

D3 Energy (Pty) Ltd

ENVIRONMENTAL NOISE IMPACT ASSESSMENT

for the

**D3 Energy Hydrocarbon and Associated Gas Extraction
Project South-east of Virginia, Free-state Province**



Study done for:



Prepared by:



P.O. Box 2047, Garsfontein East, 0060
Tel: 012 – 993 2165, Fax: 086 – 621 0292, E-mail: info@eares.co.za

EXECUTIVE SUMMARY

INTRODUCTION AND PURPOSE

Enviro-Acoustic Research ("EARES") was contracted by Environmental Impact Management Services (Pty) Ltd (the EAP - EIMS) to undertake a specialist study to determine the potential noise impact on the surrounding environment due to the proposed D3 Energy Project near Virginia, Free-State.

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

The Applicant, D3 Energy Energy (Pty) Ltd, propose to optimize the extraction of their gas resource within their production right area. The activities proposed by D3 Energy will include the following:

- Provision for ongoing exploration drilling and seismic activities;
- Existing wells may be 'worked over' and possibly included as production sites;
- Drilling of approximately 30-50 wells within identified well production corridors. The wells will be equipped to optimally extract the gas product;
- The installation of trenched sub-surface gas gathering pipelines between the production wells and a gas production plant where the gas will be compressed to deliver compressed Helium and Methane and/or alternatively where the gas will be liquified to produce LNG and the helium liquified to produce Liquid Helium (LHe).
- The generation of power (gas to power) for use by the project.

METHODOLOGY

This assessment was completed using the following approach, roughly summarized from the terms of reference provided by SANS 10328:

- Baseline description of the acoustic environment at three NSR locations;
- Source- and activity-based assessment covering traffic/logistics, site preparation, seismic surveys, trenching, drilling, plant operations considering conceptual scenarios.
- Significance ratings presented pre-mitigation, post-mitigation and final (after impact prioritisation) in Tables 12-8 to 12-10, aligned with EIMS project criteria.
- Consideration of alternatives and potential cumulative interactions.

SURROUNDING LAND USE AND POTENTIAL NOISE-SENSITIVE RECEPTORS

Potentially sensitive receptors, also known as noise-sensitive developments ("NSR"), located within or near the mineral rights area was identified using Google Earth® during the scoping phase, highlighting that NSRs are scattered in a heterogenous manner in the area. The NSR were verified during a drive-by in November 2025, and the use of the structures were not verified with discussions with the landowners.

Structures that are maintained or could be used for residential purposes was included in this assessment. There are however a number of NSR locations where structures appeared to be unused, including NSR locations 4, 5, 6, 14, 17, 22, 27, 34 and 35; this assessment will include these locations as potentially noise-sensitive as the structures may still be used for temporary or permanent residential purposes.

BASELINE ASSESSMENT

Ambient sound levels were measured at 3 locations in the vicinity of the project area in a semi-continuous manner over a period of 4-nights (approximately 1,120 daytime, and 576 night-time measurements – each with a duration of 10-minutes) during November 2025. When removing measurements collected at the third measurement location (due to unidentified noises impacting on the measurements), there are still more than 700 day-, and 350 night-time measurements.

The data indicated ambient sound levels mostly typical of a rural noise district, with bird and insect noises generally the dominant source of noise at all measurement locations. Voices were audible (and might have impacted on the measurement results) at two of the measurement locations.

This data is sufficient, as it illustrates the rural nature of the area, with similar ambient sound levels expected at other locations away from roads, animal enclosures (including chicken coups, pigstys and cattle corral/kraal(s)). Additional measurement locations, as well as measurements over a longer period will not provide more information.

Considering the average fast-weighted sound level data collected in the area, average:

- daytime fast-weighted sound levels ranged from 27 to more than 88 dBA, with average sound levels being 47.7 dBA. This is typical of a rural to suburban noise district, setting a zone sound level of 45 dBA for the daytime period; and
- night-time fast-weighted sound levels ranged from 24 to 60 dBA, with average sound levels being 37.1 dBA. This is typical of a rural to suburban noise district, setting a zone sound level of 35 dBA for the night-time period.

Considering the requirements of the Free State Provincial Noise Control Regulations, activities relating to the proposed project should not change the existing ambient sound levels with more than 5 dBA, nor exceed the World Bank Ground recommended noise limits. Recommended upper noise limits therefore would be:

- 52 dBA (less than 5 dBA from the average ambient sound levels measured in the area) for the daytime residential use; and
- 42 dBA (less than 5 dBA from the average ambient sound levels measured in the area) for night-time residential use.

If zoned as an industrial site, the project should also limit the noise level to less than 70 dBA during the daytime period and 60 dBA at night at the boundary (for the area zoned industrial).

NOISE IMPACT DETERMINATION AND FINDINGS

Using conceptual noise propagation modelling and the experience of the author, it was determined that the potential noise impacts for the different phases of the project would be:

- of a **low significance** for day- and night-time transport activities (project vehicles driving past NSR);
- of a **low significance** for daytime site preparation activities;
- of a potential **medium significance** for night-time site preparation activities, with mitigation measures available that could reduce the significance to **low**;
- of a **low significance** for daytime seismic surveys;
- of a potential **medium significance** for night-time seismic surveys, with mitigation measures available that could reduce the significance to **low**;
- of a **low significance** for day- and night-time trenching activities;
- of a **low significance** for day- and night-time activities associated with the processing of the resource (project plant operations);
- of a potential **medium significance** for the unplanned or emergency release or flaring of gas, with mitigation measures available that could reduce the noise level or the probabilities of annoying nearby NSR;
- of a **low significance** for noise associated with decommissioning activities; and
- of a **low significance** for noise associated with rehabilitation activities.

This noise assessment indicates that, with the proposed layout and setbacks, most construction, operational, decommissioning and rehabilitation activities will result in low

significance noise impacts at identified NSR locations. Medium significance may arise pre-mitigation for a limited subset of activities:

- night-time site preparation near NSR16;
- night-time seismic surveys within approximately 800–1,000 m of NSR;
- night-time drilling within approximately 1,000 m (primarily affecting NSR16); and
- night-time logistics where access routes pass within 50–200 m of dwellings.

Emergency depressurisation/flaring also carries a medium significance on a precautionary basis due to its unpredictable, high-level and short-duration character that may startle NSRs in the area.

With the gas processing plant and gas-to-power generator are located more than 2 km from the nearest NSR and, with containerised equipment, are expected to contribute low operational noise day and night.

Cumulative effects are expected to be insignificant provided that concurrent noisy tasks across contractors are limited and schedules are coordinated (particularly for night-time drilling, seismic acquisition and logistics).

MANAGEMENT AND MITIGATION

Measures proposed in this assessment to reduce noise levels or the probability of NSR being annoyed by the noise emissions from the project include:

- Vehicular traffic and logistics - The applicant must proactively engage with residents whose dwellings lie within 60 m of access roads to explain expected traffic volumes, times of day and to agree on practical housekeeping (for example, avoiding gate queuing at night). If substantiated noise complaints are received, the applicant will evaluate relocating or offsetting access roads to achieve a setback greater than 120 m from dwellings, balancing safety, environmental constraints and landowner needs. Drivers will be instructed to adhere to posted speed limits, avoid engine braking near receptors, and switch off engines when stationary at gates for more than two minutes to prevent unnecessary idling noise. Vehicles must be kept roadworthy with intact silencers, properly inflated tires and well-maintained suspensions to minimize rattle and tonal exhaust noise.
- Night-time site preparation activities - Night works should be avoided within 1,000m of dwellings; if critical works must occur, the number of simultaneously operating machines should be limited and their operating speeds reduced to lower instantaneous noise levels. Equipment can be fitted with broadband reversing alarms, and metal-on-metal impacts should be prevented by using rubber mats or

liners when material or equipment are loading or unloaded. Landowners within approximately 1,000 m must be notified at least 48 hours in advance of any night-time work, and a complaints procedure with rapid corrective action must be implemented.

- Seismic survey (night-time) - Night-time vibroseis operations should be minimized within 1,000 m of dwellings unless safety or operational factors make this unavoidable; When night-time seismic surveys are required within 1,000m from receptors, the applicant or contractor can do fewer passes and use single-source operation to minimize noise emissions. Landowners within roughly 1,000 m must be notified of schedules and durations of any night-time seismic surveys and a rapid response pathway for concerns or complaints must be maintained.
- Drilling activities – The drilling contractor should deploy a low-noise drill package, including super-silenced generator and compressor units with intake/exhaust silencers and acoustic lagging on tonal panels and pipework. The generator and compressor cab be positioned on the pad so that they are farthest from the nearest receptor, and louvres and exhausts should face away from receptors. Engines should be run at steady loads to avoid rev spikes, and the use of broadband reversing alarms could limit annoyance with tonal reverse alarms. If night-time drilling within 1,000m cannot be avoided, receptors must be notified of the duration of the planned drilling activities, with spot checks of the noise levels near receptors.
- Emergency release or flaring of gas - The plant should be designed to minimize reliance on flaring by incorporating flare gas recovery where feasible, segmenting and staging blowdowns to reduce peak flow, and sizing knock-out drums to avoid liquid carry-over. Low-noise flare tips can be installed and steam or air assist can be tuned to prevent acoustic “howl.” Where practicable, silencers and acoustic lagging can be fitted to relief headers at grade. Routine test flaring must be avoided at night, and after any emergency event, the incident must be reviewed to identify and implement corrective actions. When safe to do so, nearby residents must be informed of the cause and any measures implemented to minimise future events.

NEED AND DESIRABILITY OF PROJECT

Due to economic advantages, the extraction of hydrocarbons and associated gasses does provide valuable employment, local taxes and foreign currency. It must be noted that when industrial 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 the project needs to reach an optimal scale in terms of layout and production.

Helium especially is a critical, scarce gas with high-value uses in healthcare (MRI), semiconductor manufacturing, aerospace, leak detection and research. Domestic production reduces import risk and price volatility.

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.

CONCLUSION AND RECOMMENDATION

Monitoring and adaptive management are integral, especially the implementation of a complaint mechanism with rapid response and corrective action. While some of the noises would be audible to clearly audible at the closest NSR (especially drilling activities), the increase in noise levels is not considered a fatal flaw. On this basis, it is recommended that the D3 Energy project be authorized (from a noise perspective).



Morné de Jager

Enviro-Acoustic Research cc

2026 – 08 – 04

This report should be cited as:

De Jager, M. (2026): "*Environmental Noise Impact Assessment for the D3 Energy Hydrocarbon and Associated Gas Extraction Project South-east of Virginia, Free-state Province*". Enviro-Acoustic Research CC, Pretoria

Client:

Environmental Impact Management
Services (Pty) Ltd

8 Dalmeny Road, Pine Park
Randburg
2194

Report no:

EIMS-D3E/ENIA/202608-Rev 0

Author:

M. de Jager (B. Ing (Chem); PriSci Nat, 117253; SAIOSH, 72765282)

Review:

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

Date:

August 2026

COPYRIGHT WARNING

This information is privileged and confidential in nature and unauthorized dissemination or copying is prohibited. This information will be updated as required. Enviro-Acoustic Research CC claims protection of this information in terms of the Promotion of Access to Information Act, (No 2 of 2002) and without limiting this claim, especially the protection afforded by Chapter 4.

The document is the property of Enviro Acoustic Research CC. The content, including format, manner of presentation, ideas, technical procedure, technique and any attached appendices are subject to copyright in terms of the Copyright Act 98 of 1978 (as amended by the respective Copyright Amendment Acts No. 56 of 1980, No. 66 of 1983, No. 52 of 1984, No. 39 of 1986, No. 13 of 1988, No. 61 of 1989, No. 125 of 1992, Intellectual Property Laws Amendment Act, No. 38 of 1997 and, No. 9 of 2002) in terms of section 6 of the aforesaid Act, and may only be reproduced as part of the Environmental Impact Assessment process by Environmental Impact Management Services (Pty) Ltd.

TABLE OF CONTENTS

	page
EXECUTIVE SUMMARY.....	ii
TABLE OF CONTENTS.....	viii
LIST OF TABLES	xii
LIST OF FIGURES	xiii
APPENDICES	xiv
GLOSSARY OF ABBREVIATIONS	xv
GLOSSARY OF UNITS	xvi
1 THE AUTHOR	1
2 DOCUMENT STRUCTURE – CHECKLIST AS PER EIA REGULATIONS	
5	
3 DOCUMENT STRUCTURE – MINIMUM REQUIREMENTS AS PER	
GNR320 (SCREENING OF SITE).....	7
4 INTRODUCTION.....	10
4.1 Introduction and Purpose.....	10
4.2 Brief Project Description	10
4.3 Study area	10
4.3.1 Topography.....	11
4.3.2 Surrounding Land Use	11
4.3.3 Roads and Railways.....	11
4.3.4 Ground conditions and vegetation	11
4.3.5 Existing Ambient Sound Levels	11
4.4 Potential Noise-sensitive Receptors (Developments) and no-go areas...	12
4.5 Comments regarding noise received during this project	13
4.6 Legislative Requirements and Terms of Reference	13
4.6.1 Requirements as per Government Gazette 43110 of March 2020.....	14
4.6.2 Requirements as per South African National Standards	15
5 LEGAL CONTEXT, POLICIES AND GUIDELINES.....	21
5.1 The Environment Conservation Act (Act 73 of 1989).....	21

5.1.1	<i>Free State Provincial Noise Control Regulations (PN 24 of 1998)</i>	21
5.2	The National Environmental Management Act (Act 107 of 1998)	22
5.3	Noise Standards	23
5.3.1	<i>SANS 10103:2008</i>	24
5.3.2	<i>SANS 10328:2008</i>	27
5.4	International Guidelines	28
5.4.1	<i>Guidelines for Community Noise (WHO, 1999)</i>	28
5.4.2	<i>European Parliament Directive 200/14/EC (2000)</i>	28
5.4.3	<i>Equator Principles (2003)</i>	29
5.4.4	<i>IFC: General EHS Guidelines – Environmental Noise Management (2007)</i>	29
5.4.5	<i>Night Noise Guidelines for Europe (WHO, 2009)</i>	30
5.4.6	<i>Environmental Noise Guidelines for the European Region (WHO, 2018)</i>	31
6	RECEIVING ENVIRONMENT	32
6.1	Effect of Season on sound levels	32
6.1.1	<i>Effect of Temperature inversions</i>	33
6.1.2	<i>Effect of Wind</i>	33
6.1.3	<i>Effect of Humidity and Temperature</i>	34
6.2	Temperature and Humidity Measurements	35
6.3	Ambient Sound Level Measurements	36
6.3.1	<i>Ambient Sound Level Measurement Location – EVLTSL01</i>	38
6.3.2	<i>Ambient Sound Level Measurement Location - EVLTSL02</i>	40
6.3.3	<i>Ambient Sound Level Measurement Location - EVLTSL03</i>	42
6.4	Ambient Sound Levels – Findings and Summary	44
7	POTENTIAL NOISE SOURCES	45
7.1	Potential Exploration and Construction Noise-generating Activities	45
7.1.1	<i>Exploration Activities</i>	49
7.1.2	<i>Construction Activities</i>	49
7.1.3	<i>Traffic</i>	50
7.2	Potential Operational Noise-generating Activities	50
7.2.1	<i>Plant Activities</i>	50
7.2.2	<i>Traffic</i>	51
7.3	Potential Noise Sources: Future noise scenario – Decommissioning	51
8	METHODS: NOISE IMPACT ASSESSMENT AND SIGNIFICANCE	53
8.1	Noise Impact on Animals	53

8.1.1	<i>Domestic Animals.....</i>	55
8.1.2	<i>Wildlife</i>	56
8.1.3	<i>Avifauna</i>	57
8.1.4	<i>Laboratory Animal Studies</i>	57
8.1.5	<i>Concluding Remarks - Noise Impacts on Animals</i>	57
8.2	Why noise concerns communities	58
8.2.1	<i>Noise Annoyance.....</i>	59
8.3	Impact Assessment Criteria.....	62
8.3.1	<i>Overview: The common characteristics</i>	62
8.3.2	<i>Noise criteria of concern</i>	62
9	ASSUMPTIONS AND LIMITATIONS	65
9.1	Measurements of Ambient Sound Levels.....	65
9.2	Calculating noise emissions – Adequacy of predictive methods.....	67
9.3	Adequacy of Underlying Assumptions.....	68
9.4	Uncertainties associated with mitigation measures	68
9.5	Uncertainties of Information Provided	68
9.6	Uncertainty on how Noise could affect People	70
9.7	Conditions to which this study is subject.....	70
10	PROJECTED NOISE RATING LEVELS.....	71
10.1	Conceptual Future Scenario – Noise from Exploration and Construction Activities.....	71
10.2	Conceptual Future Scenarios – Noise from Operational Activities	73
10.3	Potential Decommissioning and Closure Noise Levels	80
10.4	Potential Post-closure Noise Levels	80
10.5	Evaluation of Alternatives	80
10.5.1	<i>Alternative 1: Activity Alternatives</i>	80
10.5.2	<i>Alternative 2: Location Alternatives</i>	81
10.5.3	<i>Alternative 3: Technology or process alternatives.....</i>	81
10.5.4	<i>Alternative 4: No-go option</i>	82
11	SPATIAL SENSITIVITY MAPPING	83
12	IMPACT SIGNIFICANCE	85
12.1	Impact Assessment Methodology	85
12.2	Planning Phase Noise Impacts.....	89
12.3	Mobilisation Noise Impacts	89

12.3.1	Impact 1 – Vehicular traffic passing NSR locations	89
12.4	Construction Noise Impacts	90
12.4.1	Impact 2 – Vehicular traffic passing NSR locations	90
12.4.2	Impact 3 – Daytime site preparation activities	91
12.4.3	Impact 4 – Daytime seismic survey activities.....	92
12.4.4	Impact 5 – Daytime trenching activities	93
12.4.5	Impact 6 – Daytime drilling activities (construction)	94
12.5	Operational Noise Impacts	95
12.5.1	Impact 7 – Daytime drilling activities (operational phase)	95
12.5.2	Impact 8 – Daytime transport of people, equipment, material, drill cores and product.....	95
12.5.3	Impact 9 – Night-time transport of people, equipment, material, drill cores and product.....	96
12.5.4	Impacts 10 (day) and 11 (night) – Day and Night-time plant operations	97
12.5.5	Impact 12 – Emergency release or flaring of gas.....	98
12.6	Decommissioning Noise Impacts	99
12.6.1	Impact 13 - Dismantling and decommissioning of project infrastructure	99
12.7	Rehabilitation Noise Impacts	100
12.7.1	Impact 14 - Various rehabilitation activities.....	100
13	SPECIALIST MANAGEMENT PLAN	104
14	RECOMMENDATIONS AND CONCLUSION	107
15	REFERENCES	109

LIST OF TABLES

	page
Table 5-1: Recommended ambient noise for different areas of occupancy indoors (Table 2 - SANS 10103:2008).....	24
Table 5-2: Acceptable Zone Sound Levels for noise in districts (Table 2 - SANS 10103:2008)	26
Table 5-3: IFC Table 7.1-Noise Level Guidelines	30
Table 6-1: Temperature and Humidity measured onsite.....	36
Table 6-2: Equipment used to measure ambient sound levels	36

Table 6-3: Sound levels considering various sound level descriptors at EVLTSL01	38
Table 6-4: Sound level descriptors as measured at EVLTSL02	40
Table 6-5: Sound level descriptors as measured at EVLTSL03	42
Table 7-1: Potential maximum noise levels generated by construction equipment	47
Table 7-2: Potential equivalent noise levels generated by various equipment	48
Table 7-3: Sound power emission levels used for modelling	48
Table 8-1: Threshold levels reported by the WHO (2009)	61
Table 10-1: Potential noise levels at NSR locations due to vibroseis survey activities.....	71
Table 10-2: Potential noise levels at NSR locations due to nearby drilling activities activities	72
Table 12-1: Criteria for Determining Impact Consequence	86
Table 12-2: Probability Scoring	86
Table 12-3: Determination of Significance (Environmental Risk)	87
Table 12-4: Significance Scores.....	87
Table 12-5: Criteria for Determining Prioritisation	88
Table 12-6: Determination of Prioritisation Factor	88
Table 12-7: Final Environmental Significance Rating	89
Table 12-8: Significance Rating – Pre Mitigation	101
Table 12-9: Significance Rating – Post Mitigation.....	102
Table 12-10: Final Significance Rating – after Impact Prioritisation	103

LIST OF FIGURES

	page
Figure 4-1: Aerial image indicating the regional location of the proposed D3 Energy Project	17
Figure 4-2: Areas identified by the online screening tool to have a “very high” sensitivity to noise	18
Figure 4-3: Aerial image indicating noise-sensitive receptors identified during scoping ..	19
Figure 4-4: Aerial image indicating verified noise-sensitive receptors close to D3 Energy Project	20
Figure 5-1: Criteria to assess the significance of impacts stemming from noise	27
Figure 6-1: Influence of temperature inversions on the propagation of sound	33
Figure 6-2: Effect of Temperature and Humidity on propagation of Sound	35
Figure 6-3: Humidity and temperature as measured onsite	35
Figure 6-4: Localities where ambient sound levels were measured	37
Figure 6-5: Ambient Sound Levels at EVLTSL01.....	39

Figure 6-6: Maximum, minimum and Statistical sound levels at EVLTSL01	39
Figure 6-7: Classification of night-time measurements in typical noise districts at EVLTSL01	39
Figure 6-8: Classification of daytime measurements in typical noise districts at EVLTSL01	39
Figure 6-9: Ambient sound levels at EVLTSL02	41
Figure 6-10: Maximum, minimum and statistical values at EVLTSL02	41
Figure 6-11: Classification of night-time measurements in typical noise districts at EVLTSL02	41
Figure 6-12: Classification of daytime measurements in typical noise districts at EVLTSL02	41
Figure 6-13: Ambient sound levels at EVLTSL03	43
Figure 6-14: Maximum, minimum and statistical values at EVLTSL03	43
Figure 6-15: Classification of night-time measurements in typical noise districts at EVLTSL03	43
Figure 6-16: Classification of daytime measurements in typical noise districts at EVLTSL03	43
Figure 8-1: Logarithmic Chart of the Hearing Ranges of Some Animals.....	54
Figure 8-2: Percentage of annoyed persons as a function of the day-evening-night noise exposure at the façade of a dwelling	60
Figure 10-1: Infrastructure where noise generating activities could take place	74
Figure 10-2: Conceptual noise-generating activities considered for exploration and construction activities	75
Figure 10-3: Projected daytime noise rating levels relating to the exploration and construction phase.....	76
Figure 10-5: Conceptual noise-generating activities considered for the operational phase	77
Figure 10-6: Projected daytime noise rating levels – conceptual operational activities ...	78
Figure 10-7: Projected night-time noise rating levels – conceptual operational activities	79

APPENDICES

<u>APPENDIX A</u>	Glossary of terms and definitions
<u>APPENDIX B</u>	Photos of measurement locations
<u>APPENDIX C</u>	Calculated conceptual noise levels and potential significance

GLOSSARY OF ABBREVIATIONS

ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
BDV	Blowdown Valve
DFFE	Department of Forestry, Fisheries and Environment
EA	Environmental Authorisation
EARES	Enviro Acoustic Research cc
ECA	Environment Conservation Act
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
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
GPS	Global Positioning System
HME	Heavy Mobile Equipment
HVAC	Heating, Ventilation and Air Conditioning
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
ISO	International Organization for Standardization
KOD	Knock-Out Drum
LHe	Liquid Helium
METI	Ministry of Economy, Trade, and Industry
MRI	Magnetic Resonance Imaging
NASA	National Aeronautical and Space Administration
PNCr	Provincial Noise Control Regulations
NSR	Noise-sensitive Receptor
PFA	Project Focus Area
PSV	Pressure Safety Valve
PWL	Sound Power Level
SABS	South African Bureau of Standards
SANS	South African National Standards

SDP	Spatial Development Framework
TLB	Tractor-Loader-Backhoe
UTM	Universal Transverse Mercator
VSD	Variable-Speed Drive
WHO	World Health Organization

GLOSSARY OF UNITS

dB	Decibel (expression of the relative loudness of the un-weighted sound level in air)
dB(A)	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)
L _{Aeq,1h}	Equivalent continuous A-weighted sound level measured over one hour
L _{A90}	A-weighted sound level exceeded 90% of the time
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)
°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, gradually moving 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 19 years and was involved with the following projects in the last few years:

Wind Energy Facilities

Full Environmental Noise Impact Assessments for - Bannf (Vidigenix), iNca Gouda (Aurecon SA), Isivunguvungu (Aurecon), De Aar (Aurecon), Kokerboom 1 (Aurecon), Kokerboom 2 (Aurecon), Kokerboom 3 (Aurecon), Kangnas (Aurecon), Plateau East and West (Aurecon), Wolf (Aurecon), Outeniqlwa (Aurecon), Umsinde Emoyeni (ARCUS), Komsberg (ARCUS), Karee (ARCUS), Kolkies (ARCUS), San Kraal (ARCUS), Phezukomoya (ARCUS), Canyon Springs (Canyon Springs), Perdekraal (ERM), Scarlet Ibis (CESNET), Albany (CESNET), Sutherland (CSIR), Kap Vley (CSIR), Kuruman (CSIR), Rietrug (CSIR), Sutherland 2 (CSIR), Perdekraal (ERM), Teekloof (Mainstream), Eskom Aberdene (SE), Dorper (SE), Spreukloof (SE), Loperberg (SE), Penhoek Pass (SE), Amakhala Emoyeni (SE), Zen (Savannah Environmental – SE), Goereesoe (SE), Springfontein (SE), Garob (SE), Project Blue (SE), ESKOM Kleinsee (SE), Namas (SE), Zonnequa (SE), Walker Bay (SE), Oyster Bay (SE), Hidden Valley (SE), Deep River (SE), Tsitsikamma (SE), AB (SE), West Coast One (SE), Hopefield II (SE), Namakwa Sands (SE), VentuSA Gouda (SE), Dorper (SE), Klipheuwel (SE), INCA Swellendam (SE), Cookhouse (SE), Iziduli (SE), Msenge (SE), Cookhouse II (SE), Rhebokfontein (SE), Suurplaat (SE), Karoo Renewables (SE), Koningaas (SE), Spitskop (SE), Castle (SE), Khai Ma (SE), Poortjies (SE), Korana (SE), IE Moorreesburg (SE), Gunstfontein (SE), Boulders (SE), Vredenburg (Terramanzi), Loeriesfontein (SiVEST), Rhenosterberg (SiVEST), Noupoot (SiVEST), Prieska (SiVEST), Dwarsrug (SiVEST),

Mining and Industry

Graskoppies (SiVEST), Philco (SiVEST), Hartebeest Leegte (SiVEST), Ithemba (SiVEST), !Xha Boom (SiVEST), Spitskop West (Terramanzi), Haga Haga (Terramanzi), Vredenburg (Terramanzi), Msenge Emoyeni (Windlab), Wobben (IWP), Trakas (SiVEST), Beaufort West (SiVEST), Pienaarspoort 1 and 2 (SE), Mphepo Zambia (SLR), Koup 1 (SiVEST), Koup 2 (SiVEST), Hamlet (SE), Aeolus (SE), Ripponn (SE), Redding (SE), Wind Garden (SE), Fronteer (SE), Hendrina North (Cabanga), Hendrina South (Cabanga), Hoogland Northern Cluster (SLR), Hoogland Southern Cluster (SLR), Jessa M, S and Z cluster of Wind Farms (SLR), Heuweltjies (SiVEST), Kraaltjies (SiVEST), Patatskloof (SiVEST), Bergriver (SE), Overberg (Arcus), Newcastle North (CESNET), Newcastle South (CESNET), Ngxwabangu (CESNET), Taaibos North (CESNET), Taaibos South (CESNET), Soutrivier North (CESNET), Soutrivier South (CESNET), Soutrivier Central (CESNET), Soyuz 1 (AEP/CESNET), Soyuz 2 (AEP/CESNET), Soyuz 3 (AEP/CESNET), Soyuz 4 (AEP/CESNET), Soyuz 5 (AEP/CESNET), Soyuz 6 (AEP/CESNET), Kaladokhwe 1 (AEP/CSIR), FE Red Sands North East (Enviro-Insight), FE Red Sands South West (Enviro-Insight), FE Red Sands North West (Enviro-Insight), FE Red Sands South East (Enviro-Insight), FE De Rust North (Enviro-Insight), FE De Rust South (Enviro-Insight), Springbok (SE), Aberdene 1 (AEP/SE), Aberdene 2 (AEP/SE), Aberdene 3 (AEP/SE), Ezelsjacht (SLR), Amsterdam (Emvelo, Sheepmoor) (ERM); Loxton 1, 2 & 3 (ARCUS); Kariaga 1, 2, 3 & 4 (EnviroAGRI); Hugo & Khoe (ERM); Taaibosch Puts Cluster (Khoemana, Gorachouqua) (JAWS); Eland (Praxos); Houmoed (Enviro-Insight); Stinkputs (Enviro-Insight); Zuurfontein (Enviro-Insight); Karoo Cluster (1, 2, 3) (SES), Tango (Savannah), Kudu (Savannah), Angora (Savannah), Oryx (Savannah), Sonvley (Blue Crane), Carissa (B-Crane), ENZO/-Dinie (Eagle Environmental), FE Peddie (Enviro-Insight), Aria 1 (G7 Energies), Gecko (Jones & Wagener), Brandberg (Nala Environmental), Ceres projects (Atana/RHDHV), Mulilo WP 1, 2 & 3 (SES), Leghoya 1, 2, 3 (SLR/Red Cap), Ntabande (SLR), Roam (SLR), Renoster 1, 2, 3, 4 (SRK), Mabele Emoyeni (SRK), uKhanda (Veers Group)

Full Environmental Noise Impact Assessments for – Delft Sand (AGES), BECSA – Middelburg (Golder Associates), Kromkrans Colliery (Geovicon Environmental), SASOL Borrow Pits Project (JMA Consulting), Lesego Platinum (AGES), Tweefontein Colliery (Cleanstream Environmental), Evraz Vametco Mine and Plant (JMA), Goedehoop Colliery (Geovicon), Hacra Project (Prescali Environmental), Der Brochen Platinum Project (J9 Environment), Brandbach Sand (AGES), Verkeerdepan Extension (CleanStream Environmental), Dwaalboom Limestone (AGES), Jagdlust Chrome (MENCO), WPB Coal (MENCO), Landau Expansion (CleanStream Environmental), 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 Environmental), EastPlats (CleanStream Environmental), Chapudi Coal (Jacana Environmental), Generaal Coal (JE), Mopane Coal (JE), Glencore Boshhoek 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 Environmental), Fumani Gold (AGES), Leiden Coal (EIMS), Colenso Coal and Power Station (SiVEST/EcoPartners), Klippoortjie Coal (Gudani), Rietspruit Crushers (MENCO), Assen Iron (Tshikovha), Transalloys (SE), ESKOM Ankerlig (SE), Nooitgedacht Titano Project (EcoPartners), Algoa Oil Well (EIMS), Spitskop Chrome (EMAssistance), Vlakfontein South (Gudani), Leandra Coal (Jacana), Grazvalley and Zoetveld (Prescali), Tjate Chrome (Prescali), Langpan Chromite (Prescali), Vereeniging Recycling (Pro Roof), Meyerton Recycling (Pro Roof), Hammanskraal Billeting Plant 1 and 2 (Unica), Development of Altona Furnace, Limpopo Province (Prescali Environmental), Haakdoordrift Opencast at Amandelbult Platinum (Aurecon), Landau Dragline relocation (Aurecon), Stuart Coal Opencast (CleanStream Environmental), Tetra4 Gas Field Development (EIMS), Kao Diamonds – Tipping Village Relocation (EIMS), Royal Sheba project (Cabanga), Kao Diamonds – West Valley Tailings Deposit (EIMS), Upington Special Economic Zone (EOH), Arcellor Mittal CCGT Project near Saldanha (ERM), Malawi Sugar Mill Project (ERM), Proposed Mooifontein Colliery (Geovicon Environmental), Goedehoop North Residue Deposit Expansion (Geovicon Environmental), Mutsho 600MW Coal-Fired Power Plant (Jacana Environmentals), Tshivhaso Coal-Fired Power Plant (Savannah Environmental), Doornhoek Fluorspar Project (Exigo), Royal Sheba Project (Cabanga Environmental), Rietkol Silica (Jacana), Gruisfontein Colliery (Jacana), Lehlabile Colliery (Jaco-K Consulting), Bloemendal Colliery (Enviro-Insight), Rondevly Colliery (REC), Welgedacht Colliery (REC), Kalabasfontein Extension (EIMS), Waltloo Power Generation Project (EScience), Buffalo Colliery (Marang), Balgarthen Colliery (Rayten), Kusipongo Block C (Rayten), Zandheuvel (Exigo), NamPower Walvis Bay (GPT), Eloff Phase 3 (EIMS), Dunbar (Enviro-Insight), Smokey Hills (Prescali), Bierspruit (Aurecon), ECM Lannex (Prescali), ECM Tweefontein (Prescali), Smokey Hills (Prescali), Dalyshope (Digby Wells), Eland Platinum Mine (JEMS), Tweefontein (Prescali), Lannex (Prescali), Salene Manganese (Prescali), Baberton Gas to Power (Rayten), SISHEN Expansion (Shangoni), Goedgevonden EMP Amendment (Jacana), Rietkol Amendment (Jacana), Vlakfontein Bunker Project (Gudani), Vlakfontein West Project (Gudani), Vygenhoek Platinum (EMAssistance), Lesego Amendment (OMI Solutions), Mpenyisi Gas to Power (Nsovo), Basani Gas to Power (Nsovo), Newlands Gas to Power (Savannah), Sudor Coal (JacoK), Nooitgedacht Titanomanganese (Ikwezi), Inyanda Project (JacoK), Ermelo Project (Zyntha), (Schurvekop Coal (Cabanga), Vlakfontein Coal (EMAssistance), Zandheuvel (Jacana), Zondagsvlei Coal (Zyntha), Sereti Witbank South (Zyntha), Bright Alloys (Phakani), Gold One (Prime Resources), Consol Nigel (Zitholele), Hendrina Green Hydrogen and Ammonia project (Enertrag/WSP), Kegakilwe Diamonds (Gudani), Naudesbank (Zyntha), Brackenfell Data

