Vredenburg Windfarm (Pty) Ltd

NOISE REPORT FOR SCOPING PURPOSES

Establishment of the 140MW Boulders Wind Farm within the Saldanha Bay Municipal Area, Western Cape

Study done for:

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Client:

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for
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EXECUTIVE SUMMARY

INTRODUCTION AND PURPOSE

Enviro-Acoustic Research cc was commissioned to undertake a specialist study to determine the potential noise impact on the surrounding environment due to the establishment of the Boulders Wind Farm (WF) on various farms close to the town of Vredenburg in the Western Cape.

This report is the result of the initial phase study (desktop) of the Environmental Impact Assessment (EIA) process investigating the potential noise impact that such a facility may have on the surrounding environment, highlighting methodologies, potential issues to be investigated as well as preliminary findings and recommendations.

PROJECT DESCRIPTION

Vredenburg Windfarm (Pty) Ltd (hereafter referred as the developer) proposes the establishment of the Boulders Wind Farm and associated infrastructure on various farms within the Saldanha Bay Local Municipal area in the Western Cape.

The footprint of the farms covers an area of approximately 43km^2, with the study area including an area up to 2,000 meters of the boundary of this WF.

The wind energy facility will include up to 45 wind turbines. Each turbine will have a hub height of up to 120m and a tip height of up to 165m.

DESCRIPTION OF AMBIENT SOUND LEVELS – PREVIOUS MEASUREMENTS

The area has been visited previously where a number of ambient baseline sound levels were measured. The data indicates that the area has the potential to be very quiet at night, though ambient sound levels increases as the wind speed increases. The visual character of the area is mainly rural and it was accepted that the SANS 10103 noise district classification could be rural for the study area (during periods of low winds).

SCOPING LEVEL NOISE IMPACT DETERMINATION AND FINDINGS

A basic sound propagation model was selected to illustrate that a noise-sensitive development/receptor could be impacted by the development of the proposed facility. This scoping level assessment indicated that there is a risk of a noise impact during the construction and operation phases due to the proximity to noise-sensitive receptors to the locations where noise generating activities may take place.

RECOMMENDATIONS

This assessment indicated that the proposed project could have a potential noise impact on the surrounding area as there are Noise-sensitive developments/receptors within the potential area of influence.

It is recommended that the potential noise impact associated with this wind energy facility be investigated in more detail in the Environmental Impact Assessment phase considering the project layout as well as the specifications of the selected wind turbines.

CONTENTS OF THE SPECIALIST REPORT – CHECKLIST

Contents of this report in terms of Regulation GNR 326 of 2014, Appendix 6	**Cross-reference in this report**
(a) details of — the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a curriculum vitae;	**Section 13**
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	**Section 14** *(also separate document to this report)*
(c) an indication of the scope of, and the purpose for which, the report was prepared; - an indication of the scope of, and age of base data used for the specialist report; - a description of existing impacts of the site, cumulative impacts of the proposed development and levels of acceptable change.	**Section 1.1**
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	**Section 3.2 and 3.3**
(e) a description of the methodology adopted in preparing the report or carrying out the specialized process inclusive of equipment and modeling used;	**Section 1.6**
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure inclusive of a site plan identifying site alternatives;	**Sections 1.3.6**
(g) an identification of any areas to be avoided, including buffers;	**Section 8.2**
(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;	**Buffer proposed to prevent high significance impact, see Figure 10-1**
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	**Section 6**
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities;	**Section 8**
(k) any mitigation measures for inclusion in the EMPr;	To be included in EIA
(l) any conditions for inclusions in the environmental authorization;	To be included in EIA
(m) any monitoring requirements for inclusion in the EMPr or environmental authorization;	To be included in EIA

(n) a reasoned opinion - whether the proposed activity, activities or portions thereof should be authorized regarding the acceptability of the proposed activity or activities; - regarding the acceptability of the proposed activity or activities; and - if the opinion is that the proposed activity, activities or portions thereof should be authorized, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Future EIA to be compiled, to be included in EIA
(o) a description of any consultation process that was undertaken during the course of the preparing the specialist report;	**Section 1.5**
(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	**Section 1.5**
(q) any other information requested by the competent authority.	None requested

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GLOSSARY OF ABBREVIATIONS

ECA	Environment Conservation Act (Act 78 of 1989)
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan

EMS	Environmental Management System
IAPs	Interested and Affected Parties
i.e.	that is
km	kilometres
m	Meters (measurement of distance)
m^2	Square meter
m^3	Cubic meter
mamsl	Meters above mean sea level
NEMA	National Environmental Management Act, 1998 (Act 107 of 1998)
NCR	Noise Control Regulations (under Section 25 of the ECA)
SABS	South African Bureau of Standards
SANS	South African National Standards
SHEQ	Safety Health Environment and Quality
WF	Wind Farm / Wind Energy Facility
WHO	World Health Organisation
WTG	Wind Turbine Generator

1 INTRODUCTION

1.1 INTRODUCTION AND PURPOSE

Enviro-Acoustic Research cc was commissioned to undertake a specialist study to determine the potential noise impact on the surrounding environment due to the proposed establishment of the Boulders Wind Farm (WF) on various farms in the vicinity of Vredenburg in the Western Cape.

This report is the result of the initial phase study (desktop) of the Environmental Impact Assessment (EIA) process investigating the potential noise impact that such a facility may have on the surrounding environment, highlighting methodologies, potential issues to be investigated as well as preliminary findings and recommendations.

It is important to note this document is only the Scoping Document. Being preliminary, the report presents conceptual scenarios to illustrate important concepts.

1.2 BRIEF PROJECT DESCRIPTION

Vredenburg Windfarm (Pty) Ltd (hereafter referred as the developer) proposes the establishment of a commercial Wind Energy Facility and associated infrastructure on various farms within the Saldanha Bay Municipal area in the Western Cape (refer to **Figure 1-1**).

The footprint of the farms cover an area of approximately 43km^2, with the study area including an area up to 2,000 meters of the boundary of this WF.

The Boulders Wind Farm project site will accommodate the following infrastructure, which will enable the wind farm to supply a contracted capacity of up to 140MW:

- Up to 45 wind turbines with a maximum hub height of up to 120m. The tip height of the turbines will be up to 165m;
- Concrete foundations to support the turbines;
- Cabling between the turbines, to be laid underground where practical;
- An on-site substation of up to 200m x 200m in extent to facilitate the connection between the wind farm and the electricity grid;
- An overhead 132kV power line, with a 32m servitude, to connect the facility to the electricity grid (to be undertaken as a separate basic assessment);
- A transformer station for each wind turbine;

- Access roads to the site and between project components with a width of approximately 6m;
- Laydown areas, crane hardstand pads, administrative buildings and offices.

1.3 STUDY AREA

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

1.3.1 Topography

The WF is proposed to be developed in an area that can be defined as moderately undulating plains with a number of small hills such as Kasteelberg, Katzenberg, and Katheuwel. The height above mean sea level ranges between 20 to 180 mamsl.

1.3.2 Roads and rail roads

There are no major roads close to the proposed facility. There are a number of small gravel roads traversing the area but traffic on them is considered to be insignificant.

1.3.3 Land use

The land use is mainly agricultural with small farming communities living on the farms. As the night-time noise environment is of particular interest in this document, current land use activities are not expected to impact on the current ambient sound environment.

1.3.4 Residential areas

There are a number of formal housing developments to the north-east with dwellings in close proximity to each other. A number of these developments are marketed as holiday homes but there are also permanent residents living in these developments. The Town of Paternoster are located just south-west from the proposed WF.

1.3.5 Ground conditions and vegetation

The area falls within the coastal renosterbosveld and strandveld of the west coast vegetation region. The area is relatively well vegetated with grasses, sedges and bushes, but due to agricultural activities, dry land fields could be bare for a certain time of the year.

1.3.6 Existing Ambient Sound Levels

Excluding the coastline (surf sound) there are little other noise sources of significance in the area. Noise from the WCO WEF is insignificant (due to the design of the WEF). Based on the available information, the study area would have a rural character in terms of the ambient sound levels.

