED DURING THIS PROJECT

No comments have been received about the proposed project at the time this report was compiled.

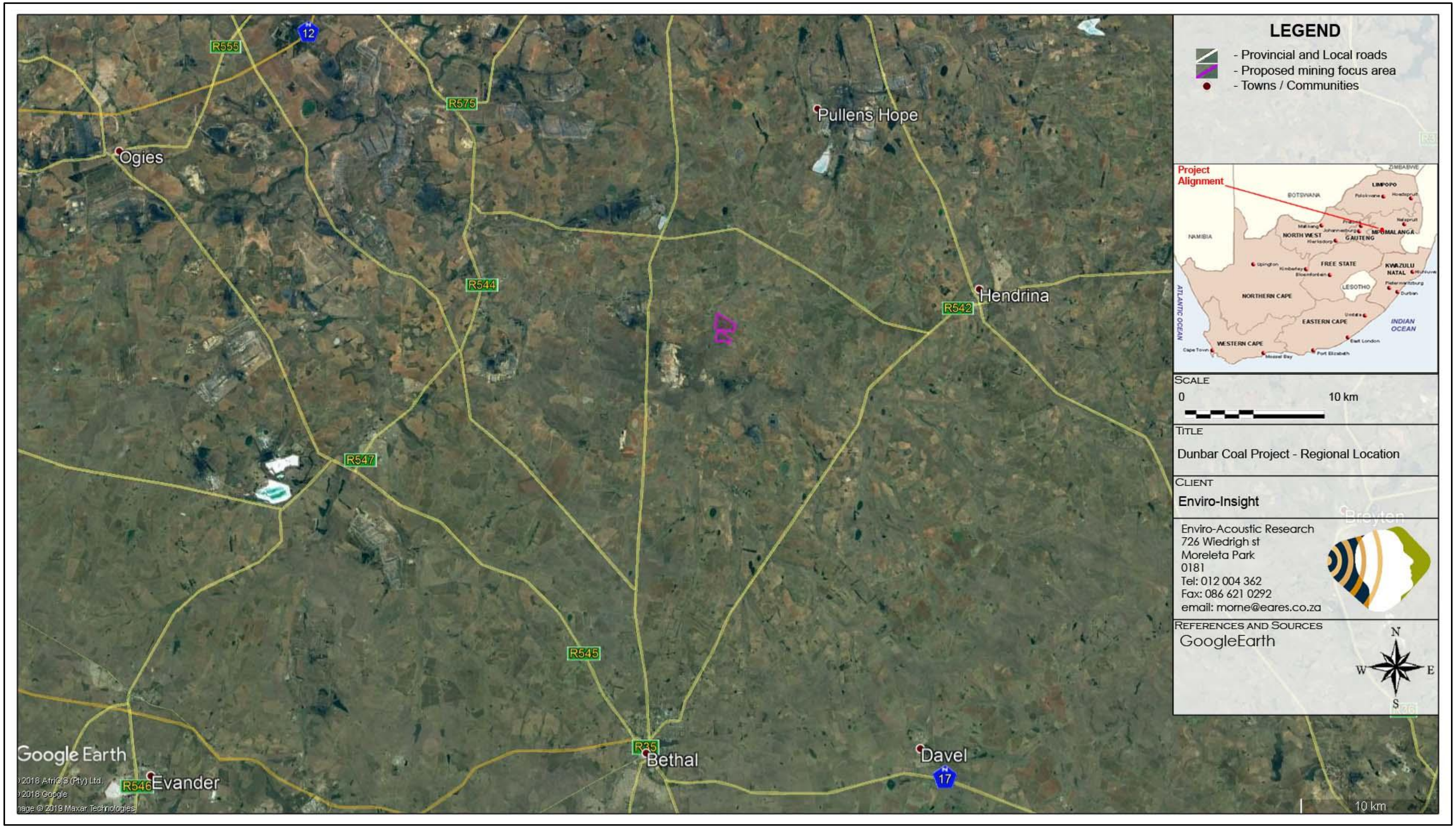

Figure 3-1: Regional location of the proposed coal project

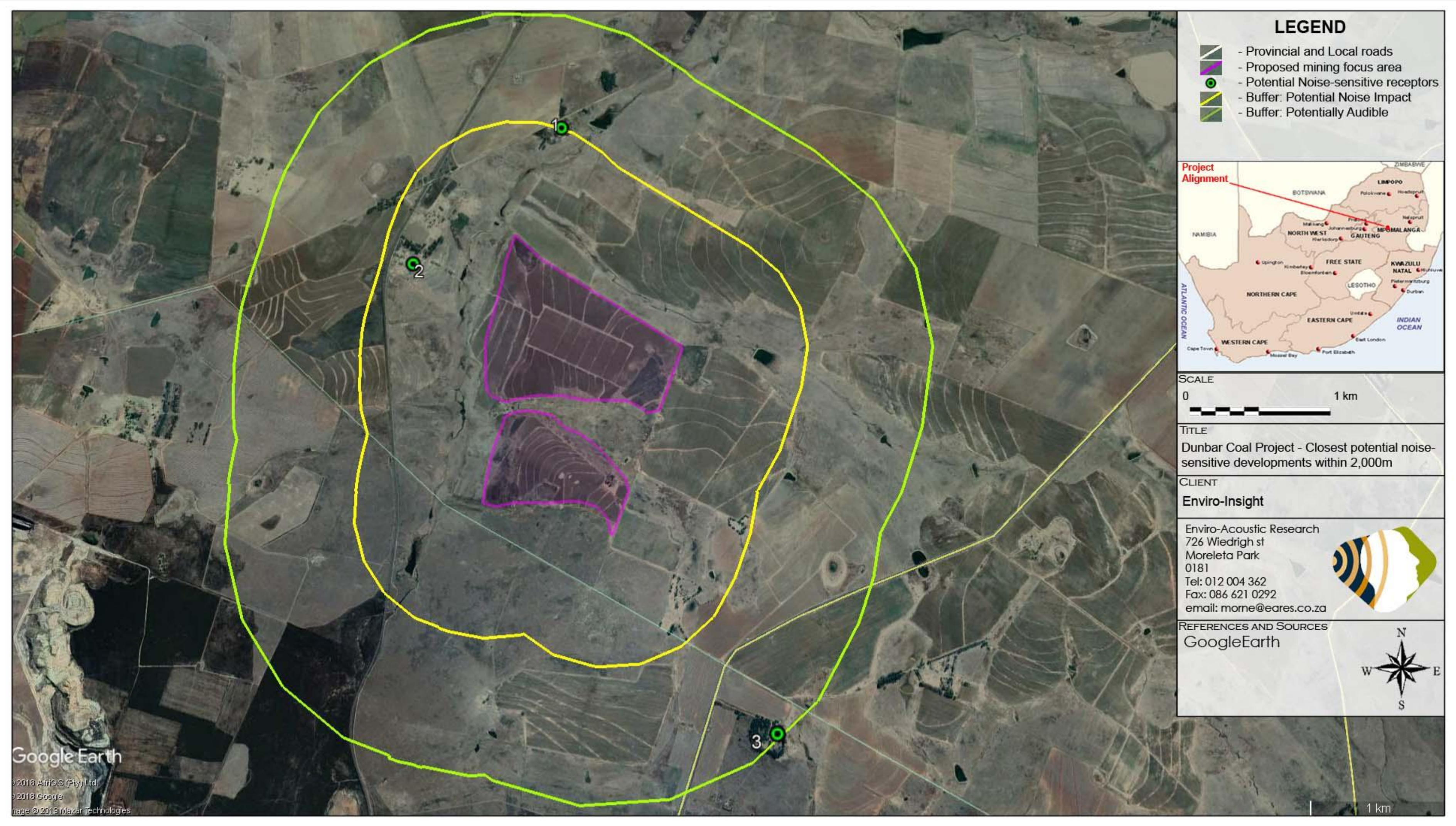

Figure 3-2: Aerial image indicating potentially noise-sensitive receptors close to proposed mining area

3.6 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 (and GN 5479 of August 1999).

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 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 4.1.1**.

4.1.1 Noise Control Regulations (GN R154 of 1992)

In terms of Section 25 of the ECA, the national Noise Control Regulations (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 exists in the Free State, Gauteng and Western Cape provinces.

The National Noise Control Regulations (GN R154 1992) defines:
"**controlled area**" as:
a piece of land designated by a local authority where in the case of--

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 meters, but not more than 1,4 meters, above the ground for a period of 24 hours, exceeds 61 dBA;

"**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 level 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".

Clause 7.(1) however exempts noise of the following activities, namely -
"The provisions of these regulations shall not apply, if -
(a) the emission of sound is for the purposes of warning people of a dangerous situation;
(b) the emission of sound takes place during an emergency."

4.2 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 10210:2004. 'Calculating and predicting road traffic noise';
- SANS 10328:2008. 'Methods for environmental noise impact assessments';
- SANS 10357:2004. 'The calculation of sound propagation by the Concave method';

- SANS 10181:2003. 'The Measurement of Noise Emitted by Road Vehicles when Stationary'; and
- SANS 10205:2003. 'The Measurement of Noise Emitted by Motor Vehicles in Motion'.

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.*

4.3 INTERNATIONAL GUIDELINES

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

4.3.1 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).

4.3.2 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 nighttime 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*."

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."

4.3.3 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.

4.3.4 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 the source. It goes as far as to propose methods for the prevention and control of noise emissions.

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**).

The effect of the different seasons is considered when assigning rating levels for certain areas. Numerous factors are considered when defining the potential rating level for an area, which include ambient sound levels (that may be impacted by seasonal effects) as well as the developmental character of the area (industrial noises, business as well as typically expected road traffic).

For environmental noise, weather also 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 include wind, temperature and humidity, as discussed in the following sections.

5.1.1 Effect of wind speeds on vegetation and sound levels

Wind speed is a determining factor for 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.

5.1.2 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 travelling to a location downwind of the source and to bend upward when travelling 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.

Over short distances, wind direction has a small impact on sound propagation as long as wind velocities are reasonably slow, i.e. less than 3 – 5 m/s.

5.1.3 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 further complicate measurements.

Generally, sound propagate better at lower temperatures (down to 10°C), and with everything being equal, a decrease in temperature from 32°C to 10°C would increase the sound level at a listener 600 m away by ±2.5 dB (at 1,000 Hz).

5.1.4 Effect of humidity on sound propagation

The effect of humidity on sound propagation is quite complex but effectively relates how increased humidity changes the density of air. Lower density translates into faster sound wave travel, so sound waves travel faster at high humidity. With everything being equal, an increase in humidity from 20% to 80% would increase the sound level at a listener 600 m away by ±4 dB (at 1,000 Hz).

5.2 FACTORS THAT INFLUENCE AMBIENT SOUND LEVELS AT A DWELLING

There are a number of factors that determine how ambient sound levels close to a dwelling might differ from the ambient sound levels further away (or even at another dwelling in the area), including:

- Type of activities taking place in the vicinity of the dwelling;
- Equipment being used near the dwelling, especially equipment such as water pumps, compressors and air conditioners;
- Whether there are any windmills (*"windpompe"*) close to the dwelling as well as their general maintenance condition;
- Types of trees around dwelling (conifers vs. broad-leaved trees, habitat that it provides to birds, food that it may provide to birds);
- The number, type and distance between the dwelling (measuring point) and trees. This is especially relevant when the trees are directly against the house (where the branches can touch the roof);
- Distance to large infrastructural developments, including roads, railroads and even large diameter pipelines (generation of low-frequency noises);
- Distances to other noise sources, whether anthropogenic or natural (such as the ocean or running water);
- The material used in the construction of the dwelling;
- The design of the building, including layout and number of openings (relating to the detection and second generation of low-frequency noises);
- How well the dwelling is maintained; and
- The type and how many farm animals are in the vicinity of the dwelling.

5.3 AMBIENT SOUND LEVEL MEASUREMENTS

Ambient sound levels were measured from 3 – 5 September 2019 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.