	Centre (Linspace), Springfield & Redan (MENCO), Somkhele Project (Ophondweni, Emamahleni, Mahujini) (MENCO), Beta Gold (OMIsolutions), Rietfontein Gold (OMIsolutions), Bright Alloys Smelter (Phakani), Sweet Sensations Sand (Digby Wells), Anglo Motlhotlo (Digby Wells), Soufflet Malt (RHDHV), Braamspruit Coal (Shangoni), Southern Sphere Project (Shangoni), Ubombu eSwatini Sugar Refinery (Core Enviro), Nchalo Malawi Sugar Refinery (Core Enviro), Olifants OMMP-BRWSP (Zutari Ndodana Joint Venture), Motuoane Project (EIMS), Red Sands BESS (Globeleq), Lüderitz Port (GPT Namibia), MMSEZ Ferrochrome, Coal Wash Plant, Coke and Heat-regeneration projects (Gudani), Nemex Chrome (Gudani), Kromkrans Coal (Zyntha), Valley Silts Project (Kongiwe), Amandelbult Expansion Project (Kongiwe), Millsell TSF Project (Prescali), Edison PV Project (Savannah), Renewstable Projects – Ananzi, Kopano, Intlantsi, Matla (Savannah), Hotel Project Gabon (Infrata), Dunrose Colenso (VHA Sustainable), CESA Highwall project (VHA Sustainable)
Urban, Roads 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), Transnet Apies-river Bridge Upgrade (Transnet), Gautrain Due-diligence (SiVest), N2 Piet Retief (SANRAL), Atterbury Extension, CoT (Bokomoso Environmental), Riverfarm Development (Terramanzi), Conakry to Kindia Toll Road (Rayten), Sutherland Road Project (Veers Group), Sassalemba Project (Enviro-Insight), Barra da Donde Angola (Enviro-Insight), Musina-Makhado SEZ (Gudani), Highbury Depot (AGES Limpopo), Mokopane project (AGES Limpopo), Deerpark Filling Station (AGES Limpopo), Highlands Estate (NALI), IPHC Wonderpark (Magoda), Busstop7,
Airport	Oudtshoorn Noise Monitoring (AGES), Sandton Heliport (Alpine Aviation), Tete Airport Scoping (Aurecon)
Noise monitoring and Audit Reports	Peerboom Colliery (EcoPartners), Thabametsi (Digby Wells), Doxa Deo (Doxa Deo), Harties Dredging (Rand Water), Xstrata Coal – Witbank Regional (Xstrata), Sephaku Delmas (AGES), Amakhala Emoyeni WEF (Windlab Developments), Oyster Bay WEF (Renewable Energy Systems), Tsitsikamma WEF Ambient Sound Level study (Cennergis and SE), Hopefield WEF (Umoya), Wesley WEF (Innowind), Ncora WEF (Innowind), Boschmanspoort (Jones and Wagner), Nqamakwe WEF (Innowind), Hopefield WEF Noise Analysis (Umoya), Dassiesfontein WEF Noise Analysis (BioTherm), Transnet Noise Analysis (Aurecon), Jeffries Bay Wind Farm (Globeleq), Sephaku Aganang (Exigo), Sephaku Delmas (Exigo), Beira Audit (BP/GPT), Nacala Audit (BP/GPT), NATREF (Nemai), Rappa Resources (Rayten), Measurement Report for Sephaku Delmas (Ages), Measurement Report for Sephaku Aganang (Ages), Bank of Botswana measurements (Linnospace), Skukuza Noise Measurements (Concor), Development noise measurement protocol for Mamba Cement (Exigo), Measurement Report for Mamba Cement (Exigo), Measurement Report for Nokeng Fluorspar (Exigo), Tsitsikamma Community Wind Farm Pre-operation sound measurements (Cennergis), Waainek WEF Operational Noise Measurements (Innowind), Sedibeng Brewery Noise Measurements (MENCO), Tsitsikamma Community Wind Farm Operational noise measurements (Cennergis), Noupoot Wind Farm Operational noise measurements (Mainstream), Twisdraai Colliery (Lefatshe Minerals), SASOL Prospecting (Lefatshe Minerals), South32 Klipspruit (Rayten), Sibanye Stillwater Kroondal (Rayten), Rooiberg Asphalt (Rooiberg Asphalt), SASOL Shondoni (Lefatshe), SASOL Twisdraai (Lefatshe), Anglo Mototolo (Exigo), Heineken Inyaniga (AECOM), Glencore Izimbiwa (Cleanstream), Glencore Impunzi (Cleanstream), Black Chrome Mine (Prescali) Sibanye Stillwater Ezulwini (Aurecon), Sibanye Stillwater Beatrix (Aurecon), Bank of Botswana (Linspace), Lakeside (Linspace), Skukuza (SiVEST), Rietvlei Colliery (Jaco-K Consulting), TCTA – Mokolo Project (GIBB), Various (Linspace), Sulzer Hydromining (Sulzer), WCO WEF (Aurora), Great Kei (EDF-Renewables), Elands Platinum (JEMS), Hartebeest WEF (juwi), Mamba Cement (TMCC), Booyens (MDTE), West Rand (MDTE), Devland (MDTE), Zandheuveld (Jacana), Glencore (Kroondal, Rhovan, Rietvlei, Waterval-West, Helena, Lion Smelter, Magareng, Thornccliffe, Boshoeck, Rustenburg Smelter, Wonderkop) (JMA), McDonalds Albert Street (Linspace), Waterfall Data Centre (Linspace), Zondereinde (Linspace), Copper Sunset Sands (Digby Wells), Exxaro Lephalale (Digby Wells), Tawana Mining (Tawana Mining), WCWF (Red Rocket), Overberg WEF (Red Rocket), Excelsior WEF (ENGIE)
Project Modelling and Consulting	JW Angola Urban Development (Rayten), Mooi-Mgeni Hydro Project (Rayten), Consmodder (Rayten), Samrand Data Centre (Rayten), Luculus Road (Rayten), Atlanta Weir (Rayten), Beestekraal Weir (Rayten), Paul Hugo Weir (Rayten), Newcastle Coal Mine (Rayten), Boldman Coal (Rayten), Worcester N1 Upgrade (Rayten), Angola Railway Project (Rayten), Nekkies Road Project (Rayten), George N2 Bypass Road (Rayten), Vanmag project (Rayten), N2 Bypass Borrowpits (Rayten), Trikoers Mix-use Development (Rayten), Fruitways Grabouw (Rayten), Tempo Steel (Rayten), Newcastle Coal (Rayten), Franskraal BESS (Rayten), Kasimira Coal (Rayten)
Small Noise Impact Assessments	TCTA AMD Project Baseline (AECOM), NATREF (Nemai Consulting), Christian Life Church (UrbanSmart), Kosmosdale (UrbanSmart), Louwlandia 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 (Noman Shaikh), Soshanguve Development (Maluleke Investments), Seshogo-D Waste Disposal (Enviroexcellence), Zambesi Safari Equipment (Owner), Noise Annoyance Assessment due to the Operation of the Gautrain (Thornhill and Lakeside Residential Estate), Upington Solar (SE), Ilangaletu Solar (SE), Pofadder Solar (SE), Flagging Trees WEF (SE), Uyekraal WEF (SE), Ruuki Power Station (SE), Richards Bay Port Expansion 2 (AECOM), Babalegi Steel Recycling (AGES), Safika Ladium (AGES), Safika Cement Isando (AGES), RareCo (SE), Struisbaai WEF (SE), Perdekraal WEF (ERM), Kotula Tsatsi Energy (SE), Olievenhoutbosch Township (Nali), , HDMS Project (AECOM), Quarry extensions near Ermelo (Rietspruit Crushers), Proposed uMzimkhulu Landfill in KZN (nZingwe Consultancy), Linksfield Residential Development (Bokomoso Environmental), Rooihuiskraal Ext. Residential Development, CoT (Plandev Town Planners), Floating Power Plant and LNG Import Facility, Richards Bay (ERM), Floating Power Plant project, Saldanha (ERM), Vopak Growth 4 project (ERM), Elandspoort Ext 3 Residential Development (Gibb Engineering), Tiegerpoort Wedding Venue (Henwood Environmental), Monavoni Development (Marindzini), Rezoning of Portion 1 (Primo Properties), Tswaing Mega City (Makole), Mabopane Church (EP Architects), ERGO Soweto Cluster (Kongiwe), Fabio Chains (Marang), GIDZ JMP (Marang), Temple Complex (KWP Create), Germiston Metals (Dorean), Sebenza Metals (Dorean), Malmesbury Abattoir Expansion (Roelcor), Mogalakwena PV Project (Zutari), Serengeti PV Review (Zutari), Nyakallo PV (GCS), Robinson Deep (IQS), Zonnebloem (Zyntha), Forzando North (Cabanga), Tumelo (Cabanga), Daggafontein projects (Kongiwe), Genesis Steyn PV (Kongiwe), ERGO Soweto Cluster (Kongiwe), Kriel PV (NALA), Mhlabatshane project (NEMAI), Coega G2P (Nsovo), Cape Roan Desalination Project (Rayten), AJCOR (Rayten), Swartfontein PV (Savannah), Kloof Reclamation projects (Kongiwe), Bryanston Objection (Legal Matter), Woodhill BESS (Woodhill), Golden Spur Cape Town (ALZU), Centurion Padel (Centurion HOA), Crocodile BWS Pipeline (ServitudeWatch), Mall@55 (Mall@55), Marnitzkraal Service Station (Tecoplan)
Noise Compliance Statements	Dwarsrug BESS (SiVEST), Hyperion BESS (SE), Loeriesfontein BESS (SiVEST), Platsjambok East and West BESS (SiVEST), Waaihoek BESS (CESNET), Koeris BESS (Zurari), Frontier Gas to Power (ERM), Hyperion BESS (Savannah), Pepsico (Zutari), Umsinde Road (EnviroAgri), Khangela Road (EnviroAgri), Mopani PV projects (AGES Limpopo)
Project reviews and amendment reports	Loperberg (Savannah), Dorper (Savannah), Penhoek Pass (Savannah), Oyster Bay (RES), Tsitsikamma Community Wind Farm Noise Simulation project (Cennergij), Amakhala Emoyeni (Windlab), Spreeukloof (Savannah), Spinning Head (SE), Kangra Coal (ERM), West Coast One (Moyeng Energy), Rheboksfontein (Moyeng Energy), De Aar WEF (Holland), Quarterly Measurement Reports – Dangote Delmas (Exigo), Quarterly Measurement Reports – Dangote Lichtenburg (Exigo), Quarterly Measurement Reports – Mamba Cement (Exigo), Quarterly Measurement Reports – Dangote Delmas (Exigo) Quarterly Measurement Reports – Nokeng Fluorspar (Exigo), Proton Energy Limited Nigeria (ERM), Hartebeest WEF Update (Moorreesburg) (Savannah Environmental), Modderfontein WEF Opinion (Terramanzi), IPD Vredenburg WEF (IPD Power Vredenburg), Paul Puts WEF (ARCUS), Juno WEF (ARCUS), Rheboksfontein WEF (ERM), Umzinde WEF (Zutari), Kokerboom 4 (Zutari), Dwarsrug WEF (SiVEST), Highlands North (Holland), Highlands Central (Holland), Highlands South (Holland), Zandheuveld (Jacana), etc.
Blasting Vibration Assessments	Anglo Bierspruit (Aurecon), Arengo Iron Thabazimbi (BeyondGES), Vlakfontein Coal (EMAssistance), Gruisfontein Coal (Jacana), Glencore Goedgevonden (Jacana), Remhoogte Coal (Zyntha), Rietkuil Coal (Zyntha), Vygenhoek Platinum (EMAssistance), Dunbar Coal (Enviro-Insight), Bloemendal Coal (Enviro-Insight), Salene Manganese (Prescali), VTM Mining (Ikwezi Vanadium), Newcastle Coal project (Ericure), De Kroon (Zyntha), Naudesbank (Zyntha), Somkhele Project (Ophondweni, Emamahleni, Mahujini) (MENCO), Wagendrift (Milnex), Glenover (Prescali), Braamspruit Coal (Shangoni), Dwaalboom Project (Prescali), Kromkrans Coal (VHA Sustainable/SAFI Coal), Spitzkop Platinum (OMI Solutions), Lehlabile Colliery (Jaco-K Consulting)

Tel (office): 012 004 0362

Tel (mobile): 082 565 4059

Office: 726 Wiedrigh Street, Moreleta Park, Pretoria

Email: morne@eares.co.za

Website: <http://eares.co.za>

2 DOCUMENT STRUCTURE – CHECKLIST AS PER EIA REGULATIONS

This report has been compiled in accordance with the EIA Regulations, 2014 (Government Notice (GN) R982). A summary of the report structure, and the specific sections that correspond to the applicable regulations, is provided in the table below.

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;	Separate form
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section 4.1
(cA)	an indication of the quality and age of base data used for the specialist report;	Section 6.1
(cB)	a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 6.1 and 6.3
(d)	the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 6.1
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 4.6 (Terms of Reference that guides the methodology)
(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 6.1, 7 and 10
(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 6.1
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 9

Contents of this report in terms of Regulation GNR 982 of 2014, Appendix 6 (as amended 2017)		Relevant Section of Specialist study
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Sections 10, 12, 13 & 14
(k)	any mitigation measures for inclusion in the EMPr;	Sections 12 and 13
(l)	any conditions for inclusion in the environmental authorisation (EA);	None recommended
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Sections 12 and 13
(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;	Section 14
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	See Section 4.5
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	See Section 4.5
(q)	any other information requested by the competent authority.	None

3 DOCUMENT STRUCTURE – MINIMUM REQUIREMENTS AS PER GNR320 (SCREENING OF SITE)

The National Web based Environmental Screening Tool¹ was used to screen the proposed site (see **Figure 4-1** for the regional location) for the noise environmental sensitivity as per the requirements of GNR320 (20 March 2020), considering the site location. The site report generated by the Screening Tool highlighted that a Noise Impact Assessment must be completed and appended to the Environmental Authorization ("EA") documentation. The screening report was developed for both:

- Mining => Mining Right, and
- Activity requiring permit or licence in terms of National or Provincial legislation governing the release or generation of emissions => Emissions.

The potential noise sensitive areas layer is not included in the above-mentioned categories, but was obtained from the Utilities Infrastructure => Electricity => Generation => Renewable => Wind category, with the noise sensitive areas illustrated on **Figure 4-2**.

Based on the output of the online screening tool, most of the area is considered to have a "very high" sensitivity to noise. This was also confirmed during the site visit that identified and confirmed various residential activities within the potential area of influence from the project activities (see also **Figure 4-3**).

In terms of GNR 320 (20 March 2020), the Noise Specialist Assessment must contain, as a minimum, the following information:

Clause	Reporting Requirements as per the Protocol for Noise Specialist Assessments	Compliance of current report / Reference
2.3.1	Current ambient sound levels recorded at relevant locations over a minimum of two nights and that provide a representative measurement of the ambient noise climate, with each sample being a minimum of ten minutes and taken at two different times of the night on each night, in order to record typical ambient sound levels at these different times of night	Section 6.3
2.3.2	Records of the approximate wind speed at the time of the measurement	Section 6.3

¹ <https://screening.environment.gov.za/screeningtool/#/pages/welcome>

Clause	Reporting Requirements as per the Protocol for Noise Specialist Assessments	Compliance of current report / Reference
2.3.3	Mapped distance of the receiver from the proposed development that is the noise source	
2.3.4	Discussion on temporal aspects of baseline ambient conditions	Section 6.3
2.4.1	Characterization and determination of noise emissions from the noise source, where characterization could include types of noise, frequency, content, vibration and temporal aspects	Section 7
2.4.2	Projected total noise levels and changes in noise levels as a result of the construction, commissioning and operation of the proposed development for the nearest receptors using industry accepted models and forecasts	Sections 10
2.4.3	Desired noise levels for the area	Section 6.3
2.5.1	Contact details of the environmental assessment practitioner or noise specialist, their relevant qualifications and expertise in preparing the statement, and a curriculum vitae	Section 1
2.5.2	a signed statement of independence by the environmental assessment practitioner or noise specialist.	Separate document
2.5.3	The duration and date of the site inspection and the relevance of the season and weather condition to the outcome of the assessment	Section 6.3
2.5.4	A description of the methodology used to undertake the on-site assessment, inclusive of the equipment and models used, as relevant, together with the results of the noise assessment	Sections 6.3 and 10
2.5.5	a map showing the proposed development footprint (including supporting infrastructure) overlaid on the noise sensitivity map generated by the screening tool	Figure 4-2
2.5.6	confirmation that all reasonable measures have been taken through micro- siting to minimise disturbance to receptors	Various layouts previously investigated
2.5.7	a substantiated statement from the specialist on the acceptability, or not, of the proposed development and a recommendation on the approval, or not, of the proposed development	Section 14
2.5.8	any conditions to which this statement is subjected	Section 14
2.5.9	the assessment must identify alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification and which were not considered	Project location limited by the presence of the gas resource
2.5.10	A motivation must be provided if there were development footprints identified as per paragraph 2.5.9 above that were	Project location limited by the

Clause	Reporting Requirements as per the Protocol for Noise Specialist Assessments	Compliance of current report / Reference
	identified as having a “low” noise sensitivity and that were not considered appropriate	presence of the gas resource
2.5.11	where required, proposed impact management outcomes, mitigation measures for noise emissions during the construction and commissioning phases that may be of relative short duration, or any monitoring requirements for inclusion in the Environmental Management Programme (EMPr), and	Sections 12 and 13
2.5.12	a description of the assumptions made and any uncertainties or gaps in knowledge or data as well as a statement of the timing and intensity of site inspection observations	Section 9

4 INTRODUCTION

4.1 INTRODUCTION AND PURPOSE

Enviro-Acoustic Research ("EARES") was contracted by Environmental Impact Management Services (Pty) Ltd (the EAP - EIMS) to undertake a specialist study to determine the potential noise impact on the surrounding environment due to the proposed D3 Energy Project near Virginia, Free-State.

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.

4.2 BRIEF PROJECT DESCRIPTION

The Applicant, D3 Energy Energy (Pty) Ltd, propose to optimize the extraction of their gas resource within their production right area, with the product location depicted in **Figure 4-1**.

The activities proposed by D3 Energy will include the following:

- Provision for ongoing exploration drilling and seismic activities;
- Existing wells may be 'worked over' and possibly included as production sites;
- Drilling of approximately 30-50 wells within identified well production corridors. The wells will be equipped to optimally extract the gas product;
- The installation of trenched sub-surface gas gathering pipelines between the production wells and a gas production plant where the gas will be compressed to deliver compressed Helium and Methane as a first phase, followed by a second phase where the gas will be liquified to produce LNG.
- The generation of power (gas to power) for use by the project.

4.3 STUDY AREA

The PFA is an area selected to enclose all potential project infrastructure up to 2,000 m from activities or equipment that may generate significant noise, excluding the main access road. The PFA is located within the Fezile Dabi and Lejweleputswa District Municipalities within

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

4.3.1 Topography

The Environmental Potential Atlas of South Africa ("ENPAT") (Van Riet *et al*, 1998) describes the topography as "*Lowlands and Hills*", though, within the scale where noise may be an issue, there are no topographical features that could limit the propagation (partly blocking the noise propagation in certain directions) from the project activities.

4.3.2 Surrounding Land Use

The surrounding land use is mainly agriculture and wilderness (game farming and ecotourism). There are some mining activities in the larger area (outside the PFA).

4.3.3 Roads and Railways

The R73 provincial road, as well as the D143 (branching from the N1 national road) transect the PFA, with a number of small gravel roads leading from these roads. There are a number of smaller gravel roads branching from these roads, mainly used by the farmers and the local communities, although traffic volumes are low on these smaller roads.

4.3.4 Ground conditions and vegetation

The area falls within the grassland biome, with the natural vegetation historically being *Cymbopogon-themeda* veld. The natural veldt type however has been significantly impacted by agricultural and mining activities.

Taking into consideration available information it is the opinion of the author that the ground conditions (when considering acoustic propagation on a ground surface) can be classified as medium, which implies that the ground surface will absorb some of the acoustic energy hitting the ground surface. 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.

4.3.5 Existing Ambient Sound Levels

Ambient sound levels were measured at 3 locations in the vicinity of the project area in a semi-continuous manner over a period of 4-nights (approximately 1,120 daytime, and 576 night-time measurements – each with a duration of 10-minutes) during November 2025, with the data indicating ambient sound levels mostly typical of a rural noise district. Noise levels were elevated at one of the measurement locations, with the source of the noises (elevating the sound levels) unknown. The data collected at this location was not used in this assessment.

Bird and insect noises were generally the dominant source of noise at all measurement locations, though voices were audible (and might have impacted on the measurement results) at two of the measurement locations. The results and findings of the ambient sound level measurements are also further discussed in **Section 6.3**.

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

Potentially sensitive receptors, also known as noise-sensitive developments (“NSR”), located within or near the mineral rights area was identified using Google Earth® during the scoping phase, highlighting that NSRs are scattered in a heterogenous manner in the area.

The online screening tool only identified two areas with a “very high” sensitivity to noise (see **Figure 4-2**), excluding most of the NSRs as identified in this assessment. NSR as identified during the Scoping phase are illustrated on **Figure 4-3**., with illustrating NSR locations as verified during the site visit in November 2025. It should be noted that the NSR locations were verified during a drive by, and the use of the structures were not verified with discussions with the land owners. Structures that are maintained, or could be used for residential purposes was included in this assessment. There are however a number of NSR locations where structures appeared to be unused, including NSR locations 4, 5, 6, 14, 17, 22, 27, 34 and 35; this assessment will include these locations as potentially noise-sensitive as the structures may still be used for temporary or permanent residential purposes. NSR outside the PFA were not verified.

Generally, noises from mining and industrial activities:

- are limited to a distance of less than 500 m from active mining access roads, though this would normally be less than 200 m with low traffic volumes and speeds associated with such roads (night-time impacts). This can be increased to a distance of 1,000 m, normally associated with very busy roads (such as a busy national road where average speeds exceed 100 km/h). Noises from mining and processing activities are normally clearly audible and very significant within 200 m from such activities both night and day;
- can be significant at receptors staying within 500 m from active mining/industrial activities. Noises may be at a sufficient level to be considered disturbing. There are only one NSR location (NSR16²) located within 500m from a location where drilling may take place;
- are normally limited to a distance of approximately 1,000 m from the active mining/industrial activities. Ambient sound levels are increased due to noises from the activities, with the potential noise impact measurable. Noise levels from such

² Location not visited, due to road conditions during the site visit.

activities are generally less than 45 dBA further than 1,000 m from these activities, and noises may be considered disturbing at night. There are 11 NSR locations located 500 – 1,000m from potential borehole locations;

- may be audible up to a distance of 2,000 m at night, though the noises may be audible up to 4,000 m during very quiet periods at night (during certain meteorological conditions). These noises are normally of a low concern at distances greater than 2,000 m from activities at night.

These distances may not be valid with very large mining or industrial operations, or in areas with very low ambient sound levels.

4.5 COMMENTS REGARDING NOISE RECEIVED DURING THIS PROJECT

The author is not aware of any comments raised by the authorities or interested and affected parties at the date this report was compiled. It should however be noted that the Noise Assessment is part of a suite of studies commissioned by the Environmental Assessment Practitioner ("EAP"), who is undertaking the Public Participation Process ("PPP") as part of the EIA. Comments regarding noise may only be available during the EIA and PPP process.

4.6 LEGISLATIVE REQUIREMENTS AND TERMS OF REFERENCE

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

- It was identified as an environmental theme needing further investigation in terms of the National Screening Tool as per the procedures of Government Gazette 43110 of 20 March 2020;
- A change in land use as highlighted in SANS 10328:2008, section 5.3;
- If an industry is to be established within 1,000 m from a potential noise sensitive development (SANS 10328:2008 [5.4 (h)]);
- If a wind farm (wind turbines - SANS 10328:2008 [5.4 (i)]) or a source of low-frequency noise (such as cooling or ventilation fans - SANS 10328:2008 [5.4 (l)]) is to be established within 2,000 m from a potential noise sensitive development *or vice versa*;
- 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 ("GN") 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).

4.6.1 Requirements as per Government Gazette 43110 of March 2020

The Department of Forestry, Fisheries and Environment also promulgated Regulation 320, dated 20 March 2020 as published in Government Gazette No. 43110. The Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in Terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, when applying for Environmental Authorisation would be applicable to this project.

This regulation defines the requirements for undertaking a site sensitivity verification, specialist assessment and the minimum report content requirements for environmental impact where a specialist assessment is required but no protocol has been prescribed. It requires that the current land use be considered using the national web based environmental screening tool to confirm the site sensitivity available at: <https://screening.environment.gov.za>.

If an applicant intending to undertake an activity identified in the scope of this protocol for which a specialist assessment has been identified on the screening tool on a site identified as being of:

- "very high" sensitivity for noise, must submit a Noise Specialist Assessment; or
- "low" sensitivity for noise, must submit a Noise Compliance Statement.

On a site where the information gathered from the site sensitivity verification differs from the designation of "very high" sensitivity on the screening tool and it is found to be of a "low" sensitivity, a Noise Compliance Statement must be submitted.

On a site where the information gathered from the initial site sensitivity verification differs from the designation of "low" sensitivity on the screening tool and it is found to be of a "very high" sensitivity, a Noise Specialist Assessment must be submitted.

If any part of the proposed development footprint falls within an area of "very high" sensitivity, the assessment and reporting requirements prescribed for the "very high" sensitivity apply to the entire footprint excluding linear activities for which noise impacts are associated with construction activities only and the noise levels return to the current levels after the completion of construction activities, in which case a compliance statement applies. In the context of this protocol, development footprint means the area on which the proposed development will take place and includes any area that will be disturbed.

The minimum requirements for a Noise Specialist Study (i.t.o GNR 320 of 2020) are also covered in **Section 2** of this report in the form of a checklist.

This assessment is comprehensive and a Noise Specialist Assessment is required because there are a number of potential noise-sensitive receptors living within 2,000 m from the proposed project activities.

4.6.2 Requirements as per South African National Standards

In addition, Appendix 6 of GN 326 of December 2014 (Government Gazette ("GG") 38282), as amended 7 April 2017 (GG. 40772), 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 environmental impact assessment ("EIA") purposes. These minimum requirements are:

1. The purpose of the investigation – **section 4.1;**
2. A brief description of the planned development or the changes that are being considered – **section 4.2;**
3. A brief description of the existing environment – **section 6.3;**
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) – **section 7;**
5. The identified noise sources that were not taken into account and the reasons why they were not investigated – **section 7;**
6. The identified noise-sensitive developments and the estimated impact on them – **sections 4.4, 10 and 12;**
7. Any assumptions made with regard to the estimated values used – **section 9;**
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 – **section 8;**
9. The location of the measurement or calculation points, i.e., a description, sketch or map – **section 10;**
10. Estimation of the environmental noise impact – **sections 10 and 12;**

11. Alternatives that were considered and the results of those that were investigated – **section 10.5;**
12. A list of all the interested or affected parties that offered any comments with respect to the environmental noise impact investigation – **section 4.5;**
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 – **section 4.5;**
14. Conclusions that were reached – **section 14;**
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 – **section 14;** 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 – **none recommended or required.**

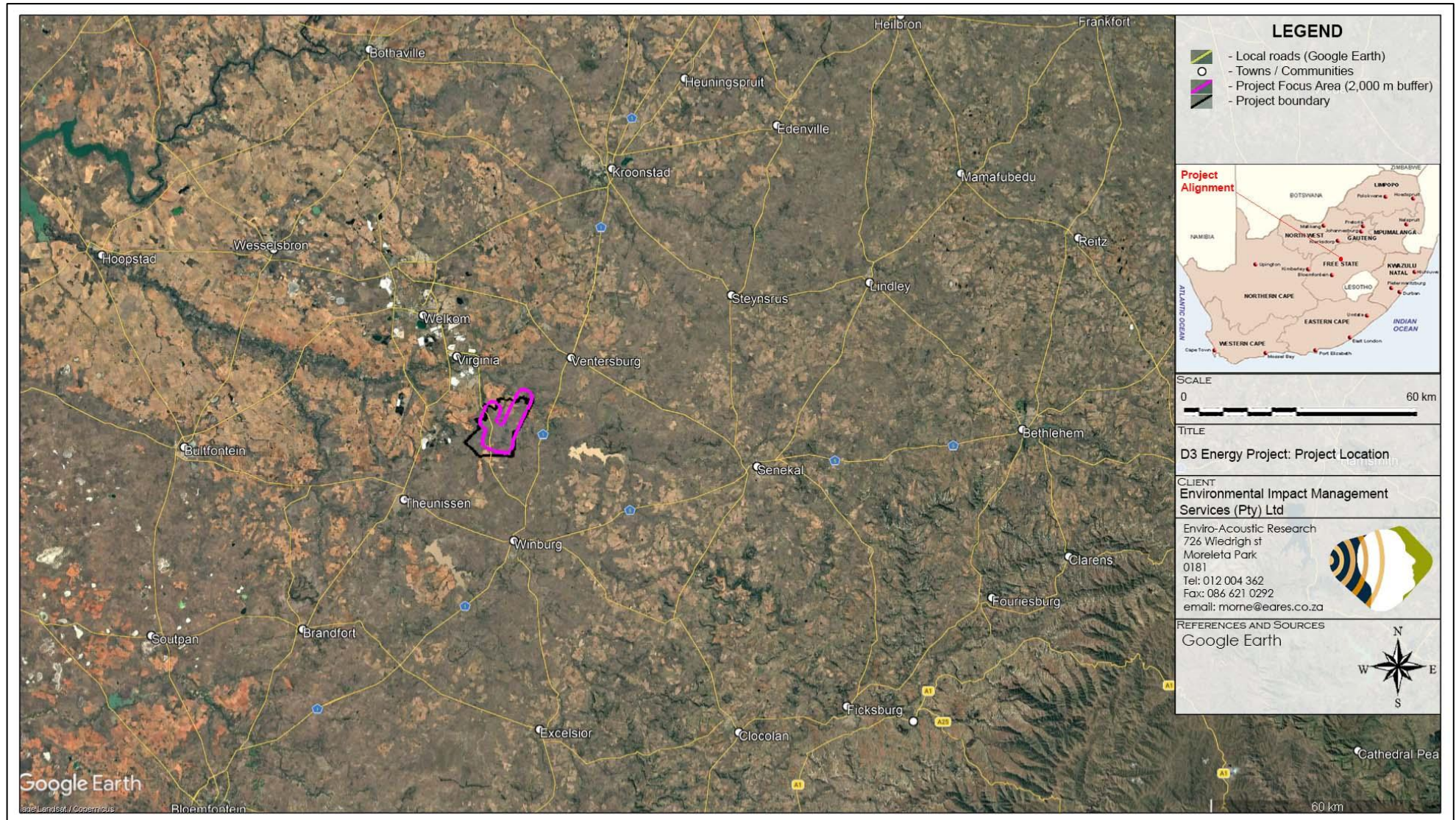


Figure 4-1: Aerial image indicating the regional location of the proposed D3 Energy Project

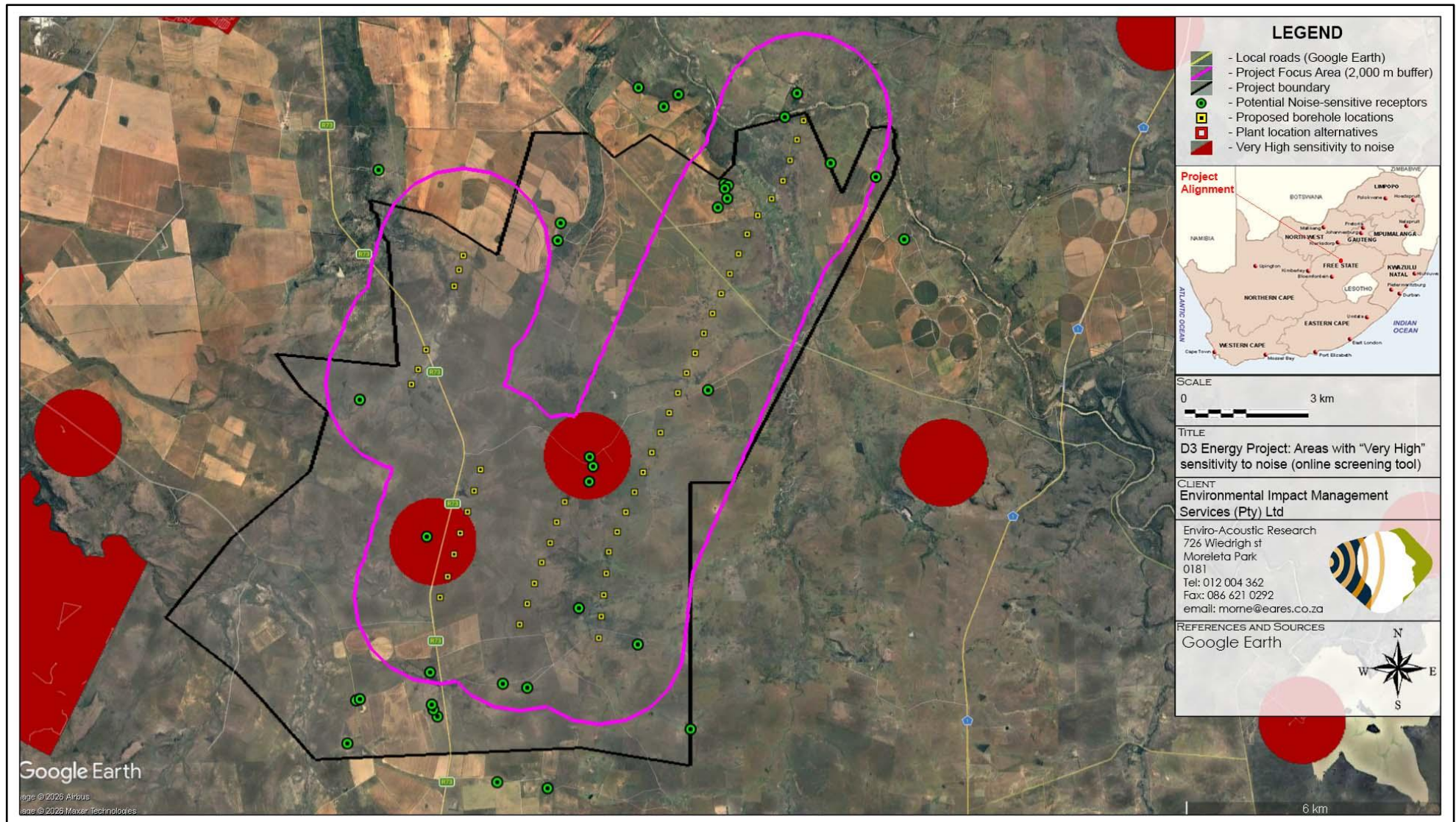


Figure 4-2: Areas identified by the online screening tool to have a "very high" sensitivity to noise