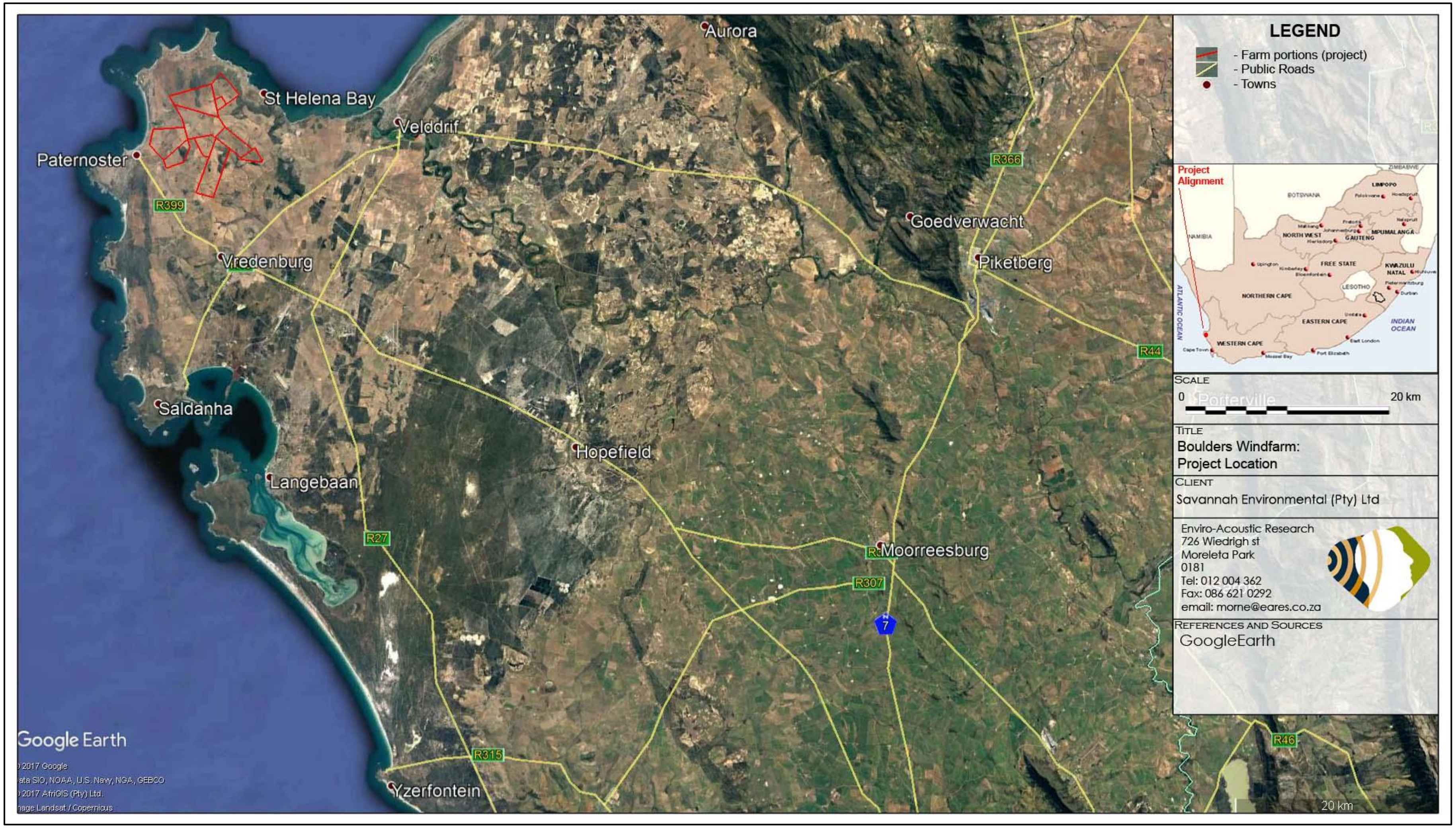

Figure 1-1: Site map indicating the location of proposed Boulders WF project site

1.3.7 Available Information

Work was previously undertaken in the area for other developers proposing wind energy facilities in the vicinity.

1.4 NOISE-SENSITIVE DEVELOPMENTS

An assessment of the area was done using the DEAT's Environmental Potential Atlas, with available topographical maps used to identify potential Noise-sensitive developments (NSD) in the area (within the area proposed, as well as potential NSD's up to 2 km from boundary of the facility). The data was imported into GoogleEarth® to allow a more visual view of the areas where Noise-sensitive developments were identified. The presence of a number of these Noise-sensitive developments were confirmed during previous site visits, but as this area fell outside the study area of the other projects a few potential receptors were identified using GoogleEarth® aerial images. The assessment indicated there are a number of such developments that occur in the area. Noise-sensitive developments as identified are highlighted in **Figure 1-2**.

It should be noted that it is known that some of the receptors identified for the approved West Coast One WEF were relocated. The new locations of these potential noise-sensitive developments are unknown and cannot be considered in this report.

Figure 1-2: Aerial Image indicating Noise-sensitive developments within 2,000 m from project site

1.5 COMMENTS PREVIOUSLY RECEIVED

The following comments were collected and received during the previous scoping public participation process undertaken as part of a previous application for Environmental authorisation for this project. There were a number of concerns raised regarding noise pollution, which was noted but will not be specifically mentioned as the compilation of the Environmental Noise Impact Assessment (EIA Phase) will cover these comments.

Concern	Raised by	Comment
Just invested in Cuniculture. Concern how the WF will impact on the rabbits.	Verna Scholtz	Noted
Potential impacts due to noise and low frequency issues.	Various	Noted
Concern regarding the accuracy of noise transmission models and the fact that the models cannot accurately consider night-time wind profiles (including lower ambient sound levels), atmospheric conditions and potential amplitude modulated sound from multiple wind turbines.	Shaun Wasso	Noted
Concern in the increase in noise levels and the potential impact on people that may be severely sensitive to increased noises.	Ian & Andrea Hart	Noted
Internet sources shows that wind farm noise is a highly contentious issue. Ambient sound levels is very low during low and moderate wind speeds. Low noises are easily heard and loud noises are insufferable during these conditions. The viability of using the turbines during such conditions should be considered. Wind direction should be considered, including the cumulative effect of all turbines operating for the worst-case scenario. The potential noise impact on people with a heightened sensitivity to noise must be considered. A sound assessment conducted over about 2-3 years is recommended.	M.F Marx	Noted
The selected specialist in not qualified at all to conduct the noise study and needs to be replaced by a suitably qualified and experienced specialist to conduct all noise measurements and studies anew. We notice that, in the notes of the public meeting held 25/8/2011 you comment that a peer review is a possible solution to the report provided by a person whose chemistry degree did not include one lecture on acoustics. The new specialist is to have experience in adjusting all standards to accommodate the sensitivities and impacts of noise on the disabled. You will not reveal the actual model of the Turbine until the EIA stage of the application. Please explain how the noise specialist is to do a comparison of the turbine against the ambient levels in our area? Issue with the use of ETSU-R-97. These guidelines are some 15 years old and technology has changed dramatically. Require the newly selected noise specialist to meet with us as I&APs to discuss this methodology in order that we may satisfy ourselves. EAP has failed to comment on any impacts of infrasound. We require a study to be done on the impact of infrasound on the human body as part of your revised ToR for your newly appointed specialist.	John Robinson	Noted
The usage of the ETSU-R-97 document is the source of most problems related to noise from modern wind farms. Nieuwerust Noise Watch Committee members are rejecting the use of the ETSU-R-97 as a guideline or its methodology for the noise assessment.	Maaike Kallenborn Nieuwerust Noise Watch	Noted
Wind noise is a natural occurrence, and people on the west coast expect it and enjoy it. It is not a constant noise as the wind gusts so the noise level changes and is sometimes non-existent. Wind	John & Anne Todd	Noted

turbine noise will however be a constant unchanging drone during wind activity. The above also applies to areas within sea noise range. Most people find the noise of wind and surf pleasing and peaceful; can the same be said of wind turbines? In many areas there is little "increased ambient sound levels due to normal daytime activities to mask the noises originating from the wind turbines". The construction phase which will generate the most noise will take up to four years to complete.		
Noise, some European countries limit WFs to a MAXIMUM of 100 turbines due to noise produced by the turbines.	K.H.B. Harrison West Coast Bird Club	Noted
The noise will affect our areas adversely taking into account the location of some of the proposed sites, the location of residential areas and prevailing wind.	K.H.B. Harrison West Coast Bird Club	Noted

1.6 TERMS OF REFERENCE

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

- If there are potential noise-sensitive receptors staying within 1,000 m from industrial activities (SANS 10328:2008);
- It is a controlled activity in terms of the NEMA regulations and a ENIA is required, because:
    - It may cause a disturbing noise that is prohibited in terms of section 18(1) of the Government Notice 579 of 2010; and
- It is generally required by the local or district authority as part of the environmental authorisation or planning approval in terms of Regulation 2(d) of GN R154 of 1992 (Regulation 4(1) in terms of PN.200 of 2013 – Western Cape).

In addition, Appendix 6 of GN 326 of December 2014 (Gov. Gaz. 38282), issued in terms of the National Environmental Management Act, No. 107 of 1998 also defines minimum information requirements for specialist reports.

In South Africa the document that addresses the issues specifically concerning environmental noise is SANS 10103:2008. It has been thoroughly revised and brought in line with the guidelines of the World Health Organisation (WHO) during 2006 - 2007. It provides the maximum average ambient noise levels during the day and night to which different types of developments may be exposed.

In addition, the SANS 10328:2008 standard specifies the methodology to assess the potential noise impacts on the environment due to a proposed activity that might impact on the environment. This standard also stipulates the minimum requirements to be investigated for Scoping purposes. These minimum requirements are:

1. The purpose of the investigation;

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

In addition, the Scoping report should contain sufficient information to allow the Environmental Assessment Practitioner (EAP) to compile the Plan of Study for Environmental Impact Assessment (EIA), including the Noise component.