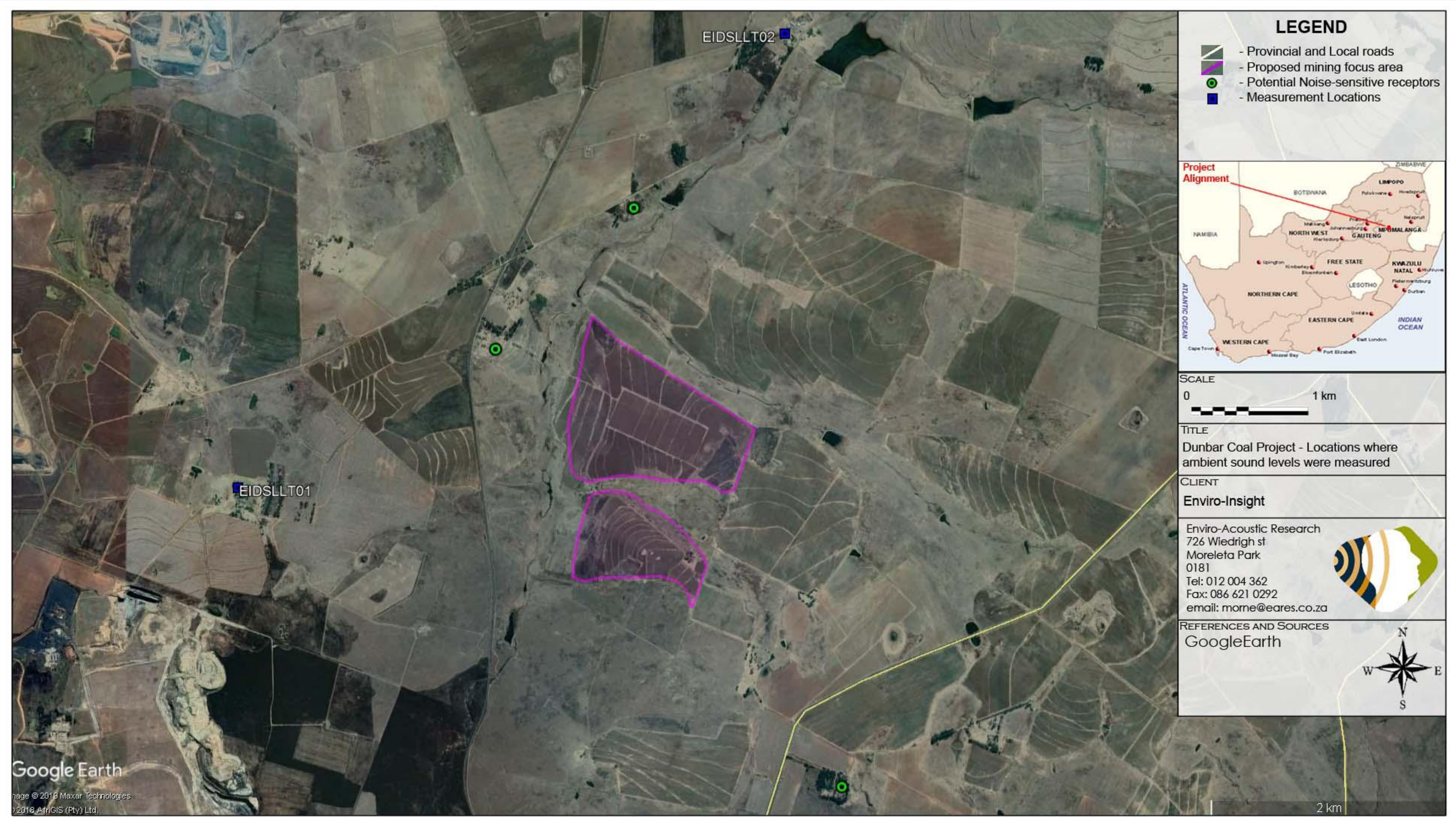

Figure 5-1: Localities of where ambient sound levels were measured

5.3.1 Ambient Sound Measurements at EIDSLLT01

The microphone was deployed away from the house on the edge of the property. There were significant large eucalyptus trees in the vicinity of the measurement location that resulted in significant wind-induced noises with increased wind speeds. 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 EIDSLLT01

Ambient Sound Character – Sounds of significance heard onsite	
Magnitude Scale Code: Barely Audible, Audible, Dominating	**Faunal and Natural**
	Deployment: Wind induced noises audible and dominant at times, with wind-induced noises from large eucalyptus trees. Birds clearly audible. Collection: Birds sounds. Wind induced noises audible from large eucalyptus trees.
	Residential and other Anthropogenic
	Deployment: Sheep bleating at times. Collection: -
	Industries, Commercial and Road Traffic
	Deployment: - Collection: -

Table 5-2: Equipment used to gather data at EIDSLLT01

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 2019
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 change 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 in **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 frequently used to define the background sound level internationally. The instrument is set to fast time-weighting. It is illustrated against time in **Figure 5-3** and **Table 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 EIDSLLT01

	$L_{Amax,i}$ (dBA)	$L_{Aeq,i}$ (dBA)	$L_{Aeq,f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{Amin,f}$ (dBA)	Comments
Day arithmetic average	-	47.5	43.1	36.2	-	-
Night arithmetic average	-	40.0	37.9	34.0	-	-
Day minimum	-	35.4	32.2	-	23.4	-
Day maximum	85.2	66.2	55.2	-	-	-
Night minimum	-	32.1	30.2	-	25.6	-
Night maximum	75.9	53.5	49.6	-	-	-
Day 1 equivalent	-	55.1	46.3	-	-	Afternoon and evening only
Night 1 Equivalent	-	41.3	39.0	-	-	8 hour night equivalent average
Day 2 equivalent	-	48.6	44.2	-	-	16 hour day equivalent average
Night 2 Equivalent	-	42.3	39.6	-	-	8 hour night equivalent average
Day 3 equivalent	-	49.8	44.9	-	-	Morning only

The statistical data (**$L_{A90,f}$**) indicate a location with elevated noise levels, even though **L_{Amin}** data indicate a location with a potential to become quiet. The elevated **$L_{A90,f}$** level indicate a relative constant noise in the area that was not defined during the site visit. **L_{Amax}** levels did not frequently exceeded 65 dBA at night. When more than 10 sound events occur at night (where the noise level exceeds 65 dBA) maximum events may disturb the sleep of people.

Considering the character of the area sounds heard as well as the average **sound level** values, ambient sound levels are typical of a **sub-urban noise district** as illustrated in in **Figure 5-4** for the night-time period and typical of a **rural noise district** as per **Figure 5-5** for the daytime period. Adopting the precautious principle, the ideal acceptable zone rating level would be typical of a **rural noise district** (35 dBA at night and 45 dBA during the day) as defined in SANS 10103:2008. Considering the average equivalent night-time

sound levels (37.9 dBA), mining activities should not increase the total noise levels higher than 45 dBA.
Considering the character of the area, sounds heard as well as the average $\mathbf{L_{Aeq,i}}$ values, ambient sound levels are typical of a **sub-urban noise district** as illustrated in **Figure 5-4** and **Figure 5-5**.

Spectral character: Third octaves were measured and are displayed for the first night and second day (**Figure 5-6** and **Figure 5-7**) with the averaged spectral character illustrated for the night and daytime periods in **Figure 5-8** and **Figure 5-9**.

Lower frequency (20 – 250 Hz) – Noise sources of significance in this frequency band would include nature (wind and surf especially – indicated by a relatively 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).

There was significant low-frequency noise during both night-time periods with the source(s) unknown. The same peaks in the frequency are visible in the daytime data.

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).

There were some acoustic energy in the 500 – 630 Hz frequency band.