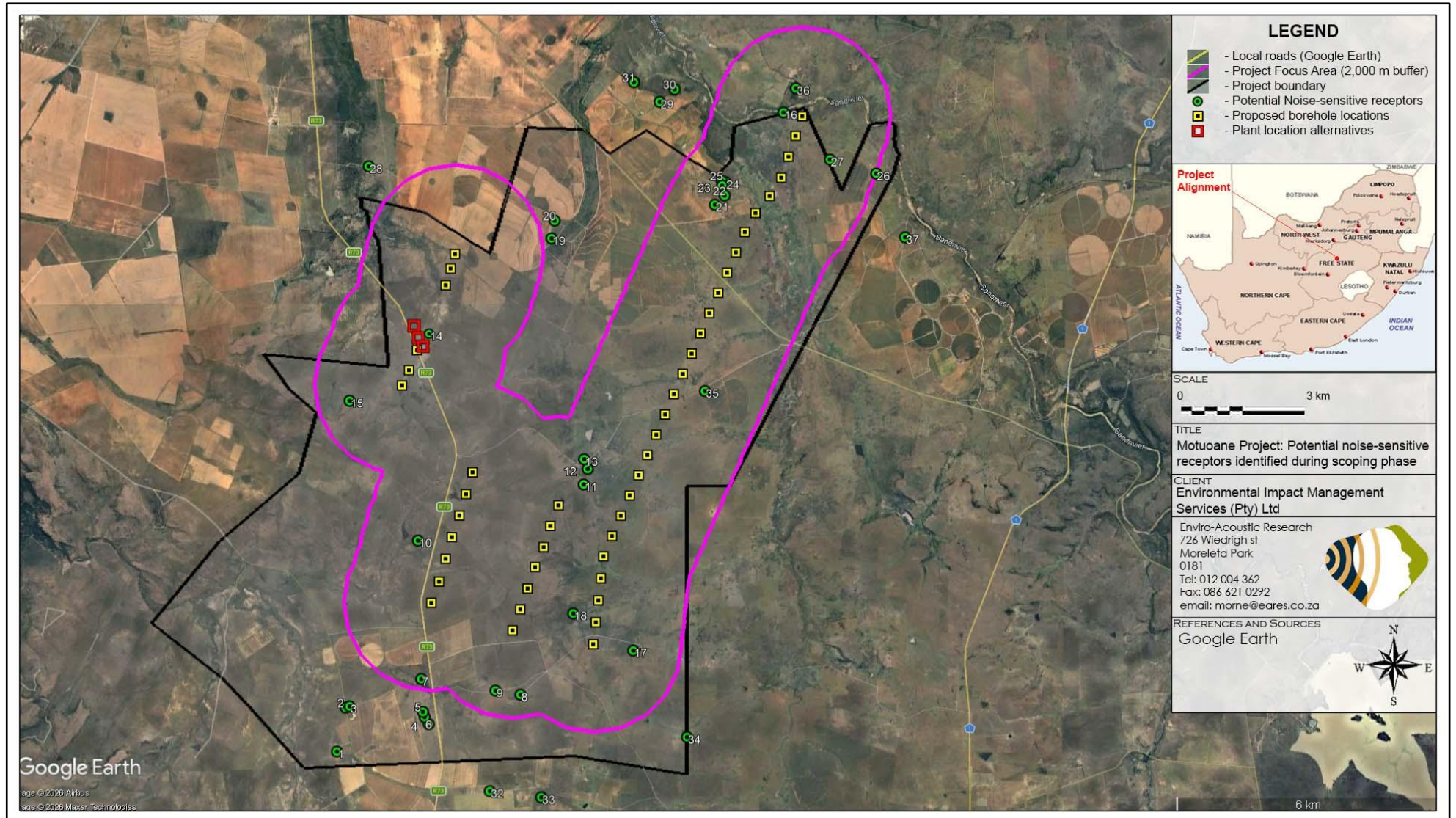


Figure 4-3: Aerial image indicating noise-sensitive receptors identified during scoping

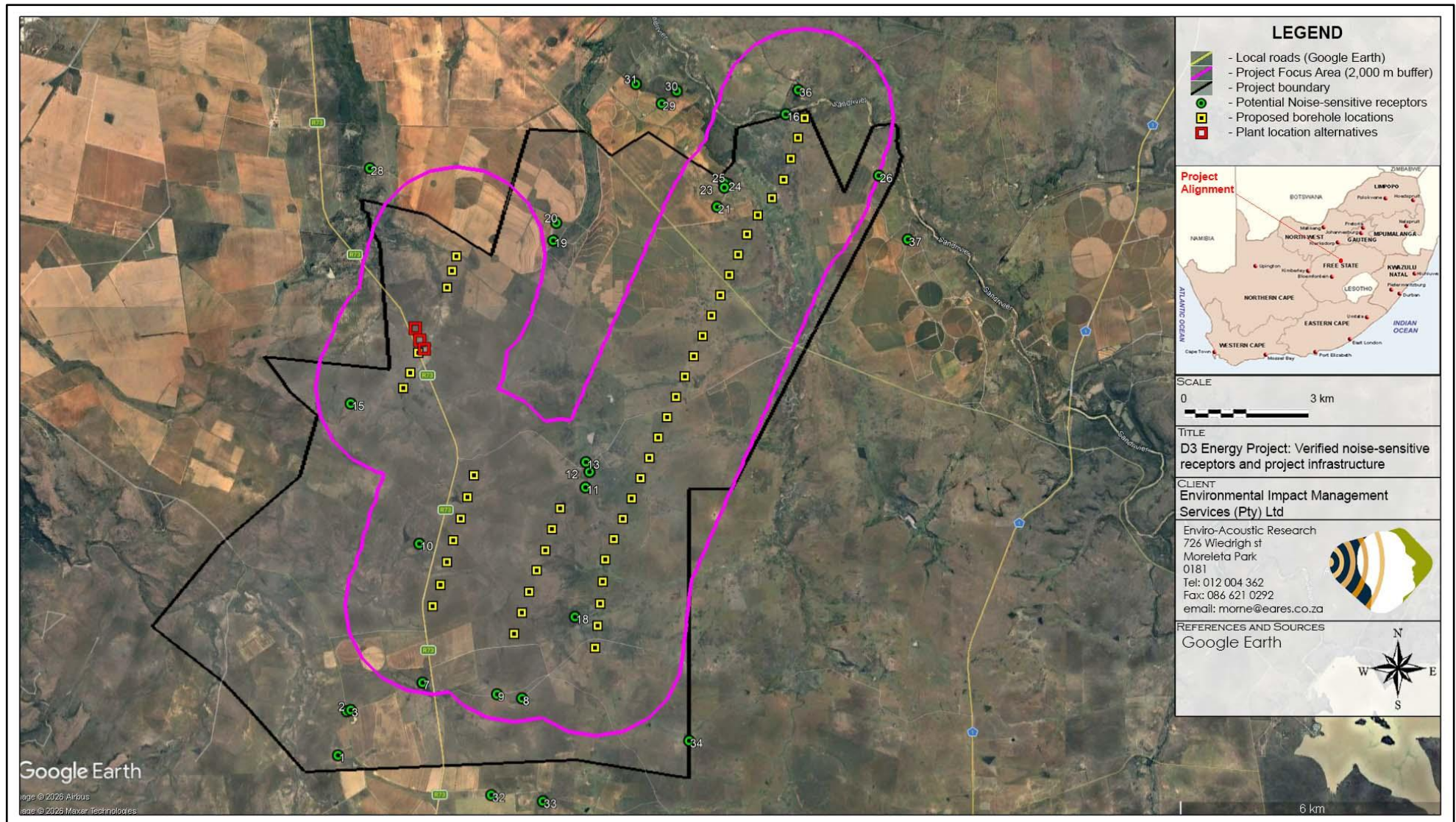


Figure 4-4: Aerial image indicating verified noise-sensitive receptors close to D3 Energy Project

5 LEGAL CONTEXT, POLICIES AND GUIDELINES

5.1 THE ENVIRONMENT CONSERVATION ACT (ACT 73 OF 1989)

The Environment Conservation Act (ECA) (Act 73 of 1989) was, prior to the promulgation of the National Environmental Management Act (NEMA), the backbone of environmental legislation in South Africa. To date the majority of the ECA has been repealed by various other Acts, however Section 25 of the Act and the Noise Regulations (GN R. 154 of 1992) promulgated under this section are still in effect. These Regulations serve to control noise and general prohibitions relating to noise impact and nuisance. The ECA allows the Minister of the Department of Forestry, Fisheries and the Environment (DFFE) to make regulations regarding noise, among other concerns.

In terms of section 25 of the ECA, the National Noise Control Regulations (GN R 154 of 1992) were promulgated. The NCRs were revised under Government Notice Number R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations.

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

5.1.1 Free State Provincial Noise Control Regulations (PN 24 of 1998)

The control of noise in the Free State Province is legislated in the form of the Provincial Noise Control Regulations (PNCR) promulgated in terms of section 25 of the ECA.

It should be noted that the regulations define:

"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 meter was put into operation;

"disturbing noise" - means a noise level that exceeds the ambient sound level measured continuously at the same measuring point by 5 dBA or more.

"noise level" - means the reading on an integrating impulse sound level meter taken at a measuring point in the presence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such meter was put into operation, and, if the alleged disturbing

noise has a discernible pitch, for example, a whistle, buzz, drone or music, to which 5 dBA has been added;

In addition:

In terms of Regulation 2 (d):

"A local authority may –

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 be conducted to the satisfaction of that local authority by the owner, developer, tenant or occupant of the facilities, land or buildings and that reports or certificates relating to the noise impact to the satisfaction of that local authority be submitted by the owner, developer, tenant or occupant to the local authority;

In terms of Regulation 3 (c):

"No person shall –

make changes to existing facilities or existing uses of land or buildings or erect new buildings, if it shall in the opinion of a local authority house or cause activities which shall, after such change or erection, cause a disturbing noise, unless precautionary measures to prevent the disturbing noise have been taken to the satisfaction of the local authority";

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".

5.2 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT 107 OF 1998)

The National Environmental Management Act ("NEMA") defines "pollution" to include any change in the environment, including noise. A duty therefore arises under section 28 of NEMA to take reasonable measures while establishing and operating any facility to prevent noise pollution occurring. NEMA sets out measures, which may be regarded as reasonable. They include the following measures:

1. to investigate, assess and evaluate the impact on the environment;
2. to inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed to avoid causing significant pollution or degradation of the environment;
3. to cease, modify or control any act, activity or process causing the pollution or degradation;
4. to contain or prevent the movement of the pollution or degradation;
5. to eliminate any source of the pollution or degradation;

6. to remedy the effects of the pollution or degradation.

In addition, a number of regulations have been promulgated as Regulation 982 of December 2014 (Government Notice 38282) in terms of this Act. It defines minimum information requirements for specialist reports, with Government Gazette (GG) 43110 (20 March 2020) updating the minimum requirements for reporting.

GG 43110 prescribe general requirements for undertaking site sensitivity verification and for protocols for the assessment and minimum report content requirements of environmental impacts for environmental themes for activities requiring environmental authorisation. These protocols were promulgated in terms of sections 24(5)(a), (h) and 44 of the National Environmental Management Act, 1998.

When the requirements of a protocol apply, the requirements of Appendix 6 of the Environmental Impact Assessment Regulations, as amended, (EIA Regulations), promulgated under sections 24(5) and 44 of the National Environmental Management Act, 1998 (Act No. 107 of 1998), are replaced by these requirements.

5.3 NOISE STANDARDS

There are a few South African scientific standards (SABS) relevant to noise from developments, 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'.
- SANS 10205:2003. 'The Measurement of Noise Emitted by Motor Vehicles in Motion'.

The relevant standards use the equivalent continuous rating level (calculated from the sound pressure levels over the reference time, see [Appendix A](#)) 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*.

5.3.1 SANS 10103:2008

SANS 10103 provide standard procedures to measure and define rating levels with respect to annoyance and speech communication, mainly focusing on subsections:

- clause 4.1 - Ambient indoor noise;
- clause 4.2 – Typical noise in various districts; and
- clause 4.5 – Assessment of annoyance.

5.3.1.1 *Clause 4.1 – Ambient indoor noise*

This is a critical section, frequently ignored by authorities and even acoustic specialists. This clause provide recommended rating levels ($L_{Req,T}$) for ambient noise for different areas of occupancy during the time periods when the areas are used for their intended purposes and with the building services (e.g. ventilation systems, air-conditioning systems, lifts, plumbing and lighting) under normal operating conditions. The rating levels given in column 2 of the table are design values, while those given in column 3 are the maximum levels beyond which the ambient noise can be considered to be annoying or otherwise intrusive. Note 2 highlights that, where these levels are used as guidance for the design of buildings in non-residential areas where the ambient noise exceeds the typical level for the type of development, the building design should provide sufficient acoustic isolation to result in the occupancy level specified in Table 1 of SANS 10103 (see example for residential use in **Table 5-1**).

Table 5-1: Recommended ambient noise for different areas of occupancy indoors (Table 2 - SANS 10103:2008)

1	2	3
Types of occupancy or activity	Design equivalent continuous rating level ($L_{Req,T}$) ^a for ambient noise dBA	Maximum equivalent continuous rating level ($L_{Req,T}$) ^a for ambient noise dBA
9. Residential buildings		
Living rooms	35	45
Kitchens and service areas	45	55
Bathrooms and toilets	40	55
Bedrooms	30	40

5.3.1.2 *Clause 4.2 – Typical noise in various districts*

This section covers typical rating levels ($L_{Req,T}$) for ambient noise in different districts in Table 2 (duplicated in **Table 5-2**). This standard recommends that these values not be exceeded, and outdoor ambient noise exceeding these levels will be considered to be annoying to the community. The levels may be used as a guide for zoning purposes and assumes that a building with natural ventilation and open windows will provide sound insulation of about 10 dBA, with the rating levels considering Table 1 rating levels. This standard highlight in note 1 that, where occupancies have to be allowed within areas where

the acceptable outdoor values are exceeded for the particular type of occupancy, the sound insulation of the building housing the occupancy should be proven to comply to the indoor levels defined in Table 1 (see example for residential use in **Table 5-1**) of this standard.

Table 5-2: Acceptable Zone Sound Levels for noise in districts (Table 2 - 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 $L_{R,dn}$	Daytime $L_{Req,d}$	Night-time $L_{Req,n}$	Day/night $L_{R,dn}$	Daytime $L_{Req,d}$	Night-time $L_{Req,n}$
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

It must be noted that SANS 10103:2008 does stipulate "for industries legitimately operating in an industrial district during the entire 24 h day/night cycle, $L_{Req,d} = L_{Req,n} = 70$ dBA can be considered as typical and normal".

5.3.1.3 Clause 4.5 – Assessment of annoyance

This section recommends investigation only when the rating level ($L_{Req,T}$) of the ambient noise exceeds the rating level ($L_{Req,T}$) of the residual noise (ambient sound levels) at the same location during the relevant time period. The ambient indoor or outdoor sound level should be compared with the appropriate level given in Table 1 (see 5.3.1.1) or Table 2 (see 5.3.1.2). This standard state that it is probable that the noise is annoying or otherwise intrusive to the community or to a group of persons if the rating level of the ambient noise under investigation exceeds the applicable of the following:

- the rating level of the residual noise (determined in the absence of the specific noise under investigation);
- the maximum rating level for the ambient noise given in table 1 (see example for residential use in **Table 5-1**); or
- the typical rating level for the ambient noise for the applicable environment given in table 2 (duplicated in **Table 5-2**). The probable community or group response to the excess ($\Delta L_{Req,T}$) is given in **Figure 5-1**.

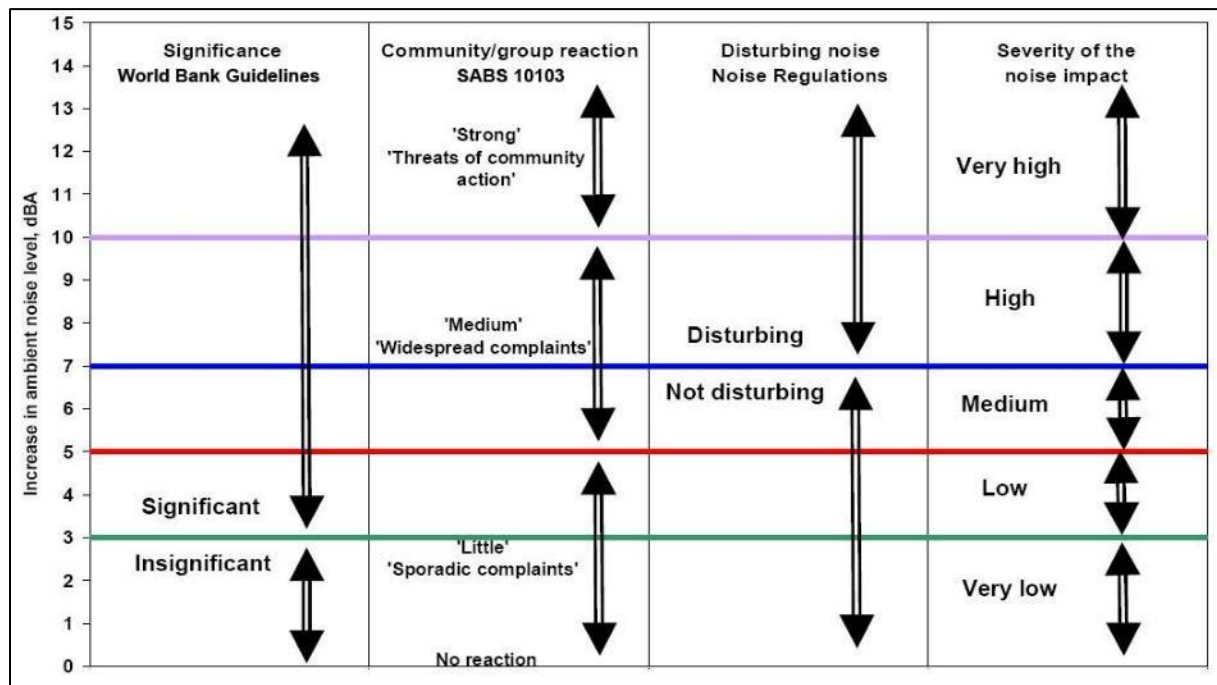


Figure 5-1: Criteria to assess the significance of impacts stemming from noise

5.3.2 SANS 10328:2008

SANS 10328 provide methods for environmental noise impact assessment, with relevant regulations (see **section 5.1.1**) and GNR320 (see **sections 4.6.1** and the checklist in **section 2**) stipulating that this standard be followed when doing a noise specialist study.

SANS 10328 recommends that the procedures given in clause 6 to clause 8 (inclusive) be followed if:

- an application, in respect of any activities identified in terms of the current relevant legislation are proposed, if noise sources listed in clauses 3.17 and 3.18 (of of SANS 10328) are to be developed, or the issues listed in clause 5 (of SANS 10328) may take place, is made to the relevant authority;
- an application for a noise-sensitive development (see 3.16 of SANS 10328) is made to the relevant authority;
- an application for a change in land use is made to the relevant authority; or
- an environmental noise impact investigation is requested by an applicant or any interested or affected party.

The minimum contents of the noise specialist study are also included in **section 4.6.2** of this report.

5.4 INTERNATIONAL GUIDELINES

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

5.4.1 Guidelines for Community Noise (WHO, 1999)

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

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

- Interference with communication, noise-induced hearing impairment, sleep disturbance effects, cardiovascular and psychophysiological effects, mental health effects, effects on performance, annoyance responses and effects on social behavior.

It further discusses how noise can affect (and propose guideline noise levels) specific environments such as residential dwellings, schools, preschools, hospitals, ceremonies, festivals and entertainment events, sounds through headphones, impulsive sounds from toys, fireworks and firearms, and parklands and conservation areas.

To protect the majority of people from being affected by noise during the daytime, it proposes that sound levels at outdoor living areas should not exceed 55 dB L_{Aeq} for a steady, continuous noise. To protect the majority of people from being moderately annoyed during the day, the outdoor sound pressure level should not exceed 50 dB L_{Aeq} . At night, equivalent sound levels at the outside façades of the living spaces should not exceed 45 dBA and 60 dBA L_{Amax} so that people may sleep with bedroom windows open. It is critical to note that this guideline requires the sound level measuring instrument to be set on the "fast" detection setting.

5.4.2 European Parliament Directive 2000/14/EC (2000)

Directive 2000/14/EC relating to the noise emission in the environment by equipment for use outdoors was adopted by the European Parliament and the Council and first published in May 2000 and applied from 3 January 2002. The directive placed sound power limits on equipment to be used outdoors in a suburban or urban setting. Failure to comply with these

regulations may result in products being prohibited from being placed on the EU market. Equipment list is vast and includes machinery such as compaction machineries, dozers, dumpers, excavators, etc. Manufacturers as a result started to consider noise emission levels from their products to ensure that their equipment will continue to have a market in most countries.

5.4.3 Equator Principles (2003)

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 EPs were developed by private sector banks and were launched in June 2003. The banks chose to model the EPs on the environmental standards of the World Bank and the social policies of the International Finance Corporation (IFC). As of March 2021, one hundred and sixteen (116) financial institutions (in 37 different countries) have adopted the EPs, 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 IFC Environmental, Health and Safety (EHS) Guidelines – focusing on governing project financial risks for international lenders.

5.4.4 IFC: General EHS Guidelines – Environmental Noise Management (2007)

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

It states that noise prevention and mitigation measures should be applied where predicted or measured noise impacts from project facilities/operations exceed the applicable noise level guideline at the most sensitive point of reception. The preferred method for controlling noise from stationary sources is to implement noise control measures at source. It goes as far as to propose methods for the prevention and control of noise emissions, including:

- Selecting equipment with lower sound power levels;
- Installing silencers for fans;
- Installing suitable mufflers on engine exhausts and compressor components;
- Installing acoustic enclosures for equipment casing radiating noise;
- Improving the acoustic performance of constructed buildings, apply sound insulation;

- Installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m² in order to minimise the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective;
- Installing vibration isolation for mechanical equipment;
- Limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas;
- Re-locating noise sources to less sensitive areas to take advantage of distance and shielding;
- Placement of permanent facilities away from community areas if possible;
- Taking advantage of the natural topography as a noise buffer during facility design;
- Reducing project traffic routing through community areas wherever possible;
- Planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas; and
- Developing a mechanism to record and respond to complaints.

It sets noise level guidelines (see **Table 5-3**) and highlights 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. Therefore, it is EARES's 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 5-3: 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 in Europe.

5.4.5 Night Noise Guidelines for Europe (WHO, 2009)

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

average of 40 dB to avoid sleep disturbance and its related health effects. The report notes that only below 30 dB (outside annual average) are “*no significant biological effects observed,*” and that between 30 and 40 dB, 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 40 dB “*Adverse health effects are observed*” and “*many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected.*”

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

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

5.4.6 Environmental Noise Guidelines for the European Region (WHO, 2018)

This document identifies levels at which noise has significant health impacts and recommends actions to reduce exposure. Compared to previous WHO guidelines on noise, this version contains five significant developments:

- Stronger evidence of the cardiovascular and metabolic effects of environmental noise;
- Inclusion of new noise sources, namely wind turbine noise and leisure noise, in addition to noise from transportation (aircraft, rail, and road traffic);
- Use of a standardized approach to assess the evidence;
- A systematic review of evidence, defining the relationship between noise exposure and risk of adverse health outcomes;
- Use of long-term average noise exposure indicators to better predict adverse health outcomes.

6 RECEIVING ENVIRONMENT

6.1 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 (or a listener) 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 higher wind speeds may have an insignificant 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 is more significant during the warmer spring and summer months as various species communicate in an effort to find mates. Faunal communication is normally less during the colder months, with ambient sound levels measured during the winter period frequently being very low.
- The occurrence of temperature inversions, see **Sub Section 6.1.1**, and
- Seasonal changes in weather patterns, mainly due to increased wind speeds (also see **Sub Section 6.1.2 6.1.1** below) and potential gustiness of the wind.

For environmental noise, weather plays an important role. The greater the separation distance, the greater the influence of the weather conditions, so, from day to day, a road 1,000 m away can sound very loud or can be completely inaudible. Other, environmental factors that impact on sound propagation includes wind, temperature and humidity, as discussed in the sub-sections below.

Ambient sound levels are generally less during the colder months (due to less faunal communication) and higher during the warmer months.

6.1.1 Effect of Temperature inversions

On a typical sunny afternoon, the air is the hottest near the ground surface 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, but, during certain meteorological conditions, the normal vertical temperature gradient could be inverted so that the air is colder near the surface, with a warmer layer blanketing the lower layer. This is illustrated in **Figure 6-1** below.

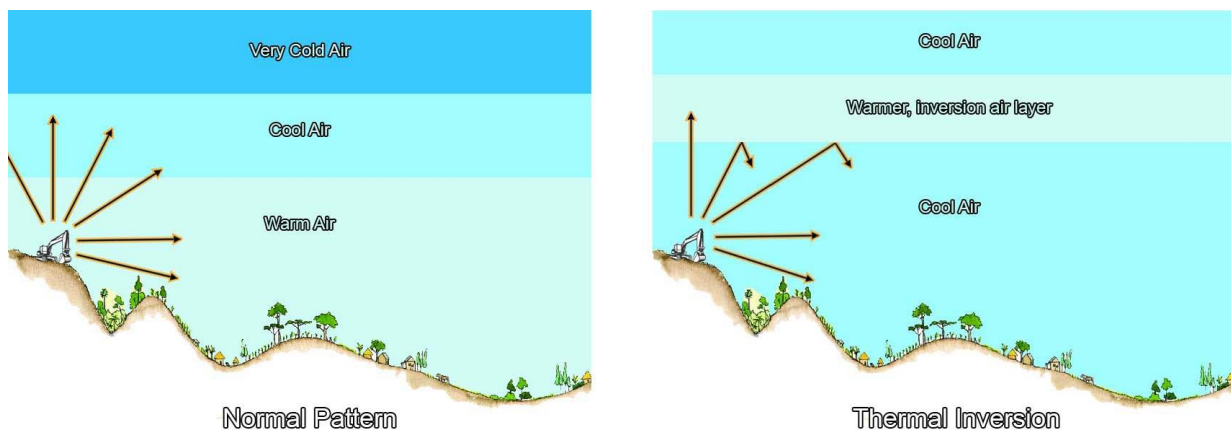


Figure 6-1: Influence of temperature inversions on the propagation of sound

When such an inversion layer is present, some of the sound waves will be refracted³ by the temperature gradient, with the refracted sound waves returned to the ground. This effect has been noticed near airports and roads, where noises can be heard over greater distances at night than other times of day (Parnell, 2015; Saurenman, 2005; Van der Berg, 2003) for various industries.

Like wind gradients, temperature gradients can influence sound propagation over long distances, complicate sound level measurements as well as propagation modelling.

6.1.2 Effect of Wind

Wind alters sound propagation by the mechanism of refraction, that is, wind bends sound waves. Wind nearer to the ground moves more slowly than wind at higher altitudes, due to surface characteristics such as hills, trees, and man-made structures that interfere with the wind. This wind gradient, with faster wind at higher elevation and slower wind at lower elevation, causes sound waves to bend downward when they are traveling to a location downwind of the source and to bend upward when traveling toward a location upwind of the

³ Redirecting the wave propagation direction due to a change in the density of the air which influence the speed of sound.

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 5 m/s.

Wind speed frequently plays a role in increasing sound levels in natural locations. With no wind, there is little vegetation movement that could generate noises and faunal noises (normally birds and insects) dominate, 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 speed 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 unanticipated consequences, as suitable vegetation may create suitable habitats and food sources attracting birds and insects (and the subsequent increase in faunal communication).

6.1.3 Effect of Humidity and Temperature

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 could increase the sound level at a listener 600 m away by ± 2.5 dB (at 1,000 Hz).

The effect of humidity on sound propagation is quite complex, but effectively relates to how increased humidity changes the density of air. Lower density translates into faster sound wave travel, so sound waves travel faster at high humidity⁴. 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 at 20°C).

Together, the impact of temperature and humidity (together with air pressure - to a minor extent) are complex and highly dependent on the frequency composition of the noise. This is illustrated in **Figure 6-2**.

⁴ The addition of water vapor to air (making the air more humid) **reduces the density of the air**. This occurs because the molar mass of water vapor (18 g/mol) is less than the molar mass of dry air (around 29 g/mol).

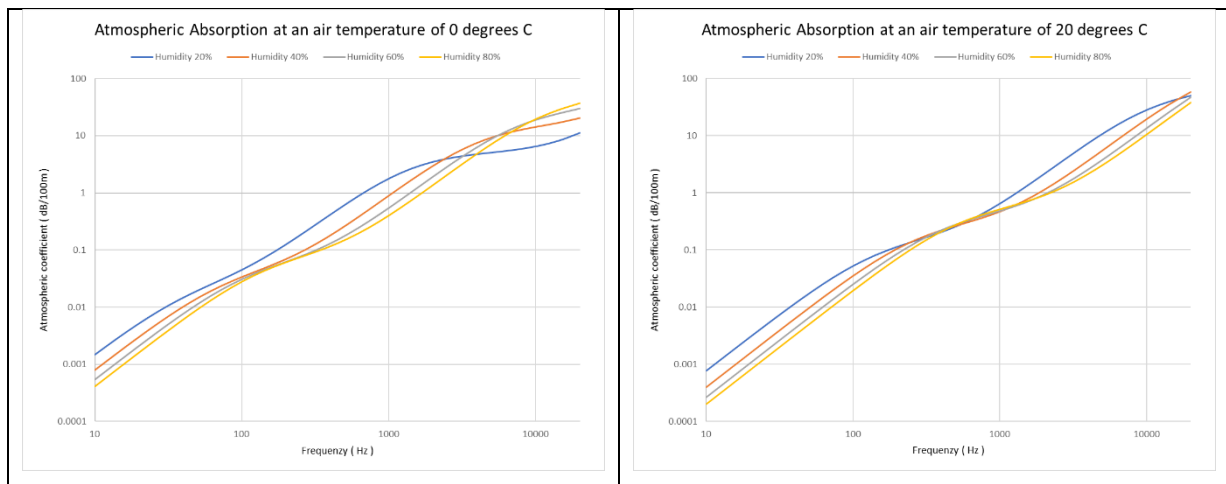


Figure 6-2: Effect of Temperature and Humidity on propagation of Sound

6.2 TEMPERATURE AND HUMIDITY MEASUREMENTS

Average, maximum and minimum readings as measured from 19 - 23 November 2025 are defined in **Table 6-1** and the data illustrated in **Figure 6-3**. For the purpose of modelling, average humidity of 70% and temperatures of 10°C at an air pressure of 900 kPa will be used (which would allow the calculation of potential worst case noise rating levels).

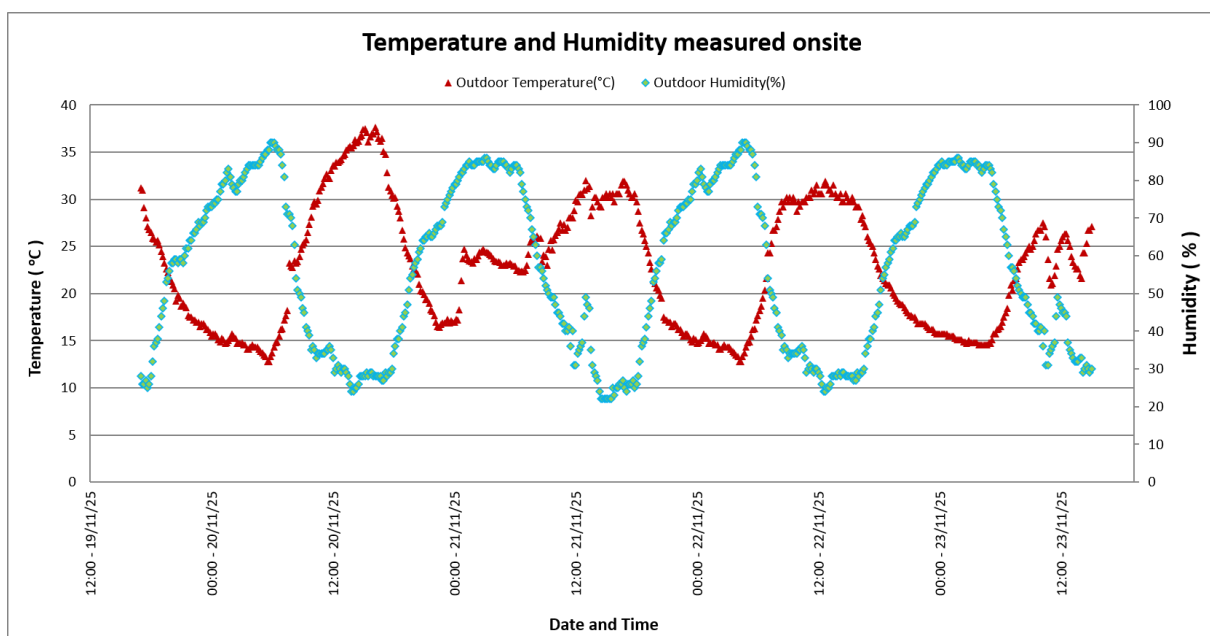


Figure 6-3: Humidity and temperature as measured onsite

Table 6-1: Temperature and Humidity measured onsite

	Humidity	Temperature
Day average	44.1	26.1
Night average	80.9	16.7
Day minimum	22.0	14.3
Day maximum	90.0	37.6
Night minimum	66.0	12.8
Night maximum	90.0	24.7

6.3 AMBIENT SOUND LEVEL MEASUREMENTS

Ambient (background) sound levels were measured over a period of four nights from 19 – 23 November 2025 at three locations considering the prescribed procedures of GNR320 of 2020, considering SANS 10103:2008 "***The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication***".