In this regard the following will be included to assist the EAP in the compilation of the Plan of Study (PoS) for the EIA:

- Details regarding the methodology followed to estimate and assess the potentially significant impacts during the EIA phase;
- The potential impact will be evaluated (where possible) in terms of the nature (description of what causes the effect, what/who might be affected and how it/they might be affected) as well as the extent of the impact. This will be done by means of a site visit, where appropriate ambient sound levels will be determined and the identification of potential noise-sensitive developments/areas;
- Calculation of projected noise levels at the residences of identified NSD using sound propagation algorithms. The projected noise levels will be used to define the potential magnitude or severity of the noise impact as per the criteria defined in this report; and
- A statement regarding the potential significance of the identified issues based on the evaluation of the issues/impacts will be included in the EIA.

2 POLICIES AND THE LEGAL CONTEXT

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

The environmental right contained in section 24 of the Constitution provides that everyone is entitled to an environment that is not harmful to his or her well-being. In the context of noise, this requires a determination of what level of noise is harmful to the well-being of humans. The general approach of the common law is to define an acceptable level of noise as that which the reasonable person can be expected to tolerate in the particular circumstances. The subjectivity of this approach can be problematic, however this has led to the development of noise standards (see Section 2.5).

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

2.2 THE ENVIRONMENT CONSERVATION ACT

The Environment Conservation Act ("ECA") allows the Minister of Environmental Affairs and Tourism ("now the Minister of Water and Environmental Affairs") to make regulations regarding noise, among other concerns. The Minister has implemented noise control regulations under the ECA, adopted in Provincial Notice 200 of 2013 by the Western Cape Provincial Authority.

2.2.1 Noise Control Regulations (GN R154 of 1992)

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

Subsequently, in terms of Schedule 5 of the Constitution of South Africa of 1996 legislative responsibility for administering the noise control regulations was devolved to provincial and local authorities. The Provincial regulations will be relevant for the Western Cape Province.

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

c) Industrial noise in the vicinity of an industry-

i. the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter is in operation, exceeds 61 dBA; or

ii. the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 meters, but not more than 1,4 meters, above the ground for a period of 24 hours, exceeds 61 dBA;

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

"**zone sound level**" as:
A derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. *This is the same as the Rating Level as defined in SANS 10103:2008.*

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

In terms of Regulation 4 of the Noise Control Regulations:

"No person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, machine, device or apparatus or any combination thereof".

2.2.2 Western Cape Provincial Noise Control Regulations: PN 200 of 2013

The control of noise in the Western Cape is legislated in the form of the Noise Control Regulations in terms of Section 25 the Environment Conservation Act No. 73 of 1989, applicable to the Province of the Western Cape as Provincial Notice 200 of 20 June 2013.

The regulations define:

"**ambient noise**" means the all-encompassing sound in a given situation at a given time, measured as the reading on an integrated impulse sound level meter for a total period of at least 10 minutes".

"**disturbing noise**" means a noise, excluding the unamplified human voice, which—
(a) exceeds the rating level by 7 dBA;
(b) exceeds the residual noise level where the residual noise level is higher than the rating level;
(c) exceeds the residual noise level by 3 dBA where the residual noise level is lower than the rating level; or
(d) in the case of a low-frequency noise, exceeds the level specified in Annex B of SANS 10103;

''noise sensitive activity'' means any activity that could be negatively impacted by noise, including residential, healthcare, educational or religious activities;

''low-frequency noise'' means sound which contains sound energy at frequencies predominantly below 100 Hz;

''rating level'' means the applicable outdoor equivalent continuous rating level indicated in Table 2 of SANS 10103;

''residual noise'' means the all-encompassing sound in a given situation at a given time, measured as the reading on an integrated impulse sound level meter for a total period of at least 10 minutes, excluding noise alleged to be causing a noise nuisance or disturbing noise;

"sound level'' means the equivalent continuous rating level as defined in SANS 10103, taking into account impulse, tone and night-time corrections;

These Regulations prohibits anyone from causing a disturbing noise (Clause 2) and uses the $L_{Aeq,impulse}$ descriptor to define ambient sound and noise levels.

Also, in terms of regulation 4:

(1) The local authority, or any other authority responsible for considering an application for a building plan approval, business license approval, planning approval or environmental authorisation, may instruct the applicant to conduct and submit, as part of the application—

(a) a noise impact assessment in accordance with SANS 10328 to establish whether the noise impact rating of the proposed land use or activity exceeds the appropriate rating level for a particular district as indicated in SANS 10103; or

(b) where the noise level measurements cannot be determined, an assessment, to the satisfaction of the local authority, of the noise level of the proposed land use or activity.

(2) *(a)* A person may not construct, erect, upgrade, change the use of or expand any building that will house a noise-sensitive activity in a predominantly commercial or industrial area, unless he or she insulates the building sufficiently against external noise so that the sound levels inside the building will not exceed the appropriate maximum rating levels for indoor ambient noise specified in SANS 10103.

(b) The owner of a building referred to in paragraph *(a)* must inform prospective tenants or buyers in writing of the extent to which the insulation measures contemplated in that paragraph will mitigate noise impact during the normal use of the building.

(c) Paragraph *(a)* does not apply when the use of the building is not changed.

(3) Where the results of an assessment undertaken in terms of subregulation (1) indicate that the applicable noise rating levels referred to in that subregulation will likely be exceeded, or will not be exceeded but will likely exceed the existing residual noise levels by 5 dBA or more—

(a) the applicant must provide a noise management plan, clearly specifying appropriate mitigation measures to the satisfaction of the local authority, before the application is decided; and

(b) implementation of those mitigation measures may be imposed as a condition of approval of the application.

(4) Where an applicant has not implemented the noise management plan as contemplated in subregulation (3), the local authority may instruct the applicant in writing to—

(a) cease any activity that does not comply with that plan; or

(b) reduce the noise levels to an acceptable level to the satisfaction of the local authority.

2.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT

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 the WF to prevent noise pollution occurring. NEMA sets out measures which may be regarded as reasonable. They include 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 in order 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;
5. to eliminate any source of the pollution or degradation; or
6. to remedy the effects of the pollution or degradation.

2.4 NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT ("AQA")

Section 34 of the National Environmental Management: Air Quality Act (Act 39 of 2004) makes provision for:

(1) the Minister to prescribe essential national noise standards -

(a) for the control of noise, either in general or by specified machinery or activities or in specified places or areas; or

(b) for determining –

(i) a definition of noise; and

(ii) the maximum levels of noise.

(2) When controlling noise the provincial and local spheres of government are bound by any prescribed national standards.

This section of the Act is in force but no such standards have yet been promulgated.

An atmospheric emission license issued in terms of section 22 may contain conditions in respect of noise. This however will not be relevant to the WF.

2.4.1 Draft Model Air Quality Management By-law for adoption and adaptation by Municipalities

Draft model air quality management by-laws for adoption and adaptation by municipalities was published by the Department of Environmental Affairs in the Government Gazette of 15 July 2009 as General Notice (for comments) 964 of 2009. Section 18 specifically focuses on Noise Pollution Management, with sub-section 1 stating:

"*No person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, animal, machine, device or apparatus or any combination thereof.*"

The draft regulations differ from the current provincial Noise Control Regulations as it defines a disturbing noise as a noise that is measurable or calculable of which the rating level exceeds the equivalent continuous rating level as defined in SANS 10103.

2.5 NOISE STANDARDS

Four South African Bureau of Standards (SABS) scientific standards are considered relevant to noises from a Wind Energy Facility. 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*'.

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

2.6 INTERNATIONAL GUIDELINES

While there exist a number of international guidelines and standards that could encompass a document in itself, the three mentioned below were selected as they are used by different countries in the subject of environmental noise management, with the last two documents specifically focussing on the noises associated by wind energy facilities.

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

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

The document uses the L_{Aeq} and $L_{A,max}$ descriptors to define noise levels. This document was important in the development of the SANS 10103 standard.

2.6.2 The Assessment and Rating of Noise from Wind Farms (ETSU, 1997)

This report describes the findings of a Working Group on Wind Turbine Noise, facilitated by the United Kingdom Department of Trade and Industry. It was developed as an Energy Technology Support Unit[1] (ETSU) project. The aim of the project was to provide information and advice to developers and planners on noise from wind turbines. The report represents the consensus view of a number of experts (experienced in assessing and controlling the environmental impact of noise from wind farms). Their findings can be summarised as follows:

1. Absolute noise limits applied at all wind speeds are not suited to wind farms; limits set relative to the background noise (including wind as seen in **Figure 7-3**) are more appropriate

[1] ETSU was set up in 1974 as an agency by the United Kingdom Atomic Energy Authority to manage research programmes on renewable energy and energy conservation. The majority of projects managed by ETSU were carried out by external organizations in academia and industry. In 1996, ETSU became part of AEA Technology plc which was separated from the UKAEA by privatisation.