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

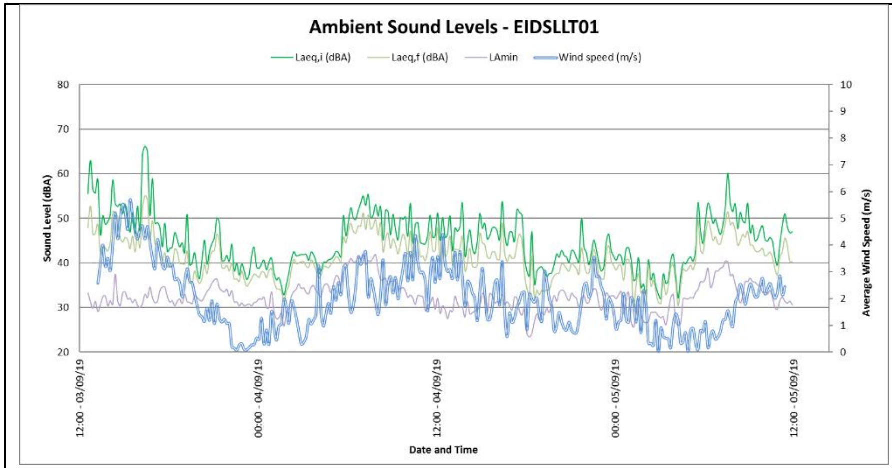

Figure 5-2: Ambient Sound Levels at EIDSLLT01

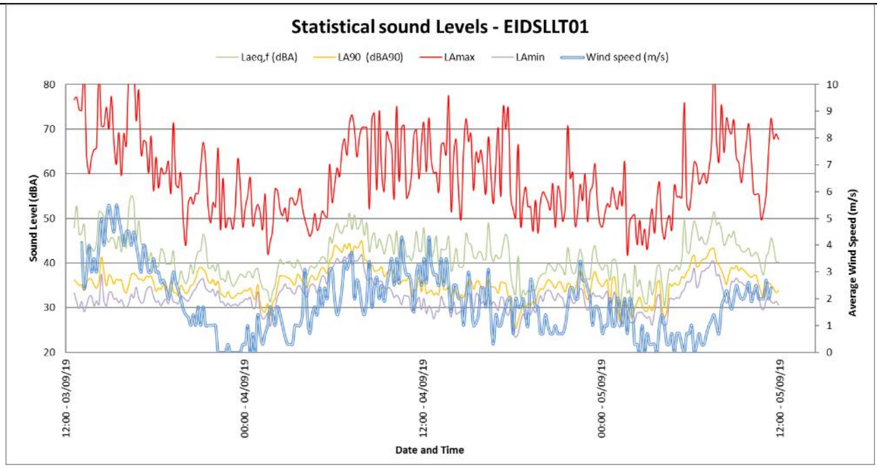

Figure 5-3: Maximum, minimum and statistical values at EIDSLLT01

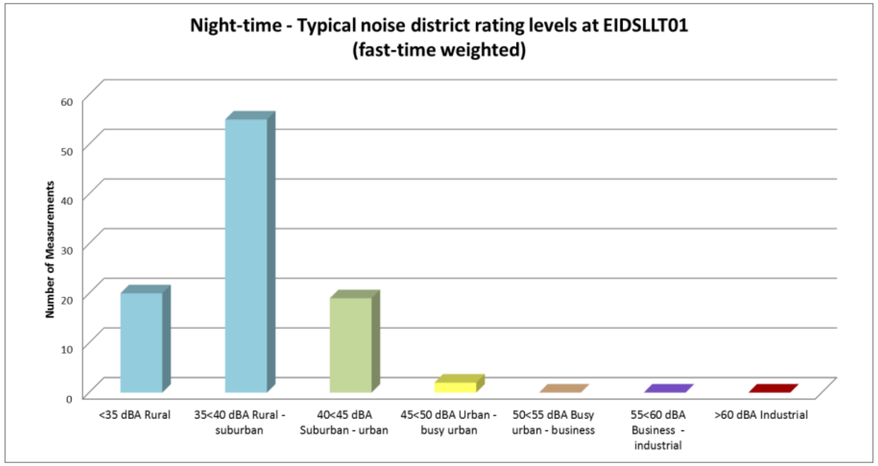

Figure 5-4: Classification of night-time noise levels – EIDSLLT01

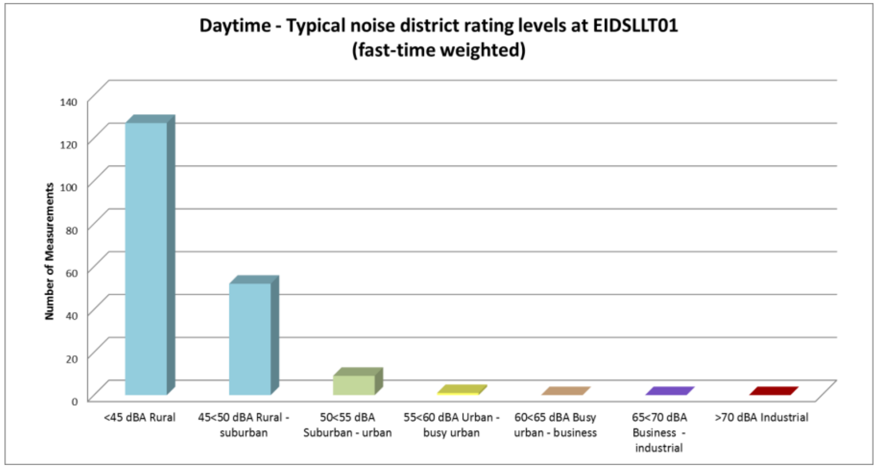

Figure 5-5: Classification of daytime noise levels - EIDSLLT01

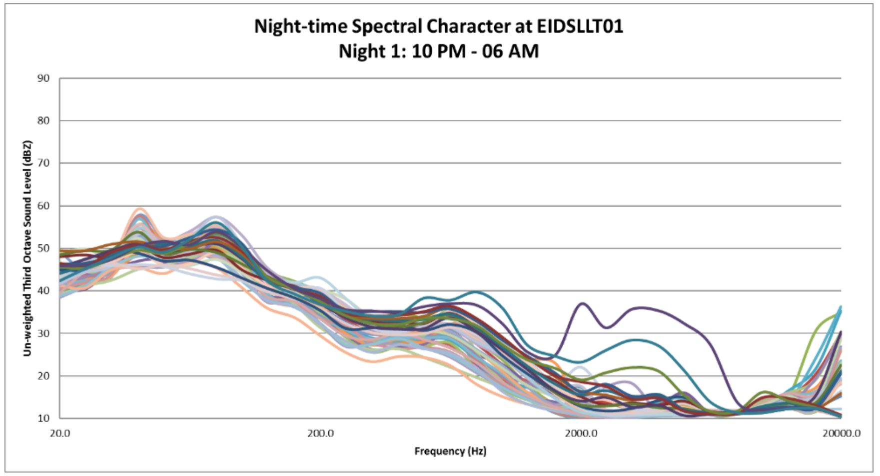

Figure 5-6: Spectral frequencies – EIDSLLT01, Night 1

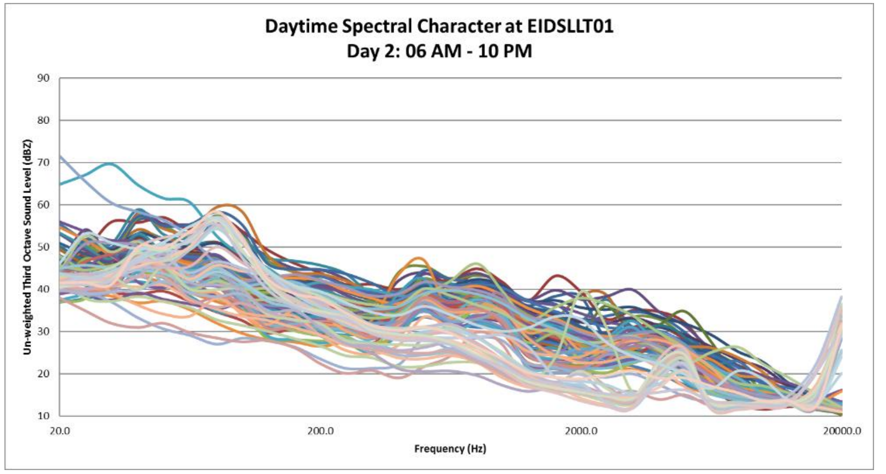

Figure 5-7: Spectral frequencies - EIDSLLT01, Day 2

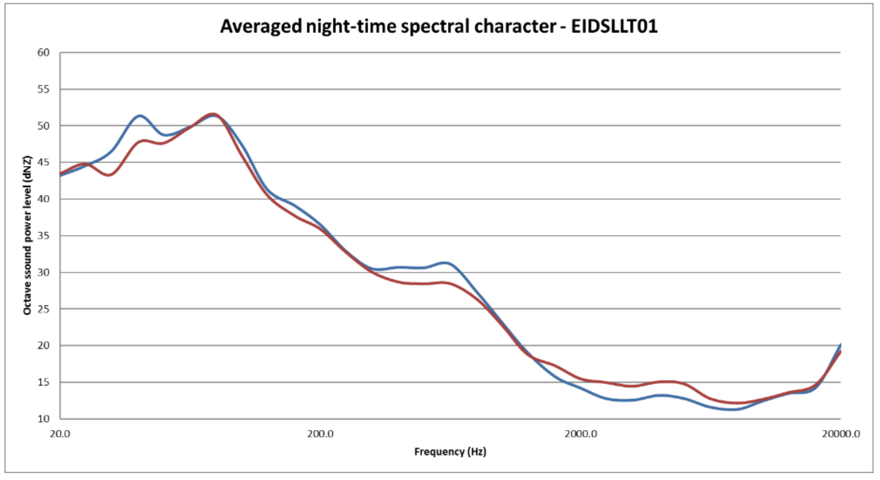

Figure 5-8: Averaged night-time spectral frequencies - EIDSLLT01

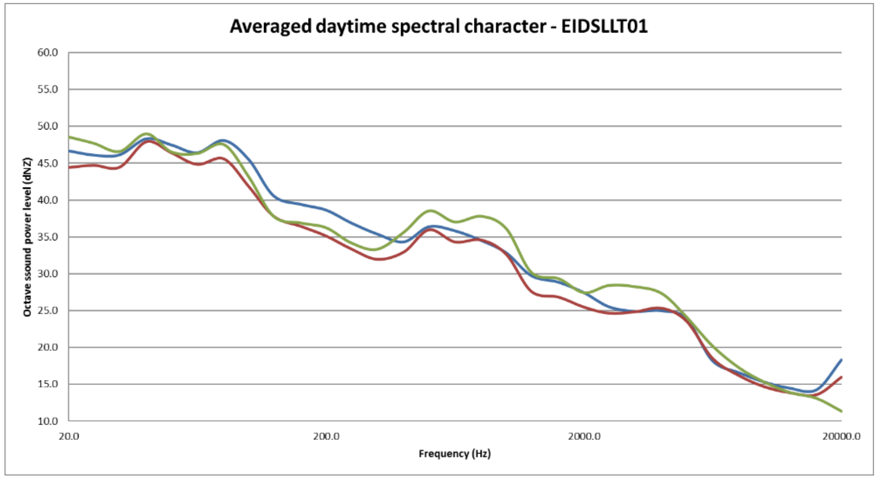

Figure 5-9: Averaged daytime spectral frequencies - EIDSLLT01

5.3.2 Ambient Sound Measurements at EIDSLLT02

The instrument was deployed away from the house close to the security fence. There were significant large eucalyptus trees in the vicinity of the measurement location that resulted in significant wind-induced noises with increased wind speeds. Refer to **Appendix B** for a photo of this measurement location. Sounds heard at the measurement location are defined in **Table 5-4**. Equipment used to gather data is presented in **Table 5-5**.

Table 5-4: Noises/sounds heard during site visits at receptor EIDSLLT02

Ambient Sound Character – Sounds of significance heard onsite	
Magnitude Scale Code: Barely Audible, Audible, Dominating	**Faunal and Natural**
	Deployment: Birds dominant. Wind induced noises due to vegetation in area. Collection: Birds dominant. Wind induced noises due to vegetation in area.
	Residential and other Anthropogenic
	Deployment: - Collection: -
	Industries, Commercial and Road Traffic
	Deployment: Workers at the stores. Collection: Trucks being loaded at the stores.

Table 5-5: Equipment used to gather data at EIDSLLT02

Equipment	Model	Serial no	Calibration Date
SLM	Svan 955	27637	October 2018
Microphone	ACO Pacific 7052E	52437	October 2018
Calibrator	Quest CA-22	J 2080094	July 2017

- Microphone fitted with the appropriate windshield.

Impulse equivalent sound levels (South African legislation): Figure 5-10 illustrates how the impulse-weighted 10-minute equivalent values change 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 in **Figure 5-10** with **Table 5-6** 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 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** and defined in **Table 5-6**.

Table 5-6: Sound levels considering various sound level descriptors at EIDSLLT02

	$L_{Amax,i}$ (dBA)	$L_{Aeq,i}$ (dBA)	$L_{Aeq,f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{Amin,f}$ (dBA)	Comments
Day arithmetic average	-	46.9	42.0	36.4	-	-
Night arithmetic average	-	41.3	38.0	33.0	-	-
Day minimum	-	32.4	27.0	-	21.0	-
Day maximum	82.1	62.8	57.4	-	-	-
Night minimum	-	30.1	27.6	-	20.8	-
Night maximum	80.5	57.1	54.1	-	-	-
Day 1 equivalent	-	45.8	40.9	-	-	Evening only
Night 1 Equivalent	-	47.1	43.2	-	-	8 hour night equivalent average
Day 2 equivalent	-	51.8	46.7	-	-	16 hour day equivalent average
Night 2 Equivalent	-	48.1	43.3	-	-	8 hour night equivalent average
Day 3 equivalent	-	52.3	48.1	-	-	8 hour night equivalent average

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 **Table 5-6** and illustrated in **Figure 5-11**.

As with measurement location EIDSLLT01, the statistical data (**$L_{A90,f}$**) indicate a location with elevated noise levels, even though **L_{Amin}** data indicate a location with a potential to become quiet. The elevated **$L_{A90,f}$** level indicate a relative constant noise in the area that was not defined during the site visit. **L_{Amax}** levels did exceed 65 dBA about 15 times over the 2-night period (7 and 8 times respectively). When more than 10 sound events occur at night (where the noise level exceeds 65 dBA) maximum events may disturb the sleep of people.

Considering the character of the area sounds heard as well as the average **sound level** values, ambient sound levels are typical of a **sub-urban noise district** as illustrated in **Figure 5-12** for the night-time period and typical of a **rural noise district** as per **Figure 5-13** for the daytime period. Adopting the precautious principle, the ideal acceptable zone rating level would be typical of a **rural noise district** (35 dBA at night and 45 dBA during the day) as defined in SANS 10103:2008. Considering the average equivalent night-time sound levels (38 dBA), mining activities should not increase the total noise levels higher than 45 dBA.

Spectral character: Third octaves were measured and are displayed for the first night and second day (**Figure 5-14** and **Figure 5-15**) with the averaged spectral character illustrated for the night and daytime periods in **Figure 5-16** and **Figure 5-17**.

Lower frequency (20 – 250 Hz) – Noise sources of significance in this frequency band would include nature (wind and surf especially – indicated by a relatively 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).

There was significant low-frequency noise during both night-time periods with the source(s) unknown. The same peaks in the frequency are visible in the daytime data.

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).

There were some acoustic energy in the 400 Hz frequency band.