This data is sufficient, as it illustrates the rural nature of the area, with similar ambient sound levels expected at other locations away from roads, animal enclosures (including chicken coups, pigstys and cattle corral/kraal(s)). Additional measurement locations, as well as measurements over a longer period will not provide more information.

The sound measurement locations are illustrated in **Figure 6-4** as blue squares. Measurements were mainly unattended semi-continuous long-term measurements over a two-night period, where the instrument will measure the sound level for a period of 10 minutes, save the data and immediately start with a new measurement. Sound levels were measured using the equipment defined in **Table 6-2**.

Table 6-2: Equipment used to measure ambient sound levels

Equipment	Model	Serial no	Calibration Date
<u>Measurement Location EVLTSL01</u>			
Sound Level Meter	Rion NL-53	00251788	February 2025
Pre-amplifier	NH-25	44843	February 2025
Microphone	UC-59	27095	February 2025
Calibrator	Quest CA-22	J 2080094	July 2025
<u>Measurement Location EVLTSL02</u>			
Sound Level Meter	Rion NL-62	00511783	October 2024
Pre-amplifier	NH-26	11981	October 2024
Microphone	UC-59L	02249	October 2024
Calibrator	Quest CA-22	J 2080094	July 2025
<u>Measurement Location EVLTSL03</u>			
Sound Level Meter	Rion NL-62	00511791	October 2024
Pre-amplifier	NH-26	11989	October 2024
Microphone	UC-59L	02257	October 2024
Calibrator	Quest CA-22	J 2080094	July 2025

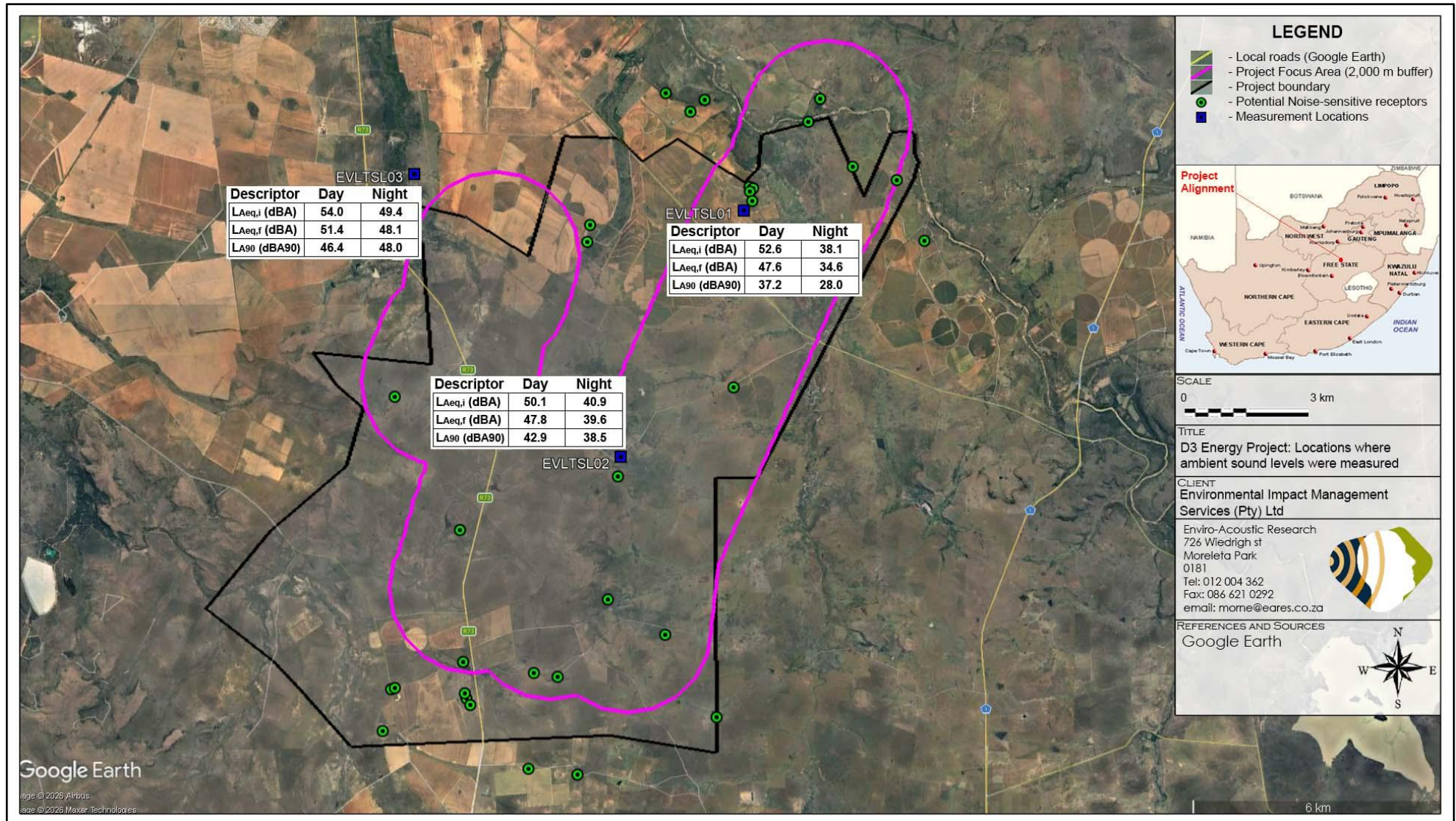


Figure 6-4: Localities where ambient sound levels were measured

6.3.1 Ambient Sound Level Measurement Location – EVLTSL01

The instrument was deployed between the residential house and the property fence, with the microphone deployed under a number of trees. Sounds from birds and insects were generally constant and the dominant noise source in the area, with sounds from voices (in the house audible at times). The trees near the measurement location could increase ambient sound levels during periods with increased winds. Photos of the measurement location are presented in [Appendix B.1](#). Spectral data confirmed that faunal noises were significant early mornings and most of the day.

Impulse time-weighted equivalent sound levels $L_{Aeq,10min}$ and fast time-weighted equivalent sound levels $L_{AFeq,10min}$ are presented in **Figure 6-5** and summarised in **Table 6-3** below. The impulse time-weighted sound descriptor is mainly used in South Africa to define sound and noise levels with 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.

The maximum (L_{Amax}), minimum (L_{Amin}) and 90th percentile (L_{A90}) statistical values are illustrated in **Figure 6-6**. The L_{A90} level is presented in this report 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 average sound level. The L_{A90} level is typical as expected for a rural noise district.

Table 6-3: Sound levels considering various sound level descriptors at EVLTSL01

	$L_{Amax,i}$ (dBA)	$L_{Aeq,i}$ (dBA)	$L_{Aeq,f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{Amin,f}$ (dBA)
Day arithmetic average	-	52.6	47.6	37.2	-
Night arithmetic average	-	38.1	34.6	28.0	-
Day equivalent	-	61.2	56.5	-	-
Night equivalent	-	52.3	46.5	-	-
Day minimum	-	28.5	26.9	-	22.1
Day maximum	96.8	76.2	74.4	-	-
Night minimum	-	26.5	24.5	-	17.9
Night maximum	74.5	65.7	59.9	-	-

The numerous 10-minute measurements are further classified for the day- and night-time periods in terms of the SANS 10103:2008 typical noise district areas in **Figure 6-7** (night) and **Figure 6-8** (day).

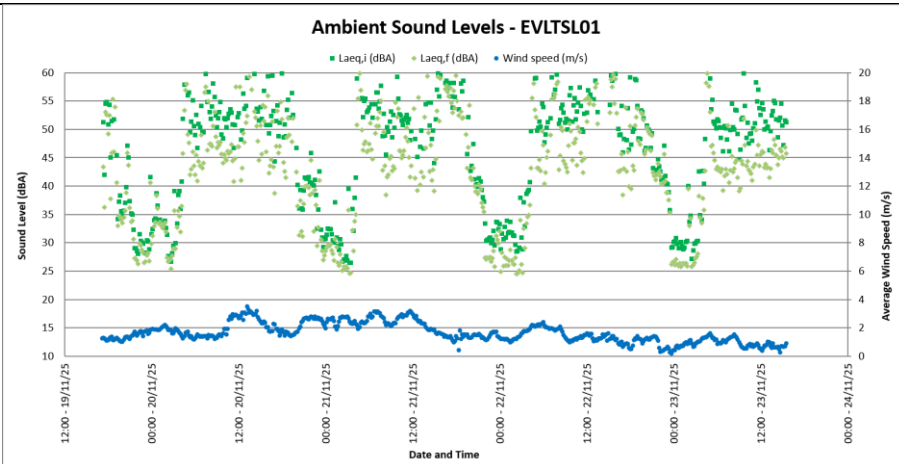


Figure 6-5: Ambient Sound Levels at EVLTSL01

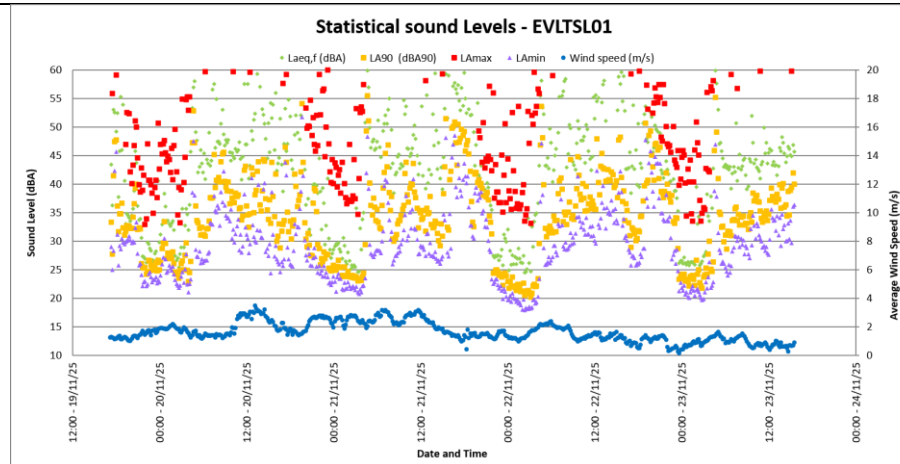


Figure 6-6: Maximum, minimum and Statistical sound levels at EVLTSL01

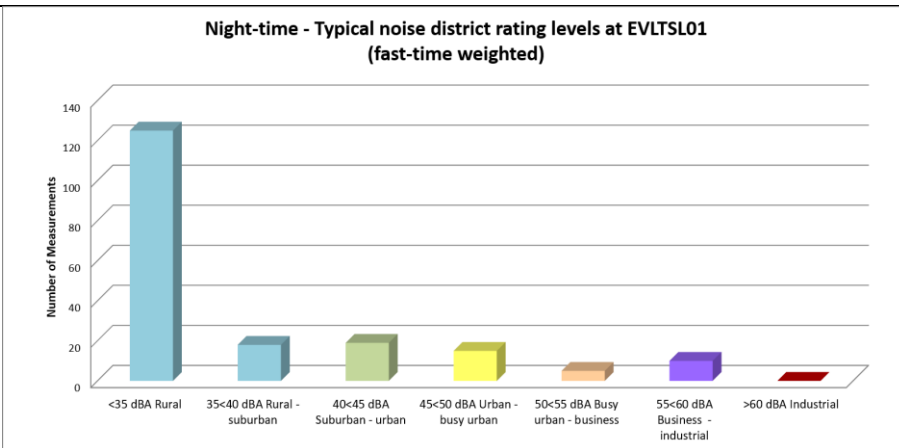


Figure 6-7: Classification of night-time measurements in typical noise districts at EVLTSL01

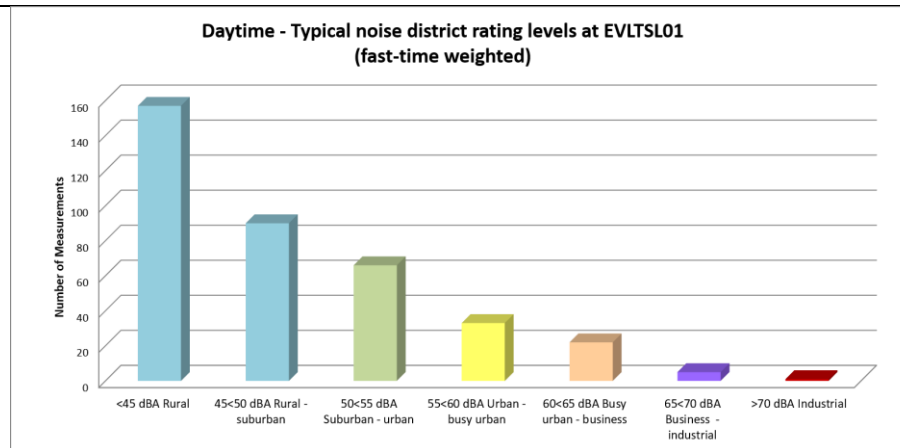


Figure 6-8: Classification of daytime measurements in typical noise districts at EVLTSL01

6.3.2 Ambient Sound Level Measurement Location - EVLTSL02

The microphone was deployed near the common area (bar, relaxation, restaurant) of the Bloemskraal Guestfarm. As a result, this data may at time reflect voices of the guests of the guesthouse. During the times onsite, ambient sound levels were dominated by faunal noises, mainly birds and crickets, though voices were clearly audible at times. Photos of the measurement location are presented in [Appendix B.3](#). Spectral data confirm that insect noises were significant at night, with various noises impacting on the soundscape during the day.

Impulse time-weighted equivalent sound levels $L_{Aeq,10min}$ and fast time-weighted equivalent sound levels $L_{AFeq,10min}$ are presented in **Figure 6-9** and summarised in **Table 6-4** below. The maximum (L_{Amax}), minimum (L_{Amin}) and 90th percentile (L_{A90}) statistical values are illustrated in **Figure 6-10**.

The L_{A90} levels were higher than expected from a rural noise district, with spectral data indicating that faunal noises were the main source of noise.

Table 6-4: Sound level descriptors as measured at EVLTSL02

	$L_{Amax,i}$ (dBA)	$L_{Aeq,i}$ (dBA)	$L_{Aeq,f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{Amin,f}$ (dBA)
Day arithmetic average	-	50.1	47.8	42.9	-
Night arithmetic average	-	40.9	39.6	38.5	-
Day equivalent	-	66.0	64.2	-	-
Night equivalent	-	45.3	43.1	-	-
Day minimum	-	33.9	33.3	-	28.2
Day maximum	97.5	90.2	88.5	-	-
Night minimum	-	30.0	29.9	-	24.1
Night maximum	78.0	58.0	54.2	-	-

The numerous 10-minute measurements are further classified for the day- and night-time periods in terms of the SANS 10103:2008 typical noise district areas in **Figure 6-11** (night) and **Figure 6-12** (day).

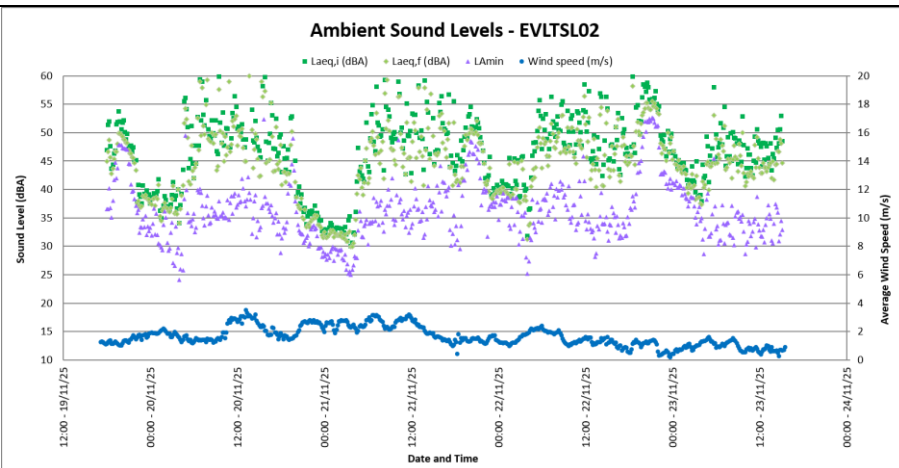


Figure 6-9: Ambient sound levels at EVLTSLO2

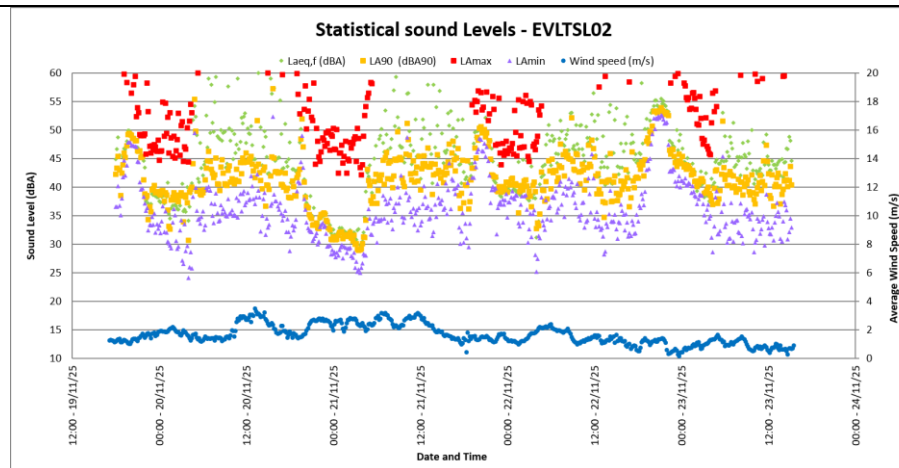


Figure 6-10: Maximum, minimum and statistical values at EVLTSLO2

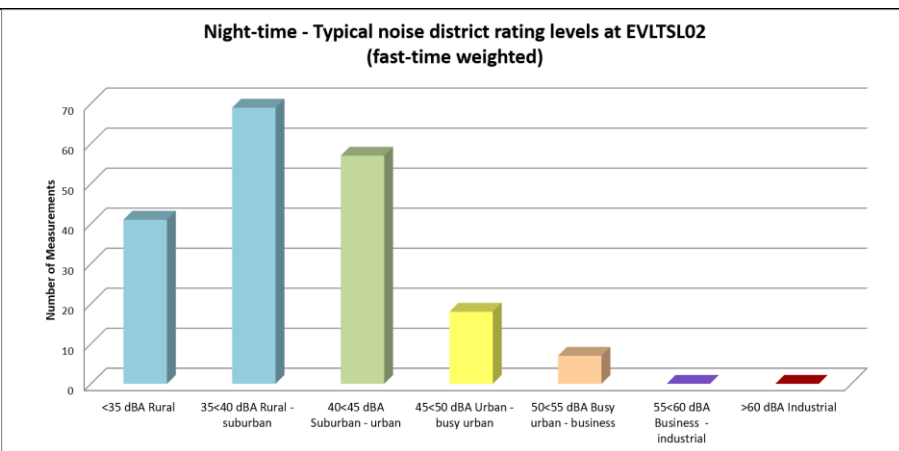


Figure 6-11: Classification of night-time measurements in typical noise districts at EVLTSLO2

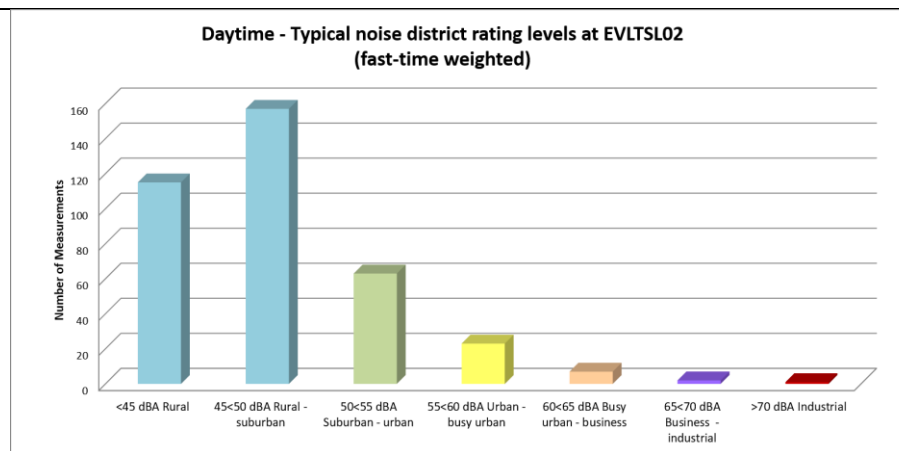


Figure 6-12: Classification of daytime measurements in typical noise districts at EVLTSLO2

6.3.3 Ambient Sound Level Measurement Location - EVLTSL03

The microphone was deployed in a vegetable garden on the edge of the property. Bird and insect noises were generally dominant when the instrument was deployed and collected. Voices of farm workers were audible during deployment. Photos of the measurement location are presented in [Appendix B.2](#). There were a noise that significantly impacted on the measurement, elevating the ambient sound levels and the data will not be used in this assessment.

Impulse time-weighted equivalent sound levels $L_{A_{eq},10min}$ and fast time-weighted equivalent sound levels $L_{A_{eq},10min}$ are presented in **Figure 6-13** and summarised in **Table 6-5** below. The maximum ($L_{A_{max}}$), minimum ($L_{A_{min}}$) and 90th percentile (L_{A90}) statistical values are illustrated in **Figure 6-14**.

The L_{A90} levels were must higher than expected from a rural noise district, with spectral data indicating significant faunal noises during the day (significant acoustic energy in the 500 – 800 Hz & 2,000 – 6,300 Hz range). A noise source with significant acoustic energy at 1,000 Hz also impacted on evening and night-time noises. The source(s) of this noise are undefined.

Table 6-5: Sound level descriptors as measured at EVLTSL03

	$L_{A_{max},i}$ (dBA)	$L_{A_{eq},i}$ (dBA)	$L_{A_{eq},f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{A_{min},f}$ (dBA)
Day arithmetic average	-	54.0	51.4	46.4	-
Night arithmetic average	-	49.4	48.1	48.0	-
Day equivalent	-	57.5	54.6	-	-
Night equivalent	-	51.9	52.2	-	-
Day minimum	-	40.8	36.3	-	29.7
Day maximum	94.1	72.4	68.7	-	-
Night minimum	-	34.0	33.6	-	28.2
Night maximum	81.8	61.3	58.4	-	-

The numerous 10-minute measurements are further classified for the day- and night-time periods in terms of the SANS 10103:2008 typical noise district areas in **Figure 6-15** (night) and **Figure 6-16** (day).

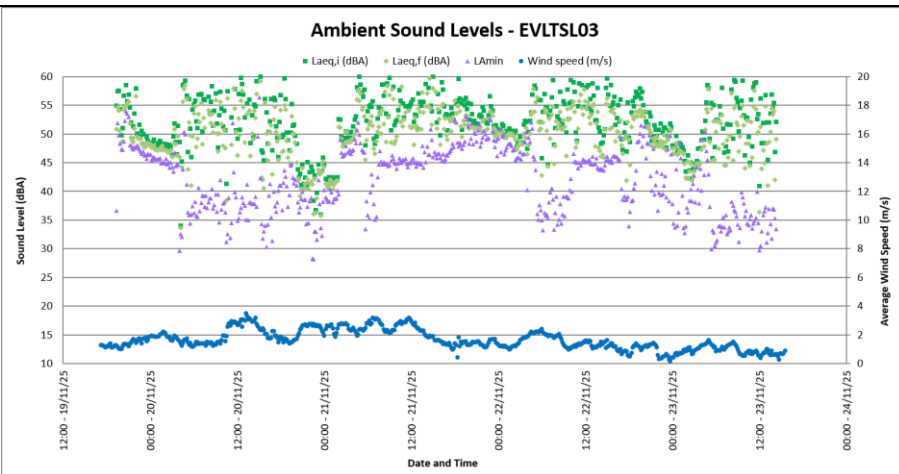


Figure 6-13: Ambient sound levels at EVLTSLO3

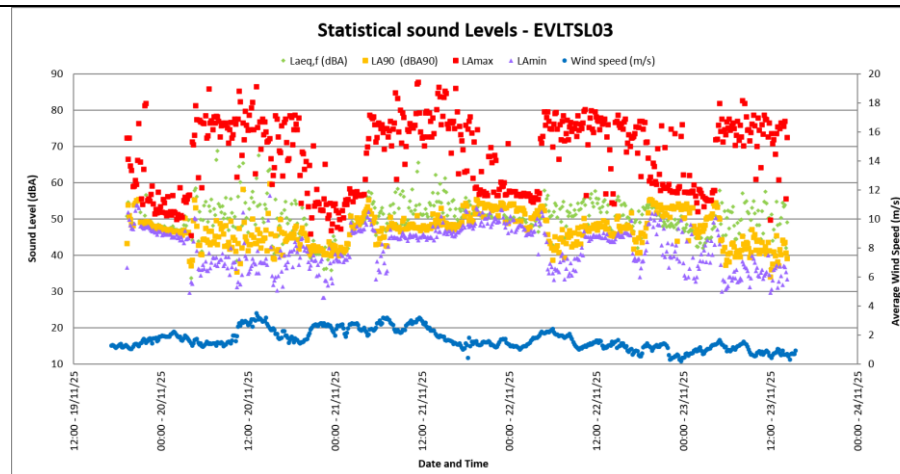


Figure 6-14: Maximum, minimum and statistical values at EVLTSLO3

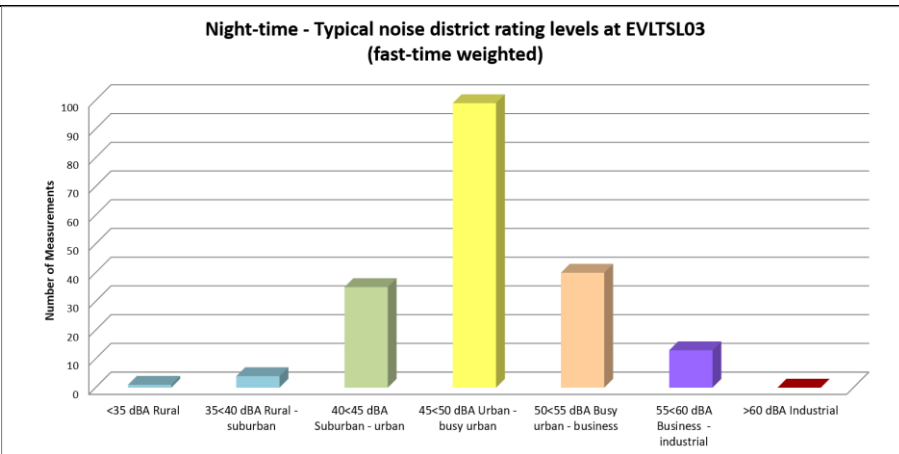


Figure 6-15: Classification of night-time measurements in typical noise districts at EVLTSLO3

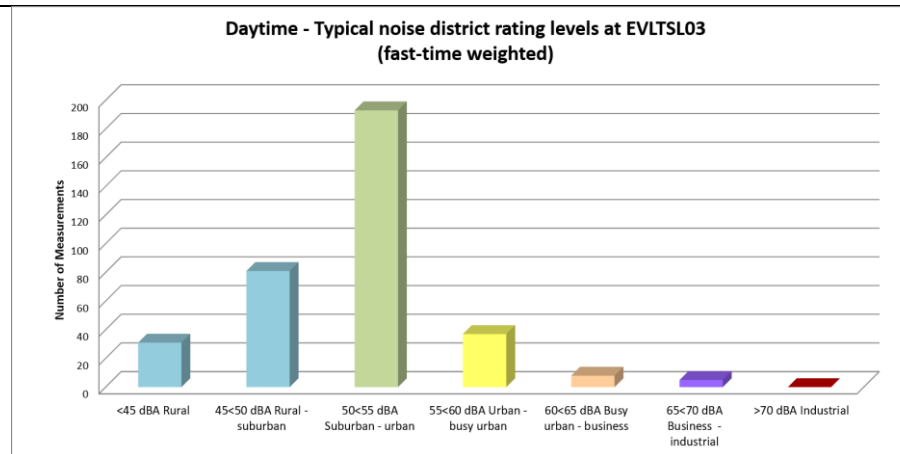


Figure 6-16: Classification of daytime measurements in typical noise districts at EVLTSLO3

6.4 AMBIENT SOUND LEVELS – FINDINGS AND SUMMARY

The measurements done from 19 – 23 November 2025 resulted in more than 1,000 daytime, and 500 night-time measurements. When removing measurements collected at the third measurement location, there are still more than 700 day-, and 350 night-time measurements. Each measurement was collected over a 10-minute period and included a number of sound level descriptors, including; equivalent values, minimum and maximum levels, statistical sound levels as well as spectral information. Confidence levels in the resulting data are high and it is expected that the ambient sound level data would be applicable of other locations in the area (away from any roads).

Considering the average fast-weighted sound level data collected in the area, average:

- daytime fast-weighted sound levels ranged from 27 to more than 88 dBA, with average sound levels being 47.7 dBA. This is typical of a rural to suburban noise district, setting a zone sound level of 45 dBA for the daytime period; and
- night-time fast-weighted sound levels ranged from 24 to 60 dBA, with average sound levels being 37.1 dBA. This is typical of a rural to suburban noise district, setting a zone sound level of 35 dBA for the night-time period.

Considering the requirements of the PNCR (see **section 5.1.1**), activities relating to the proposed project should not change the existing ambient sound levels with more than 5 dBA, nor exceed the WHO and IFC noise limits (see **section 5.4.4**). Recommended upper noise limits therefore would be:

- 52 dBA (less than 5 dBA from the average ambient sound levels measured in the area) for the daytime residential use; and
- 42 dBA (less than 5 dBA from the average ambient sound levels measured in the area) for night-time residential use.

If zoned as an industrial site, the project should also limit the noise level to less than 70 dBA during the daytime period and 60 dBA at night at the boundary (for the area zoned industrial).

7 POTENTIAL NOISE SOURCES

Increased noise levels are directly linked with the various activities associated with exploration, construction and operational phases. Noises emitted by the exploration, 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, the “whine” of an electrical pump, etc.) and noises from vehicles moving around. It should be noted that there may not be a clear distinction between construction and operational activities in terms of noise.

As such this noise impact assessment considers conceptual scenarios to estimate the potential impact of noise on the surrounding NSR and the scenarios should not be seen as a reflection of a project schedule or the specific noise levels at receptors at any specific time. While actual activities and average traffic may be significantly less, this assessment considers potential worst-case scenarios as per the precautionary principle.

This assessment will focus on two potential scenarios, namely:

- Future construction phase, with various noise-generating activities conceptualized to illustrate a potential construction scenario. Both a day- and night-time scenario will be investigated, with equipment operating on ground level (no berms between activities and NSR), with various equipment operating simultaneously (worst-case scenario). This scenario also include borehole drilling as well as vibroseis activities, even though these activities may extent into the operational phase, with activities such as vibroseis exploration starting before the construction activities start. This is a worst-case scenario, and may slightly overmodel noise levels with 1 - 5 dBA; and
- Future noise-generating activities associated with the potential operational phase of the project. Both a day- and night-time scenario will be investigated, considering a worst-case scenario (with power provided by an onsite generator). This is a worst-case scenario, and likely overmodel noise levels with 1 – 5 dBA.

7.1 POTENTIAL EXPLORATION AND CONSTRUCTION NOISE-GENERATING ACTIVITIES

The level and character of the exploration and 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.

The potential extent and impact of construction noises depend on a number of factors, including the prevailing ambient sound levels during the instance the maximum noise event occurred, as well as the spectral character of the noise and the surrounding soundscape.

Potential maximum noise levels generated by construction equipment and/or activities, as well as the potential extent are presented in **Table 7-1**. 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 7-2**.

A list of construction equipment and/or activities that was used for the modelling are defined in **Table 7-3**. Due to the various activities that may take place at different locations, this assessment will use the sound power level (PWL) of potential noise generating activities and equipment taking place at numerous locations to assess a potential worst-case scenario.

A description of the various construction noise sources and activities are also discussed in the following subsections. It should be noted that while some of these activities may take place in isolation, there are typically a number of activities that would take place simultaneously, and noise is generally the cumulative effect from multiple activities taking place in the area.