2. $L_{A90,10mins}$ is a much more accurate descriptor when monitoring ambient and turbine noise levels
3. The effects of other wind turbines in a given area should be added to the effect of any proposed wind energy facility, to calculate the cumulative effect
4. Noise from a wind energy facility should be restricted to no more than 5 dBA above the current ambient noise level at a NSD. Ambient noise levels is measured onsite in terms of the $L_{A90,10min}$ descriptor for a period sufficiently long enough for a set period
5. Wind farms should be limited within the range of 35dBA to 40dBA (day-time) in a low noise environment. A fixed limit of 43 dBA should be implemented during all night time noise environments. This should increase to 45 dBA (day and night) if the NSD has financial investments in the wind energy facility
6. A penalty system should be implemented for wind turbine/s that operates with a tonal characteristic

This is likely the guideline used in the most international countries to estimate the potential noise impact stemming from the operation of a Wind Energy Facility. It also recommends an improved methodology (compared to a fixed upper noise level) on determining ambient sound levels in periods of higher wind speeds, critical for the development of a wind energy facility. Because of its international importance, the methodologies used in the ETSU R97 document will be recommended in this Scoping Report for implementation during the Environmental Noise Impact Assessment phase should projected noise levels (from the proposed WF at PSRs) exceed the zone sound levels as recommended by SANS 10103:2008.

2.6.3 Noise Guidelines for Wind Farms (MoE, 2008)

This document establishes the sound level limits for land-based wind power generating facilities and describes the information required for noise assessments and submissions under the Environmental Assessment Act and the Environmental Protection Act, Canada.

The document defines:

- Sound Level Limits for different areas (similar to rural and urban areas), defining limits for different wind speeds at 10 m height, refer also **Table 2-1**[2]
- The Noise Assessment Report, including;
  - Information that must be part of the report

[2]The measurement of wind induced background sound level is not required to establish the applicable limit. The wind induced background sound level reference curve was determined by correlating the A-weighted ninetieth percentile sound level (L90) with the average wind speed measured at a particularly quiet site. The applicable Leq sound level limits at higher wind speeds are given by adding 7 dB to the wind induced background L90 sound level reference values

- Full description of noise sources
- Adjustments, due to the wind speed profile (wind shear)
- The identification and defining of potential sensitive receptors
- Prediction methods to be used (ISO 9613-2)
- Cumulative impact assessment requirements
- It also defines specific model input parameters
- Methods on how the results must be presented
- Assessment of Compliance (defining magnitude of noise levels)

Table 2-1: Summary of Sound Level Limits for Wind Farms (MoE)

Wind speed (m/s) at 10 m height	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Wind Turbine Sound Level Limits, Class 3 Area, dBA	40	40	40	43	45	49	51
Wind Turbine Sound Level Limits, Class 1 & 2 Areas, dBA	45	45	45	45	45	49	51

The document used the $L_{Aeq,1h}$ noise descriptor to define noise levels.

It should be noted that these Sound Level Limits are included for the reader to illustrate the criteria used internationally. Due to the lack of local regulations specifically relevant to wind energy facilities this criteria will also be considered during the determination of the significance of the noise impact.

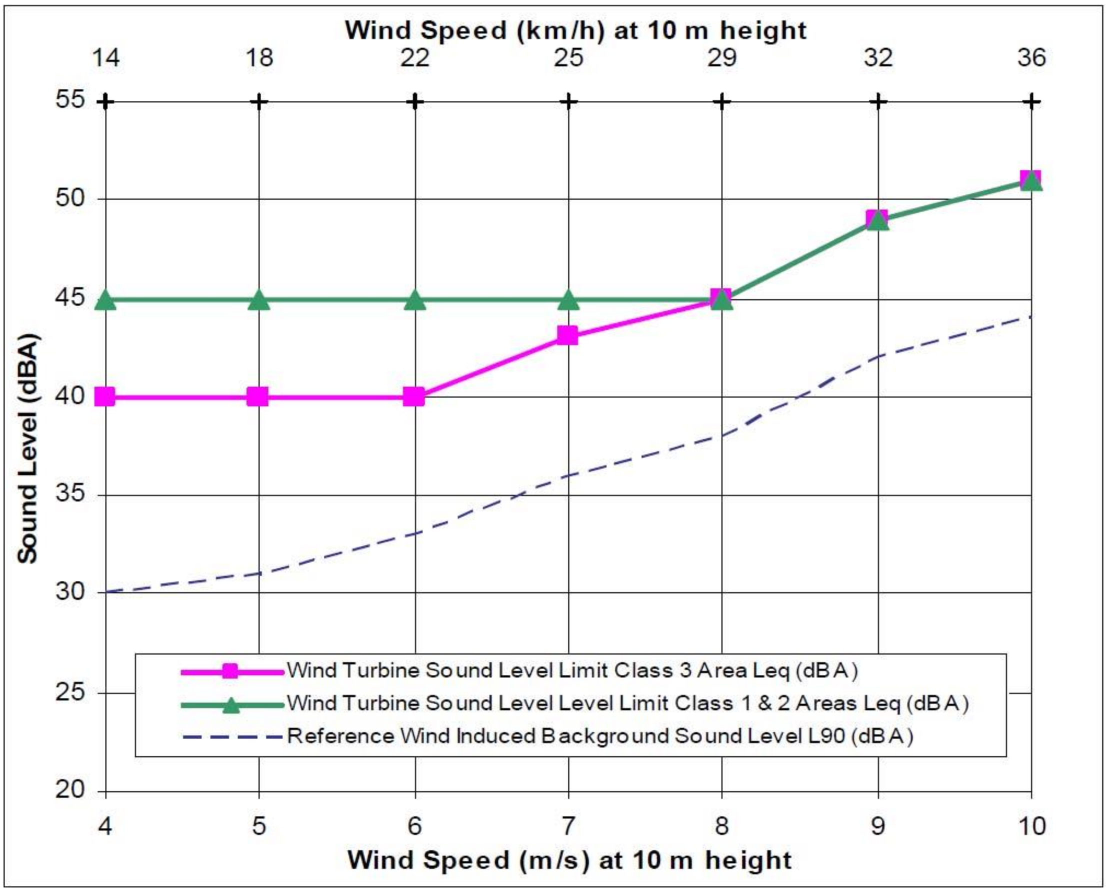

Figure 2-1: Summary of Sound Level Limits for Wind Turbines (MoE Canada)

2.6.4 Equator Principles

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

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

2.6.5 IFC: General EHS Guidelines – Environmental Noise Management

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

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

It goes as far as to propose methods for the prevention and control of noise emissions, 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/m^2 in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective;
- Installing vibration isolation for mechanical equipment;
- Limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas ;
- Re-locating noise sources to less sensitive areas to take advantage of distance and shielding;
- Placement of permanent facilities away from community areas if possible;
- Taking advantage of the natural topography as a noise buffer during facility design;
- Reducing project traffic routing through community areas wherever possible;
- Planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas; and
- Developing a mechanism to record and respond to complaints.

It sets noise level guidelines (see **Table 2.2**) as well as highlighting the certain monitoring requirements pre- and post-development.

Table 2.2: 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 $L_{Aeq,1\ hr}$ noise descriptors to define noise levels. It does not determine the detection period, but refers to the IEC standards, which requires the fast detector setting on the Sound Level Meter during measurements for Europe.

3 ENVIRONMENTAL SOUND CHARACTER

3.1 INFLUENCE OF WIND ON AMBIENT SOUND LEVELS

Natural sounds have been 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 as wind flowing through vegetation increasing as wind speed increases. 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, as well as the total vegetation surface, all determine both the sound level as well as spectral characteristics.

While the total ambient sound levels are of importance, the spectral characteristics also determines the likelihood that someone will hear external noises that may or may not be similar in spectral characteristics to that of vegetation created noise. Bolin (2006) did investigate spectral characteristics and determined the annoyance might occur at levels where noise generated by wind turbine noise exceeds natural ambient sounds with 3dB or more.

Unfortunately, current regulations and standards do not consider changing ambient sound levels due to natural events, such as can be found near the coast (from the ocean waves) or areas where wind induced noises (from vegetation) are prevalent, which is unfeasible with wind energy facilities, as these facilities will only operate when the wind is blowing. It is therefore important that the impact of wind-induced noises be considered when determining the impact of an activity such as a wind energy facility. This is discussed further in **Section 7.3.3**.

3.2 AMBIENT SOUND MEASUREMENTS PROCEDURE

The measurement of ambient sound levels is defined by the South African National Standard SANS 10103:2008 as: "***The measurement and rating of environmental noise with respect to land use, health, annoyance and speech communication***". The standard specifies the acceptable techniques for sound measurements including:

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

As discussed in the previous section, ambient sound measurements are ideally collected when wind speeds are less than 3m/s with no measurements collected when wind speeds exceed 5m/s. Due to the fact that wind energy facilities will only be in operation during periods that the wind is blowing, it is critical that ambient sound level measurements reflect expected sound levels at various wind speeds. Because of the complexity of these measurements the following methodology is followed:

- Compliance with the latest version of SANS 10103;
- The sound measuring equipment was calibrated directly before, and directly after the measurements was collected. In all cases drift[3] was less than 0.2 dBA between these two measurements.
- The measurement equipment made use of a windshield specifically designed for outdoor use during increased wind speeds;
- The areas where measurements were recorded was selected so as to minimize the risks of direct impacts by the wind on the microphone;
- Measurements took place in 10-minute bins for at least two full night-time periods;
- Noise data was synchronised with the wind data measured onsite using an anemometer at a 1.5 m height.