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

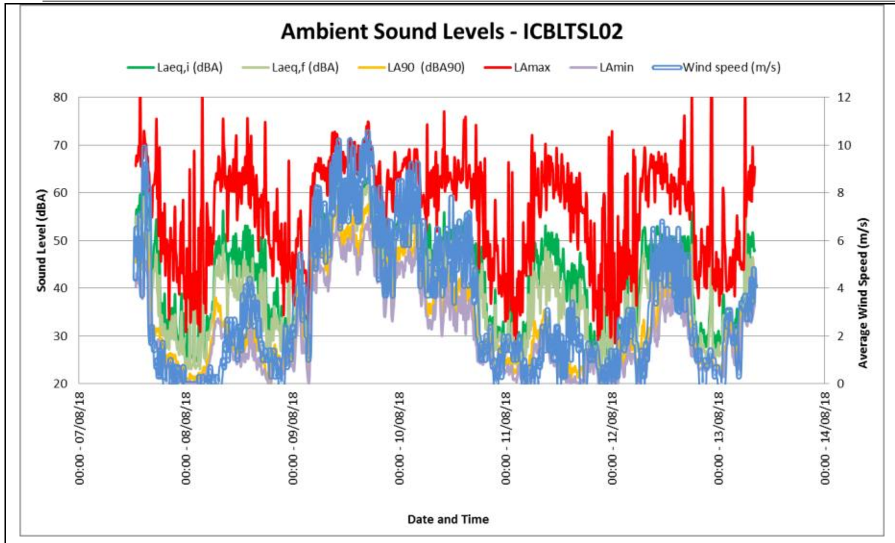

Figure 5-10: Ambient Sound Levels at EIDSLLT02

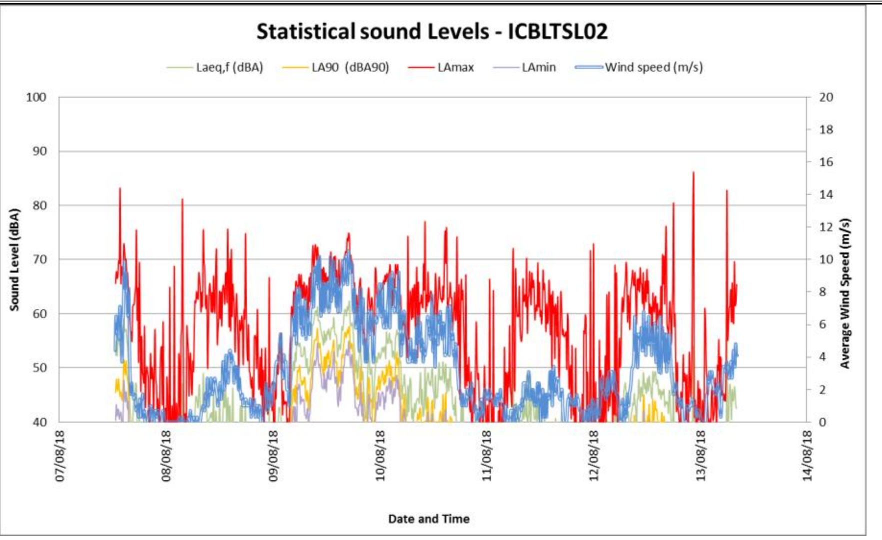

Figure 5-11: Maximum, minimum and statistical values at EIDSLLT02

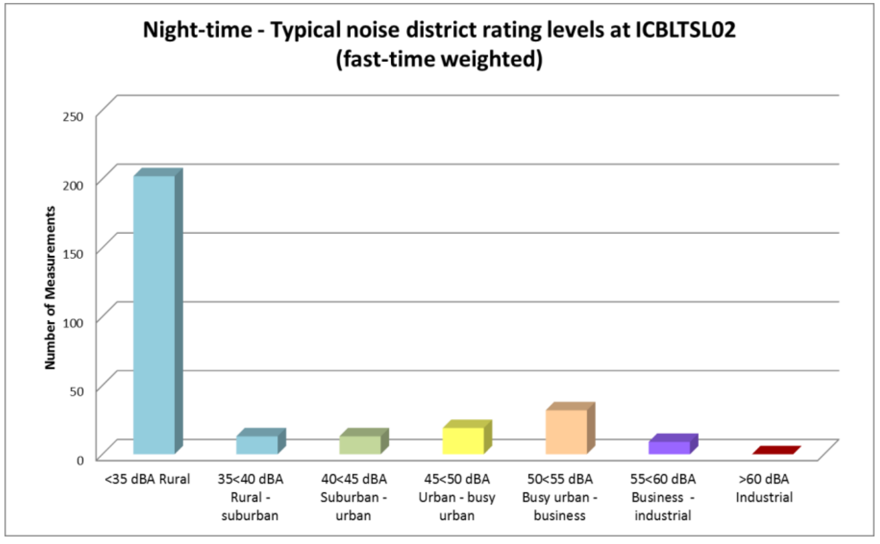

Figure 5-12: Classification of night-time noise levels – EIDSLLT02

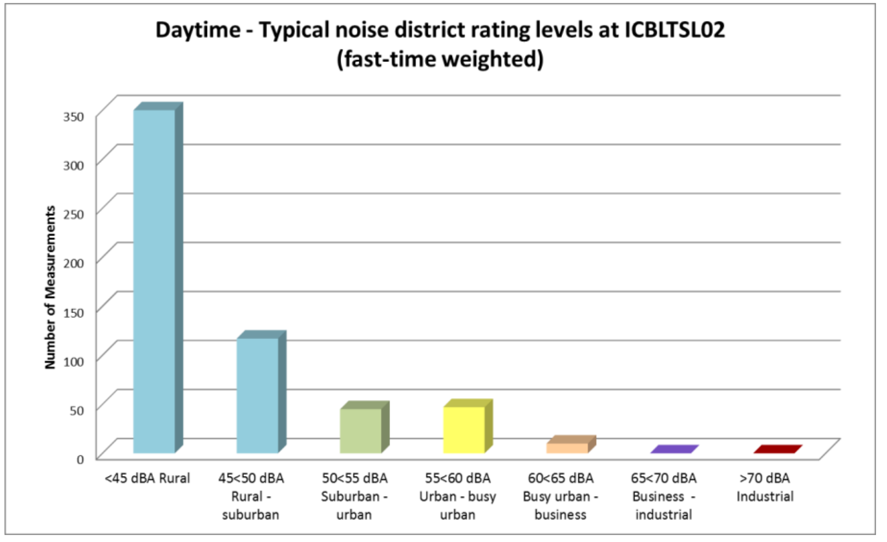

Figure 5-13: Classification of daytime noise levels - EIDSLLT02

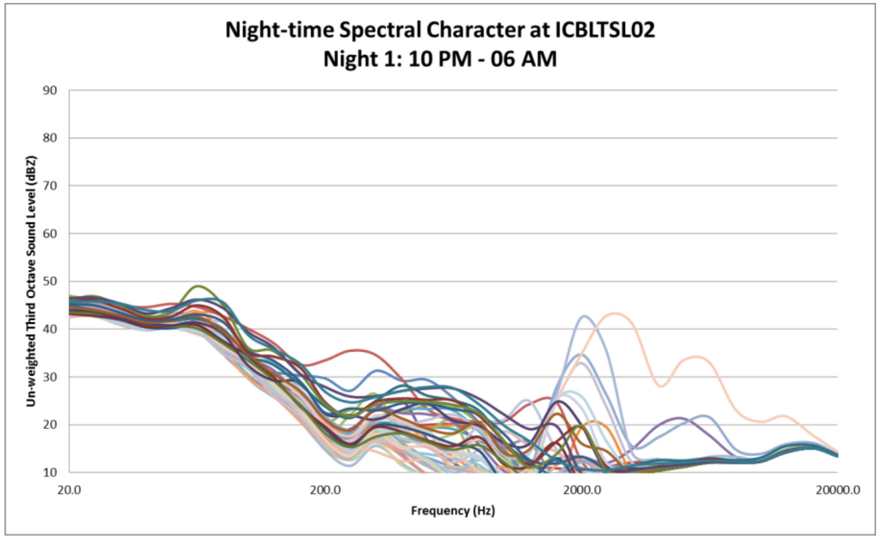

Figure 5-14: Spectral frequencies – EIDSLLT02, Night 1

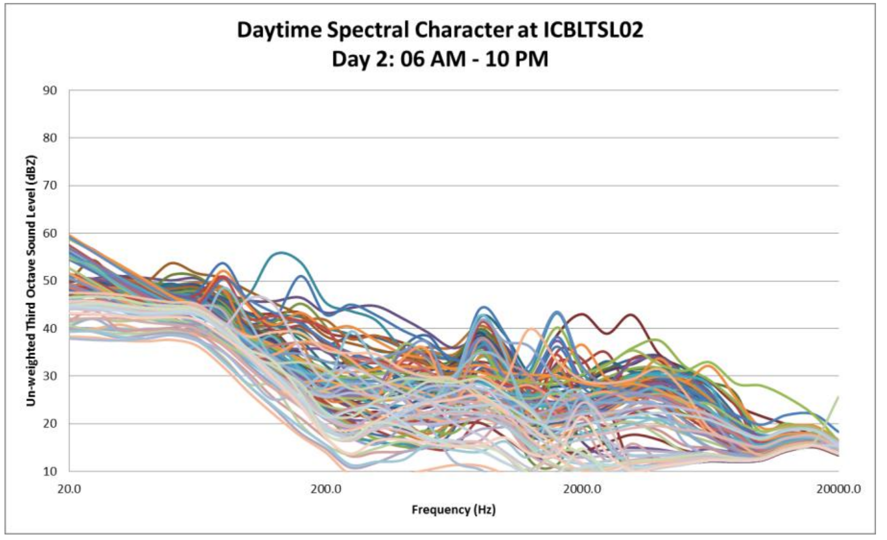

Figure 5-15: Spectral frequencies - EIDSLLT02, Day 2

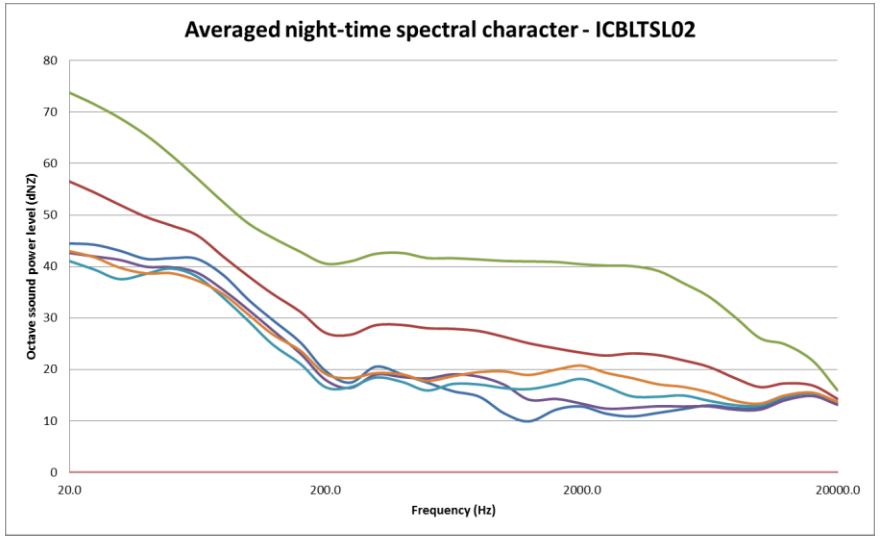

Figure 5-16: Averaged night-time spectral frequencies - EIDSLLT02

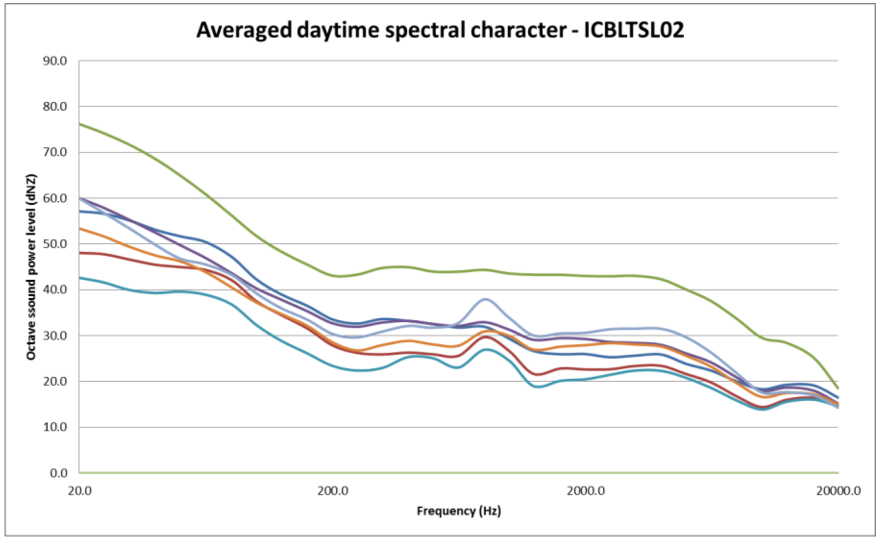

Figure 5-17: Averaged night-time spectral frequencies - EIDSLLT02

5.4 Summary of Ambient Sound Levels

The onsite ambient sound levels are defined in the previous section, and, considering the developmental nature of the area as well as the onsite sound levels with sound levels measured in similar areas, it can be summarized that:

- **EIDSLLT01 - Measurement representing sound levels typical dwelling:**
  - Considering the average $L_{Aeq,f}$ daytime data, sound levels are typical of a rural noise district (average daytime levels of 43.1 dBA, mean of the three daytime periods of the equivalent level is 45.1 dBA). Considering the developmental character of the area, daytime ambient sound levels should be typical of a rural noise district;
  - Considering the average $L_{Aeq,f}$ night-time data, sound levels are typical of a sub-urban noise district (average night-time levels of 37.9 dBA, mean of the two night-time periods of the equivalent level is 39.3 dBA). Considering the developmental character of the area, night-time ambient sound levels should be typical of a rural noise district.
- **EIDSLLT02 - Measurement representing sound levels typical dwelling:**
  - Considering the average $L_{Aeq,f}$ daytime data, sound levels are typical of a rural noise district (average daytime levels of 42.0 dBA, mean of the three daytime periods of the equivalent level is 45.2 dBA). Considering the developmental character of the area, daytime ambient sound levels should be typical of a rural noise district;
  - Considering the average $L_{Aeq,f}$ night-time data, sound levels are typical of a sub-urban noise district (average night-time levels of 38.0 dBA, mean of the two night-time periods of the equivalent level is 43.2 dBA). Considering the developmental character of the area, night-time ambient sound levels should be typical of a rural noise district.

Day- and night-time ambient sound levels were higher than measurements collected in other areas with a rural sound character as can be observed from **Figure 5-18** and **Figure 5-19**. Ideally, the activities of the proposed mining activity should not change the existing ambient sound levels with more than 7 dBA. Considering average night-time ambient sound levels, mining activities should not increase the noise levels higher than 45 dBA (similar to the WHO / IFC noise limit for residential use).

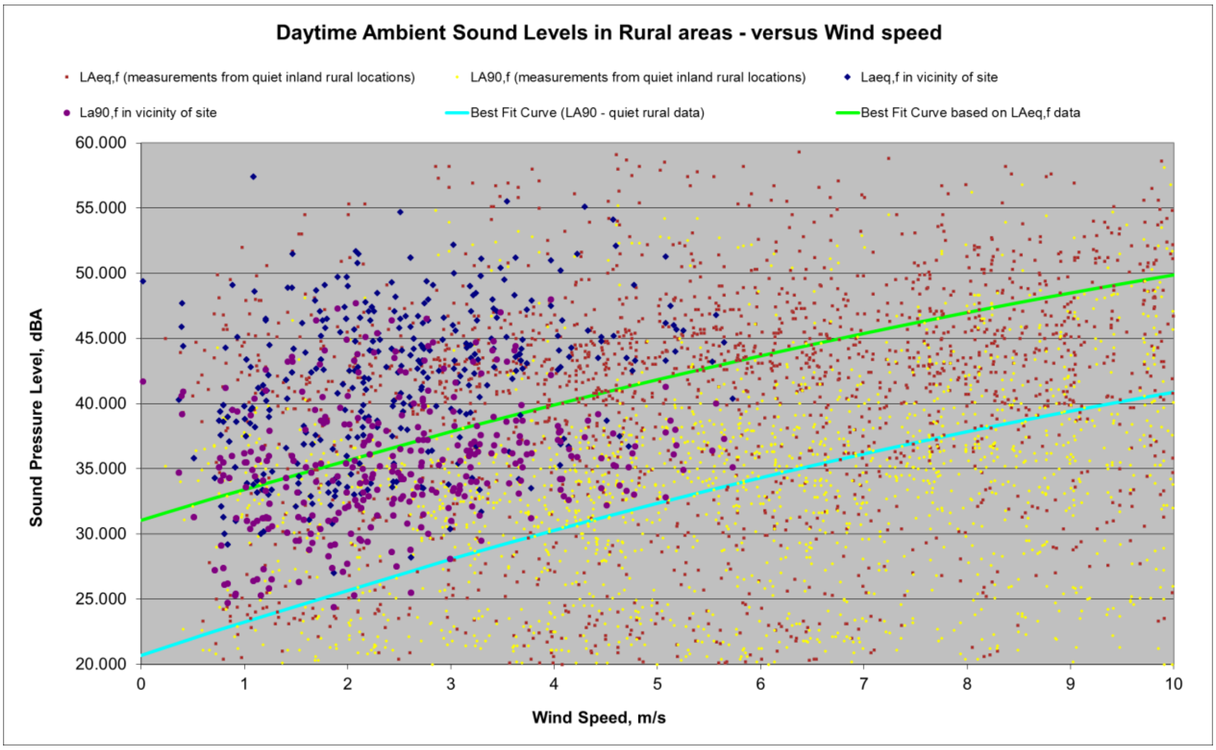

Figure 5-18: Summary of onsite daytime sound levels compared to long-term sound levels measured in other rural areas

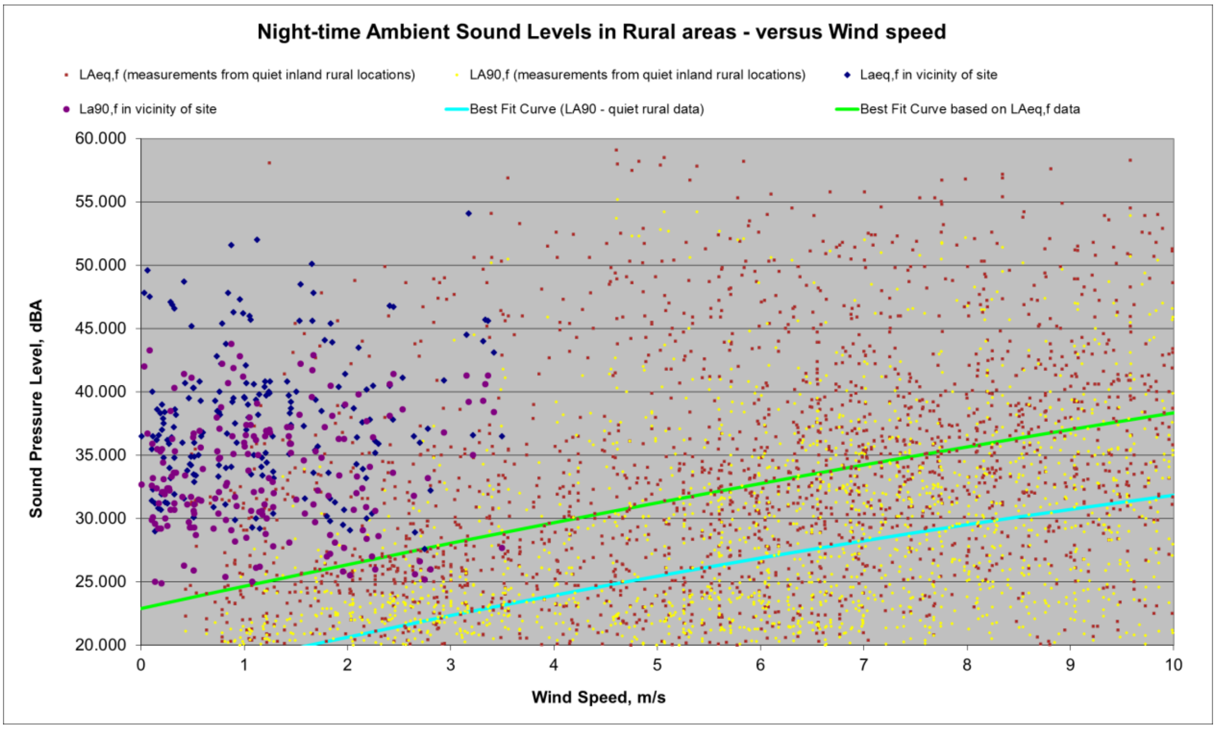

Figure 5-19: Summary of onsite night-time sound levels compared to long-term sound levels measured in other rural areas

6 POTENTIAL NOISE SOURCES

Increased noise levels are directly linked with the various activities associated with the construction as well as the operational phase of the mining activity. Noise emitted by the construction and operations can be associated with various noise sources, including mechanical sources due to operation of equipment, material impact noises (such as the noise made when materials are dropped at a height to ground level), electrical noise (reverse hooters from equipment or the "whine" of an electrical pump) and noises from vehicles moving around.