Table 7-1: Potential maximum noise levels generated by construction equipment

Equipment Description ⁵	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
Bulldozer	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
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
Gas flare (safety)	No	131.0	106.0	100.0	94.0	86.0	80.0	76.5	74.0	70.5	66.0	62.5	60.0	54.0
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
Pile Driver - Impact	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
Mounted Impact Hammer	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
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

⁵Equipment list and Sound Power Level source: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

Table 7-2: Potential equivalent noise levels generated by various equipment

Equipment Description	PWL (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
Compressor - Main gas	106.8	81.8	75.8	69.8	61.8	55.8	52.3	49.8	46.3	41.8	38.3	35.8	29.8
Drilling - Percussion	120.8	95.8	89.8	83.8	75.8	69.8	66.3	63.8	60.3	55.8	52.3	49.8	43.8
Fans - Air cooled condensers	100.5	75.5	69.5	63.5	55.5	49.5	46.0	43.5	40.0	35.5	32.0	29.5	23.5
General Noise	108.8	83.8	77.8	71.8	63.8	57.8	54.3	51.8	48.3	43.8	40.3	37.8	31.8
Generator - 3 MW G2P	95	70.0	64.0	58.0	50.0	44.0	40.5	38.0	34.5	30.0	26.5	24.0	18.0
Pumps and Valves – Gas	104	79.0	73.0	67.0	59.0	53.0	49.5	47.0	43.5	39.0	35.5	33.0	27.0
Trencher - Tracked	107.1	82.1	76.1	70.1	62.1	56.1	52.6	50.1	46.6	42.1	38.6	36.1	30.1
Vibroiseis Truck	109.5	84.5	78.5	72.5	64.5	58.5	55.0	52.5	49.0	44.5	41.0	38.5	32.5

Table 7-3: Sound power emission levels used for modelling

Equipment	Sound power level, dB re1 pW, in octave band, Hz							PWL (dBA)
Process	63	125	250	500	1000	2000	4000	
Point noise sources (dBA re 1 pW)								
Compressor - Main gas	77.8	89.9	94.4	101.8	102	100.2	94	106.8
Drilling	95.4	107.2	109.7	112.1	114.2	115.1	112.3	120.8
Fans - Air cooled condensers	79.8	87.9	92.4	94.8	95	93.2	87	100.5
General Noise	68.8	83.9	94.4	101.8	105	101.2	101	108.8
Generator - 3 MW G2P	73.4	81.5	85	88.4	89.6	88.8	84.6	95
Pumps and Valves - Gas	67.8	79.9	89.4	97.8	100	98.2	92	104
Trencher - Tracked	81.8	92.9	96.4	100.8	102	101.2	96	107.1
Vibroiseis Truck	91.8	98.9	101.4	102.8	104	102.2	97	109.5
Area noise sources (dBA/m ² re 1 pW)								
General Noise (medium-intensity)	95.0	100.0	103.0	105.0	105.0	100.0	100.0	65.0

7.1.1 Exploration Activities

Typical noise-generating activities associated with onshore exploration for hydrocarbons and associated gas include vibroseis truck sweeping, exploratory well drilling, diesel power generation and heavy construction equipment. High noise-generating activities are:

- Road trucks: The transport of various equipment and material to the project area;
- Vibroseis (Thumper) Truck: A heavy, specialized truck with a large diesel engine that drop a large hydraulic pad onto the ground. The pad vibrates to push a low-frequency acoustic sweep into the earth for around 8 – 20 seconds, creating a loud, localized mechanical hum. This sweep normally repeats this sweep a number of times at the same location, before moving a few meters away to start again. Depending on the terrain and geology, a vibroseis truck can cover 500 – 1,500m per hour;
- Geophone Deployment Vehicles: Minor noises generated by light delivery vehicles (LDV) to lay out and retrieve ground microphones (geophones);
- Drilling activities: Consisting of a diesel engine to power the mechanical top drive that rotates the drill string, one or more mud circulation pumps and a large air compressor. Drilling can take a week or two at one location before moving to a next location.
- Power generation: A drilling site may also require a power generator to power lights and other ancillary equipment;
- Pipe Handling: The physical process of lifting, connecting, and lowering heavy steel casing pipes into the wellbore can cause loud impulsive noises due to metal-on-metal impacts; and
- Reverse alarms: Fitted to all mobile equipment, reverse alarms do not generate high noise levels. This noise are however frequently reported as a source of annoyance if audible at nearby receptors, especially when mobile equipment moves around at night.

7.1.2 Construction Activities

Excluding exploration activities, the following are likely the main noise-generating activities during the construction phase:

- Road trucks: The transport of various equipment and material to the project area;
- Graders, bulldozers or tractor-loader-backhoes (TLB): Site preparation activities to clear any vegetation, stripping of soil (and stockpiling), levelling the surface for site infrastructure and developing access roads;
- TLB or excavators: Digging of foundations, trenches and drainage channels;
- Generators: One or more diesel generators to provide electrical power to various equipment and lights;

- Compressors: Required to drive air-powered equipment;
- TLBs, excavators and dump trucks: Excavation, loading and transport of excess material;
- General noises: Civils relating to the construction of the infrastructure and various material handling noises.

7.1.3 Traffic

The potential significant source of noise during the exploration and construction phase are additional traffic to and from the site, as well as traffic on the site.

Construction traffic is expected to be generated throughout the entire construction period, however, the volume and type of traffic generated will be dependent upon the construction activities being conducted, which will vary significantly during the construction period. Noise levels due to traffic were estimated using the methodology stipulated in RLS-90 (Calculating and predicting road traffic noise).

For the purpose of this assessment six (6) each heavy mobile vehicles (HMF) and LDVs per hour are assumed, with the vehicles travelling between the closest provincial road and project areas. All vehicles are travelling at an average speed of 40 km/h (daytime only). It is likely that actual traffic volumes would be less than the assumed traffic volumes or speeds.

7.2 POTENTIAL OPERATIONAL NOISE-GENERATING ACTIVITIES

7.2.1 Plant Activities

The typical noise-generating activities associated with an operational hydrocarbon and helium processing plant include gas to power generation, gas compression, cooling fan operation, and large centrifugal pumping. Unlike the temporary to short-term noises audible during the exploration and construction phase, a processing plant creates a permanent, 24/7 continuous industrial acoustic profile. A list of potential equipment (and activities) that were used for noise modelling are defined in **Table 7-3**, with this assessment considering a potential worst-case scenario (various noise generating activities taking place simultaneously, considering typical PWL of equipment, excluding the potential shielding effect from containerized activities/equipment).

Main noise generating activities are:

- Generators: A generator to provide electrical power to various plant equipment, with noise generated by the reciprocating engine, exhaust noises, air intake and cooling system;

- Compressors (Reciprocating and/or Centrifugal): Machines that compress gas to ultra-high pressures that can generate a continuous, low-frequency noise. Compressors are fitted with industrial electric motors or gas-fired turbines that cumulative add to noise levels;
- Coolers – Fan fin or air-cooled condensers: Normally a bank of fans (and electric motors) containing numerous individual fans that generate mechanical hum and aerodynamic noises;
- Valves: When high-pressure gas passes through a constriction valve, it creates intense aerodynamic turbulence (a continuous rushing sound audible from piping);
- Pumps: Required to move liquid natural gas (LNG), condensed hydrocarbons, and cooling water;
- Plant Logistics: The regular movement of heavy fluid transport trucks, maintenance vehicles, and nitrogen/helium ISO-container trucks introduces localized reverse alarms and heavy diesel engine noise.

As with all noises, 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 a range of equipment and the potential extent of these sounds are presented in **Table 7-1**, with **Table 7-2** illustrating the equivalent (average) noise levels and potential extent.

7.2.2 Traffic

A source of noise during the operational phase will be traffic to and from the plant, traffic around the infrastructure facilities and product transport. While trucks moving around on the site do have a clearly audible noise during passing, the average noise contribution during the day is relatively low compared to the other noise sources.

For the purpose of this assessment 12 heavy mobile vehicles (HMV) and six LDVs per hour are assumed, with the vehicles travelling between the closest provincial road and plant areas. All vehicles are travelling at an average speed of 40 km/h (daytime only). It is likely that actual traffic volumes would be less than the assumed traffic volumes or speeds.

7.3 POTENTIAL NOISE SOURCES: FUTURE NOISE SCENARIO – DECOMMISSIONING

The Decommissioning Phase is considered as the phase which begins when insufficient gas are available to economically continue the processing plant.

Activities that can take place include:

- Decommissioning and rehabilitation of the remaining infrastructure unless it is required for post-project 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.

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 significantly 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 noise levels during decommissioning.

8 METHODS: NOISE IMPACT ASSESSMENT AND SIGNIFICANCE

8.1 NOISE IMPACT ON ANIMALS⁶

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).

Noise impacts on animals may result in:

- causing hearing damage (very loud or loud impulsive sounds);
- increasing 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.

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.

⁶Report to Congressional Requesters, 2005; USEPA, 1971; Autumn, 2007; Noise quest, 2010

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 8-1** below.

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

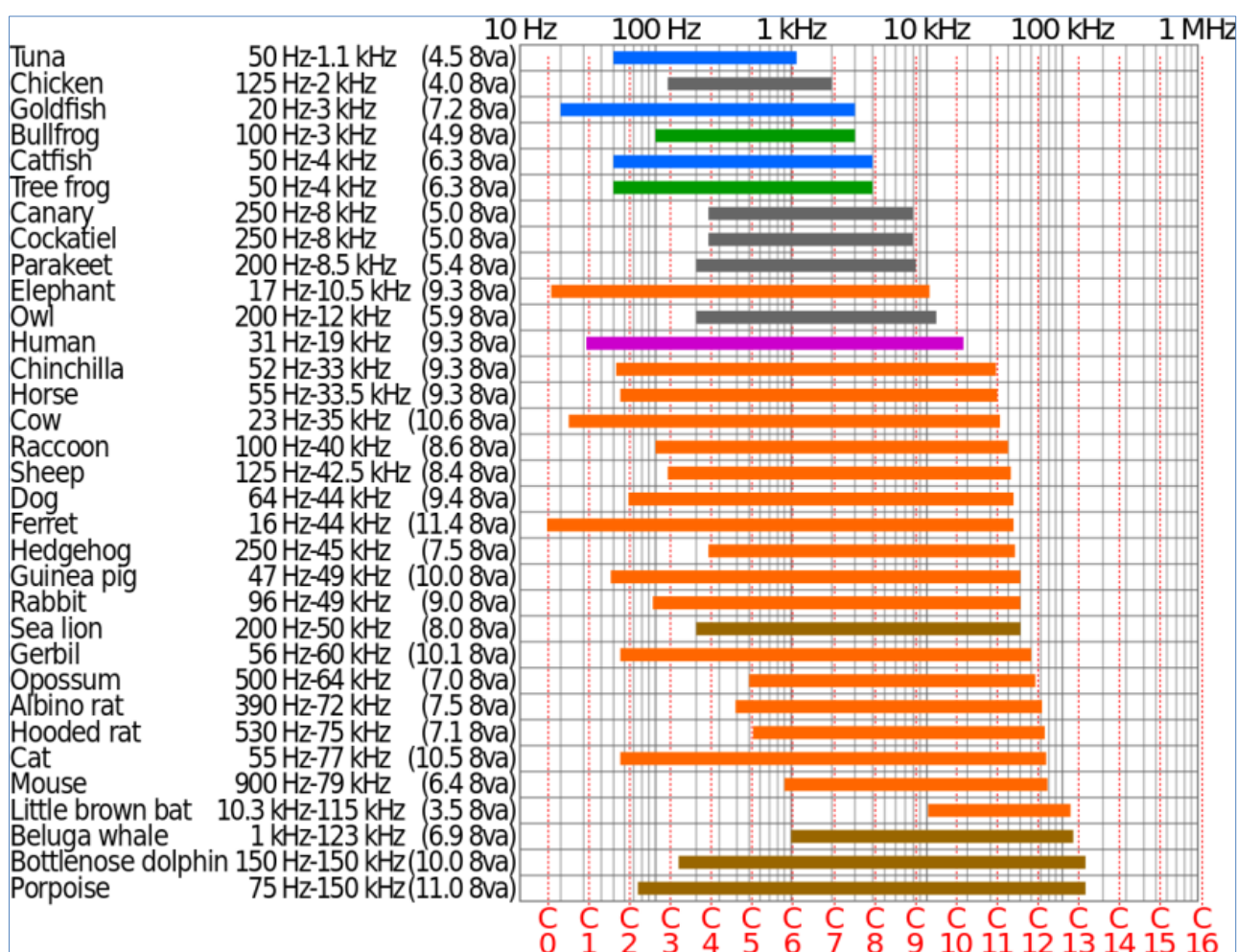


Figure 8-1: Logarithmic Chart of the Hearing Ranges of Some Animals⁷

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

⁷ https://en.wikipedia.org/wiki/Hearing_range

- Animals respond to impulsive (sudden) noises (higher than 90 dBA) by running/flying 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).
- Animals of most species exhibit adaptation to noise (Broucek, 2014), including impulsive noises, by changing their behaviour.
- More sensitive species would relocate to a quieter 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 do 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.

8.1.1 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 still 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)^{8&9}. The high noise levels may see negative influences on animals' cardiovascular systems and behaviour.

According to Šottník, 2011, noise as high as 80 dB had no negative effect on dairy cows. As noise levels increased (up to 105 dB), feed consumption, milk yield and intensity of milk release decreased.

Unexpected high intensity noise (above 110 dB), such as low altitude jet aircraft overflights at milking time could reduce effectiveness of the milk ejection reflex, decrease efficiency of milk removal, increase residual milk, and lead to overall reduction in milk yield. However, a majority of the studies reviewed suggests that there is little or no effect of

⁸Crista L. Coppola. Noise in the Animal Shelter Environment: Building Design and the Effects of Daily Noise Exposure.

⁹ David Key, Essential Kennel Designs.

aircraft noise on cattle. Adverse effects of low-altitude flights have been noted in some studies but have not been uniformly reproduced in other reports (Manci, 1988).

Domesticated animals may therefore 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 a slight unfamiliar sound. 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 was noted in the above studies. How small changes (in environmental noise levels) may impact on domesticated animals have however not yet been studied.

8.1.2 Wildlife

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

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

Studies indicated that most animals adapt to noises, and would even return to a site after an initial disturbance, even if the noise is continuous. The more sensitive animals that might be impacted by noise would most likely relocate to a quieter area. Helldin (2012) however highlights that the network of access road could be a significant factor impacting on animals, though he also note that the changes may be due to increased vehicular movement. Noise impacts are therefore very highly species-dependent, but there are also

other factors that could impact on animals (such as visibility and increased movement of people and vehicles)¹⁰.

8.1.3 Avifauna¹¹

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 other species may:

- avoid noisy areas or completely relocate;
- may start to sing at different times;
- may change the frequency, pitch or character of their calls/singing/signals;
- increase the volume of their calls/singing/signals; or/and
- changes in reproductive success.

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.

8.1.4 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 activities¹². 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 effects¹³.

8.1.5 Concluding Remarks - Noise Impacts on Animals

From these and other studies the following can be concluded:

¹⁰ Blickley, 2010; Cummings, 2012; Cummings, 2009; Łopucki, 2016; Noise Quest, 2010; Rabin, 2006

¹¹ Autumn, 2007; Brumm, 2004; Cummings, 2009; Dooling, 2007; Francis, 2012; Francis, 2011; Ortega, 2012; Halfwerk, 2011; Parris, 2009; Zwart, 2014.

¹²USEPA, 1971.

¹³ Baldwin, 2007.

- To date there are no guidelines or sound limits with regards to noise levels that can be used to estimate the potential significance of noises on animals (Blickley *et al.* 2010).
- Animals respond to impulsive (sudden) noises (higher than 90 dBA) by running away. If the noises continue, animals would try to relocate (Dooling, 2007).
- Terrestrial wildlife responses begin at noise levels of approximately 40 dBA, with 20% of papers documenting impacts below 50 dBA (Shannon *et al.* 2015).
- 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, 2010), with Helldin *et al.* (2012) reporting that levels of 60–75 dBA have been shown to cause stress, e.g., increased respiration and heart rate, increased vigilance, and decreased time for grazing in domestic animals such as sheep and horses.
- Animals of most species exhibit adaptation with noise (Broucek, 2014), including impulsive noises, by changing their behaviour.
- More sensitive species would relocate to a quieter area, especially species that depend on hearing to hunt or evade prey, or species that makes use of sound/hearing to locate a suitable mate (Dooling, 2007).
- Noises associated with helicopters, motor- and quad bikes significantly impact on animals (startle response). This is due to the sudden and significant increase in noise levels as well as the presence of humans (Autumn, 2007; USEPA, 1971).

8.2 WHY NOISE CONCERNS COMMUNITIES¹⁴

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.

¹⁴World Health Organization, 1999; Noise quest, 2010; Journal of Acoustical Society of America, 2009

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

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

How a noise may impact (with this assessment using annoyance about the noise) on a receptor is also very complex to assess for the reasons highlighted in **section 8.2.1** below. Only considering the intensity of a sound (or noise) level, some people may become annoyed without hearing any noise (perceived impacts) where others may not even be reporting noise to be a concern, even when subjected to very high levels.

8.2.1 Noise Annoyance

Annoyance is the most widely acknowledged effect of environmental noise exposure, and is considered to be the most widespread. It is estimated that less than a third of the individual noise annoyance is accounted for by acoustic parameters, and that the non-acoustic factors play a major role. Non-acoustic factors that have been identified include age, economic dependence on the noise source, attitude towards the noise source and self-reported noise sensitivity (Council of Canadian Academies, 2015; Miedema and Vos, 2003; WHO, 2009).

On the basis of a number of studies into noise annoyance, exposure-response relationships were derived for high annoyance from different noise sources. These relationships, illustrated in **Figure 8-2**, are recommended in a European Union position paper published in 2002, stipulating policy regarding the quantification of annoyance. This can be used in environmental health impact assessment and cost-benefit analysis to translate noise maps into overviews of the numbers of persons that may be annoyed, thereby giving insight into the situation expected in the long-term. It is not applicable to local complaint-type situations or to an assessment of the short-term effects of a change in noise levels.

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 and health state of the receptor; and
- The attitude of the receptor about the emitter (noise source).

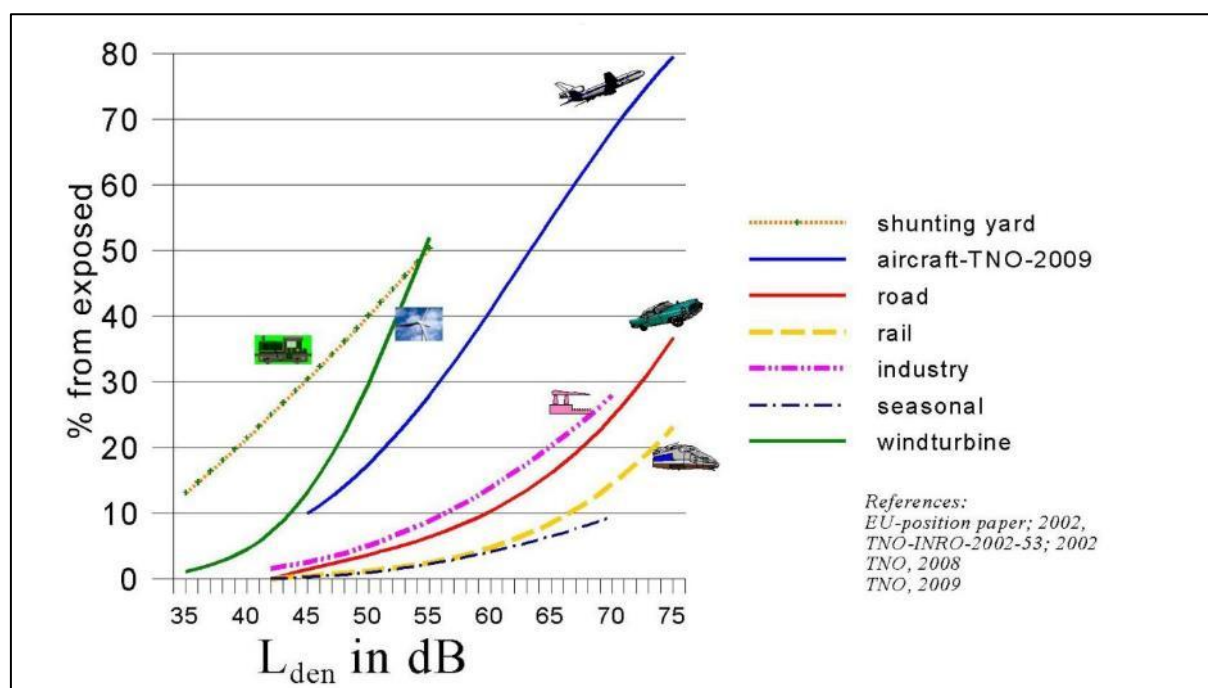


Figure 8-2: Percentage of annoyed persons as a function of the day-evening-night noise exposure at the façade of a dwelling¹⁵

8.2.1.1 *Disturbance to Sleep*

Sleep is essential for mental and physical health, and noise is one of the most reported reasons why people may experience sleep interruptions at night. This may be sudden loud noises, with the WHO (2009) reporting that, when maximum noises exceed 60 dBA, with average noise levels exceeding 40 dBA, it may increase the probability of being awakened. People report that quality of life suffer with increased instances of disturbed sleep that may also increase annoyance with a project (Van den Berg *et al* (2014)). It should be noted that Van den Berg *et al* (2014) showed an indirect effect between sleep disturbances and annoyance, but not between sleep disturbance and the noise level. It is postulated that this is due to increased annoyance due to the visual impact from the noise source.

¹⁵ Image from <https://rigolett.home.xs4all.nl/ENGELS/topic.htm>. Wind Turbine Annoyance curve from Pedersen (2007)

8.2.1.2 *Potential Health Effects from WTN*

The WHO (2009) does report threshold levels where people may report or experience effects from noise, with these thresholds highlighted in **Table 8-1**. The WHO does use the L_{Amax} and L_{night} ¹⁶ descriptors to describe these levels.

Table 8-1: Threshold levels reported by the WHO (2009)

Effect	Indicator	Threshold (dBA)
EEG awakening	$L_{Amax,inside}$	35
Onset of motility	$L_{Amax,inside}$	32
Changes in sleep patterns	$L_{Amax,inside}$	35
Waking up in the night and/or too early in the morning	$L_{Amax,inside}$	42
Increased average motility when sleeping	$L_{night,outside}$	42
Self-reported sleep disturbances	$L_{night,outside}$	42
Environmental insomnia	$L_{night,outside}$	42
Hypertension	$L_{night,outside}$	50
Myocardial infarction	$L_{night,outside}$	50
Psychic disorders	$L_{night,outside}$	60

8.2.1.3 *Situational and Personal Factors*

There are a few other aspects, collectively referred to as non-acoustical factors that may increase annoyance with a project [Miedema and Vos, 2003]. These could include:

- Situational factors (visual issues, attractiveness of area);
- Socio-economic factors (age, gender, income, level of education);
- Social factors (attitude towards the applicant/producer/government, media coverage);
- Personal factors (fear or worry in relation to noise source, sensitivity to noise, economic benefit from project, existing health condition); and
- Attitude towards the project and exposure to negative sentiment.

¹⁶ Refers to the European Union definition in Directive 2002/49/EC – equivalent outdoor sound pressure level associated with a particular type of noise source to which a receptor is exposed to over the 8-hour night-time period, calculated over a period of a year

8.3 IMPACT ASSESSMENT CRITERIA

8.3.1 Overview: The common characteristics

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

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

Of the four common characteristics of sound, intensity is the only one which is not subjective and can be quantified. Loudness is a subjective measure of the effect sound has on the human ear. As a quantity, it is therefore complicated but has been defined by experimentation on subjects known to have normal hearing.

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

8.3.2 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 5-1**.
- *Zone Sound Levels:* Previously referred to as the acceptable rating levels, it sets acceptable noise levels for various areas. See also **Table 5-2**.
- *Absolute or total noise levels:* Depending on their activities, people generally are tolerant to noise up to a certain absolute level, e.g., 65 dBA. Anything above this level will be considered unacceptable.

In South Africa, the document that addresses the issues concerning environmental noise is SANS 10103:2008 (See also **Table 5-2**). 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.

Considering the average fast-weighted sound level data collected in the area, average:

- daytime fast-weighted sound levels ranged from 27 to more than 88 dBA, with average sound levels being 47.7 dBA. This is typical of a rural to suburban noise district, setting a zone sound level of 45 dBA for the daytime period; and
- night-time fast-weighted sound levels ranged from 24 to 60 dBA, with average sound levels being 37.1 dBA. This is typical of a rural to suburban noise district, setting a zone sound level of 35 dBA for the night-time period.

Considering the requirements of the PNCR (see **section 5.1.1**), activities relating to the proposed project should not change the existing ambient sound levels with more than 5 dBA, nor exceed the WHO and IFC noise limits (see **section 5.4.4**). Recommended upper noise limits therefore would be:

- 52 dBA (less than 5 dBA from the average ambient sound levels measured in the area) for the daytime residential use; and
- 42 dBA (less than 5 dBA from the average ambient sound levels measured in the area) for night-time residential use.

If zoned as an industrial site, the project should also limit the noise level to less than 70 dBA during the daytime period and 60 dBA at night at the boundary (for the area zoned industrial).

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:

- **$\Delta \leq 3$ 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.
- **$3 < \Delta \leq 5$ 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.
- **$5 < \Delta \leq 15$ 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 5 dBA is defined as a disturbing noise and prohibited (PNCr - see **section 5.1.1**).

9 ASSUMPTIONS AND LIMITATIONS

9.1 MEASUREMENTS OF AMBIENT SOUND LEVELS

Ambient sound levels are the cumulative effects of innumerable sounds generated at various instances both far and near. A high measurement may not necessarily mean that the area is always noisy. 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 day, dependant on faunal characteristics (mating season, dawn chorus⁽¹⁷⁾ early hours of the morning, temperature etc.), vegetation in the area and meteorological conditions (especially wind).

Selecting an ideal measurement location could be difficult, with various criteria assessed to identify the viability of a certain location as a point to define ambient sound levels. When selecting a measurement location, the most important criteria would be:

1. Security of the instrument (minimise risk to the technician; prevent theft; sabotage of the equipment);
2. Safety of the equipment (ensure that it does not prevent, interfere or limit typical agricultural or household activities; ensure that the instrument are not in a location where an animal could damage the instrument); and lastly,
3. The suitability of the measurement location to define ambient sound levels (the presence of certain trees or equipment, wetland or other water resources will influence ambient sound level significantly).

As such, after ensuring that the instrument is safe and secure, there are various environmental factors that could influence ambient sound levels measured. These constraints and limitations are discussed below and could include:

- Seasonal changes in the surrounding environment can influence typical ambient sound levels, as many faunal species are more active during warmer periods than the colder periods. As an example, cicada is usually only active during warmer 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⁽¹⁸⁾;
- Defining ambient sound levels using the result of one 10-minute measurement may be very inaccurate (very low confidence level in the results) relating to the reasons mentioned above, and measurements over a longer-term period is critical;

⁽¹⁷⁾ Environ. We Int. Sci. Tech. *Ambient noise levels due to dawn chorus at different habitats in Delhi*. 2001. Pg. 134.

⁽¹⁸⁾ Clyne, D. "Cicadas: Sound of the Australian Summer, *Australian Geographic*" Oct/Dec Vol 56. 1999.

- Some equipment that could influence measurements may be missed when deploying instruments, or, the equipment may not be audible. This could include equipment such as hidden water pumps and associated pipelines and outflows, ESKOM stepdown transformers, hidden compressors, inverters, condensers or other electrical equipment, etc. While not audible during deployment, such equipment may significantly influence ambient sound levels during quiet periods;
- Type, the number and sizes of trees in the vicinity of the instrument, as well as the distances between the microphone and these trees. Certain trees, especially fruiting trees could attract birds and other animals that will significantly impact on ambient sound levels;
- Type and number of animals in the vicinity of the microphone. Dogs, chickens, geese, etc. generate different noises randomly both night and day, and other livestock (sheep, goats, cattle, horses, etc.) kept in enclosures will also raise noise levels, especially if these animals are penned in large numbers;
- Measurements over wind speeds of 3 m/s could provide data influenced by wind-induced noises. However, when determining the ambient sound levels associated with increased wind speeds, it is desired to measure ambient sound levels at higher wind speeds;
- Ambient sound levels recorded near rivers, streams, wetlands, trees and bushy areas can be high due to faunal activity which can dominate the sound levels around the measurement point (specifically during summertime, rainfall event or during dawn chorus of bird songs). This generally is still considered naturally quiet and accepted as features of the natural environment, and in various cases sought after and pleasing. Ambient sound level data measured in such area however should not be used to develop an opinion in the potential prevailing ambient sound levels in the larger area;
- Exact location of a sound level meter in an area in relation to structures, infrastructure, vegetation, wetlands and external noise sources will influence measurements. It may determine whether you are measuring anthropogenic sounds from a receptors dwelling, or environmental ambient baseline contributors of significance (faunal, roads traffic, railway traffic movement etc.); and
- As an area develops the presence of people or activities will result in increased residential and/or project related 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.

9.2 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 time the activities and equipment are operational and generating the noise rating levels as assumed. For this project a worst-case was assessed, assuming that most equipment (excluding the bulldozer used for clearing of vegetation) would be operating at a 100% load (generating the maximum noise rating levels), 100% of the time. In practice this is inaccurate as no activity or equipment are 100% operational of the time and the assumption will result in an over-estimated noise rating levels;
- 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. Fifty per cent (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 potential project 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.

This noise model generates the potential L_{A10} noise level (which the modelling software convert to an equivalent noise level), which is used in various countries (such as the United States of America, United Kingdom, Germany, Canada, Australia, New Zealand, etc.) to define potential road traffic noise analysis (and abatement). In this project, it illustrates the potential extent of the calculated noises (the noise rating level) 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 an actual noise level at a potential noise-sensitive receptor. For this, the selected model is internationally recognised and considered adequate. This noise model is recommended for use to calculate potential traffic noises in Germany, Switzerland, Netherlands, United Kingdom, France, Denmark, Italy, Denmark and Austria.

9.3 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.

9.4 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 NSR). 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 that any mitigation measures proposed for the construction phase (if any), will be implemented and continued during the operational phase (if required).

9.5 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 rating levels at a receptor from any operation. The projected noise rating 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 rating 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 activities are proposed is well vegetated and sufficiently uneven to allow the consideration of medium ground conditions.

9.6 UNCERTAINTY ON HOW NOISE COULD AFFECT PEOPLE

How noise affect communities are discussed in **section 8.2**, with this assessment considering a number of studies and guidelines such as:

- Cooper and Chan (2002) that discuss and present a number of dose-effect relationships as well as summarize a number of international guidelines and standards that can be used to assess noise effects. While focusing on wind farm noise, it can also be used for noise from mining and other industrial noises;
- Crichton *et al* (2014) that studied how expectations can influence symptom and mood reports in both positive and negative directions;
- Directive 2002/49/EC (EU, 2002), directing members of the European Union with a guideline on the assessment and management of environmental noise. This directive recommends the use of dose-effect relationships to assess the effect of noise on populations;
- Miedema and Vos (2003), that integrated the findings from a number of studies on the relationship between noise sensitivities and exposure to noise; and
- SANS 10103 (2008) that can be used to assess how environmental noise can be measured and used to assess annoyance in communities.

It is important to understand that guidelines and dose-effect relationship studies focus on how communities respond to noise and it is difficult to predict or foresee how an individual may respond to noise.

9.7 CONDITIONS TO WHICH THIS STUDY IS SUBJECT

This study is not subject to any conditions.

10 PROJECTED NOISE RATING LEVELS

10.1 CONCEPTUAL FUTURE SCENARIO – NOISE FROM EXPLORATION AND CONSTRUCTION ACTIVITIES

Noise will be generated during the exploration and production phase from:

- Site preparation activities (removing vegetation);
- Drilling;
- Seismic surveys;
- Transportation of equipment, people and drill core samples; and
- Trenching and pipeline installations.

Of the various exploration and construction activities, drilling and seismic exploration were investigated in more detail, because these activities could generate significant noise and would take place at numerous locations as illustrated in **Figure 10-1**. Potential noise levels associated with seismic surveys (over the larger area) were estimated with the noise levels presented per NSR in **Table 10-1**. Potential noise levels associated with borehole drilling activities were estimated with the noise levels presented per NSR in **Table 10-2**.

Table 10-1: Potential noise levels at NSR locations due to vibroseis survey activities

Receptor	Distance between NSR and survey location (m)	Potential Noise Level (dBA)	Comments
NSR04	15	75.5	Near potential seismic line, though site visit indicated no noise sensitive activities at area.
NSR05	129	56.8	Near potential seismic line, though site visit indicated no noise sensitive activities at area.
NSR06	210	52.6	Near potential seismic line, though site visit indicated no noise sensitive activities at area.
NSR07	510	44.9	Far from drilling activities, though near proposed seismic line
NSR10	319	48.9	NSR within 350m from seismic line, and near borehole
NSR11	427	46.4	NSR within 500m from seismic line, and 745m from borehole
NSR12	562	44.0	NSR within 500m from seismic line, further than 1,000m from borehole
NSR13	402	46.9	NSR within 500m from seismic line, further than 1,000m from borehole
NSR16	82	60.7	Use not verified (access limitation). Near seismic line and proposed boreholes
NSR17	306	49.3	NSR within 500m from seismic line, and 922m from borehole. Structure appears unused.
NSR18	550	44.2	NSR within 500m from seismic line, and 550m from borehole
NSR21	312	49.1	NSR within 500m from seismic line, and 917m from borehole. Traffic may pass close to house.