Ambient sound levels were measured over a period of 5 nights during October 2015 with the locations used to measure ambient (background) sound levels presented in **Figure 3-1**. The wind turbines from the WCO WEF was operational during this measurement period, but with the wind turbines located further than 1,000m from measurement location VASL02, the turbines would not impact the sound measurements (the wind turbines were never audible, even when walking closer to the turbines). Photos taken during the measurement date is presented in **Appendix B**.

[3] Changes in instrument readings due to a change in altitude (air pressure), temperature and humidity

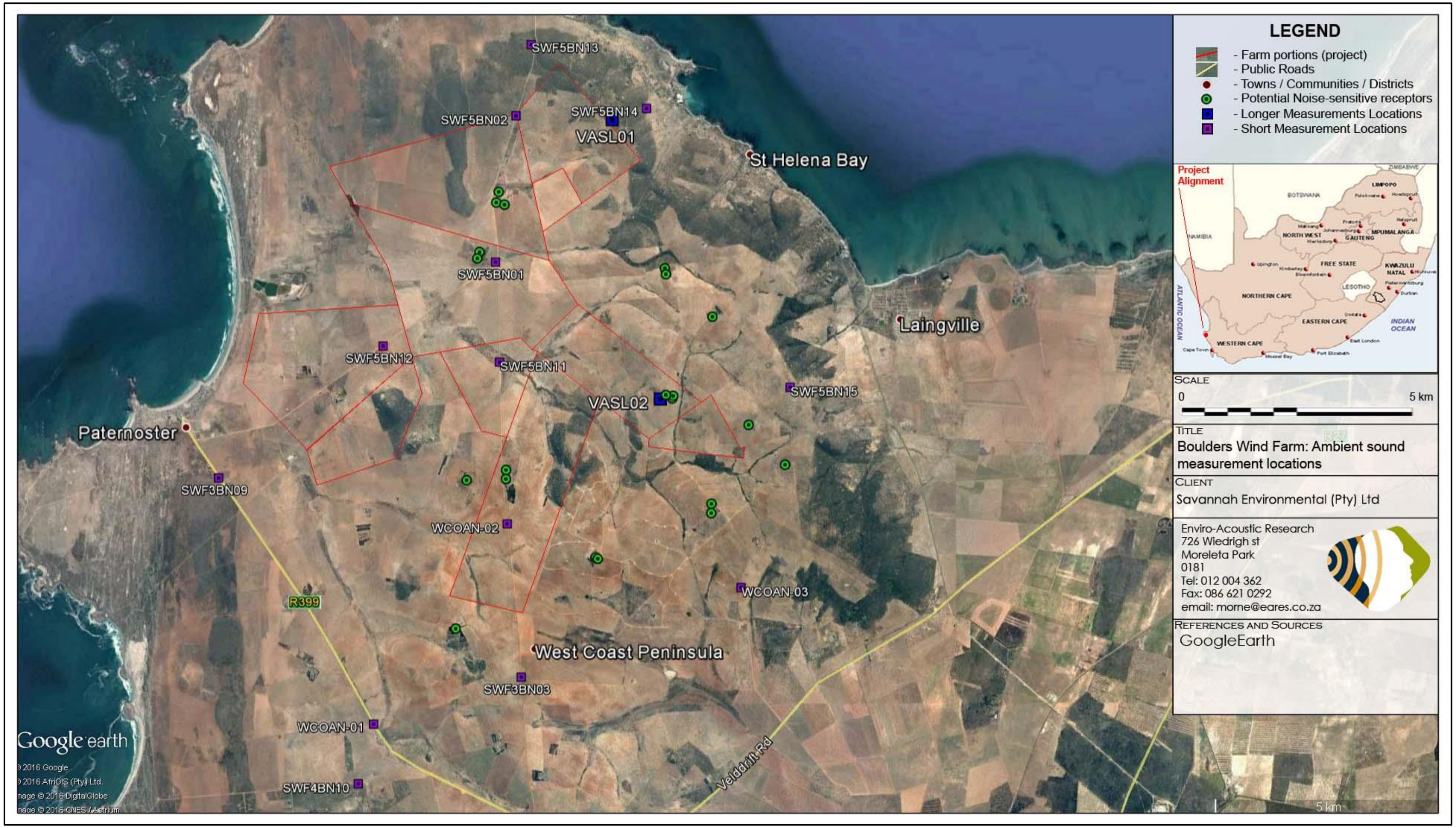

Figure 3-1: Localities of where ambient sound levels were measured

3.3 AMBIENT SOUND MEASUREMENTS COLLECTED IN AREA

3.3.1 Measurement Point VASL01: Mr. Doug Portsmouth

This location was selected to represent potential ambient sound levels in the Britannica Heights community.

The equipment defined in **Table 3-1** was used for gathering data. Measured sound levels are presented in **Figure 3-2** and **Figure 3-3** and defined in **Table 3-2**.

Table 3-1: Equipment used to measure sound levels at VASL01

Equipment	Model	Serial no	Calibration Date
SLM	Svan 977	34849	May 2015
Microphone	ACO Pacific 7052E	55974	May 2015
Calibrator	Quest CA-22	J 2080094	June 2016
Anemometer	W3081	-	-

* Microphone fitted with the RION WS-03 outdoor all-weather windshield.

The measurement location was selected to be reflective of the typical environmental ambient sound levels that receptors in the Britannica Heights community may experience. The SLM was erected in a relatively open area adjacent to the house with a clear line of sight to the proposed Boulders WF project area. Refer to Appendix B for a photo of this measurement location. Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes) are defined in **Table 3-2**.

Table 3-2: Noises/sounds heard during site visits at receptor VASL01

		During Deployment	During Collection
Magnitude Scale Code: • **Barely Audible** • **Audible** • **Dominating or clearly audible**	**Faunal and natural**	Wind-induced noises. Bird call.	Wind-induced noises. Bird call (at times).
	Residential	-	-
	Industrial & transportation	Neighbour working with power tools.	-

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

Fast equivalent sound levels (International guidelines): Fast-weighted 10-minute equivalent (average) sound levels for the day and night-time periods are shown on **Figure**

3-2 with **Table 3-3** defining the average values for the time period. Fast-weighted equivalent sound levels are included in this report as this is the sound descriptor used in most international countries to define the Ambient Sound Level.

Statistical sound levels ($L_{A90,f}$): The L_{A90} level is presented in this report as it is used to define the "background ambient sound level", or the sound level that can be expected if there were little single events (loud transient noises) that impacts on the average sound level. L_{A90} is a statistical indicator that describes the noise level that is exceeded 90% of the time and frequently used to define the background sound level internationally. The instrument is set to fast time-weighting. It is illustrated against time on **Figure 3-3** and defined in **Table 3-3**.

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

Table 3-3: Sound levels considering various sound level descriptors at VASL01

	$L_{Amax,i}$ (dBA)	$L_{Aeq,i}$ (dBA)	$L_{Aeq,f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{Amin,f}$ (dBA)	Comments
Day arithmetic average	-	49	45	38	-	-
Night arithmetic average	-	39	37	33	-	-
Day minimum	-	38	35	-	27	-
Day maximum	95	73	63	-	-	-
Night minimum	-	33	31	-	27	-
Night maximum	78	54	46	-	-	-
Day 1 equivalent	-	63	54	-	-	Late afternoon and evening only
Night 1 Equivalent	-	43	40	-	-	8 hour night equivalent average
Day 2 equivalent	-	56	49	-	-	16 hour day equivalent average
Night 2 Equivalent	-	42	36	-	-	8 hour night equivalent average
Day 3 equivalent	-	50	45	-	-	Most of day

Wind-induced noises significantly dominated the soundscape and apart from the power tools and bird calls (audible at times), little other noises could be discerned. Considering the development character and sounds heard, the area can be considered naturally quiet.