This report will focus on three scenarios, namely:

- Construction activities taking place at the proposed mining area. Both a day- and night-time scenario will be investigated, with equipment operating on ground level (no berms between activities and NSDs), with various equipment operating simultaneously;
- A mitigated construction scenario with a berm developed between the proposed mining area and the construction activities. Only the night-time scenario was investigated;
- Typical operational activities taking place at the mining pit, considering the scenario as highlighted in **section 6.2.**

6.1 CONSTRUCTION NOISES

Construction activities include:

- Site establishment;
- Construction of access roads;
- Vegetation removal;
- Topsoil removal and the development of stockpile footprints. It will be assumed that the topsoil and soft material will be stockpiled in the edge of the opencast to assist in the mitigation of noises from the mine;
- The removal of soft (using excavator) and hard overburden (drill and blast to remove very hard material) during the development of the opencast/box cut. Drilling activities will continue at night; and
- The establishment of infrastructures such as pollution control dam, offices/workshops, stockpile areas and plant (crushing/screen etc.) area.

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.

For the construction scenario it was selected to model the following activities/equipment:

- a general noise (such as a bulldozer) operating in the area where the boxcut, PCDs, RoM, plant, stockpiles and dumps are proposed;
- a general noise source at the location proposed for the boxcut;
- an number of excavators and articulated dump trucks (ADTs) loading topsoil and overburden at the boxcut area;
- an ADT off-loading topsoil on the edge of the boxcut area (constructing berm). This noise source only operate during the day;
- drills operating at the location proposed for the boxcut;
- 20 ADTs and 10 LDVs per hour travelling to and on the construction site at an average speed of 40 km/h.

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
Rivit 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

6.2 Operational Noises – General

6.2.1 Mining Activities

Coal will be mined through an opencast bench mining method. The benches will be mined at a height of 10 metres with the final mining depth determined by the coal resource.

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;
- 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;
- Drilling operations will commence in the front of the advancing pit after the topsoil and soft overburden has been removed. This will take place 24 hours per day 5 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 at least 15 m below the ground surface. This will be repeated until the coal resource is reached. Excavation and the hauling of overburden will continue at night;
- 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. This will take place 24 hours per day 20m below the ground surface;
- 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;
- Construction activities at the second pit (location north-west corner, second pit) similar to the construction phase; and
- Various plant activities to beneficiate the resource, stockpiling and loading onto road trucks to allow transport to the market (no product transport at night).

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.

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 6-3** will be used in the noise modelling for both the construction and operational phase.

Table 6-3: 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 - Bell 25 ton	102.5	108.6	106.5	105.4	104.5	99.2	97.2	108.4
Bulldozer CAT D5	107.4	105.9	104.8	104.5	104.4	97.5	90.2	107.4
Coal beneficiation plant (50kt/m)	110.6	111.2	110.9	111.2	110.8	107.0	100.6	117.5
Drilling Machine and compressor	107.2	109.4	109.2	106.1	104.7	101.2	99.8	120.0
Excavator and truck	111.0	112.2	109.3	106.4	105.4	101.6	98.4	110.0
FEL - Bell L1806C	109.0	106.7	107.3	97.9	95.8	92.5	87.6	102.7
FEL and Truck	105.0	117.0	113.0	114.0	111.0	107.0	101.0	110.0
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

6.2.2 Traffic

A source of noise during the operational phase will be traffic to and from the site, traffic around the infrastructure facilities, ROM and product transport and activities associated with waste management. While trucks moving around on the site do have a clearly audible noise during passing, the average noise contribution is relatively low compared to the other noise sources. For the purpose of this study, potential peak hauling activities will be assumed at an average of 16 trucks per hour travelling at 60 km/h from the site to the D622 road (day-time only). Around 10 ADTs are moving around onsite between the active mining pit and the processing plant (day and night).

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

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[4]

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 to 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, characteristics 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 to 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 in **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

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

few studies that discuss behavioural changes in other faunal species due to increased 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).

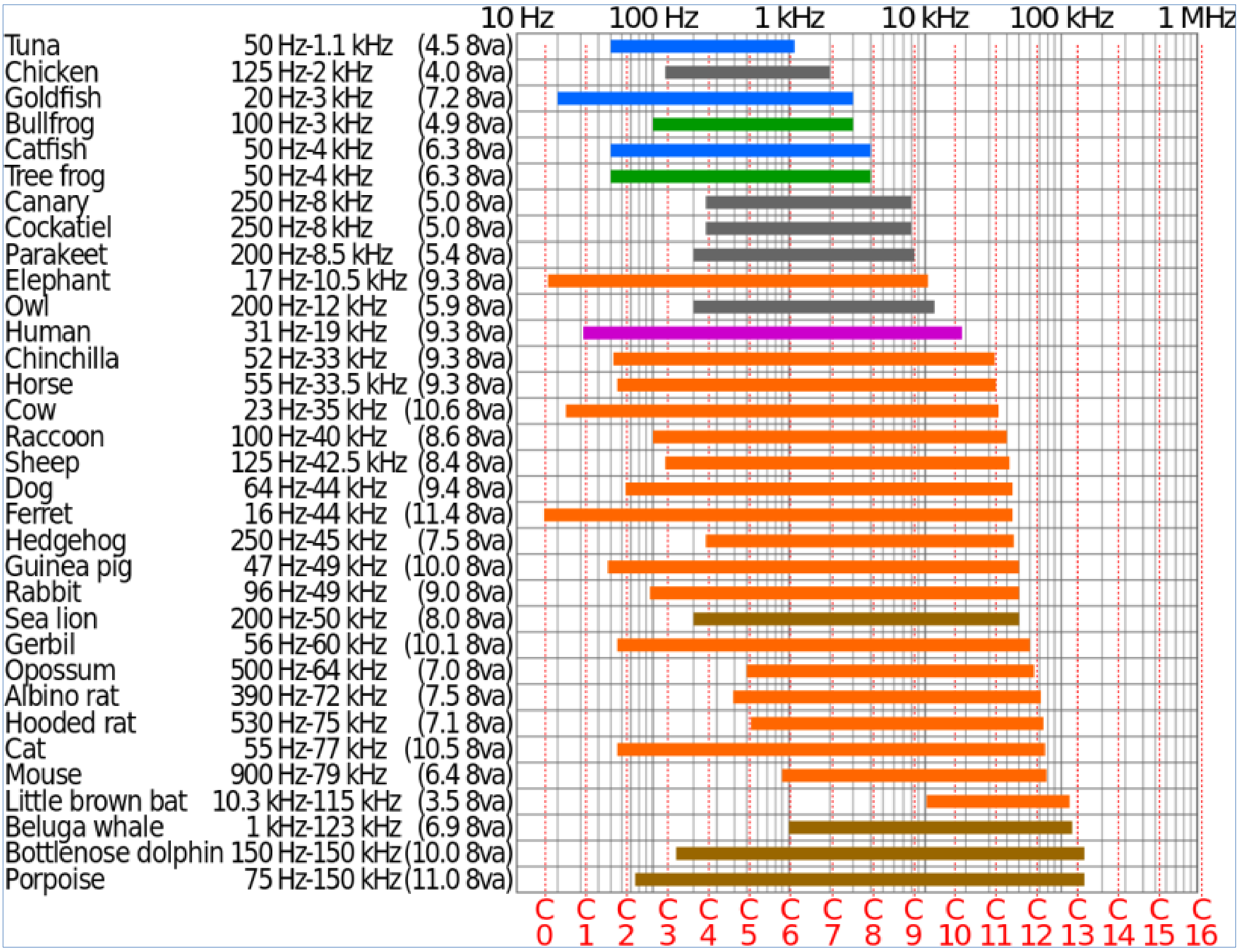

Figure 7-1: Logarithmic Chart of the Hearing Ranges of Some Animals[5]

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

- Animals respond to impulsive (sudden) noises (higher than 90 dBA) by running away. If the noises continue, animals would try to relocate (Drooling, 2007).
- 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 (Baber, 2009).

[5] https://en.wikipedia.org/wiki/Hearing_range

- Animals of most species exhibit adaptation with noise (Broucek, 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 (Drooling, 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.

7.1.1 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)[6 & 7]. The high noise levels may see negative influences on animals' cardiovascular systems and behaviour and may be damaging to the hearing of dogs in the kennel facility[8].

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 have not been studied.

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.

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[6]Crista L. Coppola. Noise in the Animal Shelter Environment: Building Design and the Effects of Daily Noise Exposure.
[7] David Key, Essential Kennel Designs.
[8]Wei, B. L. (1969). Physiological effects of audible sound. AAAS Symposium Science, 166(3904), 533-535.

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, character or both).

There are a few specific studies discussing the potential impacts of noise on wildlife associated with construction, transportation and industrial facilities. Available information indicates that noises from transportation and industrial sources may mask the sound of a predator approaching; similarly, predators depending on hearing would not be able to locate their prey.

7.1.3 Avifauna[9]

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 behavioural 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.

[9] Ortega, 2012; Halfwerk, 2011; Francis, 2012; Francis, 2011; Parris, 2009, Brumm, 2004.

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.[10] Other dissimilarities to laboratory tests and a natural environment include the time exposure (duration of noise), the spectral and noise character (impulsive noise vs. constant noise) etc. Although there exist dissimilarities in tests conducted and noise levels around commercial and industrial environments, laboratory rodents exposed to high noise levels did indicate physiological, behavioural changes, hearing loss and other such effects[11].

7.2 Why noise concerns communities[12]

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
- 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.

[10] USEPA, 1971.
[11] Baldwin, 2007.
[12] World Health Organization, 1999; Noise quest, 2010; Journal of Acoustical Society of America, 2009

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, the 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 the noise. With regards to the Noise Control Regulations (promulgated in terms of the ECA), an increase of more than 5 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.

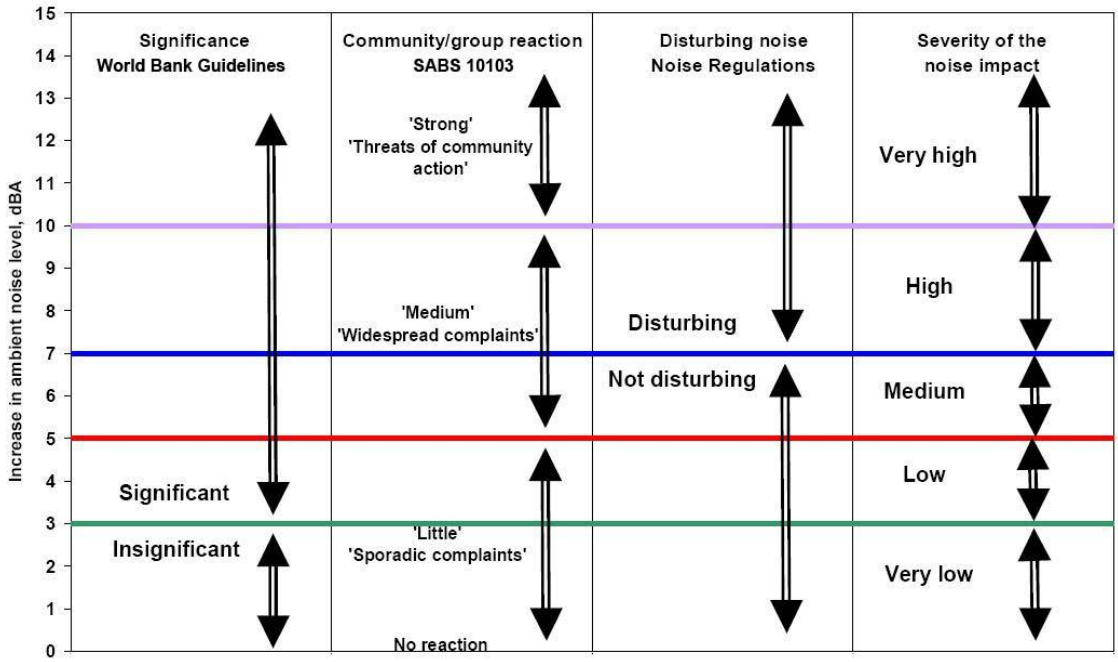

Figure 7-2: Criteria to assess the significance of impacts stemming from noise

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 complex and different rating levels (noise limits) should be considered, such as:

- "Rural Noise District" (45 and 35 dBA day/night-time Rating i.t.o. SANS 10103:2008).

- "Sub-urban Noise District" (50 and 40 dBA day/night-time Rating i.t.o. SANS 10103:2008).
- "Urban Noise District" (55 and 45 dBA day/night-time Rating i.t.o. SANS 10103:2008).

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

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 Noise Control Regulations).

7.3.3 Determining the Significance of the Noise Impact

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

Once a potential impact has been determined it is necessary to identify which project activity will cause the impact, the probability of occurrence of the impact, and its magnitude and extent (spatial and temporal). This information is important for evaluating the significance of the impact, and for defining mitigation and monitoring strategies. Direct and indirect impacts of the impacts identified during the specialist investigations were assessed in terms of five standard rating scales to determine their significance.