NSR22	40	67.0	Location not noise-sensitive. within 500m from seismic line, and 917m from borehole. Traffic may pass close to house.
NSR23	144	55.8	NSR within 500m from seismic line, further than 900m from borehole
NSR24	240	51.4	NSR within 500m from seismic line, further than 900m from borehole
NSR25	233	51.7	NSR within 500m from seismic line, further than 1000m from borehole
NSR27	171	54.3	Location within 500m from seismic line, further than 1000m from borehole. Site not noise sensitive
NSR35	121	57.4	Location near seismic line, though structure not used for noise-sensitive activities
NSR36	669	42.5	NSR further than 500m from seismic line and boreholes

Table 10-2: Potential noise levels at NSR locations due to nearby drilling activities activities

Receptor	Distance between NSR and survey location (m)	Potential Noise Level (dBA)	Comments
NSR01	3984	32.0	Far from project activities, noise levels will be low through all phases
NSR02	3061	34.3	Far from project activities, noise levels will be low through all phases
NSR03	2983	34.5	Far from project activities, noise levels will be low through all phases
NSR04	2739	35.3	Near potential seismic line, though site visit indicated no noise sensitive activities at area.
NSR05	2471	36.2	Near potential seismic line, though site visit indicated no noise sensitive activities at area.
NSR06	2585	35.8	Near potential seismic line, though site visit indicated no noise sensitive activities at area.
NSR07	1734	39.2	Far from drilling activities, though near proposed seismic line
NSR08	1462	40.7	Further than 1,000m from seismic line or proposed boreholes
NSR09	1412	41.0	Further than 1,000m from seismic line or proposed boreholes
NSR10	748	46.5	NSR within 350m from seismic line, and near borehole
NSR11	745	46.6	NSR within 500m from seismic line, and 745m from borehole
NSR12	1060	43.5	NSR within 500m from seismic line, further than 1,000m from borehole
NSR13	1197	42.4	NSR within 500m from seismic line, further than 1,000m from borehole
NSR14	465	50.7	Use of structures not noise-sensitive
NSR15	1240	42.1	NSR location not verified, far from project infrastructure
NSR16	435	51.2	Use not verified (access limitation). Near seismic line and proposed boreholes
NSR17	922	44.7	NSR within 500m from seismic line, and 922m from borehole. Structure appears unused.
NSR18	550	49.2	NSR within 500m from seismic line, and 550m from borehole
NSR19	2226	37.1	Further than 1,000m from seismic line or proposed boreholes
NSR20	2387	36.5	Further than 1,000m from seismic line or proposed boreholes
NSR21	917	44.8	NSR within 500m from seismic line, and 917m from borehole. Traffic may pass close to house.
NSR22	803	45.9	Location not noise-sensitive. within 500m from seismic line, and 917m from borehole. Traffic may pass close to house.
NSR23	978	44.2	NSR within 500m from seismic line, further than 900m from borehole
NSR24	973	44.2	NSR within 500m from seismic line, further than 900m from borehole

NSR25	1058	43.5	NSR within 500m from seismic line, further than 1000m from borehole
NSR26	2024	37.9	Further than 1,000m from seismic line or proposed boreholes
NSR27	950	44.5	Location within 500m from seismic line, further than 1000m from borehole. Site not noise sensitive
NSR28	2786	35.1	NSR further than 1,000m from seismic line or borehole
NSR29	3173	34.0	NSR further than 500m from seismic line and further than 1,000m from borehole
NSR30	2938	34.6	NSR further than 500m from seismic line and further than 1,000m from borehole
NSR31	3864	32.3	NSR further than 500m from seismic line and further than 1,000m from borehole
NSR32	3665	32.7	NSR further than 1,000m from seismic line or borehole
NSR33	3651	32.8	NSR further than 1,000m from seismic line or borehole
NSR34	2991	34.5	NSR further than 1,000m from seismic line or borehole
NSR35	637	47.9	Location near seismic line, though structure not used for noise-sensitive activities
NSR36	650	47.7	NSR further than 500m from seismic line and boreholes
NSR37	3122	34.1	NSR further than 1,000m from seismic line or borehole

Noise models were developed considering various exploration and construction activities as discussed in **Section 7.1** and conceptualised in **Figure 10-2**. As various activities should not be considered in isolation, certain activities are grouped to allow the calculation or estimation of the potential cumulative noise levels.

The projected worst-case construction noise rating levels (various simultaneous activities) are illustrated in **Figure 10-3** and defined per NSR in **Appendix C, Table 1** for the daytime period, with the findings relevant for all alternatives.

10.2 CONCEPTUAL FUTURE SCENARIOS – NOISE FROM OPERATIONAL ACTIVITIES

Noise models were developed considering the conceptual operational activities as discussed in **Section 7.2** and conceptualised in **Figure 10-4**. This assessment only focusses on the potential plant activities for the operational phase. The scenario was selected to illustrate potential worst-case noise rating levels, at the same time assisting in defining (and illustrating) the effect of worst-case noise emissions from the project. The projected operational noise rating levels are illustrated in:

- **Figure 10-5** and defined per NSR in **Appendix C, Table 2** for the daytime period; and
- **Figure 10-6** and defined per NSR in **Appendix C, Table 3** for the night-time period.

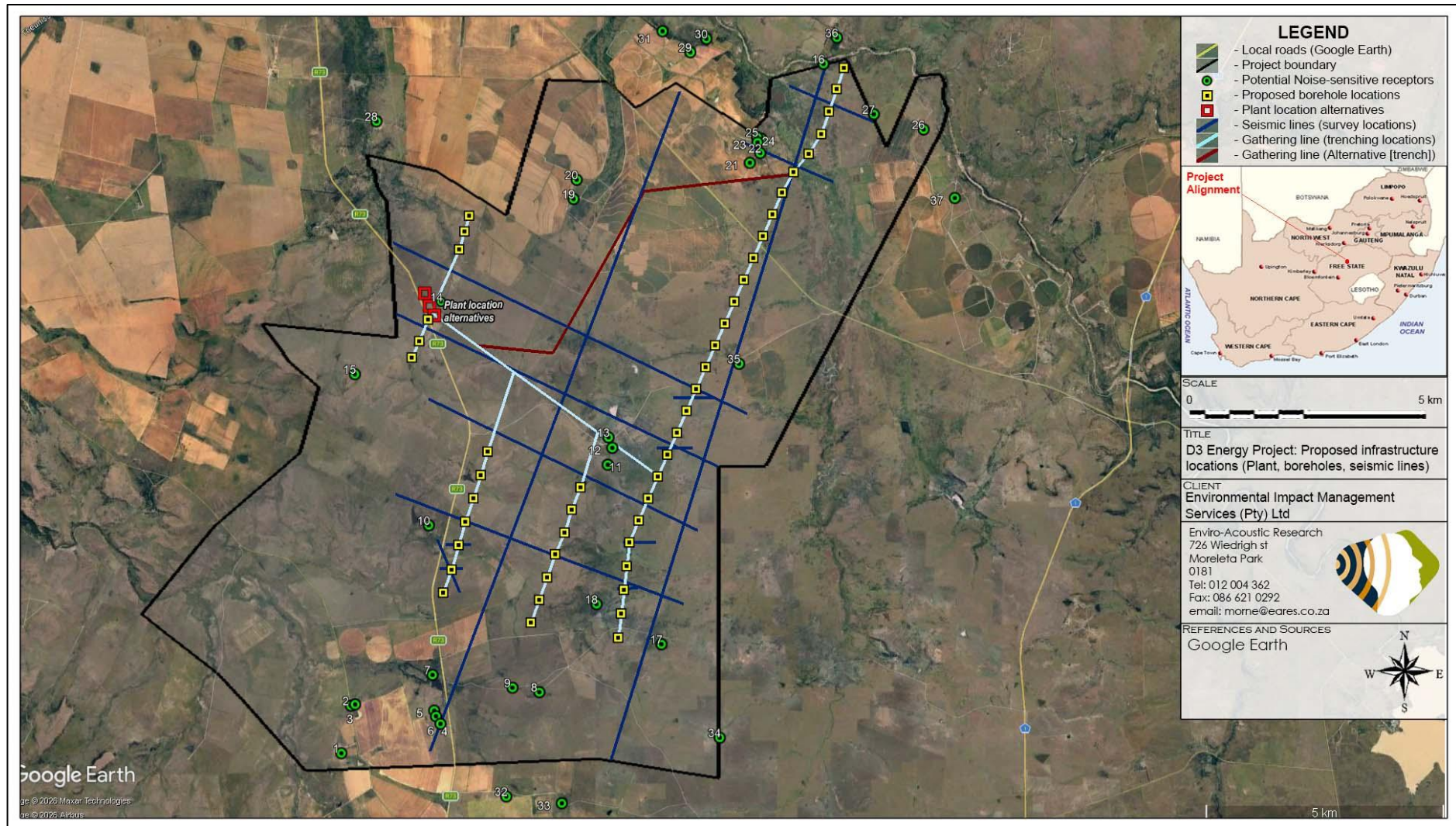


Figure 10-1: Infrastructure where noise generating activities could take place

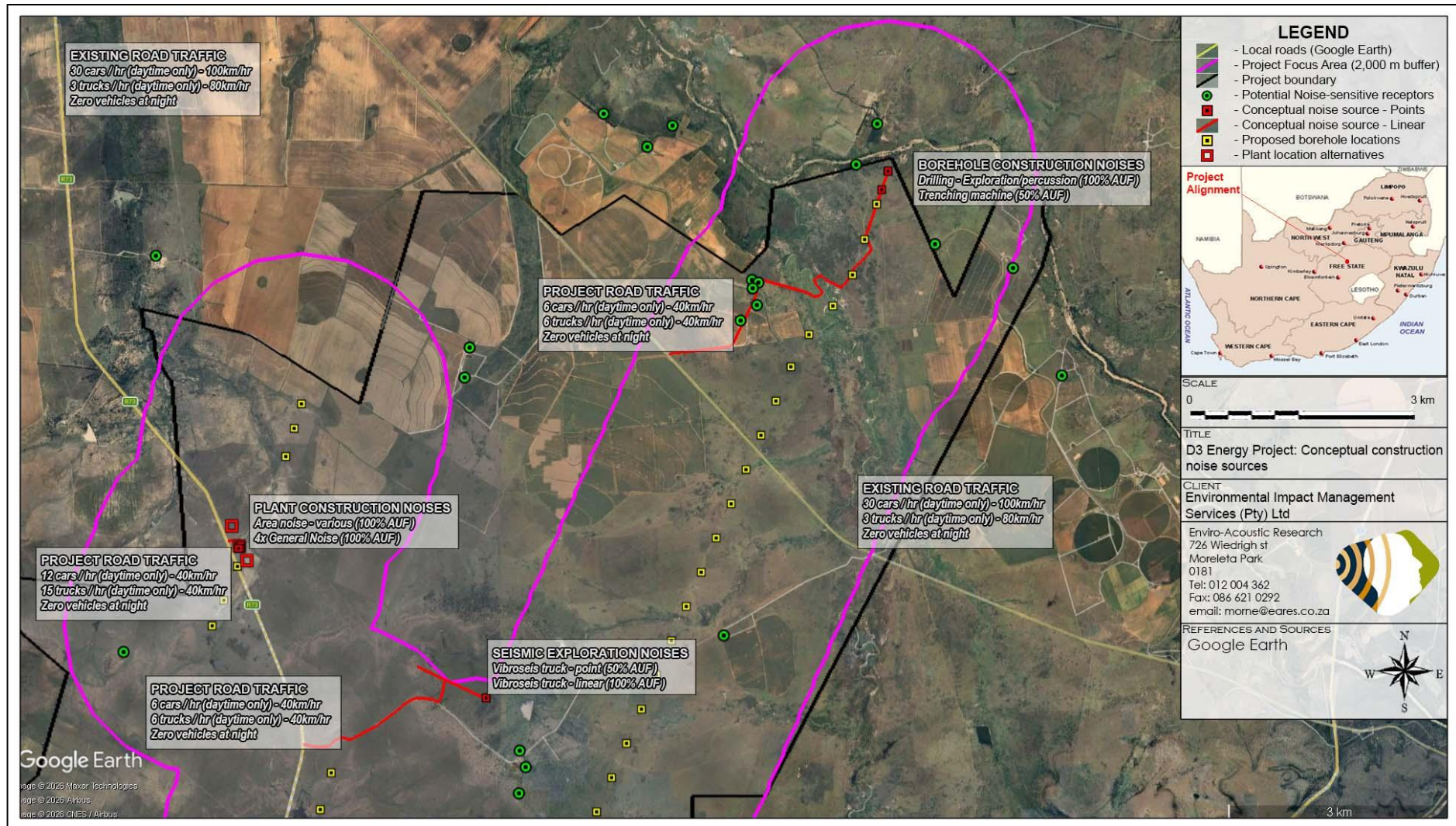


Figure 10-2: Conceptual noise-generating activities considered for exploration and construction activities

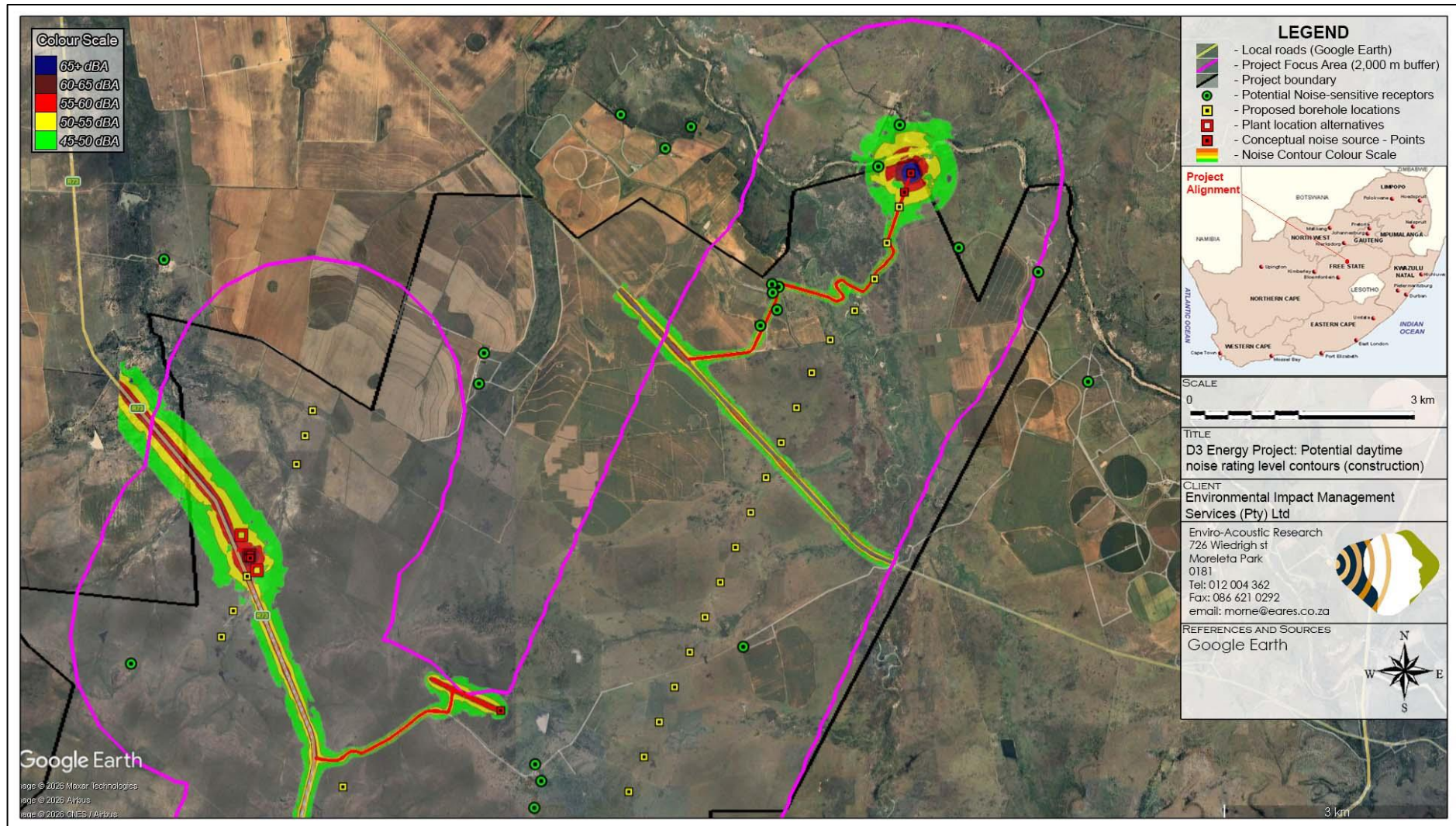


Figure 10-3: Projected daytime noise rating levels relating to the exploration and construction phase

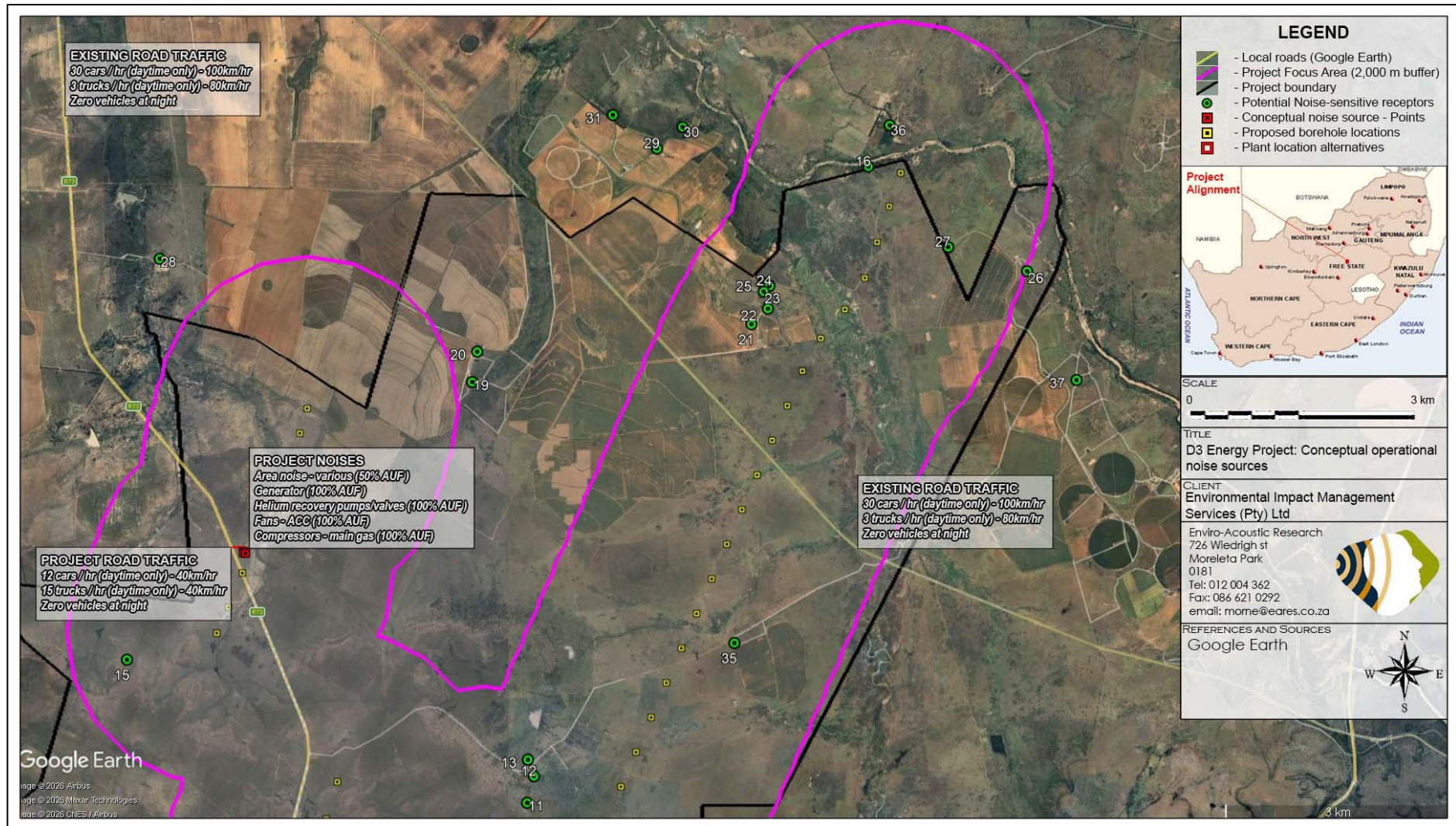


Figure 10-4: Conceptual noise-generating activities considered for the operational phase

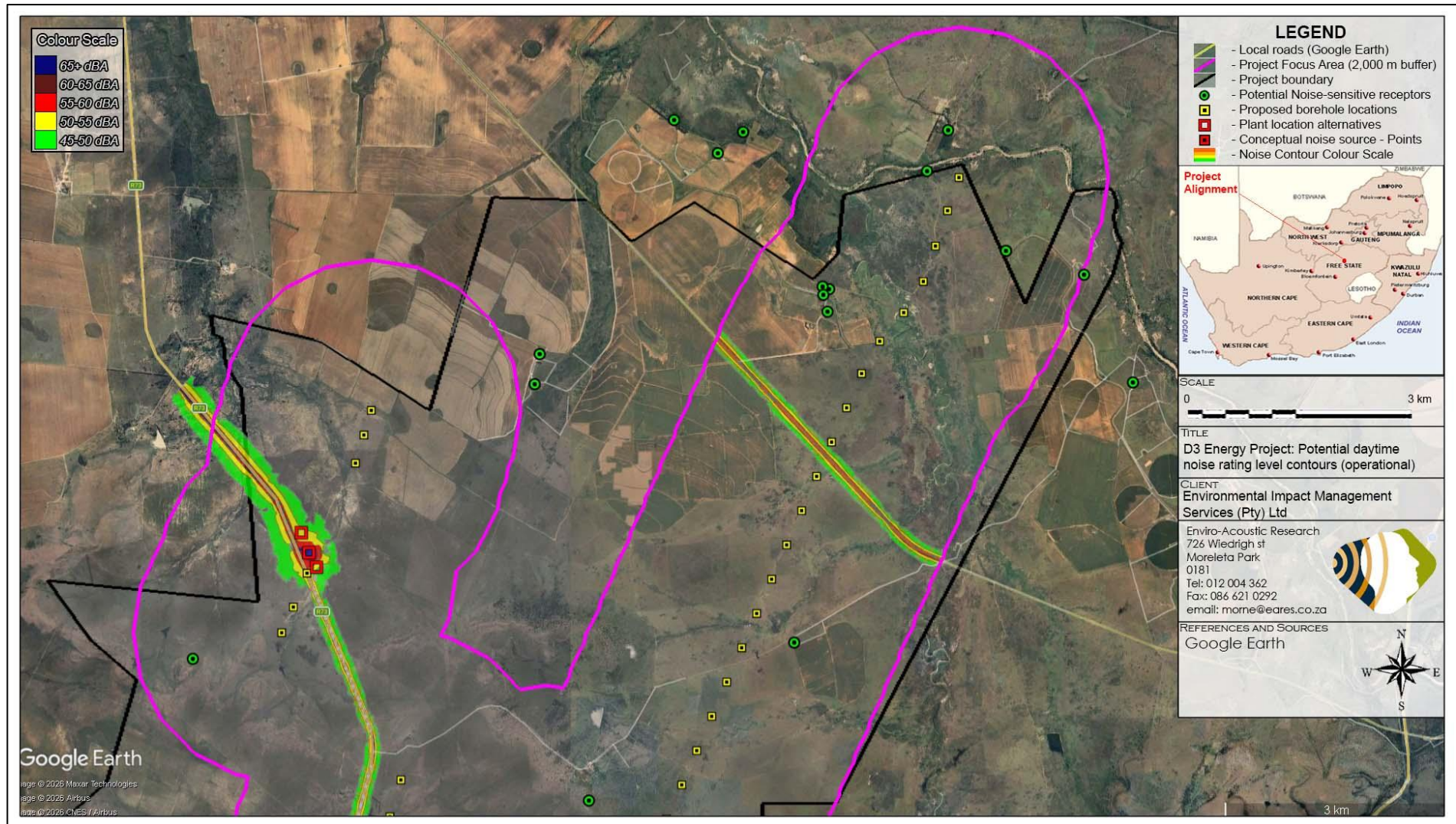


Figure 10-5: Projected daytime noise rating levels – conceptual operational activities

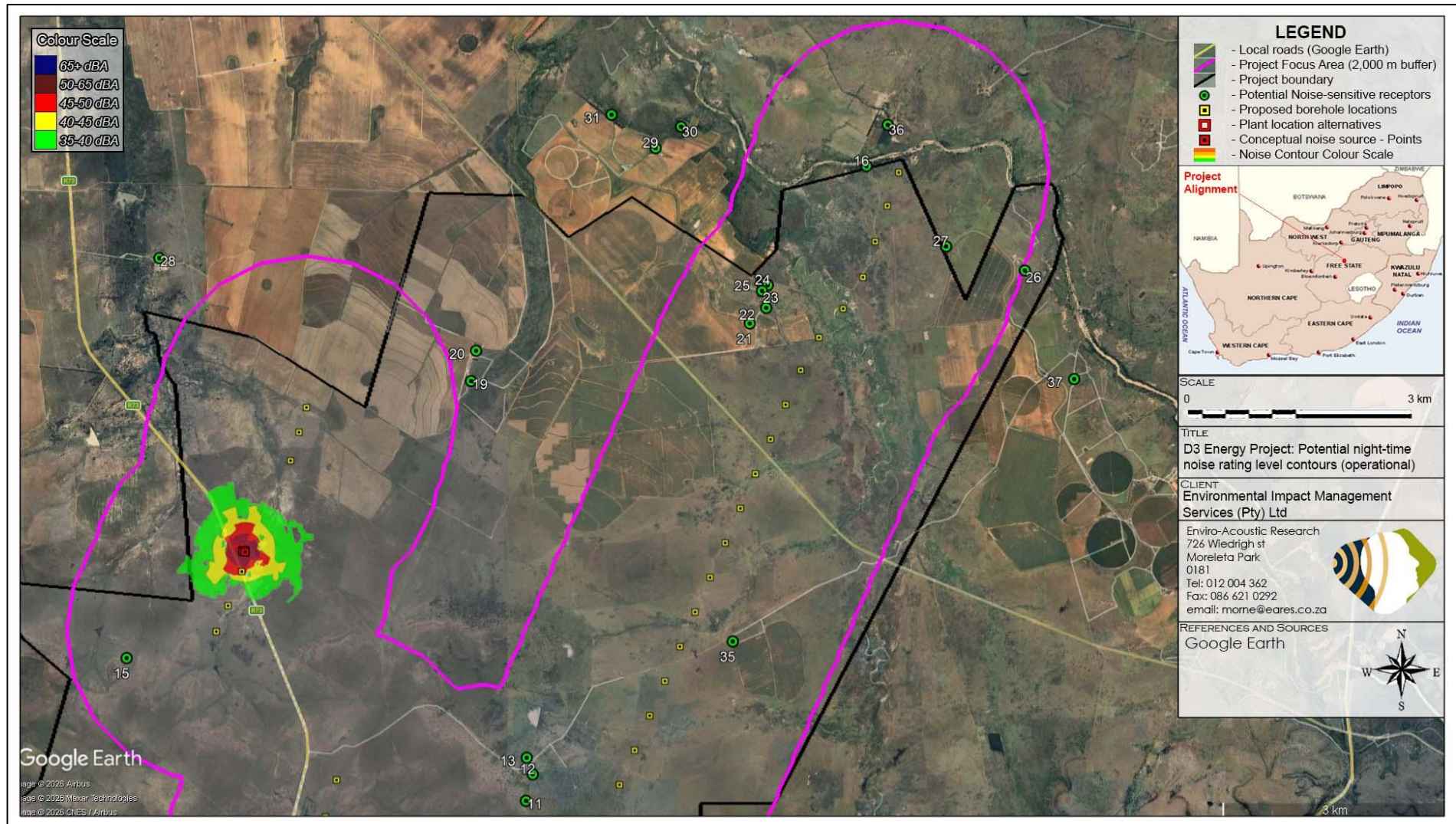


Figure 10-6: Projected night-time noise rating levels – conceptual operational activities

10.3 POTENTIAL DECOMMISSIONING AND CLOSURE NOISE LEVELS

The potential for a noise impact to occur during the decommissioning and closure phase will be much lower than that of the construction and/or operational phases. This is because:

1. Decommissioning activities normally are limited to the daytime period, due to the lower urgency to complete this phase; and
2. Decommissioning activities normally use smaller and less equipment, generating less noise than the typical construction or operational phases.

If required, the noise levels for decommissioning can be compared with the daytime construction phase noise rating levels, and the noise impact are similar or less.

10.4 POTENTIAL POST-CLOSURE NOISE LEVELS

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

10.5 EVALUATION OF ALTERNATIVES

Alternatives can typically be identified according to:

- Activity alternatives;
- Location alternatives (including design and layout);
- Technology/Process alternatives;
- Design and Layout alternatives; and
- The No Action alternative (No-go Alternative).

10.5.1 Alternative 1: Activity Alternatives

The current land uses within the study area and surroundings comprise predominantly of mining and agriculture. The Tetra4 production development is also located adjacent to the proposed D3 Energy production right study area. The development of renewable energy facilities for power generation is often seen as a better option than gas production. However, there are numerous renewable energy facilities already in the region and nationally that aim to meet the demand for renewable power. Furthermore, D3 Energy is a natural gas and helium company and doesn't engage in other project activities. Gas utilisation is also specifically included in the IRP2025 as a flexible, dispatchable resource to stabilise the system during a rapid transition away from coal. As such no alternative activity alternatives were identified.

10.5.2 Alternative 2: Location Alternatives

From a macro-location perspective, the D3 Energy production project is constrained by the presence of underground gas resources within Exploration Right 315 in the Lejweleputswa District, meaning no regional location alternatives are feasible to shift noise-generating activities to an entirely different area. Consequently, management of noise levels and impacts on nearby sensitive receptors relies heavily on a micro-scale sensitivity planning approach within preliminary identified 500-metre development corridors.

By utilizing specialist sensitivity mapping to establish buffer zones and identify "no-go" areas, the final positioning of the new production wells and interconnecting pipeline routes can be adjusted to maximize distance from human and environmental receptors, thereby minimizing localized noise disturbances. This is mainly a potential measure to minimize potential noise levels at identified NSR.

Additionally, the final selection between the three proposed micro-location options for the helium recovery and gas processing plant near the Virginia fault line will dictate the fixed area of long-term operational noise, which will similarly be optimized using sensitivity data to protect surrounding receptors.

10.5.3 Alternative 3: Technology or process alternatives

10.5.3.1 Drilling Alternatives

The selection of a drilling method heavily influences the level of noise and vibration disruption experienced by nearby receptors and workers. Rotary drilling utilizes heavy spinning machinery that generates significant noise and vibration pollution, which can be highly disruptive to residential areas. Similarly, diamond core drilling delivers a precise cut with minimal localized material damage, yet it remains inherently noisy and creates unpleasant vibrations for surrounding residents. While rotary-percussion drilling causes less surface disruption and is often considered suitable for urban environments, percussion drilling is ultimately designated as the preferred method for this project. Should drilling result in potential unacceptable noise levels, boreholes may be moved slightly as mitigation, or the applicant may restrict drilling activities to the daytime period.

10.5.3.2 Survey Alternatives

Subsurface seismic survey techniques present vastly different acoustic profiles depending on whether they rely on active or passive energy sources. The Vibroseis technique uses specialized trucks to generate artificial seismic waves via controlled mechanical vibrations, offering a relatively low-impact data collection method. In contrast, Accelerated Weight

Drop (AWD) surveys rely on surface impacts from a heavy falling weight. This method creates a repetitive thumping force that can cause localized ground and soil disturbances. In areas where receptors are very sensitive to noise, Magnetotelluric (MT) require no drilling, mechanical thumping, or active ground disturbance. This assessment will consider the potential noise from vibroseis surveys, considering survey alternatives should mitigation be required (and if feasible).

10.5.3.3 Gas Testing Alternatives

During the intermittent well clean-up and flow testing phases, the chosen gas disposal method directly dictates the noise exposure of surrounding communities. Gas venting involves the direct, uncombusted release of natural gas into the atmosphere through valves and piping systems. While this process avoids the continuous acoustic roar of a flame, it carries severe climate impacts and localized explosion risks if gas accumulates. Conversely, gas flaring safely burns off excess methane via horizontal or vertical flare stacks. Although widely preferred for safety and greenhouse gas reduction, the open-flame combustion process generates distinct flame, heat radiation, and noise emissions that can directly affect nearby receptors. These activities however are irregular and required for safe operation of the project.

10.5.4 Alternative 4: No-go option

The ambient sound levels will remain as is and the area would keep the existing noise character. This alternative may be considered should noise result in environmental impacts with a very high significance because mitigation will not reduce the environmental significance and the project may be fatally flawed.

11 SPATIAL SENSITIVITY MAPPING

Sensitivity mapping is generally not undertaken for noise because it tends to oversimplify a highly variable, context-dependent phenomenon. Unlike static environmental constraints (e.g., wetlands or heritage sites), noise is dynamic: it varies by source type, operating state, orientation of the noise source, duration of activities, and by how people perceive and tolerate sound.

“Sensitivity layers” can therefore misrepresent both risk and opportunity, either overstating impacts where effective controls are feasible or understating them where unfavourable operating conditions prevail.

Key reasons include:

- Human variability: Different people have different sensitivities and expectations (rural quiet versus busy farmyards), differing times of occupancy, and varying tolerance to specific sound characters (tonal, impulsive, low-frequency).
- Activity dependence: Noise levels depend on what activities occur, when they occur, and for how long. Short, infrequent tasks can be negligible; continuous night operations may be prominent even at greater distances.
- Equipment mix and numbers: The number of plant items operating simultaneously within the same receptor catchment strongly influences levels. E.g. One TLB operating intermittently for an hour is not equivalent to three machines working concurrently at high load in the same area.
- Orientation and layout of equipment and infrastructure: Equipment, fans, louvers, and exhausts have a noise with a directional component. Turning the noisiest faces away from receptors or placing equipment behind site structures or stockpiles can materially change outcomes.
- Sound power levels and acoustic usage factors: Manufacturer sound power ratings, actual duty cycles, and load states (e.g., variable-speed drives at part load) drive both average and maximum levels. A 10 dB reduction at source can more than halve the perceived loudness.
- Mitigation measures: Enclosures, silencers, acoustic screens, and operational “night modes” can reduce levels by 10–25 dB(A) at source or at the pad edge, transforming the potential significance ratings.
- Topography and ground cover: Terrain, berms, buildings, vegetation, and ground absorption/shielding alter propagation; small siting shifts can move a receptor from direct line-of-sight to shielded, changing results by several decibels.

- Meteorology and timing: Night-time inversions and low winds increase propagation into a certain direction, where daytime turbulence can reduce the propagation of sound/noise. Mapping cannot reliably embed time-varying conditions without scenario analysis.
- Cumulative scheduling: Overlaps between contractors or tasks matter; a map cannot predict coordination successes or failures.