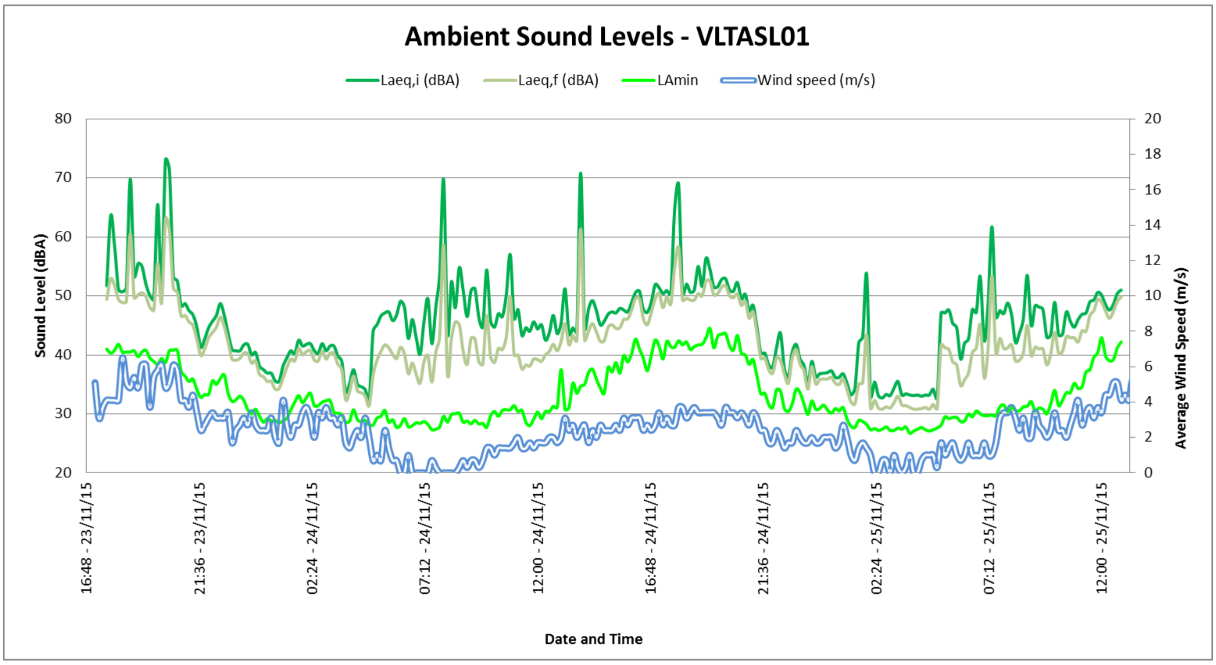

Figure 3-2: Ambient Sound Levels at VASL01

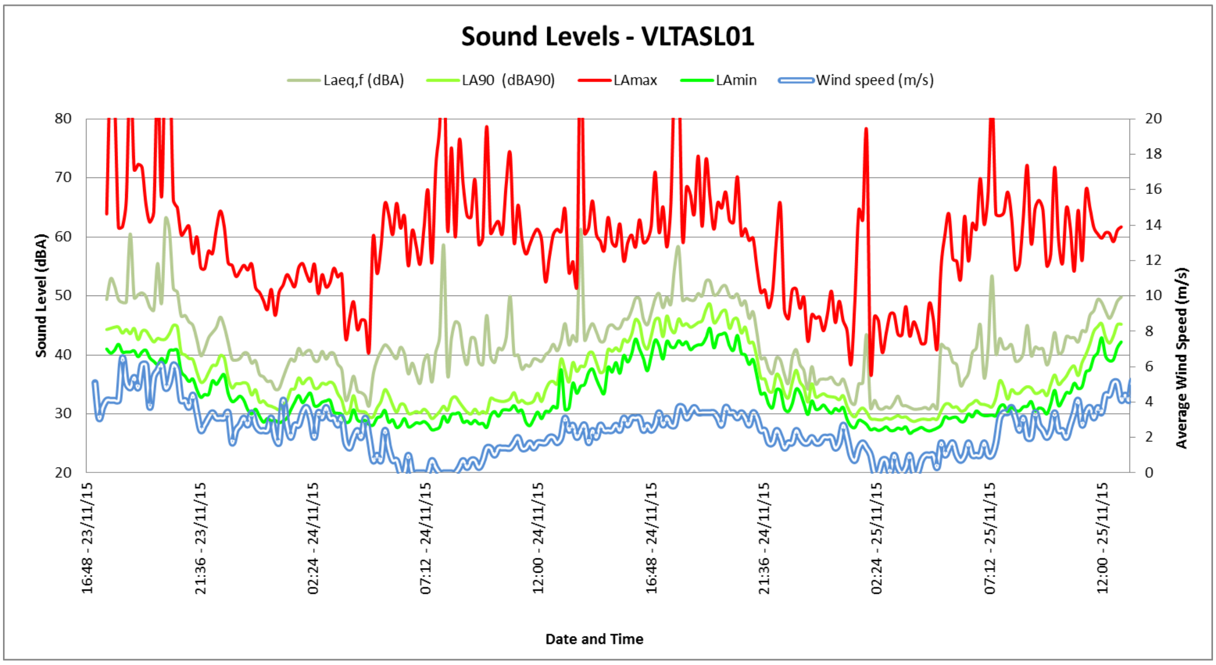

Figure 3-3: Maximum, minimum and statistical values at VASL01

Third octaves were measured and are displayed in the following figures. Wind-induced noises had a significant impact on most of the measurements.

Lower frequency (20 – 250 Hz) – Noise sources of significance in this frequency band would include nature (wind and surf especially – indicated by a relative smooth curve) and sounds of anthropogenic origin and vehicles (engine sounds and electric motors – erratic bumps at certain frequencies). Lower frequencies tend to travel further through the atmosphere than higher frequencies. Night-time data indicated only a few measurements where there were external noises that generated acoustic energy in these frequencies. This may be that there were little sounds or that wind-induced noises masked the sounds in this frequency band. Daytime measurements indicated various measurements where there were sounds that had acoustic energy in this low frequency band. The sources were different, indicating numerous peaks. Apart from the wind induced curves (smooth curves) there is no distinctive character.

Third octave surrounding the 1,000 Hz (200 – 2,000 Hz) – This range contains energy mostly associated with human speech (350 Hz – 2,000 Hz; mostly below 1,000 Hz) and dwelling noises (including sounds from larger animals such as chickens, dogs, goats, sheep and cattle). Road-tyre interaction (from vehicular traffic) normally features in 630 – 1,600 Hz range. There were a number of measurements that indicated sounds from various different sources, but sounds were mainly masked by wind-induced noises.

Higher frequency (2,000 Hz upwards) – Smaller faunal species such as birds, crickets and cicada use this range to communicate and hunt etc. While wind-induced noises generally dominated, there were significant peaks in the 3 150 – 6 300 frequency bands both night and day. This is likely from birds and insects.

Compliance with international guidelines: While the sound levels are elevated and higher than the sound levels typical of a rural area, it was mainly due to natural sounds, typical of spring and summer seasons. It would likely reduce during the winter. Considering the developmental character of the area, the acceptable zone rating level would be typical of a rural area (35 dBA at night and 45 dBA during the day) as defined in SANS 10103:2008.