The rating system used for assessing impacts (or when specific impacts cannot be identified, the broader term issue should apply) is based on five criteria, namely:

- **Status** of impacts (**Table 7-2**) – determines whether the potential impact is positive (positive gain to the environment), negative (negative impact on the environment), or neutral (i.e. no perceived cost or benefit to the environment). Take note that a positive impact will have a low score value as the impact is considered favourable to the environment;
- **Spatial extent** of impacts (**Table 7-3**) – determines the spatial scale of the impact on a scale of localised to global effect. Many impacts are significant only within the immediate vicinity of the site or within the surrounding community, whilst others may be significant at a local or regional level. Potential impact is expressed numerically on a scale of 1 (site-specific) to 5 (global);
- **Duration** of impacts (**Table 7-4**) – refers to the length of time that the aspect may cause a change either positively or negatively on the environment. Potential impact is expressed numerically on a scale of 1 (project duration) to 5 (permanent);
- **Severity** of impacts (**Table 7-5**) – quantifies the impact in terms of the magnitude of the effect on the baseline environment, and includes consideration of the following factors:
    - The reversibility of the impact;
    - The sensitivity of the receptor to the stressor;
    - The impact duration, its permanency and whether it increases or decreases with time;
    - Whether the aspect is controversial or would set a precedent;
    - The threat to environmental and health standards and objectives;
- **Frequency of the activity** (**Table 7-6**) – The frequency of the activity refers to how regularly the activity takes place. The more frequent an activity, the more potential there is for a related impact to occur.

- **Probability** of impacts (**Table 7-7**) – quantifies the impact in terms of the likelihood of the impact occurring on a percentage scale of <5% (improbable) to >95% (definite).

The Consequence Rating is calculated by summing Spatial Scale (Extent), Duration and Severity, with the Likelihood (of the impact) Rating calculated by summing Frequency and Probability. The significance is estimated by multiplying the Consequence with Likelyhood ratings.

Table 7-2: Status of Impact

Rating	Description	Quantitative Rating
Positive	A benefit to the receiving environment (positive impact)	+
Neutral	No determined cost or benefit to the receiving environment	N
Negative	At cost to the receiving environment (negative impact)	-

Table 7-3: Impact Assessment Criteria – Extent of Impacts

Rating	Description	Quantitative Rating
Very Low	**Site Specific** – impacts confined within the project site boundary	1
Low	**Proximal** – impacts extend to within 1 km of the project site boundary	2
Medium	**Local** – impacts extend beyond to within 5 km of the project site boundary	3
High	**Regional** – impacts extend beyond the site boundary and have a widespread effect - i.e. > 5 km from project site boundary	4
Very High	**Global** – impacts extend beyond the site boundary and have a national or global effect	5

Table 7-4: Impact Assessment Criteria – Duration

Rating	Description	Quantitative Rating
Very Low	**Project duration** – impacts expected only for the duration of the project or not greater than 1 year	1
Low	**Short term** – impacts expected on a duration timescale of 1 to 2 years	2
Medium	**Medium term** – impacts expected on a duration timescale of 2-5 years	3
High	**Long term** – impacts expected on a duration timescale of 5-15 years	4
Very High	**Permanent** – impacts expected on a duration timescale exceeding 15 years	5

Table 7-5: Impact Assessment Criteria – Severity of Impact (Magnitude / Intensity)

Rating	Description	Quantitative Rating
Very Low	Negligible – zero or very low impact. Increase in average sound pressure levels between 0 and 3 dB from the expected ambient sound levels / typical rating level.	1
Low	Site specific and short term impacts. Increase in average sound pressure levels between 3 and 5 dB from the expected ambient sound levels / typical rating level.	2
Medium	Local scale and / or short term impacts. Increase in average sound pressure levels between 5 and 7 dB from the ambient sound levels / typical rating level.	3
High	Regional and / or long term impacts. Increase in average sound pressure levels between 7 and 10 from the ambient sound levels / typical rating level.	4
Very High	Global scale and / or permanent environmental change. Increase in average ambient sound pressure levels / typical rating level higher than 10 dBA.	5

Table 7-6: Impact Assessment Criteria – Frequency of impact

Rating	Frequency	Quantitative Rating
Very Low	Annually or less	1
Low	6 monthly	2
Medium	Monthly	3
High	Weekly	4
Very High	Daily	5

Table 7-7: Impact Assessment Criteria – Probability of Impact Occuring

Rating	Description	Quantitative Rating
Highly Improbable	Likelihood of the impact arising is estimated to be negligible; <5%.	1
Improbable	Likelihood of the impact arising is estimated to be 5-35%.	2
Possible	Likelihood of the impact arising is estimated to be 35-65%	3
Probable	Likelihood of the impact arising is estimated to be 65-95%.	4
Highly Probable	Likelihood of the impact arising is estimated to be > 95%.	5

Determination of Impact Significance

The information presented above in terms of identifying and describing the aspects and impacts is summarised and the significance is assigned with supporting rationale. Significance will be classified according to the following:

- Very Low to Low - it will not have an influence on the decision;
- Medium to Medium-High - it should have an influence on the decision unless it is mitigated;
- High to Very High- it would influence the decision regardless of any possible mitigation. Alternative options including rehabilitation and/or offset should be investigated.

The environmental significance rating is an attempt to evaluate the importance of a particular impact, the consequence and likelihood as assessed.

The sum of the first three criteria (spatial scope, duration and severity) provides a collective score for the consequence of each impact. The sum of the last two criteria (frequency of activity and probability of impact) determines the likelihood of the impact occurring. The product of consequence and likelihood leads to the assessment of the significance of the impact, shown in the significance matrix below in **Table 7-8** and **Table 7-9**.

Table 7-8: Assessment Criteria: Significance Assessment Matrix

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	4	6	8	10	12	14	16	08	20	22	24	26	28	30
3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

Table 7-9: Assessment Criteria: Significance Impact Ratings

Colour Code	Significance Rating	Value	Negative Impact Management Recommendation	Positive Impact Management Recommendation
	Very High	126-150	Improve Current Management	Maintain Current Management
	High	101-125	Improve Current Management	Maintain Current Management
	Medium-High	76-100	Improve Current Management	Maintain Current Management
	Low-Medium	51-75	Maintain Current Management	Improve Current Management
	Low	26-50	Maintain Current	Improve Current

			Management	Management
	Very Low	1-25	Maintain Current Management	Improve Current Management

The model outcome is then assessed in terms of impact certainty and consideration of available information. Where a particular variable rationally requires weighting or an additional variable requires consideration the model outcome is adjusted accordingly.

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 can be inaccurate (very low confidence level in the results) for the reasons mentioned above. The more measurements that can be collected at a location the higher the confidence levels in the ambient sound level determined. The more complex the sound environment, the longer the required measurement. When singular measurements are used, a precautious stance must be adopted (as done in this report).
- 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-con);
  - 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[13] on the N12 is significant and traffic noises will have an impact on the ambient sound levels in an area up to about 1,000m either side of the N12, and depending on specific conditions, it may be more during other times. 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.

- 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, unfortunately, coincided with a relatively windy period.
- Ambient sound levels are dependent 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. Winter months unfortunately also coincide with lower temperatures and very stable atmospheric conditions, ideal conditions for propagation of noise. 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].
- 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.

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[13] [13] Derived from https://nraaudit.nra.ie/CurrentTrafficCounterData/html/N17-15.htm and https://www.arrivealive.co.za/2003-TRAFFIC-OFFENCE-SURVEY-Comprehensive-Report-on-Fatal-Crash-Statistics-and-Road-Traffic-Information-11

[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 operational phase 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.

In this project, it illustrates the potential extent of the calculated noises of the complete project and not noise levels at a specific moment in time. It 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 is 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 an 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 are 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 worst-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 comply with the precautionary principle and operational time periods are frequently overestimated. The result is that projected noise levels would likely be 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 per cent (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 PROPOSED CONSTRUCTION PHASE NOISE IMPACT

This section investigates the conceptual construction activities as discussed in **section 6.1**. Two conceptual noise models were developed considering the activities as depicted in **Figure 9-1**.

It is assumed that all equipment would be operating under full load (generate the most noise) at a number of locations and that atmospheric conditions would be ideal for sound propagation. Scenario 1 assumes that mining equipment is operating at surface level without the benefit of the berms, stockpiles or an overburden dump, with scenario 2 implementing a 3 m berm between the construction activities and the closest NSD. This is likely the worst case scenario that can occur during the construction phase of the project.

Noise rating level contours are illustrated in **Figure 9-2** (daytime) and **Figure 9-3** (night time) for Scenario 1 and **Figure 9-4** (night-time) for scenario 2 (with a 3 m berm).

Table 9-1: Projected noise levels due to construction activities

NSD	Rating level considering character of area and existing noise sources (dBA)		Projected (maximum) construction noise rating level (dBA)		Projected (maximum) construction noise rating level (dBA) – with 3 m berm	
	Day	Night	Day	Night	Day	Night
1	45	35	48.1	48.0	44.0	43.8
2	45	35	47.1	46.7	46.5	46.1
3	45	35	29.9	28.2	29.9	29.4