Illustrative examples:

- Roads: One vehicle—or even a few vehicles per hour—travelling at low speeds on a good surface may be inaudible inside a dwelling at 100 m, particularly by day. Conversely, frequent heavy vehicles using engine brakes near a receptor at night could be clearly audible significance distances. A single “sensitive corridor” polygon cannot capture this spread.
- Drilling: A rig with a super-silenced generator and compressor, intake/exhaust silencers, and a drill head fitted with an effective shroud can be 10–20 dB(A) quieter at 10 m than a standard package. With thoughtful orientation and temporary screening, receptors that might appear “high risk” on a generic map can experience low residual levels in practice.

Given these dependencies, noise is better assessed through receptor-specific, scenario-based modelling as undertaken in this assessment. This approach provides actionable predictions and tailored controls, whereas generalized sensitivity mapping can mislead siting and prioritization decisions.

12 IMPACT SIGNIFICANCE

This assessment considers potential conceptual scenarios, with the noise model considering various construction and operational activities taking place simultaneously.

Critical factors that could meaningfully affect the significance assessment considers the potential future worst-case noise levels (estimated or calculated) as well as the probability of a noise impact occurring. Probability specifically is difficult to define, as noise from the mining activities will be audible to clearly audible at times at the nearest NSR, though audibility is not necessary a noise impact. This assessment therefore uses reported dose-response relationships (such as illustrated in **Figure 5-1** and **Figure 8-2**) as well as guideline noise levels (see **Table 5-1**, **Table 5-2**, **Table 5-3** & **Table 8-1**) to predict a potential probability per NSR.

12.1 IMPACT ASSESSMENT METHODOLOGY

The impact assessment methodology is guided by the requirements of the NEMA EIA Regulations (2014, as amended). The broad approach to the significance rating methodology is to determine the significance (S) of an environmental risk or impact by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relating this to the probability/ likelihood (P) of the impact occurring. The S is determined for the pre- and post-mitigation scenario. In addition, other factors, including cumulative impacts and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the S to determine the overall final significance rating (FS). The impact assessment will be applied to all identified alternatives.

Determination of Significance of the Environmental Impact

The final significance (FS) of an impact or risk is determined by applying a prioritisation factor (PF) to the post-mitigation environmental significance. The significance is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and Reversibility (R) applicable to the specific impact. For the purpose of this methodology the consequence of the impact is represented by:

$$C = \frac{(E + D + M + R) \times N}{4}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in **Table 12-1**.

Table 12-1: Criteria for Determining Impact Consequence

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary),
	3	Local (i.e. the area within 5 km of the site),
	4	Regional (i.e. extends between 5 and 50 km from the site)
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years),
	3	Medium term (6-15 years),
	4	Long term (the impact will cease after the operational life span of the project),
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction).
Magnitude/ Intensity	1	Minor - Increase in average sound pressure levels between 0 and 3 dB from the expected or average ambient sound levels.
	2	Low - Increase in average sound pressure levels between 3 and 5 dB from the expected or average ambient sound levels.
	3	Moderate - Increase in average sound pressure levels between 5 and 7 dB from the expected or average ambient sound levels.
	4	High - Increase in average sound pressure levels between 7 and 10 from the expected or average ambient sound level.
	5	Very High - Increase in average sound pressure levels between 0 and 3 dB from the expected or average ambient sound levels.
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring prohibitively high time and cost.
	5	Irreversible Impact

Once the C has been determined, the significance is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/scored as per **Table 12-2**.

Table 12-2: Probability Scoring

Probability	1	Improbable - Daytime noise levels are less than 50 dBA; Night-time noise levels less than 40 dBA.
	2	Low - Daytime noise levels are less than 55 dBA; Night-time noise levels less than 45 dBA.
	3	Medium - Daytime noise levels are less than 60 dBA; Night-time noise levels less than 50 dBA.

	4	High - Daytime noise levels are less than 65 dBA; Night-time noise levels less than 55 dBA.
	5	Definite - Daytime noise levels exceeding 65 dBA; Night-time noise levels higher than 55 dBA.

The result is a qualitative representation of relative significance associated with the impact. Significance (c) is therefore calculated as follows:

$$ER = C \times P$$

Table 12-3: Determination of Significance (Environmental Risk)

Consequence	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
Probability						

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in **Table 12-4**.

Table 12-4: Significance Scores

Environmental Risk Score	
Value	Description
< 4.25	Low (i.e. where this impact is unlikely to be a significant environmental risk),
≥4.25; <8.5	Medium (i.e. where the impact could have a significant environmental risk),
≥8.5; <13.75	High-Medium (i.e. where the impact could have a significant environmental risk),
≥ 13.75	High (i.e. where the impact will have a significant environmental risk).

The impact significance will be determined for each impact without relevant management and mitigation measures (pre-mitigation significance), as well as post implementation of relevant management and mitigation measures (post-mitigation significance). This allows for a prediction in the degree to which the impact can be managed/mitigated.

Impact Prioritisation:

In accordance with the requirements of Appendix 2 and Appendix 3 of the 2014 EIA Regulations (GNR 982), and further to the assessment criteria presented in the Section above it is necessary to assess each potentially significant impact in terms of:

- Cumulative impacts; and
- The degree to which the impact may cause irreplaceable loss of resources.

To ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impacts' post-mitigation significance (post-mitigation). This prioritisation factor does not aim to detract from the significance ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the post-mitigation significance based on the assumption that relevant suggested management/mitigation impacts are implemented.

Table 12-5: Criteria for Determining Prioritisation

Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.
Irreplaceable loss of resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 11. The impact priority is therefore determined as follows:

$$\text{Priority} = \text{CI} + \text{LR}$$

The result is a priority score which ranges from 2 to 6 and a consequent PF ranging from 1 to 1.5 (Refer to **Table 12-6**).

Table 12-6: Determination of Prioritisation Factor

Priority	Prioritisation Factor
2	1
3	1.125
4	1.25
5	1.375
6	1.5

In order to determine the final impact significance (FS), the PF is multiplied by the post-mitigation significance scoring. The ultimate aim of the PF is an attempt to increase the

post mitigation environmental risk rating by a factor of 0.5, if all the priority attributes are high (i.e. if an impact comes out with a high medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a higher significance).

Table 12-7: Final Environmental Significance Rating

Environmental Significance Rating	
Value	Description
<-25	Very High (Impacts in this class are extremely significant and pose a very high environmental risk. In certain instances these may represent a fatal flaw. They are likely to have a major influence on the decision and may be difficult or impossible to mitigate. Offset's may be necessary.
<-13.75 to -25	High negative (These impacts are significant and must be carefully considered in the decision-making process. They have a high environmental risk or impact and require extensive mitigation measures).
-8.5 to -13.75	Medium-High negative (i.e. Impacts in this class are more substantial and could have a significant environmental risk. They may influence the decision to develop in the area and require more robust mitigation measures).
<-4.25 to <-8.5	Medium- Low negative (i.e. These impacts are slightly more significant than low impacts but still do not pose a major environmental risk. They might require some mitigation measures but are generally manageable).
-1 to -4.25	Low negative (i.e. Impacts in this class are minor and unlikely to have a significant environmental risk. They do not influence the decision to develop in the area and are typically easily mitigated.
0	No impact
1 to 4.25	Low positive
>4.25 to <8.5	Medium-Low positive
8.5 to 13.75	Medium-High positive
>13.75	High positive

12.2 PLANNING PHASE NOISE IMPACTS

Little noise is typically associated with the activities associated with the planning phase. While this phase may include LDV driving on the site, LDV generally do not generate significant noises, and activities will not raise ambient sound levels above the levels to which NSRs are accustomed.

12.3 MOBILISATION NOISE IMPACTS

12.3.1 Impact 1 – Vehicular traffic passing NSR locations

The transport of people, equipment, material and drilling cores using available access roads. Trucks and vehicles driving past NSR locations will slightly change ambient sound levels, with the magnitude of change mostly depending on the number and average speeds of the vehicles. Vehicular traffic however does not change ambient sound levels

significantly (more than 3 dBA as measured over an hour), and, considering that residents are typically at work or busy with typical daytime activities (which also generate noise), the significance of the noise impact from such activities will be minor. The final significance of the noise impact from vehicular traffic passing NSR locations during the initial mobilisation phase is low.

12.3.1.1 Mitigation Measures

Additional mitigation measures are not required, though, the applicant should discuss how project traffic noises (where access roads are located closer than 60m from the residential dwellings [NSR locations]) will affect ambient sound levels at potentially affected receptors (NSR locations). Should any complaints about traffic noise be registered, the applicant should consider:

- Enforcing reduced speeds when project traffic drives within 100m from NSR locations. Employees and contractors should not use hooters when driving close to NSR locations;
- the relocation of access roads further than 60m from residential dwellings.

12.3.1.2 Cumulative Impacts

Vehicular traffic will have an insignificant cumulative effect when considering existing vehicular traffic or other noise-generating activities in the area.

12.3.1.3 Irreplaceable loss of Resources

Noise generating activities do not destroy resources permanently, and a quiet environment is generally considered a renewable or restorable resource rather than an irreplaceable one.

12.3.1.4 Impact on Alternatives Considered

This assessment assume that project vehicular traffic will initially use existing farm roads, though this impact may be limited to NSR locations 21, 23, 24 and 25. The applicant however may develop access roads near the collection pipelines and collection boreholes that would eliminate noise impacts associated with vehicular traffic.

12.4 CONSTRUCTION NOISE IMPACTS

12.4.1 Impact 2 – Vehicular traffic passing NSR locations

The transport of people, equipment, material and drilling cores using available access roads during the construction phase. Trucks and vehicles driving past NSR locations will slightly change ambient sound levels, with the magnitude of change mostly depending on the number and average speeds of the vehicles. Vehicular traffic however does not change

ambient sound levels significantly (less than 3 dBA as measured over an hour), and, considering that residents are typically at work or busy with typical daytime activities (which also generate noise), the final significance of the noise impact from vehicular traffic passing NSR locations during the construction phase is **low**. This significance of this impact is summarized in **Table 12-8** (pre-mitigation), **Table 12-9** (post-mitigation), **Table 12-10** (Final significance after impact prioritisation).

12.4.1.1 Mitigation Measures

Additional mitigation measures are not required, though, the applicant should discuss how project traffic passing will affect ambient sound levels with potentially affected receptors (NSR locations where access roads are closer than 60m from the residential dwellings). Should any complaints about noise be registered, the applicant should consider the relocation of access roads further than 60m from residential dwellings. Night-time vehicular traffic should be minimized should they require to pass within 120m from dwellings used for residential purposes.

12.4.1.2 Cumulative Impacts

Vehicular traffic will have an insignificant cumulative effect when considering existing vehicular traffic or other noise-generating activities in the area.

12.4.1.3 Irreplaceable loss of Resources

Noise generating activities do not destroy resources permanently, and a quiet environment is generally considered a renewable or restorable resource rather than an irreplaceable one.

12.4.1.4 Impact on Alternatives Considered

As discussed in This assessment assume that project vehicular traffic will initially use existing farm roads, though this impact may be limited to NSR locations 21, 23, 24 and 25. The applicant however may develop access roads near the collection pipelines and collection boreholes that would eliminate noise impacts associated with vehicular traffic.

12.4.2 Impact 3 – Daytime site preparation activities

The use of earthworks equipment (potentially grader, bulldozer or TLB) clear vegetation, level the ground surface, dig trenches and potential foundations. Such activities will raise noise levels, with the magnitude of the noise level depending on the type of equipment, the PWL of the equipment and number of equipment operating simultaneously within 500m from the same NSR location. The final significance of the noise impact from daytime site preparation activities during the construction phase will be **low**. This significance of this

impact is summarized in **Table 12-8** (pre-mitigation), **Table 12-9** (post-mitigation), **Table 12-10** (Final significance after impact prioritisation).

12.4.2.1 Mitigation Measures

Additional mitigation measures are not required for typical daytime site preparation activities. The working hours stipulated in the Construction permit, where applicable, must be adhered to. Where this is not applicable, the following working hours must be adhered to: Monday to Friday from sunrise to sunset and where applicable on a Saturday which must be agreed upon between the affected parties and the Contractor.

12.4.2.2 Cumulative Impacts

Daytime site preparation activities will have an insignificant cumulative effect when considering other noise-generating activities in the area.

12.4.2.3 Irreplaceable loss of Resources

Noise generating activities do not destroy resources permanently, and a quiet environment is generally considered a renewable or restorable resource rather than an irreplaceable one.

12.4.2.4 Impact on Alternatives Considered

As discussed in **section 10.5.2**, final borehole positions could be moved after considering various no-go areas. Daytime site preparation activities however will not impact on any NSRs.

12.4.3 Impact 4 – Daytime seismic survey activities

Daytime seismic surveys (e.g., vibroseis sweeps, support vehicles, limited drilling of shallow shot holes where required) will raise ambient noise temporarily along survey lines and at staging/line-crossing points. The magnitude of impact depends on source type and drive level, proximity to NSR locations, terrain, and the number of simultaneous sources operating within the same NSR catchment. Given daytime operation and short dwell times at any one point, the pre-mitigation significance is **low** for all NSR locations, with brief, localized peaks during individual sweeps or pass-bys. This significance of this impact is summarized in **Table 12-8** (pre-mitigation), **Table 12-9** (post-mitigation), **Table 12-10** (Final significance after impact prioritisation).

12.4.3.1 Mitigation Measures

Additional mitigation measures are not required for typical daytime seismic surveying activities.

12.4.3.2 Cumulative Impacts

Daytime site preparation activities will have an insignificant cumulative effect when considering other noise-generating activities in the area.

12.4.3.3 Irreplaceable loss of Resources

Noise generating activities do not destroy resources permanently, and a quiet environment is generally considered a renewable or restorable resource rather than an irreplaceable one.

12.4.3.4 Impact on Alternatives Considered

As discussed in **section 10.5.2**, selecting vibroseis over impulsive sources, optimizing line layouts to increase setbacks from NSR locations, and minimizing crew size/equipment near NSR locations reduce noise and keep significance low without additional engineered controls.

12.4.3.5 Impact on Alternatives Considered

Selecting vibroseis over impulsive sources, optimizing line layouts to increase setbacks, limiting crew size/equipment near settlements, and shifting work to daytime reduce the significance from medium to low without additional engineered controls.

12.4.4 Impact 5 – Daytime trenching activities

Daytime trenching (e.g., excavator/TLB trenching, limited compaction/backfill, support vehicles) will temporarily raise noise levels along trench alignments and laydown points. Given that trenching activities are generally located more than 500 m from all NSR locations, dwell times at any point are short, and works occur during daytime, the pre-mitigation significance is **low**. This significance of this impact is summarized in **Table 12-8** (pre-mitigation), **Table 12-9** (post-mitigation), **Table 12-10** (Final significance after impact prioritisation).

12.4.4.1 Mitigation Measures

Additional mitigation measures are not required for night-time trenching activities.

12.4.4.2 Cumulative Impacts

If several trench crews operate concurrently near the same receptor catchment, the frequency of audible events may increase. The impact will however be insignificant.

12.4.4.3 Irreplaceable loss of Resources

Noise generating activities do not destroy resources permanently, and a quiet environment is generally considered a renewable or restorable resource rather than an irreplaceable one.

12.4.4.4 Impact on Alternatives Considered

Optimizing trench (pipeline) alignments to maximize distance from NSR locations, clustering utilities, and using existing corridors maintains low significance without additional engineered controls.

12.4.5 Impact 6 – Daytime drilling activities (construction)

Daytime borehole drilling using a drill rig with onboard/auxiliary generator and compressor will raise noise levels at nearby NSR locations. Although undertaken during daytime, continuous operation and tonal components (compressor, fans) can be clearly audible where setbacks are constrained. The pre-mitigation significance is **medium** for NSR locations generally within approximately 800 m of the drill site (mainly NSR16) and low beyond this distance. This will also be applicable to drilling activities at more than one location. This significance of this impact is summarized in **Table 12-8** (pre-mitigation), **Table 12-9** (post-mitigation), **Table 12-10** (Final significance after impact prioritisation).

12.4.5.1 Mitigation Measures

- Source control: low-noise drill package; effective mufflers/silencers on generator and compressor; acoustic lagging on tonal panels/pipework; maintain mounts and belts.
- Layout/orientation: position generator/compressor farthest from nearest NSR; orient louvres/exhausts away from NSRs; use terrain/stockpiles as shielding.
- Temporary controls if complaints are received: deploy mobile acoustic screens on NSR-facing edges where NSRs lie within ~800 m; limit simultaneous high-noise tasks (e.g., hammering) near same NSR.
- Operations: steady engine loads; avoid unnecessary revving/idling; use broadband reversing alarms; schedule particularly noisy activities for mid-day.
- Engagement: notify nearby landowners of expected drilling duration; complaints logging and rapid response. With these measures, the residual significance is expected to be low; brief low/medium peaks may occur during specific short-duration tasks.

12.4.5.2 Cumulative Impacts

Concurrent drilling at multiple boreholes in the same receptor catchment can extend the duration and levels of audible noise. The impact will however be insignificant.

12.4.5.3 Irreplaceable loss of Resources

Noise generating activities do not destroy resources permanently, and a quiet environment is generally considered a renewable or restorable resource rather than an irreplaceable one.

12.4.5.4 Impact on Alternatives Considered

Selecting borehole locations with greater setback from NSRs, and employing low-noise generator/compressor packages can reduce significance from medium to low without additional engineered controls.

12.5 OPERATIONAL NOISE IMPACTS

12.5.1 Impact 7 – Daytime drilling activities (operational phase)

The impact, mitigation measures, cumulative impacts, loss of resource and alternatives are the same as determined for the construction phase (**section 12.4.5**).

12.5.2 Impact 8 – Daytime transport of people, equipment, material, drill cores and product

During operations, light and heavy vehicles will use existing access roads to transport personnel, consumables, spares and product. Pass-by noise and short periods of idling near gates/laydown areas will slightly raise daytime ambient levels at nearby NSR locations. Given daytime context, short exposure per pass-by and typical separation distances, the pre-mitigation significance is low. This significance of this impact is summarized in **Table 12-8** (pre-mitigation), **Table 12-9** (post-mitigation), **Table 12-10** (Final significance after impact prioritisation).

12.5.2.1 Mitigation Measures

Additional mitigation measures are not required for daytime transport (logistics) activities.

12.5.2.2 Cumulative Impacts

Shared corridors with other projects or agricultural peaks can increase pass-by frequency. The impact will however be insignificant.

12.5.2.3 Irreplaceable loss of Resources

Noise generating activities do not destroy resources permanently, and a quiet environment is generally considered a renewable or restorable resource rather than an irreplaceable one.

12.5.2.4 Impact on Alternatives Considered

Alternatives that reduce noise would include relocating access roads further than 60m from NSR locations, consolidating loads to fewer trips with quieter, well-maintained vehicles.

12.5.3 Impact 9 – Night-time transport of people, equipment, material, drill cores and product

Because the gas processing plant is located far from NSR locations, night-time traffic will not impact on any NSR. Night-time vehicle movements to and from drilling sites however may pass NSR locations and raise audibility due to low background levels and favourable propagation. The pre-mitigation significance is **medium** for NSR locations situated along access routes within approximately 50–200 m of frequent night movements, and **low** elsewhere. This significance of this impact is summarized in **Table 12-8** (pre-mitigation), **Table 12-9** (post-mitigation), **Table 12-10** (Final significance after impact prioritisation).

12.5.3.1 Mitigation Measures (mainly for traffic passing within 120m from NSR locations)

- Routing: use bypass routes with greatest feasible separation; avoid passing within 60 m of dwellings where practicable; where routes pass within 120 m, minimize night movements.
- Scheduling: restrict heavy-vehicle movements to daytime where possible; establish night delivery windows that avoid late-night/early morning periods; avoid convoying at night.
- Driving controls: enforce reduced night speeds; prohibit exhaust/engine braking near NSR locations; minimizing idling near dwellings used for residential purposes.
- Fleet maintenance: ensure effective mufflers and well-maintained suspension/tires; use broadband (“white noise”) reversing alarms.
- Engagement: advance notice to nearby residents of planned night movements; complaints logging and rapid response. With these measures, the residual significance is expected to be low along all routes; short, localized low/medium peaks may occur during occasional abnormal loads.

12.5.3.2 Cumulative Impacts

Multiple contractors using the same corridors at night can increase pass-by frequency. Coordinate schedules, stagger movements, and limit simultaneous night-time heavy-vehicle trips within the same receptor catchment to maintain low cumulative effects.

12.5.3.3 Irreplaceable loss of Resources

Noise generating activities do not destroy resources permanently, and a quiet environment is generally considered a renewable or restorable resource rather than an irreplaceable one.

12.5.3.4 Impact on Alternatives Considered

Selecting longer bypass routes with greater setback, consolidating loads to reduce trip numbers, shifting movements to daytime where feasible, and relocating access points farther from dwellings reduce night-time logistics noise from medium to low without additional engineered controls.

12.5.4 Impacts 10 (day) and 11 (night) – Day and Night-time plant operations

The gas processing plant (and gas to power generator) is located further than 2,000m from the closest NSR location used for residential purposes, and, with most of the noise generating containerized equipment (which will reduce noise emission levels), operational noise levels at all NSR are expected to be low. While continuous and intermittent operation of the generator (for testing/emergency), compressors, and ventilation/cooling fans may be audible off site, particularly at night when backgrounds are low, noise levels will be low and the pre-mitigation significance will be **low** for both day- and night-time periods. This significance of this impact is summarized in **Table 12-8** (pre-mitigation), **Table 12-9** (post-mitigation), **Table 12-10** (Final significance after impact prioritisation).

12.5.4.1 Mitigation Measures

Additional mitigation measures are not required for typical operational activities (including gas to power generation, compressors, cooling processes, pumps, valves and motors, but excluding flare noises).

12.5.4.2 Cumulative Impacts

The processing plant is too far from any NSR and noise from the plant activities will not contribute to noise levels in the area from other project or third party activities.

12.5.4.3 Irreplaceable loss of Resources

Noise generating activities do not destroy resources permanently, and a quiet environment is generally considered a renewable or restorable resource rather than an irreplaceable one.

12.5.4.4 Impact on Alternatives Considered

While modelling was only done for plant alternative location A, this finding will be valid for all three plant location alternatives.

12.5.5 Impact 12 – Emergency release or flaring of gas

Emergency depressurisation or flaring and gas blowdown events can generate very high unscheduled noise levels (e.g., flare jet “roar,” relief valve discharge), with heightened startle potential at night. All NSR locations are >2 km from the plant (most 3.5–4.5 km). The pre-mitigation significance is **medium** due to the unpredictable, high-level, short-duration nature of the noise, especially at night, and would be relevant for instantaneous, multiple instantaneous events in a short space of time, and a longer continuous event. This significance of this impact is summarized in **Table 12-8** (pre-mitigation), **Table 12-9** (post-mitigation), **Table 12-10** (Final significance after impact prioritisation).

12.5.5.1 Mitigation Measures

The medium significance is the result of strict EIA criteria and the precautionary principle, as worst-case maximum (instantaneous) noise levels from a flare could range between 40 to 60 dBA at 4km. At night this may annoy NSR, and if the applicant receives complaints about this emergency flaring/gas release, the applicant can consider:

- Source reduction/design: minimize reliance on flaring via flare gas recovery; optimize blowdown segmentation and staged depressurisation; throttle/sequence BDV¹⁹ to reduce instantaneous mass flow; install larger KOD²⁰ to prevent liquid carry-over/combustion instability.
- Acoustic controls: high-performance, low-noise flare tips (sonic suppression/Coandă designs²¹); steam/air-assist tuning to avoid howl; high-grade

¹⁹ Blowdown Valve — rapidly depressurizes process equipment to a flare or vent header during emergencies; high mass flow can be very noisy.

²⁰ Knock-Out Drum — vessel in the flare system that removes liquids/condensate from relief gas to prevent liquid carryover, flame instability, and excess noise/soot.

²¹ Flare tip geometry that uses the Coandă effect (jet attaching to a curved surface) to enhance air entrainment and mixing, stabilizing combustion and reducing soot and acoustic “roar” compared with conventional tips.

silencers on PSV²²/BDVs where practicable; acoustic lagging on relief headers near grade; maintain purge/assist rates at lowest safe settings.

- Operational management: classify/emergency only use; avoid routine test flaring at night; post-event review and corrective actions.
- Communication/engagement: opt-in SMS/WhatsApp/email notifications to nearby NSR explaining cause/duration when safe to do so; publish an information sheet on emergency noise characteristics and contacts for queries/complaints.

12.5.5.2 Cumulative Impacts

Cumulative effects associated with flaring or the release of gas are not expected, and due to the different character, does not cumulatively increase noise levels. It may however increase annoyance with the project.

12.5.5.3 Irreplaceable loss of Resources

Noise generating activities do not destroy resources permanently, and a quiet environment is generally considered a renewable or restorable resource rather than an irreplaceable one.

12.5.5.4 Impact on Alternatives Considered

As discussed in **section 10.5.3.3**, flaring would be the preferred option, even though noise emissions will be higher. While the release of unburned gasses may be quieter, it also increases the carbon footprint of the project which may not be acceptable to financial backers of the project.

12.6 DECOMMISSIONING NOISE IMPACTS

12.6.1 Impact 13 - Dismantling and decommissioning of project infrastructure

Dismantling and removal of skids, small structures, walkways, cabling, and ancillary infrastructure will generate intermittent handling and tool noise (cutting, unbolting, craning, loading) during decommissioning. Works are short-duration at any one location and typically scheduled for daytime, with setback distances maintained from NSR locations. The pre-mitigation significance is low as summarized in **Table 12-8** (pre-mitigation), **Table 12-9** (post-mitigation), **Table 12-10** (Final significance after impact prioritisation).

12.6.1.1 Mitigation Measures

Additional mitigation measures are not required for typical decommissioning activities.

²² Pressure Safety Valve — spring- or pilot-operated valve that opens automatically to protect equipment from overpressure, discharging to the flare/relief system; can generate tonal noise on lift.

12.6.1.2 Cumulative Impacts

Concurrent dismantling at multiple pads using shared access could increase pass-by frequency and handling noise, but the cumulative effect would be low.

12.6.1.3 Irreplaceable loss of Resources

Noise generating activities do not destroy resources permanently, and a quiet environment is generally considered a renewable or restorable resource rather than an irreplaceable one.

12.6.1.4 Impact on Alternatives Considered

Alternatives were not assessed for decommissioning activities.

12.7 REHABILITATION NOISE IMPACTS

12.7.1 Impact 14 - Various rehabilitation activities

Rehabilitation (regrading, topsoiling, erosion control, revegetation, minor compaction and watering) will generate intermittent, low-level noise from light earthmoving plant, small pumps and support vehicles. Activities are short-duration at any point, occur in daytime, and generally maintain setbacks from NSR locations. The pre-mitigation significance is low as summarized in **Table 12-8** (pre-mitigation), **Table 12-9** (post-mitigation), **Table 12-10** (Final significance after impact prioritisation).

12.7.1.1 Mitigation Measures

Additional mitigation measures are not required for typical decommissioning activities.

12.7.1.2 Cumulative Impacts

Potential cumulative effects from rehabilitation activities will be low.

12.7.1.3 Irreplaceable loss of Resources

Noise generating activities do not destroy resources permanently, and a quiet environment is generally considered a renewable or restorable resource rather than an irreplaceable one.

12.7.1.4 Impact on Alternatives Considered

Having a minor risk to result in a noise impact, alternatives were not assessed for rehabilitation activities.

Table 12-8: Significance Rating – Pre Mitigation

Impact	Phase	Event	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Pre-Mitigation Significance
Daytime transport of people, equipment, material and drilling cores	Mobilisation	Normal operations or events	-1	2	1	1	1	-1.25	1	-1.25	Low -
Daytime transport of people, equipment, material and drilling cores	Construction	Normal operations or events	-1	2	1	1	1	-1.25	1	-1.25	Low -
Various daytime site preparation activities raising noise levels	Construction	Normal operations or events	-1	2	1	2	1	-1.5	2	-3	Low -
Seismic surveys raising noise levels during the day	Construction	Normal operations or events	-1	2	1	2	1	-1.5	2	-3	Low -
Trenching activities raising noise levels during the day	Construction	Normal operations or events	-1	2	1	1	1	-1.25	2	-2.5	Low -
Daytime drilling of boreholes (drilling, generator, compressor)	Construction	Normal operations or events	-1	2	1	2	1	-1.5	4	-6	Medium to low -
Daytime drilling of boreholes (drilling, generator, compressor)	Operation	Normal operations or events	-1	2	1	2	1	-1.5	4	-6	Medium to low -
Daytime transport of people, equipment, material and product	Operation	Normal operations or events	-1	2	4	1	1	-2	1	-2	Low -
Night-time transport of people, equipment, material and product	Operation	Normal operations or events	-1	3	4	1	1	-2.25	1	-2.25	Low -
Daytime plant operations (generator, compressors, fans, etc.)	Operation	Normal operations or events	-1	2	4	1	1	-2	1	-2	Low -
Night-time plant operations (generator, compressors, fans, etc.)	Operation	Normal operations or events	-1	3	4	1	1	-2.25	1	-2.25	Low -
Emergency release or flaring of gas	Operation	Abnormal or unplanned events	-1	3	4	3	1	-2.75	3	-8.25	Medium to low -
Dismantling of equipment and infrastructure (daytime)	Decommissioning	Normal operations or events	-1	2	1	1	1	-1.25	1	-1.25	Low -
Rehabilitation activities (daytime)	Rehab and Closure	Normal operations or events	-1	2	1	1	1	-1.25	1	-1.25	Low -

Table 12-9: Significance Rating – Post Mitigation

Impact	Phase	Event	Post-Nature	Post-Extent	Post-Duration	Post-Magnitude	Post-Reversibility	Consequence2	Post-Probability	Post-mitigation Significance Score	Post-Mitigation Significance
Daytime transport of people, equipment, material and drilling cores	Mobilisation	Normal operations or events	-1	2	1	1	1	-1.25	1	-1.25	Low -
Daytime transport of people, equipment, material and drilling cores	Construction	Normal operations or events	-1	2	1	1	1	-1.25	1	-1.25	Low -
Various daytime site preparation activities raising noise levels	Construction	Normal operations or events	-1	2	1	2	1	-1.5	2	-3	Low -
Seismic surveys raising noise levels during the day	Construction	Normal operations or events	-1	2	1	2	1	-1.5	2	-3	Low -
Trenching activities raising noise levels during the day	Construction	Normal operations or events	-1	2	1	1	1	-1.25	2	-2.5	Low -
Daytime drilling of boreholes (drilling, generator, compressor)	Construction	Normal operations or events	-1	2	1	2	1	-1.5	2	-3	Low -
Daytime drilling of boreholes (drilling, generator, compressor)	Operation	Normal operations or events	-1	2	1	2	1	-1.5	2	-3	Low -
Daytime transport of people, equipment, material and product	Operation	Normal operations or events	-1	2	4	1	1	-2	1	-2	Low -
Night-time transport of people, equipment, material and product	Operation	Normal operations or events	-1	3	4	1	1	-2.25	1	-2.25	Low -
Daytime plant operations (generator, compressors, fans, etc.)	Operation	Normal operations or events	-1	2	4	1	1	-2	1	-2	Low -
Night-time plant operations (generator, compressors, fans, etc.)	Operation	Normal operations or events	-1	3	4	1	1	-2.25	1	-2.25	Low -
Emergency release or flaring of gas	Operation	Abnormal or unplanned events	-1	3	4	3	1	-2.75	2	-5.5	Medium to low -
Dismantling of equipment and infrastructure (daytime)	Decommissioning	Normal operations or events	-1	2	1	1	1	-1.25	1	-1.25	Low -
Rehabilitation activities (daytime)	Rehab and Closure	Normal operations or events	-1	2	1	1	1	-1.25	1	-1.25	Low -

Table 12-10: Final Significance Rating – after Impact Prioritisation

Impact	Phase	Event	Confidence	Cumulative Impact	Irreplaceable loss	Priority Factor	Final score	Final Significance
Daytime transport of people, equipment, material and drilling cores	Mobilisation	Normal operations or events	Medium	1	1	1.00	-1.25	Low -
Daytime transport of people, equipment, material and drilling cores	Construction	Normal operations or events	Medium	1	1	1.00	-1.25	Low -
Various daytime site preparation activities raising noise levels	Construction	Normal operations or events	Medium	1	1	1.00	-3.00	Low -
Seismic surveys raising noise levels during the day	Construction	Normal operations or events	Medium	1	1	1.00	-3.00	Low -
Trenching activities raising noise levels during the day	Construction	Normal operations or events	Medium	1	1	1.00	-2.50	Low -
Daytime drilling of boreholes (drilling, generator, compressor)	Construction	Normal operations or events	Medium	1	1	1.00	-3.00	Low -
Daytime drilling of boreholes (drilling, generator, compressor)	Operation	Normal operations or events	Medium	1	1	1.00	-3.00	Low -
Daytime transport of people, equipment, material and product	Operation	Normal operations or events	Medium	1	1	1.00	-2.00	Low -
Night-time transport of people, equipment, material and product	Operation	Normal operations or events	Medium	1	1	1.00	-2.25	Low -
Daytime plant operations (generator, compressors, fans, etc.)	Operation	Normal operations or events	Medium	1	1	1.00	-2.00	Low -
Night-time plant operations (generator, compressors, fans, etc.)	Operation	Normal operations or events	Medium	1	1	1.00	-2.25	Low -
Emergency release or flaring of gas	Operation	Abnormal or unplanned events	Low	1	1	1.00	-5.50	Medium to low -
Dismantling of equipment and infrastructure (daytime)	Decommissioning	Normal operations or events	Medium	1	1	1.00	-1.25	Low -
Rehabilitation activities (daytime)	Rehab and Closure	Normal operations or events	Medium	1	1	1.00	-1.25	Low -

13 SPECIALIST MANAGEMENT PLAN

Potential management measures are highlighted in the table for below for potential inclusion in the environmental management programme report for the project.