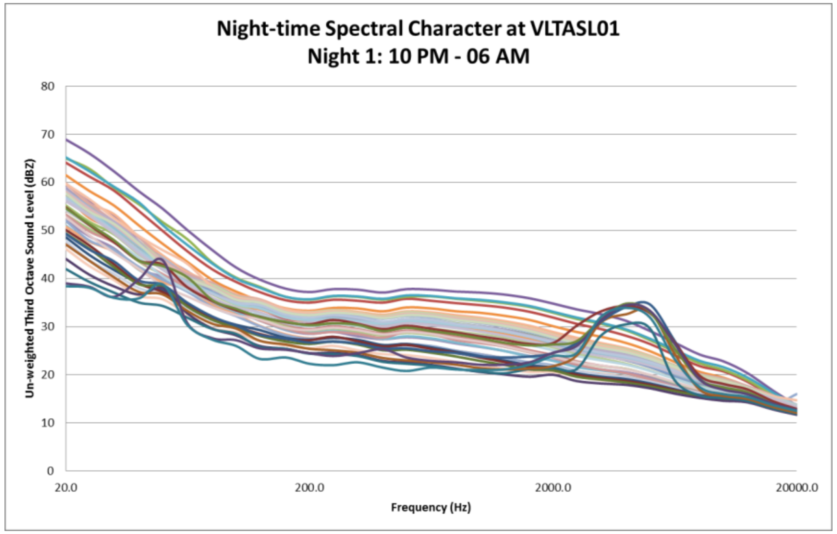

Figure 3-4: Spectral frequencies – VASL01, Night 1

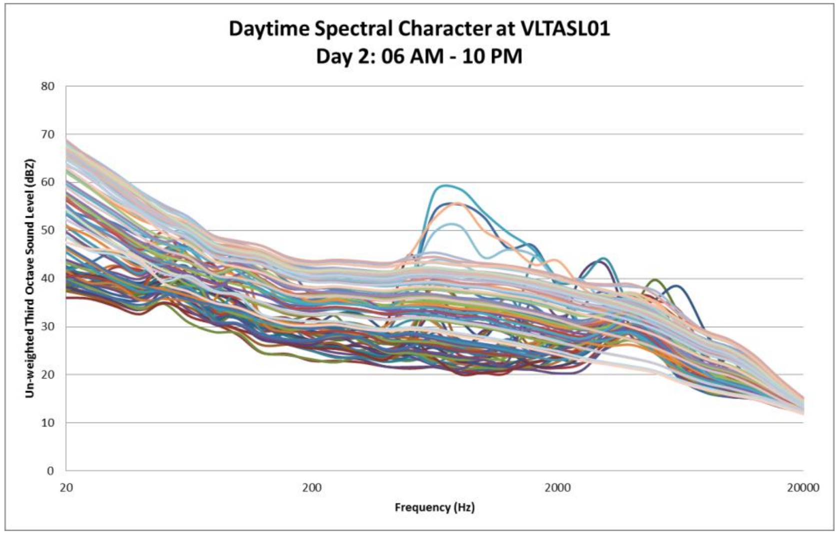

Figure 3-5: Spectral frequencies - VASL01, Day 2

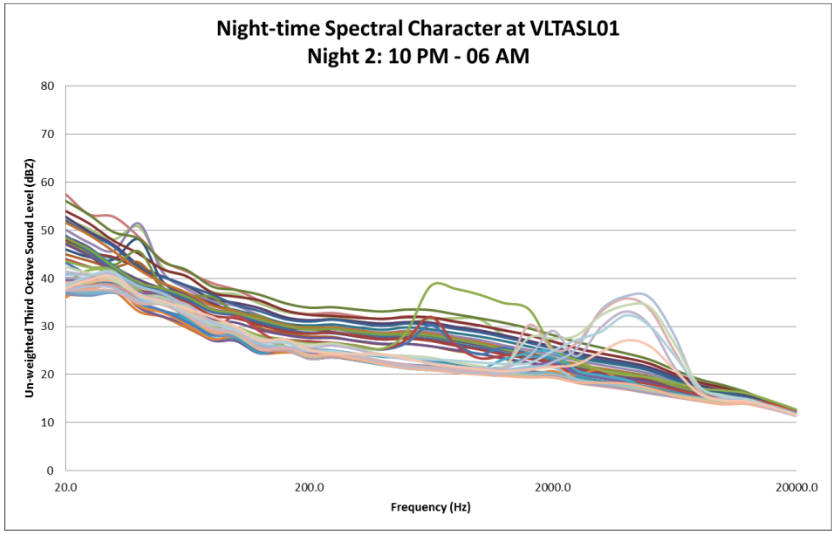

Figure 3-6: Spectral frequencies - VASL01, Night 2

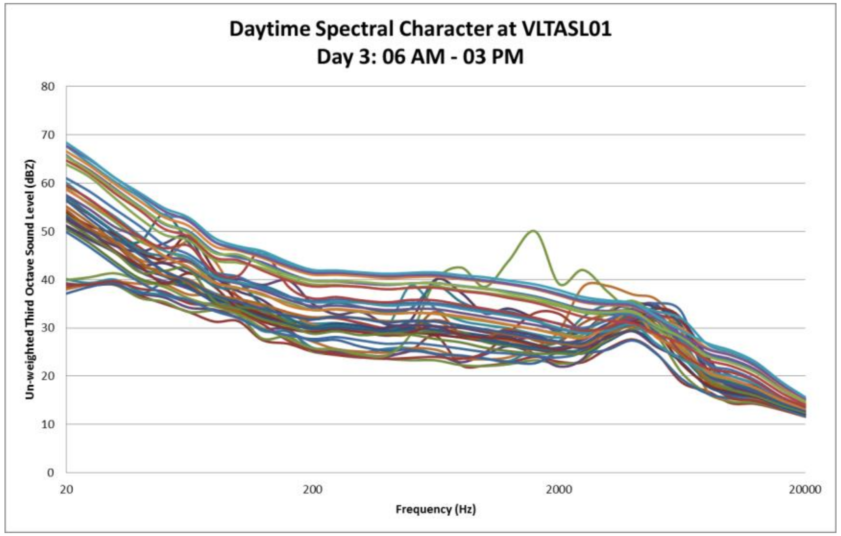

Figure 3-7: Spectral frequencies - VASL01, Day 3

3.3.2 Measurement Point VASL02: Mr. Nico Lombard

The equipment defined in **Table 3-4** was used for gathering data. Measured sound levels are presented in **Figure 3-8** and **Figure 3-9** and defined in **Table 3-6**.

Table 3-4: Equipment used to measure sound levels at VASL02

Equipment	Model	Serial no	Calibration Date
SLM	Svan 977	34849	May 2015
Microphone	ACO Pacific 7052E	55974	May 2015
Calibrator	Quest CA-22	J 2080094	June 2016
Anemometer	W3081	-	-

* Microphone fitted with the RION WS-03 outdoor all-weather windshield.

The SLM was erected in a relatively open area in front of his house. Refer to Appendix B for a photo of this measurement location. There were a number of very large eucalyptus trees close to the house with wind induced sounds being dominant. Agricultural activities were taking place in the area but barely audible. Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes) are defined in **Table 3-5**.

Table 3-5: Noises/sounds heard during site visits at receptor VASL02

		During Deployment	During Collection
Magnitude Scale Code: • **Barely Audible** • **Audible** • **Dominating or clearly audible**	**Faunal and natural**	Wind-induced noises. Bird call (at times). Chickens sounds. Insects communication at times.	Wind-induced noises Bird call.
	Residential	-	-
	Industrial & transportation	Tractor or similar moving in distance.	-

Impulse equivalent sound levels (South African legislation): Figure 3-8 illustrates how the impulse-weighted 10-minute equivalent values changes over time with **Table 3-3** defining the average values for the time period. This sound descriptor is mainly used in South Africa to define sound and noise levels. The instrument is set to measure the impulse time-weighted sound levels.

Fast equivalent sound levels (International guidelines): Fast-weighted 10-minute equivalent (average) sound levels for the day and night-time periods are shown on **Figure 3-8** with **Table 3-6** defining the average values for the time period. Fast-weighted equivalent sound levels are included in this report as this is the sound descriptor used in most international countries to define the Ambient Sound Level.

Statistical sound levels ($L_{A90,f}$): The L_{A90} level is presented in this report as it is used to define the "background ambient sound level", or the sound level that can be expected if there were little single events (loud transient noises) that impacts on the average sound level. **L_{A90}** is a statistical indicator that describes the noise level that is exceeded 90% of the time and frequently used to define the background sound level internationally. The instrument is set to fast time-weighting. It is illustrated against time on **Figure 3-9** and defined in **Table 3-6**.

Measured maximum and minimum sound levels: These are statistical sound descriptors that can be used to characterise the sound levels in an area along with the other sound descriptors. These sound level descriptors are defined in **Table 3-6** and illustrated in **Figure 3-9**.

Table 3-6: Sound levels considering various sound level descriptors at VASL02

	$L_{Amax,i}$ (dBA)	$L_{Aeq,i}$ (dBA)	$L_{Aeq,f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{Amin,f}$ (dBA)	Comments
Day arithmetic average	-	54	51	46	-	-
Night arithmetic average	-	48	46	42	-	-
Day minimum	-	37	34	-	27	-
Day maximum	98	76	68	-	-	-
Night minimum	-	34	33	-	29	-
Night maximum	89	71	62	-	-	-
Day 1 equivalent	-	63	60	-	-	Evening only
Night 1 Equivalent	-	60	52	-	-	8 hour night equivalent average
Day 2 equivalent	-	59	56	-	-	16 hour day equivalent average
Night 2 Equivalent	-	53	48	-	-	8 hour night equivalent average
Day 3 equivalent	-	53	51	-	-	16 hour day equivalent average
Night 3 Equivalent	-	55	50	-	-	8 hour night equivalent average
Day 4 equivalent	-	54	51	-	-	Early morning only

The house made use of a power generator, but the generator was barely audible at the measurement location. Wind-induced noises and sounds from nocturnal birds dominated the soundscape. Insects were just audible at times. The data indicated an area with increased noise levels, but the noises are mainly from natural origin. As such the area can be considered naturally quiet.