Figure 9-1: Conceptual construction noise sources

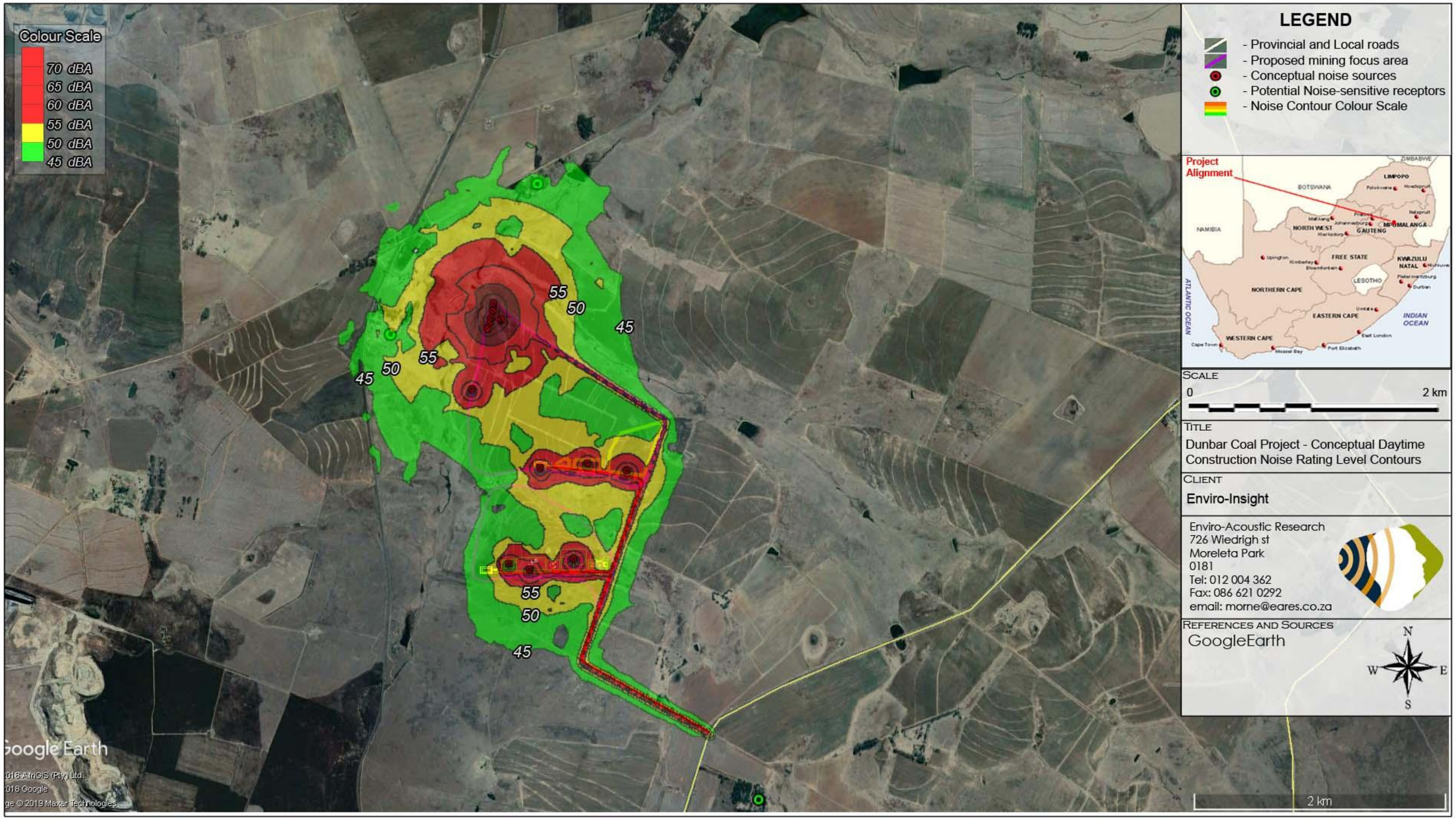

Figure 9-2: Projected conceptual daytime construction noise levels

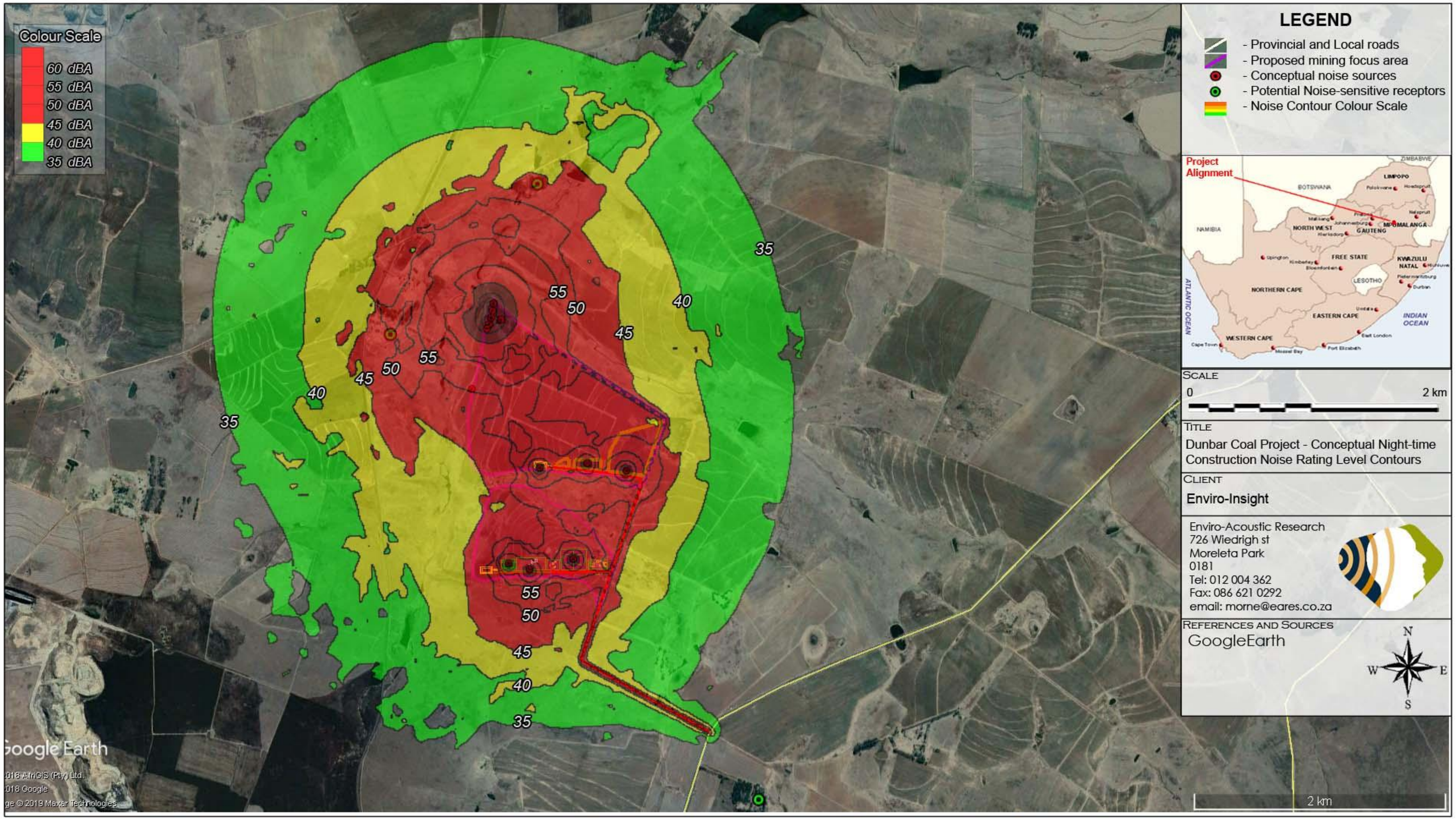

Figure 9-3: Projected conceptual night-time construction noise levels

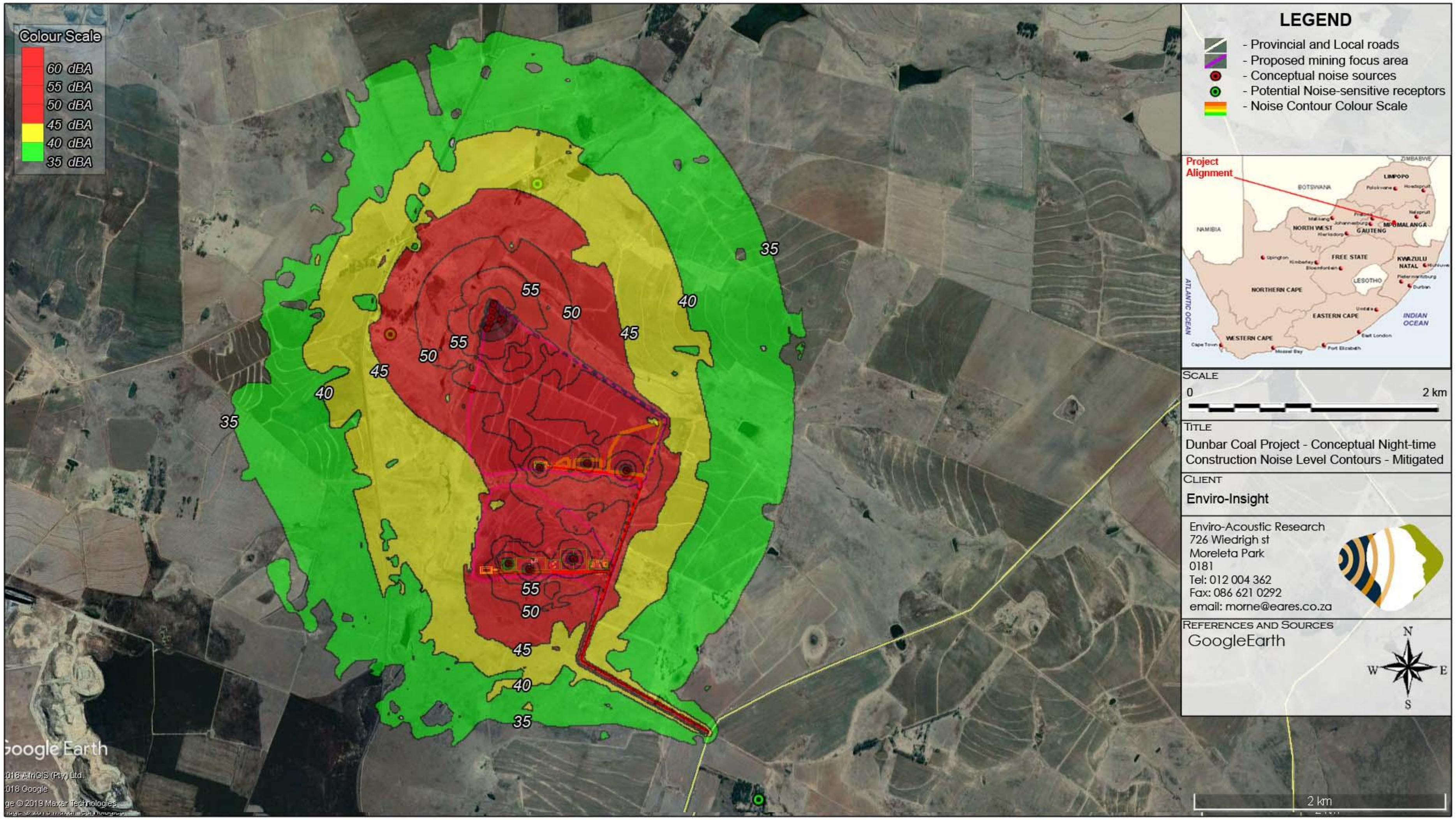

Figure 9-4: Projected conceptual night-time construction noise levels – Mitigated

9.2 Operational Phase Noise Impact

This section investigates the conceptual operational activities as discussed in **section 6.2**. A conceptual noise model was developed considering the activities as depicted in **Figure 9-5**.

It is assumed that all equipment would be operating under full load (generate the most noise) at a number of locations and that atmospheric conditions would be ideal for sound propagation. This is likely the worst case scenario that can occur during the construction phase of the project. Noise rating level contours are illustrated in **Figure 9-6** (daytime) and **Figure 9-7** (night time) for the scenario as conceptualized in **Figure 9-5**.

Table 9-2: Projected noise rating levels due to operational activities

NSD	Rating level considering character of area and existing noise sources (dBA)		Projected (maximum) Operational noise rating level (dBA)	
	Day	**Night**	**Day**	**Night**
1	45	35	41.6	40.9
2	45	35	46.6	45.4
3	45	35	34.0	30.8

9.3 Potential Decommissioning and Closure Noise Impacts

The potential for a noise impact to occur during the decommissioning and closure phase will be much lower than that of the construction and operation phases and noise from the decommissioning and closure phases will not be investigated further.

9.4 Potential Post-closure Noise Impacts

The potential for a noise impact to occur during the post-closure phase will be minimal and mainly relate to maintenance activities. The noise impact from this phase will not be investigated further.