No.	Mitigation Measures	Phase(s)	Timeframe	Responsible Party (for implementation)	Monitoring Party	Target	Performance Indicators
Traffic / Logistics – project vehicular traffic passing NSR locations							
A	Inform NSRs within 60 m of access roads; consider relocating/offsetting access >60 m if complaints; minimize night movements within 120 m; enforce speed limits, reduce speeds within 60m from NSR; no idling >2 min at gates; prohibit engine braking near NSRs; maintain silencers/tires; schedule heavy deliveries daytime; avoid convoying past NSRs	Mobilization Construction Operation Decommissioning Rehabilitation	Route planning during planning phase.	Applicant (routing/engagement); Contractor (driving/maintenance) Environmental Control Officer (ECO) (auditing/training/ complaint log)	ECO (monthly spot checks; complaint log continuous)	Compliance with legislation and EMP conditions	No substantiated complaints
Site preparation activities							
B	Applicant to consider the use of broadband reverse alarms; ensure well-maintained mufflers and equipment; limit concurrent activities when working within 500m from NSR	Construction	Method statements before works; continued during works.	Contractor	ECO (weekly during bulk earthworks; continuation of complaints log)	Compliance with legislation and EMP; best international practice	No substantiated complaints
Seismic surveys							

C	Optimize line layout to maximize setbacks further than 500m from all NSR where possible; reduce speeds when within 60m from NSR; applicant to consider the use of broadband alarms; stage/refuel away from NSR locations	Construction Operation	Method statements before works; continued during works.	Seismic Contractor; Applicant (authorisation/engagement)	ECO to review complaint log	Compliance with legislation and EMPr	No substantiated complaints
Trenching activities within 500m from NSR							
D	Notify nearby NSRs of proposed trenching activities	Construction Operation	Method statements before works; continued during works.	Contractor/ECO	ECO to review complaint log monthly.	Compliance with legislation and EMPr	No substantiated complaints
Borehole drilling activities							
E	Ensure silencers on generator/compressor; Operate drill at steady loads, no unnecessary revving; minimize simultaneous high-noise tasks when operating closer 1,000m from NSR; notify NSR of drilling activities.	Construction Operation	Method statements before works; continued during works.	Contractor/ECO	ECO to review complaint log monthly.	Compliance with legislation and EMPr	No substantiated complaints
Emergency release or flaring of gas							
F	Minimize reliance on flaring (segmented/staged blowdown); low-noise tips; tuned steam/air assist; silencers on reliefs where practicable; avoid test flaring at night; post-event review; NSR notifications (when safe)	Operations (abnormal/emergency)	Design readiness before operation; during events; post-event	Process Engineer/Operations Manager	ECO / Applicant (Event log each occurrence; incident review within 5 working days; complaint log)	Compliance with legislation and EMPr	Avoid events/incidents, limited substantiated complaints

Notes:

- Legislation/guidelines: Refer to PNCR (see section 5.1.1) and this report for recommended upper noise limits as well as EA/EMPr conditions.

- Where “spot noise measurement” is stated, use a Class 1 meter, reporting on the $L_{Aeq,1h}$ (and note tones/impulsivity if present).
- If any substantiated complaint is received, implement a corrective action plan (source check, additional screening, schedule adjustment) within 10 working days.

14 RECOMMENDATIONS AND CONCLUSION

This ENIA covers the proposed development of the D3 Energy Project south-east of Virginia, Free State Province. Potential worst-case noise rating levels were calculated using a sound propagation model using conceptual scenarios for the construction and operational phases, using simplified noise propagation modelling to estimate potential noise impacts associated with the decommissioning and rehabilitation phases.

Using conceptual noise propagation modelling and the experience of the author, it was determined that the potential noise impacts for the different phases of the project would be:

- of a **low significance** for daytime transport activities (project vehicles driving past NSR locations);
- of a **low significance** for daytime site preparation activities;
- of a **low significance** for daytime seismic surveys;
- of a **low significance** for daytime trenching activities;
- of a potential **medium significance** for the drilling of production boreholes, with mitigation measures available that could reduce the noise level or the probabilities of annoying nearby NSR;
- of a **low significance** for day- and night-time activities associated with the processing of the resource (project plant operations);
- of a potential **medium significance** for the unplanned or emergency release or flaring of gas, with mitigation measures available that could reduce the noise level or the probabilities of annoying nearby NSR;
- of a **low significance** for noise associated with decommissioning activities; and
- of a **low significance** for noise associated with rehabilitation activities.

This noise assessment indicates that, with the proposed layout and setbacks; construction, operational, decommissioning and rehabilitation activities will result in low significance noise impacts at identified NSR locations. Medium significance may arise pre-mitigation for a limited subset of activities, mainly associated with production borehole drilling (when near NSR locations) and abnormal plant operations (plant blowdown, release of gas, :

- night-time site preparation near NSR16;
- night-time seismic surveys within approximately 800–1,000 m of NSR;
- night-time drilling within approximately 1,000 m (primarily affecting NSR16); and
- night-time logistics where access routes pass within 50–200 m of dwellings.

Emergency depressurisation/flaring also carries a medium significance on a precautionary basis due to its unpredictable, high-level and short-duration character that may startle NSRs in the area.

With the gas processing plant and gas-to-power generator are located more than 2 km from the nearest NSR and, with containerised equipment, are expected to contribute low operational noise day and night.

Cumulative effects are expected to be insignificant, because noise do not contribute to other noises generated at other locations located further than 2,000m from a noise-generating activity.

Monitoring and adaptive management are integral, especially the implementation of a complaint mechanism with rapid response and corrective action. While some of the noises would be audible to clearly audible at the closest NSR (especially drilling activities), the increase in noise levels is not considered a fatal flaw. On this basis, it is recommended that the D3 Energy project be authorized (from a noise perspective).

This assessment is not subject to any conditions.

15 REFERENCES

In this report reference was made to the following documentation:

1. Autumn, Lyn Radle. 2007: *The effect of noise on Wildlife: A literature review*.
2. Baldwin, A.L. 2007: *Effect of Noise on Rodent Physiology*.
3. Barber, J.R., K.R. Crooks, and K. Fristrup. 2010. *The costs of chronic noise exposure for terrestrial organisms*. Trends Ecology and Evolution 25(3): 180–189
4. Bennet-Clark, H.C, 1994. *The Scaling of Song Frequency in Cicadas*. The Company of Biologist Limited.
5. Blickley, J.L. and Patricelli, G.L. 2010. Impacts of Anthropogenic Noise on Wildlife: Research Priorities for the Development of Standards and Mitigation. Journal of International Wildlife Law & Policy, 13:274–292.
6. Broucek, J. 2014. Effect of Noise on Performance, Stress and Behaviour of Animals. Slovak J. Anim. Sci., 47, 2014 (2): 111-123
7. Brüel&Kjær, 2007: Investigation of Tonal Noise.
8. Brumm, 2004: The impact of environmental noise on songs amplitude in a territorial bird: Journal of Animal Ecology 2004 73, p. 434-440
9. Cooper, S. Chan, C. 2020: *Determination of Acoustic Compliance of Wind Farms*. Acoustics **2020**, 2, 416–450; doi:10.3390/acoustics2020024
10. Council of Canadian Academies, 2015: Understanding the Evidence: Wind Turbine Noise. Ottawa (ON): The Expert Panel on Wind Turbine Noise and Human Health. Council of Canadian Academies
11. Crichton *et al.* (2014): *Can expectations produce symptoms from infrasound associated with wind turbines?*. Health Psychology, Vol 33(4), Apr 2014, 360-364
12. Crichton, F., Dodd, G., Schmid, G., Gamble, G., Cundy, T., & Petrie, K. J. (2014). *The power of positive and negative expectations to influence reported symptoms and mood during exposure to wind farm sound*. Health psychology : official journal of the Division of Health Psychology, American Psychological Association, 33(12), 1588–1592. <https://doi.org/10.1037/hea0000037>
13. Cummings, J. 2012: *Wind Farm Noise and Health: Lay summary of new research released in 2011*. Acoustic Ecology Institute, April 2012 (online resource: http://www.acousticecology.org/wind/winddocs/AEI_WindFarmsHealthResearch2011.pdf)
14. Cummings, J. 2009: *AEI Special Report: Wind Energy Noise Impacts*. Acoustic Ecology Institute, (online resource: <http://acousticecology.org/srwind.html>)
15. Department of Transport. *Calculation of Road Traffic Noise*. 1988.
16. Dooling, R. J., Popper, A. N. 2007. *The effects of highway noise on birds*. Report to the California Department of Transportation, contract 43AO139. California

- Department of Transportation, Division of Environmental Analysis, Sacramento, California, USA
17. Commission Green Paper (Com (96) 540)
 18. European Parliament, 2002: '*Directive 2002/49/EC, relating to the assessment and management of environmental noise*'. Official Journal of the European Communities, L 189/12
 19. Everest and Pohlmann, 2009: *Master Handbook of Acoustics*. Fifth Edition.
 20. Fégeant, O. 2002: *Masking of Wind Turbine Noise: Influence of Wind Turbulence on Ambient Noise Fluctuations*
 21. Francis, C.D. et al, 2011: *Different behavioural responses to anthropogenic noise by two closely related passerine birds*. Biol. Lett. (2011) 7, 850-852 doi:10.1098 / rsbl.2011.0359
 22. Francis, C.D. et al, 2012: *Noise pollution alters ecological services: enhanced pollination and disrupted seed dispersal*. Proc. R Soc. B doi: 10.1098 / rsbl.2012.0230
 23. International Finance Corporation. *General EHS Guidelines – Environmental Noise Management*.
 24. ISO 9613-2: 1996. *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*.
 25. Halfwerk, W. et al. 2011: *Low-frequency songs lose their potency in noisy urban conditions*. PNAS, August 30, 2011, vol. 108, no. 35, 14549-14554.
 26. Hartley, J.C., 1991: *Can Bush Crickets Discriminate Frequency?* University of Nottingham.
 27. Helldin, J.O., Jung, J., Neumann, W., Olsson, M., Skarin, A. and Widemo, F. 2012. *The impacts of wind power on terrestrial mammals: a synthesis*. Report 6510. Swedish Environmental Protection Agency.
 28. Lohr, B. Wright, TF. Dooling, RJ. 2003: *Detection and discrimination of natural calls in masking noise by birds: estimating the active space of a signal*. Animal Behavior 65:763-777
 29. Łopucki, R. Klich, D. Gielarek, S. 2016: *Do terrestrial animals avoid areas close to turbines in functioning wind farms in agricultural landscapes?* Environ Monit Assess (2016) 188:122
 30. Miedema, H.M., Vos, H. 2003: *Noise sensitivity and reactions to noise and other environmental conditions*. J. Acoust. Soc. Am. **113**(3), 1492–504
 31. Milieu, 2010: *Inventory of Potential Measures for a Better Control of Environmental Noise*. DG Environment of the European Commission.
 32. National Park Services. *Soundscape Preservation and Noise Management*. 2000. Pg. 1.

33. Ortega, CP. 2012. *Ornithological Monographs. Chapter 2: Effects of noise pollution on birds: A brief review of our knowledge*. 74(1), pp.6-22.
34. Norton, M.P. and Karczub, D.G., 2003: *Fundamentals of Noise and Vibration Analysis for Engineers*. Second Edition.
35. Noise quest, Aviation Noise Information & Resources, 2010: <https://www.noisequest.psu.edu/noiseeffects-animals.html>
36. Parnell, J. 2015: "*The Generation and propagation of noise from large coal mines, and how it is managed in NSW*". NSW Department of Planning and Environment, Sydney NSW, Australia
37. Parris, M. Schneider, A. 2009: *Impacts of traffic noise and traffic volume on birds of roadside habitats*. Ecology and Society 14(1): 29
38. Rabin, L.A., R.G. Coss, D.H. Owings. 2006. *The effects of wind turbines on antipredator behavior in California ground squirrels (Spermophilus beecheyi)*. Biological Conservation 131: 410-420
39. SANS 10103:2008. *The measurement and rating of environmental noise with respect to annoyance and to speech communication*.
40. SANS 10210:2004. *Calculating and predicting road traffic noise*.
41. SANS 10328:2008. *Methods for environmental noise impact assessments*.
42. SANS 10357:2004. *The calculation of sound propagation by the Concave method*.
43. SANS 9614-3:2005. *Determination of sound power levels of noise sources using sound intensity – Part 3: Precision method for measurement by scanning*.
44. Saurenman, H. Chambers, J. Sutherland, LC. Bronsdon, RL. Forschner, H. 2005: "*Atmospheric effects associated with highway noise propagation*". Final Report 555. Arizona Department of Transportation, US Dept of Transport. Federal Highway Administration
45. Schaub, A, J. Ostwald and B.M. Siemers. 2008. "*Foraging bats avoid noise*". The Journal of Experimental Biology 211: 3174-3180
46. Senekal, HB. 2021: *Traffic Impact Assessment Report – Proposed Arnot South Coal Mining Project, situated near Hendrina, Mpumalanga Province*. EDL Engineers (Pty) Ltd, Pretoria
47. Sing et al, 2001: *Ambient noise levels due to dawn chorus at different habitats in Delhi*. Environ. We Int. J. Sci. Tech. 6, Pg. 123-134.
48. Shannon, G., McKenna, M.F., Angeloni, L.M., Crooks, K.R., Fristrup, K.M., Brown, E., Warner, K.A., Nelson, M.D., White, C., Briggs, J., McFarland, S. and Wittemyer, G. 2015. *A synthesis of two decades of research documenting the effects of noise on wildlife*. Biological Reviews.
49. Šottník, J. 2011: *Influence of noise and object noisiness on animal breeding*. Šiška, B. – Hauptvogel, M. – Eliašová, M. (eds.). Bioclimate: Source and Limit of Social

Development International Scientific Conference, 6th – 9th September 2011,
Topoľčianky, Slovakia

50. USEPA, 1971: *Effects of Noise on Wildlife and other animals*.
51. Van den Berg, G.P., 2003. 'Effects of the wind profile at night on wind turbine sound'. Journal of Sound and Vibration
52. Van den Berg, F., Verhagen, C., Uitenbroek, D. (2014): *The relation between scores on noise annoyance and noise disturbed sleep in a public health survey*. Int. J. Environ. Res. Public Health **11**(2), 2314–27
53. Van Riet, W et al. 1998: *Environmental potential atlas for South Africa*. Pretoria.
54. Wei, B.L., 1969: *Physiological effects of audible sound*. AAAS Symposium Science, 166(3904). 533-535.
55. White Noise Reverse Alarms: www.brigade-electronics.com/products.
56. World Health Organization, 2009. *Night Noise Guidelines for Europe*.
57. World Health Organization, 1999. Protection of the Human Environment. *Guidelines for Community Noise*.
58. Zwart, M.C et al. 2014: *Wind farm noise suppresses territorial defense behavior in a songbird*. Behavioral Ecology arv128(1), July 2014

APPENDIX A

Glossary of Acoustic Terms, Definitions and General Information

<i>1/3-Octave Band</i>	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.
<i>A – Weighting</i>	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.
<i>Air Absorption</i>	The phenomena of attenuation of sound waves with distance propagated in air, due to dissipative interaction within the gas molecules.
<i>Alternatives</i>	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.
<i>Ambient</i>	The conditions surrounding an organism or area.
<i>Ambient Noise</i>	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.
<i>Ambient Sound</i>	The all-encompassing sound at a point being composite of sounds from near and far.
<i>Ambient Sound Level</i>	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.
<i>Amplitude Modulated Sound</i>	A sound that noticeably fluctuates in loudness over time.
<i>Applicant</i>	Any person who applies for an authorisation to undertake a listed activity or to cause such activity in terms of the relevant environmental legislation.
<i>Assessment</i>	The process of collecting, organising, analysing, interpreting and communicating data that is relevant to some decision.
<i>Attenuation</i>	Term used to indicate reduction of noise or vibration, by whatever method necessary, usually expressed in decibels.
<i>Audible frequency Range</i>	Generally assumed to be the range from about 20 Hz to 20,000 Hz, the range of frequencies that our ears perceive as sound.
<i>Ambient Sound Level</i>	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.
<i>Broadband Noise</i>	Spectrum consisting of a large number of frequency components, none of which is individually dominant.
<i>C-Weighting</i>	This is an international standard filter, which can be applied to a pressure signal or to a <i>SPL</i> or <i>PWL</i> 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.
<i>Controlled area (as per National Noise Control Regulations)</i>	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 from 06:00 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;
<i>dB(A)</i>	Sound Pressure Level in decibel that has been A-weighted, or filtered, to match the response of the human ear.
<i>Decibel (db)</i>	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.
<i>Diffraction</i>	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.
<i>Direction of Propagation</i>	The direction of flow of energy associated with a wave.
<i>Disturbing noise</i>	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.
<i>Environment</i>	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.
<i>Environmental Control Officer</i>	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.
<i>Environmental impact</i>	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.
<i>Environmental Impact Assessment</i>	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.
<i>Environmental issue</i>	A concern felt by one or more parties about some existing, potential or perceived environmental impact.
<i>Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$)</i>	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.
<i>Equivalent continuous A-weighted rating level ($L_{Req,T}$)</i>	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.
<i>F (fast) time weighting</i>	(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.
<i>Footprint area</i>	Area to be used for the construction of the proposed development, which does not include the total study area.
<i>Free Field Condition</i>	An environment where there are no reflective surfaces.
<i>Frequency</i>	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.
<i>Greenfield</i>	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.
<i>G-Weighting</i>	An International Standard filter used to represent the infrasonic components of a sound spectrum.
<i>Harmonics</i>	Any of a series of musical tones for which the frequencies are integral multiples of the frequency of a fundamental tone.
<i>I (impulse) time weighting</i>	(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.
<i>Impulsive sound</i>	A sound characterized by brief excursions of sound pressure (transient signal) that significantly exceed the ambient sound level.
<i>Infrasound</i>	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.
<i>Integrated Development Plan</i>	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).
<i>Integrated Environmental Management</i>	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.
<i>Interested and affected parties</i>	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.
<i>Key issue</i>	An issue raised during the Scoping process that has not received an adequate response and that requires further investigation before it can be resolved.
<i>L_{A90}</i>	the sound level exceeded for the 90% of the time under consideration
<i>Listed activities</i>	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.
<i>L_{AMin} and L_{AMax}</i>	Is the RMS (root mean squared) minimum or maximum level of a noise source.
<i>Loudness</i>	The attribute of an auditory sensation that describes the listener's ranking of sound in terms of its audibility.
<i>Magnitude of impact</i>	Magnitude of impact means the combination of the intensity, duration and extent of an impact occurring.
<i>Masking</i>	The raising of a listener's threshold of hearing for a given sound due to the presence of another sound.
<i>Mitigation</i>	To cause to become less harsh or hostile.
<i>Negative impact</i>	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).
<i>Noise</i>	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.
<i>Noise Level</i>	The term used in lieu of sound level when the sound concerned is being measured or ranked for its undesirability in the contextual circumstances.

<i>Noise-sensitive development</i>	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
<i>Octave Band</i>	A filter with a bandwidth of one octave, or twelve semi-tones on the musical scale representing a doubling of frequency.
<i>Positive impact</i>	A change that improves the quality of life of affected people or the quality of the environment.
<i>Property</i>	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
<i>Public Participation Process</i>	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
<i>Reflection</i>	Redirection of sound waves.
<i>Refraction</i>	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.
<i>Reverberant Sound</i>	The sound in an enclosure which results from repeated reflections from the boundaries.
<i>Reverberation</i>	The persistence, after emission of a sound, has stopped, of a sound field within an enclosure.
<i>Significant Impact</i>	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.
<i>S (slow) time weighting</i>	(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.
<i>Sound Level</i>	The level of the frequency and time-weighted sound pressure as determined by a sound level meter, i.e. A-weighted sound level.
<i>Sound Power</i>	Of a source, the total sound energy radiated per unit time.
<i>Sound Pressure Level (SPL)</i>	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.
<i>Soundscape</i>	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.
<i>Study area</i>	Refers to the entire study area encompassing all the alternative routes as indicated on the study area map.

<i>Sustainable Development</i>	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).
<i>Tread braked</i>	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.
<i>Zone of Potential Influence</i>	The area defined as the radius about an object, or objects beyond which the noise impact will be insignificant.
<i>Zone Sound Level</i>	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

Photos of Measurement Locations

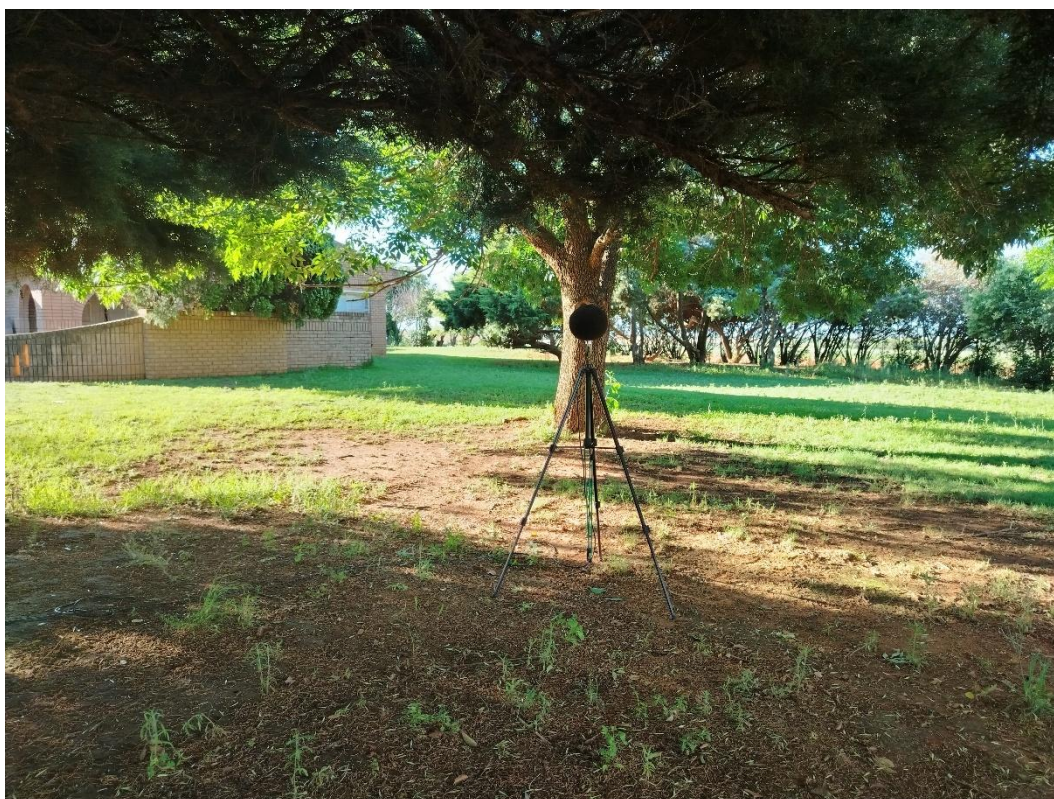


Photo B.1: Photos of measurement location EVLTSL01



Photo B.2: Photos of measurement location EVLTS02



Photo B.3: Photos of measurement location EVLTSL03

APPENDIX C

Calculated conceptual noise rating levels and
potential significance

Appendix C, Table 1: Projected worst-case noise rating levels and impact – Conceptual daytime construction activities

Potential Noise-sensitive development / Receptor(s)	Recommended Rating Levels (noise limit - daytime rating level, Rural)	Potential Existing Ambient Sound Levels (long-term average as measured - Fast-weighted)	Potential Ambient Noise Levels (Modelled - Existing road traffic)	Projected Noise Level (modelled or calculated, excluding existing ambient sound levels)	Change in rating level	Magnitude / Intensity	Duration	Extent	Reversibility	Probability of Impact Occurring	Significance
NSR01	45	47.7	15.2	32.0	0.1	Minor	Temporary	Site	High	Improbable	Low
NSR02	45	47.7	19.3	34.3	0.2	Minor	Temporary	Site	High	Improbable	Low
NSR03	45	47.7	20.1	34.5	0.2	Minor	Temporary	Site	High	Improbable	Low
<i>NSR04</i>	<i>45</i>	<i>47.7</i>	<i>42.2</i>	<i>75.5</i>	<i>27.8</i>	<i>Very High</i>	<i>Temporary</i>	<i>Site</i>	<i>High</i>	<i>Definite</i>	<i>High-Medium</i>
<i>NSR05</i>	<i>45</i>	<i>47.7</i>	<i>39.6</i>	<i>56.8</i>	<i>9.6</i>	<i>High</i>	<i>Temporary</i>	<i>Site</i>	<i>High</i>	<i>Likely</i>	<i>Low-medium</i>
<i>NSR06</i>	<i>45</i>	<i>47.7</i>	<i>40.1</i>	<i>52.6</i>	<i>6.1</i>	<i>Moderate</i>	<i>Temporary</i>	<i>Site</i>	<i>High</i>	<i>Possible</i>	<i>Low</i>
NSR07	45	47.7	40.1	44.9	1.8	Minor	Temporary	Site	High	Improbable	Low
NSR08	45	47.7	19.3	40.7	0.8	Minor	Temporary	Site	High	Improbable	Low
NSR09	45	47.7	24.4	41.0	0.8	Minor	Temporary	Site	High	Improbable	Low
NSR10	45	47.7	36.2	48.9	3.7	Low	Temporary	Site	High	Improbable	Low
NSR11	45	47.7	11.3	46.6	2.5	Minor	Temporary	Site	High	Improbable	Low
NSR12	45	47.7	10.6	44.0	1.6	Minor	Temporary	Site	High	Improbable	Low
NSR13	45	47.7	11.1	46.9	2.6	Minor	Temporary	Site	High	Improbable	Low
<i>NSR14</i>	<i>45</i>	<i>47.7</i>	<i>35.4</i>	<i>50.7</i>	<i>4.7</i>	<i>Low</i>	<i>Temporary</i>	<i>Site</i>	<i>High</i>	<i>Possible</i>	<i>Low</i>
NSR15	45	47.7	21.3	42.1	1.1	Minor	Temporary	Site	High	Improbable	Low
NSR16	45	47.7	6.9	60.7	13.3	Very High	Temporary	Site	High	Highly Likely	High-Medium
<i>NSR17</i>	<i>45</i>	<i>47.7</i>	<i>0.1</i>	<i>49.3</i>	<i>3.9</i>	<i>Low</i>	<i>Temporary</i>	<i>Site</i>	<i>High</i>	<i>Improbable</i>	<i>Low</i>
NSR18	45	47.7	10.3	49.2	3.8	Low	Temporary	Site	High	Improbable	Low
NSR19	45	47.7	14.5	37.1	0.4	Minor	Temporary	Site	High	Improbable	Low
NSR20	45	47.7	15.5	36.5	0.3	Minor	Temporary	Site	High	Improbable	Low
NSR21	45	47.7	28.1	49.1	3.8	Low	Temporary	Site	High	Improbable	Low

<i>NSR22</i>	<i>45</i>	<i>47.7</i>	<i>25.0</i>	<i>67.0</i>	<i>19.3</i>	<i>Very High</i>	<i>Temporary</i>	<i>Site</i>	<i>High</i>	<i>Definite</i>	<i>High-Medium</i>
NSR23	45	47.7	23.9	55.8	8.8	High	Temporary	Site	High	Likely	Low-medium
NSR24	45	47.7	22.9	54.5	7.6	High	Temporary	Site	High	Possible	Low
NSR25	45	47.7	23.2	51.7	5.4	Moderate	Temporary	Site	High	Possible	Low
NSR26	45	47.7	7.3	39.1	0.6	Minor	Temporary	Site	High	Improbable	Low
<i>NSR27</i>	<i>45</i>	<i>47.7</i>	<i>14.6</i>	<i>54.3</i>	<i>7.5</i>	<i>High</i>	<i>Temporary</i>	<i>Site</i>	<i>High</i>	<i>Possible</i>	<i>Low</i>
NSR28	45	47.7	11.9	35.1	0.2	Minor	Temporary	Site	High	Improbable	Low
NSR29	45	47.7	10.9	34.0	0.2	Minor	Temporary	Site	High	Improbable	Low
NSR30	45	47.7	18.9	34.6	0.2	Minor	Temporary	Site	High	Improbable	Low
NSR31	45	47.7	10.3	32.3	0.1	Minor	Temporary	Site	High	Improbable	Low
NSR32	45	47.7	0.0	32.7	0.1	Minor	Temporary	Site	High	Improbable	Low
<i>NSR33</i>	<i>45</i>	<i>47.7</i>	<i>18.2</i>	<i>32.8</i>	<i>0.1</i>	<i>Minor</i>	<i>Temporary</i>	<i>Site</i>	<i>High</i>	<i>Improbable</i>	<i>Low</i>
<i>NSR34</i>	<i>45</i>	<i>47.7</i>	<i>2.6</i>	<i>50.4</i>	<i>4.6</i>	<i>Low</i>	<i>Temporary</i>	<i>Site</i>	<i>High</i>	<i>Possible</i>	<i>Low</i>
NSR35	45	47.7	5.2	57.4	10.1	Very High	Temporary	Site	High	Likely	Low-medium
NSR36	45	47.7	0.0	47.7	3.0	Low	Temporary	Site	High	Improbable	Low
NSR37	45	47.7	0.0	0.0	0.0	Minor	Temporary	Site	High	Improbable	Low

NSR is grey/italicized font were identified during scoping phase, but are not noise sensitive (storage/shed, uninhabited)

Appendix C, Table 2: Projected worst-case noise rating levels and impact – Conceptual daytime operational activities

Potential Noise-sensitive development / Receptor(s)	Recommended Rating Levels (noise limit - daytime rating level, Rural)	Potential Existing Ambient Sound Levels (long-term average as measured - Fast-weighted)	Potential Ambient Noise Levels (Modelled - Existing road traffic)	Projected Noise Level (modelled or calculated, excluding existing ambient sound levels)	Change in rating level	Magnitude / Intensity	Duration	Extent	Reversibility	Probability of Impact Occurring	Significance
NSR01	45	47.7	15.2	15.2	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR02	45	47.7	19.3	19.3	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR03	45	47.7	20.1	20.1	0.0	Minor	Short-term	Local	High	Improbable	Low
<i>NSR04</i>	<i>45</i>	<i>47.7</i>	<i>42.2</i>	<i>42.2</i>	<i>1.1</i>	<i>Minor</i>	<i>Short-term</i>	<i>Local</i>	<i>High</i>	<i>Improbable</i>	<i>Low</i>
<i>NSR05</i>	<i>45</i>	<i>47.7</i>	<i>39.6</i>	<i>39.6</i>	<i>0.6</i>	<i>Minor</i>	<i>Short-term</i>	<i>Local</i>	<i>High</i>	<i>Improbable</i>	<i>Low</i>

ENVIRO-ACOUSTIC RESEARCH

ENIA – D3 ENERGY PROJECT



NSR06	45	47.7	40.1	40.1	0.7	Minor	Short-term	Local	High	Improbable	Low
NSR07	45	47.7	40.1	40.1	0.7	Minor	Short-term	Local	High	Improbable	Low
NSR08	45	47.7	19.3	19.3	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR09	45	47.7	24.4	24.4	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR10	45	47.7	36.2	36.2	0.3	Minor	Short-term	Local	High	Improbable	Low
NSR11	45	47.7	11.3	11.4	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR12	45	47.7	10.6	12.9	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR13	45	47.7	11.1	13.5	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR14	45	47.7	35.4	44.5	1.7	Minor	Short-term	Local	High	Improbable	Low
NSR15	45	47.7	21.3	25.6	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR16	45	47.7	6.9	6.9	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR17	45	47.7	0.1	0.1	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR18	45	47.7	10.3	10.3	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR19	45	47.7	14.5	17.2	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR20	45	47.7	15.5	17.4	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR21	45	47.7	28.1	28.1	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR22	45	47.7	25.0	25.0	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR23	45	47.7	23.9	23.9	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR24	45	47.7	22.9	22.9	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR25	45	47.7	23.2	23.2	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR26	45	47.7	7.3	7.3	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR27	45	47.7	14.6	14.6	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR28	45	47.7	11.9	11.9	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR29	45	47.7	10.9	10.9	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR30	45	47.7	18.9	18.9	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR31	45	47.7	10.3	10.3	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR32	45	47.7	0.0	0.0	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR33	45	47.7	18.2	18.2	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR34	45	47.7	2.6	2.6	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR35	45	47.7	5.2	5.2	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR36	45	47.7	0.0	0.0	0.0	Minor	Short-term	Local	High	Improbable	Low
NSR37	45	47.7	0.0	0.0	0.0	Minor	Short-term	Local	High	Improbable	Low

Appendix C, Table 3: Projected worst-case noise rating levels and impact – Conceptual night-time operational activities

Potential Noise-sensitive development / Receptor(s)	Recommended Rating Levels (noise limit - night-time rating level, Rural)	Potential Existing Ambient Sound Levels (long-term average as measured - Fast-weighted)	Potential Ambient Noise Levels (Modelled - Existing road traffic)	Projected Noise Level (modelled or calculated, excluding existing ambient sound levels)	Change in rating level	Magnitude / Intensity	Duration	Extent	Reversibility	Probability of Impact Occurring	Significance
NSR01	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR02	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR03	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR04	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR05	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR06	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR07	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR08	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR09	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR10	35	37.1	0.0	9.2	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR11	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR12	35	37.1	0.0	8.9	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR13	35	37.1	0.0	9.5	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR14	35	37.1	0.0	42.3	6.4	Moderate	Long-term	Regional	High	Possible	Low
NSR15	35	37.1	0.0	21.2	0.1	Minor	Long-term	Regional	High	Improbable	Low
NSR16	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR17	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR18	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR19	35	37.1	0.0	12.7	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR20	35	37.1	0.0	11.7	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR21	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR22	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR23	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low

NSR24	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR25	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR26	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR27	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR28	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR29	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR30	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR31	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR32	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR33	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR34	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR35	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR36	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low
NSR37	35	37.1	0.0	0.0	0.0	Minor	Long-term	Regional	High	Improbable	Low

End of Report