Figure 9-5: Conceptual operational noise sources

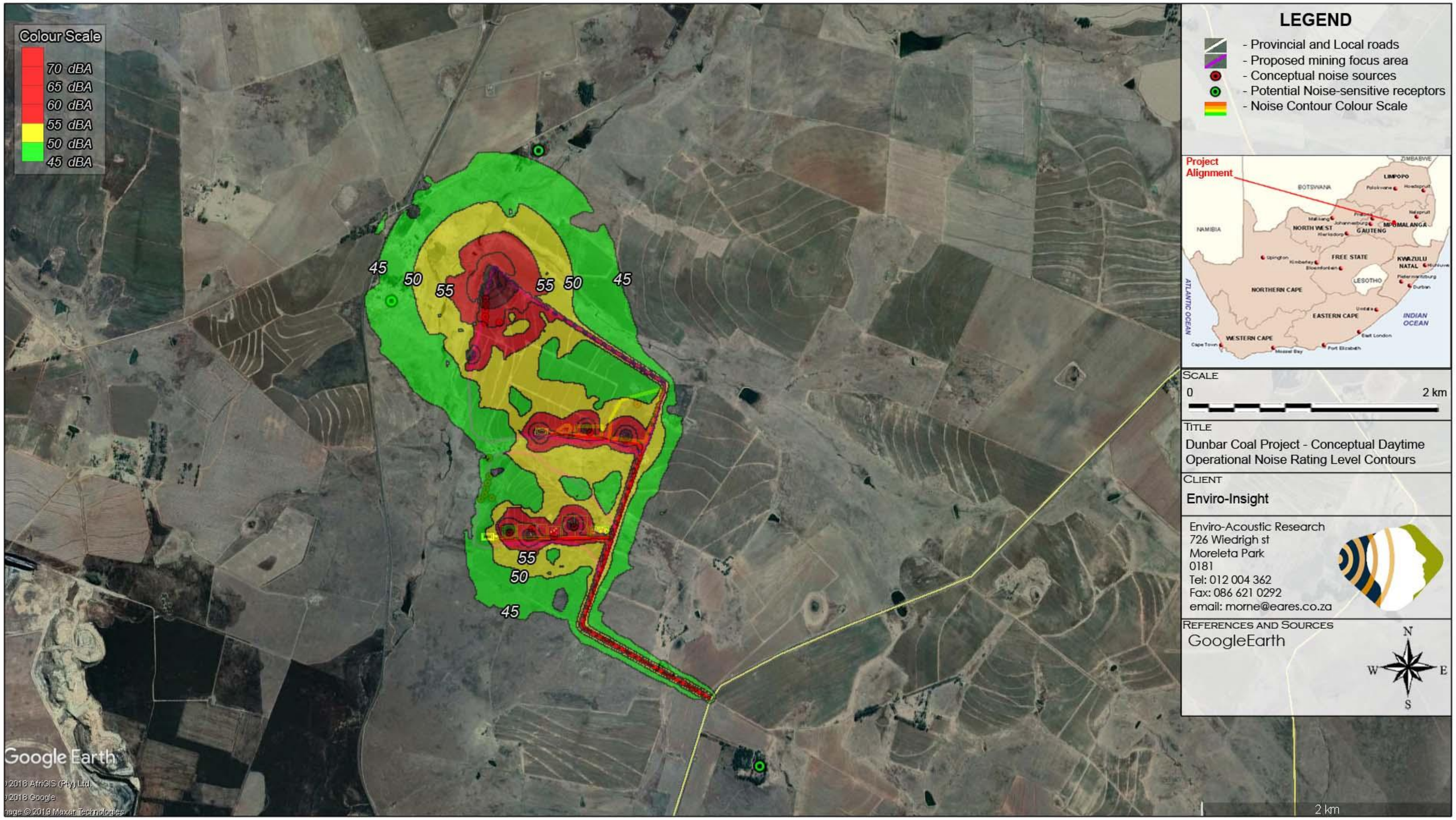

Figure 9-6: Projected conceptual daytime operational noise rating levels

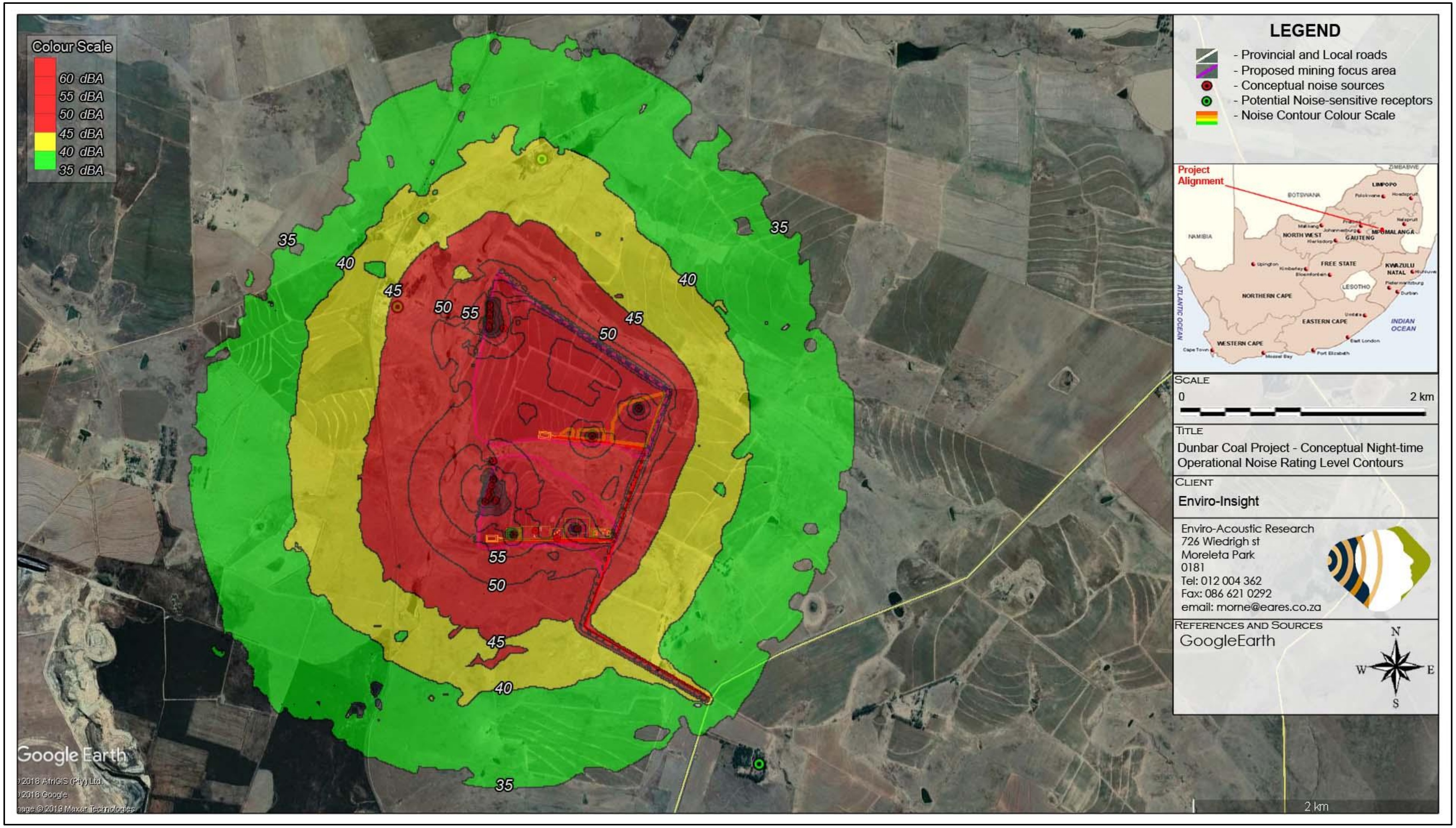

Figure 9-7: Projected conceptual night-time operational noise rating levels

10 SIGNIFICANCE OF THE NOISE IMPACT

10.1 Construction Phase Noise Impact

The potential magnitude of construction noise impacts are calculated in section **9.1**, and defined in **Table 9-1**. 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	Precautious approach, with ambient sound level measurements indicating potential noise rating levels typical of a rural noise district. See **Table 9-1** for the acceptable daytime rating levels (ideal 45 dBA during the day), with the noise limit as recommended by the WHO/IFC guidelines (55 dBA during the day, see **Table 4-1**) used as the upper limit.	
Status (Table 7-2)	Negative	
	Without Mitigation	***With Mitigation***
Extent (Table 7-3)	Low (Proximal - 2)	Low (Proximal - 2)
Duration (Table 7-4)	Low (Short – 2)	Low (Short – 2)
Severity (Table 7-5)	Low (2)	Low (2)
Frequency (Table 7-6)	Very high (Daily – 5)	Very high (Daily – 5)
Probability (Table 7-7)	Improbable (2)	Improbable (2)
Significance of Impact	**Low (42)**	**Low (42)**
Reversibility	High	High
Irreplaceable loss of resources?	Potential loss of quiet soundscape.	Potential loss of quiet soundscape.
Comments	Worst case scenario with numerous simultaneous construction activities	
Degree of Confidence	**High**	
Mitigation:	Mitigation not required for daytime construction activities.	
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	Precautious approach, with ambient sound level measurements indicating potential noise rating levels typical of a rural noise district. See **Table 9-1** for the acceptable night-time rating levels (ideal 35 dBA at night), with the noise limit as recommended by the WHO/IFC guidelines (45 dBA during the day, see **Table 4-1**) used as the upper limit.	
Status (Table 7-2)	Negative	
	Without Mitigation	***With Mitigation***
Extent (Table 7-3)	Low (Proximal - 2)	Low (Proximal - 2)
Duration (Table 7-4)	Low (Short – 2)	Low (Short – 2)
Severity (Table 7-5)	Very-high (5)	High (4)
Frequency (Table 7-6)	Very high (Daily – 5)	Very high (Daily – 5)
Probability (Table 7-7)	Probable (4)	Possible (3)
Significance of Impact	**Medium-high (81)**	**Low-medium (64)**
Reversibility	High	High
Irreplaceable loss of resources?	Potential loss of quiet soundscape.	Potential loss of quiet soundscape.
Comments	Worst case scenario with numerous simultaneous construction activities	
Degree of Confidence	**High**	
Mitigation:	• General mitigation measures, see **section 11.1**. • The mine can develop a berm between the proposed opencast area and the closest NSD (closer than 1,000m from the active mining activities). This berm should be as high as possible, with a berm of 5 m recommended. This berm should be developed during the daytime period. • The mine can minimise night-time activities when operating within 1,000m from NSD (only allow drilling and the loading of material at one location within 1,000m with other construction activities further than 1,500m from NSD).	
Residual Impacts:	This impact will only disappear after mine decommissioning and closure is completed.	

10.2 Operational Phase Noise Impact

The impact assessment for the various activities defined in **section 6.2** was conceptualised and calculated in **section 9.2** with the potential magnitude of operational noise impacts defined in **Table 9-2**.

The potential significance of the noise impacts is summarized in **Table 10-3** and **Table 10-4** for the day and night-time scenarios respectively. This scenario is based on the assumption that a berm (minimum height of 3 m) was constructed between the mining activities and the closest NSD (including the haul roads).

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

Nature:	***Numerous simultaneous operational activities***	
Acceptable Rating Level	Precautious approach, with ambient sound level measurements indicating potential noise rating levels typical of a rural noise district. See **Table 9-1** for the acceptable daytime rating levels (ideal 45 dBA during the day), with the noise limit as recommended by the WHO/IFC guidelines (55 dBA during the day, see **Table 4-1**) used as the upper limit.	
Status (Table 7-2)	Negative	
	Without Mitigation	***With Mitigation***
Extent (Table 7-3)	Low (Proximal - 2)	Low (Proximal - 2)
Duration (Table 7-4)	High (Long term – 4)	High (Long term – 4)
Severity (Table 7-5)	Very-low (1)	Very-low (1)
Frequency (Table 7-6)	Very high (Daily – 5)	Very high (Daily – 5)
Probability (Table 7-7)	Improbable (2)	Improbable (2)
Significance of Impact	**Low (49)**	**Low (49)**
Reversibility	High	High
Irreplaceable loss of resources?	Potential loss of quiet soundscape.	Potential loss of quiet soundscape.
Comments	Worst case scenario with numerous simultaneous construction activities	
Degree of Confidence	**High**	
Mitigation:	Mitigation not required for daytime operational activities.	
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	Precautious approach, with ambient sound level measurements indicating potential noise rating levels typical of a rural noise district. See **Table 9-1** for the acceptable night-time rating levels (ideal 35 dBA at night), with the noise limit as recommended by the WHO/IFC guidelines (45 dBA during the day, see **Table 4-1**) used as the upper limit.	
Status (Table 7-2)	Negative	
	Without Mitigation	***With Mitigation***
Extent (Table 7-3)	Low (Proximal - 2)	Low (Proximal - 2)
Duration (Table 7-4)	High (Long – 4)	Low (Short – 2)
Severity (Table 7-5)	Very-high (5) Noise levels higher than 45 dBA at NSD02	High (4)
Frequency (Table 7-6)	Very high (Daily – 5)	Very high (Daily – 5)
Probability (Table 7-7)	Probable (4)	Possible (3)
Significance of Impact	**Medium-high (99)**	**Low-medium (64)**
Reversibility	High	High
Irreplaceable loss of resources?	Potential loss of quiet soundscape.	Potential loss of quiet soundscape.
Comments	Worst case scenario with numerous simultaneous construction activities	
Degree of Confidence	**High**	
Mitigation:	• General mitigation measures, see **section 11.1**. • The mine can develop a berm between the proposed opencast area and the closest NSD (closer than 1,000m from the active mining activities). This berm should be as high as possible, with a berm of 5 m recommended. This berm should be developed during the daytime period. • The mine can minimise night-time activities when operating within 1,000m from NSD.	
Residual Impacts:	The noise level will decrease as mining moves away from closest NSD. This impact will only disappear after mine decommissioning and closure is completed.	

10.3 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.

10.4 EVALUATION OF ALTERNATIVES

10.4.1 No-go option

The ambient sound levels will remain as is. The noise levels experienced by the surrounding receptors (from the activity) will remain as it is currently.

10.4.2 Alternative 1: Proposed mining activities

The proposed mining activities (worse-case evaluated) will raise the noise levels at a number of closest potential noise-sensitive developments. These noises could be annoying 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). The impacts can be managed to an acceptable low significance.

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. It was determined that the potential noise impact would be of low significance during the day and medium-high during the night. Mitigation is recommended to ensure that potential night-time operational noises are mitigated.

11.1.1 Mitigation options available to reduce Construction Noise Impact

Mitigation options included both management measures as well as technical changes. Options to reduce the noise impact during the construction phase include:

- 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.
- Use the topsoil and soft material to develop a noise berm between the mining opencast area (including haul roads) and the closest NSD (especially near NSD02 and 01). This berm should only be constructed during the daytime period.
- It is recommended that a noise monitoring programme is developed after the mine selected the final location of the plant. The noise monitoring program should be able to define existing long-term sound levels before the construction phase starts. This will allow the identification of a potential noise impact if a noise complaint is registered;
- Ensure a good working relationship between mine management and all potentially noise-sensitive receptors. Communication channels should be established to ensure prior notice to the sensitive receptor if work is to take place close to them. Information that should be provided to potentially sensitive receptor(s) includes:
  - Proposed working dates, the duration that work will take place in an area and working times;
  - The reason why the activity is taking place;
  - The construction methods that will be used; and
  - Contact details of a responsible person where any complaints can be lodged should there be an issue of concern.
- 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 reversing 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 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 characteristics and that of the surrounding soundscape (both level and spectral character).

11.1.2 Construction mitigation options that should be included in the EMP

- 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.

[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/

- Use the topsoil and soft material to develop a noise berm between the mining opencast area (including haul roads) and the closest NSD. This berm should only be constructed during the daytime period.
- Development and implementation of a noise monitoring programme.

11.2 Operational Phase Mitigation Measures

The study considers the potential noise impact on the surrounding environment due to operational activities. It was determined that the potential noise impact could be of a medium-high significance for night-time activities.

Mitigation options included both management measures as well as technical changes.

11.2.1 Mitigation options available to reduce Operational Noise Impact

Mitigation measures should include:

- Ensure that equipment is well maintained and fitted with the correct and appropriate noise abatement measures;
- Continuation of noise measurement programme;
- 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.
- The mine should investigate the use of white-noise alarms instead of tonal reverse alarms on heavy vehicles operating on roads and at stockpile areas;
- 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 indicates 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).

11.2.2 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.

iii. The continuation of a noise measurement programme.

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 development 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.

Active environmental noise monitoring is recommended due to the medium-high significance for a noise impact to develop. In addition, should a valid complaint be registered, the mine must investigate this complaint as per the following sections. It is recommended that the noise investigation is done by an independent acoustic consultant.

While this section recommends a noise monitoring programme, it 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 are recommended at NSD01 and 02 during construction and operational phase.

If any of these receptors are relocated the measurement locations should be replaced with a similar location. If there are no potential noise-sensitive receptors living within 1,000m (maximum distance where noise may be problematic, SANS 10328) from any noise sources (associated with the mine) no noise measurements are required.

In addition, noise measurements must be conducted at the location of the person that registered a valid and reasonable noise complaint. 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

Once-off ambient sound measurements are recommended before construction activities start at the measurement locations identified in **Section 13.1.1** (or any additional measurement locations that can be motivated) using a defined measurement procedure (see **Section 13.1.3**). This is to define the pre-mining ambient sound levels at these locations.

Once construction starts, noise measurements should be conducted on an annual basis at the measurement locations identified in **Section 13.1.1** (or any additional measurement locations that can be motivated) using a defined measurement procedure (see **Section 13.1.3**). Noise measurements should continue during the operational phase when the noise monitoring plan can be reviewed (measurements increased, continued, reduced or stopped). Compliance with the set Environmental Management Objectives (**Section 12**) as well as the number of registered noise complaints should be considered.

13.1.3 Measurement Procedures

Ambient sound measurements should be collected as defined in SANS 10103:2008. 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 Data Capture Protocols

13.3.1 Measurement Technique

Noise measurements must be conducted as required by the National Noise Control Regulations (GN R154 of 1992) and SANS 10103:2008.

13.3.2 Variables to be analysed

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.

13.3.3 Database Entry and Backup

Data must be stored unmodified in the electronic file saved from the instrument. This file can be opened to extract the data to a spreadsheet system to allow the processing of the data and to illustrate the data graphically. Data and information should be safeguarded from accidental deletion or corruption.

13.3.4 Feedback to Receptor

A monitoring report must be compiled considering the requirements of the National Noise Control Regulations (GN R154 of 1992) and SANS 10103:2008. The mine must provide feedback to the potential noise-sensitive receptors using the channels and forums established in the area to allow interaction with stakeholders, alternatively in a written report.

13.4 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 the Dunbar Coal Project west of Hendrina, Mpumalanga. 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 a medium-high risk of a noise impact for night-time construction and mining activities. Mitigation is recommended to ensure that potential annoyance with the project is managed and reduce the potential significance of the noise impact.

Mitigation may include:

- 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.
- The mine should use the topsoil and soft material to develop noise berms between the mining opencast area (including haul roads) and the closest NSD (especially near NSD01 and 01). This berm should only be constructed during the daytime period.
- It is recommended that a noise monitoring programme is developed;
- 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.
- 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 indicates 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).

It is concluded that, if the mine considers the recommendations in this report (incorporated in the Environmental Management Plan), that the increases in noise levels do not constitute a fatal flaw. It is, therefore, the recommendation that the Dunbar Coal Project is authorized (from a noise impact perspective).

15 REFERENCES

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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 centre 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 5 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 have 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 are no reflective surfaces.
Frequency	The rate of oscillation of a sound, measured in units of Hertz (Hz) or kiloHertz (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.
Greenfield	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, workforce, 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}andL_{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 healthcare 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 are 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 EIDSLLT01

Photo B.2: Measurement location EIDSLLT02

<u>End of Report</u>