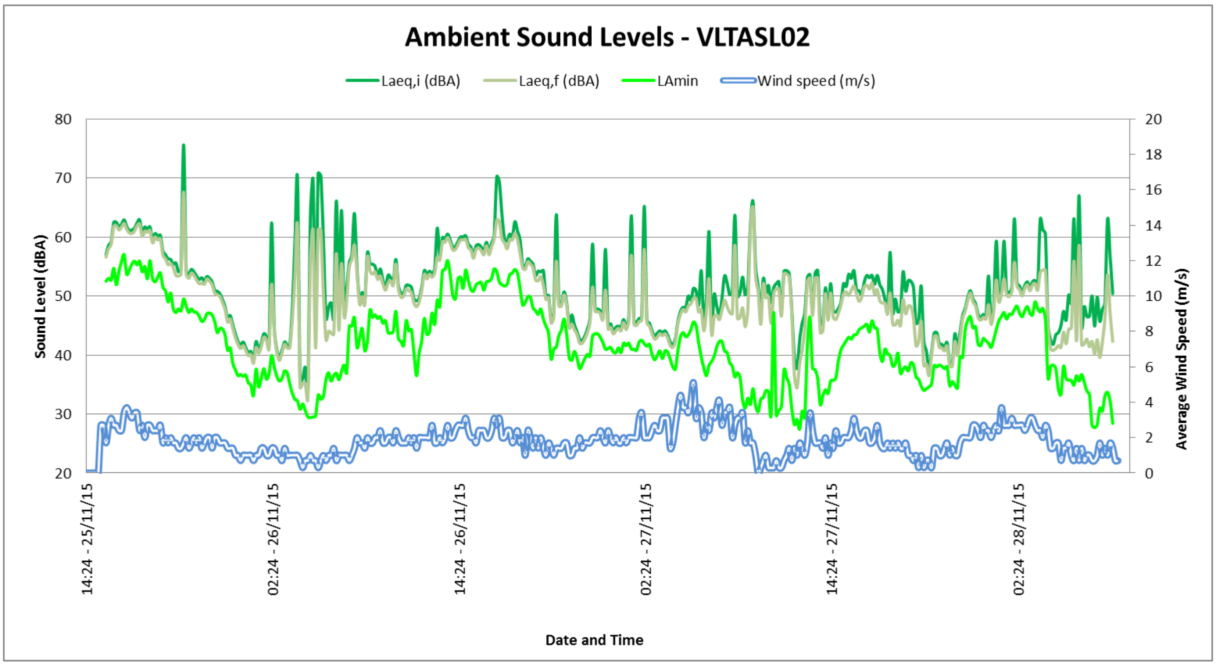

Figure 3-8: Ambient Sound Levels at VASL02

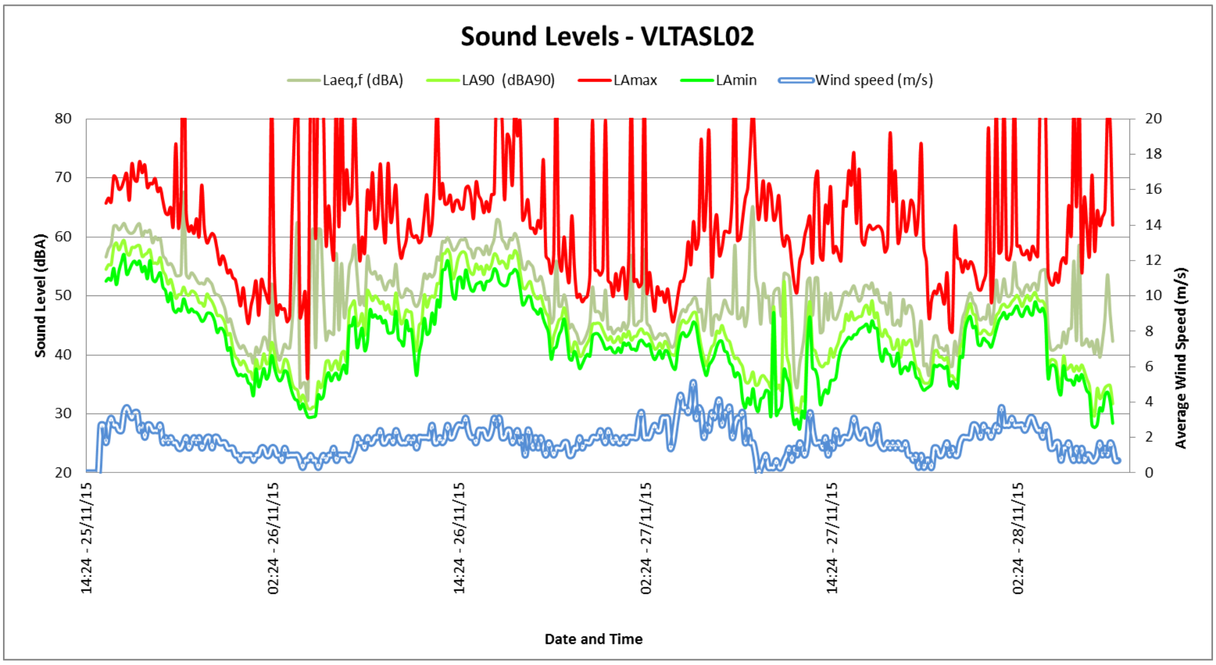

Figure 3-9: Maximum, minimum and statistical values at VASL02

Third octaves were measured and are displayed in the following Figures. Wind-induced noises had a significant impact on the data for the first day, night and most of the second day (the relatively smooth curves).

Lower frequency (20 – 250 Hz) – Noise sources of significance in this frequency band would include nature (wind and surf especially – indicated by a relative smooth curve) and sounds of anthropogenic origin and vehicles (engine sounds and electric motors – erratic bumps at certain frequencies). Lower frequencies tend to travel further through the atmosphere than higher frequencies. As with the previous measurement location, wind-induced noises dominated most measurements. Most measurements does indicate a peak at 31.5 Hz, the source is unknown (might be a petroleum water pump or power generator not audible), with daytime data indicating numerous other sounds from different sources. This likely relates to agricultural equipment moving around on the site.

Third octave surrounding the 1,000 Hz (200 – 2,000 Hz) – This range contains energy mostly associated with human speech (350 Hz – 2,000 Hz; mostly below 1,000 Hz) and dwelling noises (including sounds from larger animals such as chickens, dogs, goats, sheep and cattle). A number of night-time measurements indicate peaks in the 630 and 1 000 Hz frequencies, possibly from sounds from larger domesticated animals. There were numerous daytime measurements that indicated that there were various different sound sources that are at this measurement location.

Higher frequency (2,000 Hz upwards) – Smaller faunal species such as birds, crickets and cicada use this range to communicate and hunt etc. The night-time periods were generally low in sounds with acoustic energy in this frequency range, but it might be that wind-induced noises dominated and masked sounds in this frequency range. There were some measurements with peaks at 16 000 Hz, but at 20 – 25 dB the level is very low. Daytime measurements indicated that there are numerous different sounds in this frequency bands, but wind-induced noises likely masked most of this sound.

Compliance with international guidelines: The sound levels are significantly elevated and higher than the sound levels typical of a rural area. Night-time data is mainly due to natural sounds although agricultural activities did influence the daytime sound levels. Considering the developmental character of the area, the acceptable zone rating level would be typical of a sub-urban to urban area (40 dBA at night and 50 dBA during the day for suburban, 45 and 55 dBA for an urban area) as defined in SANS 10103.

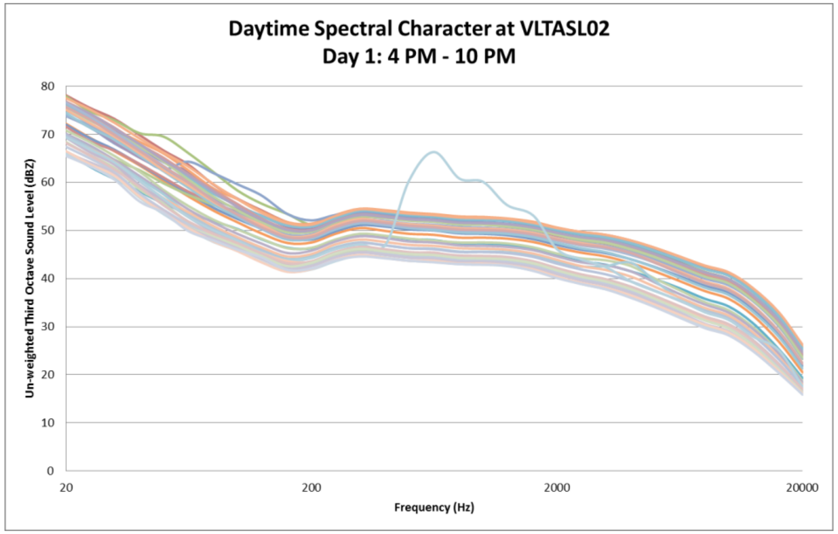

Figure 3-10: Spectral frequencies – VASL02, Day 1

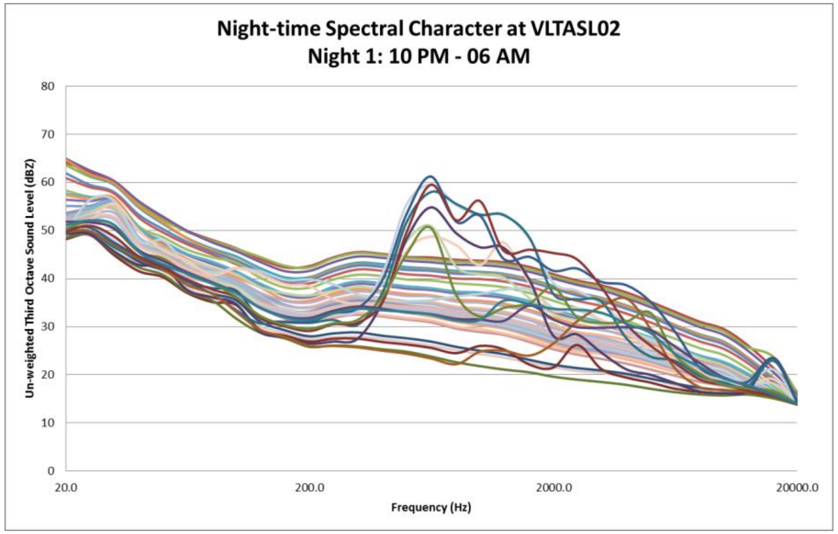

Figure 3-11: Spectral frequencies - VASL02, Night 1

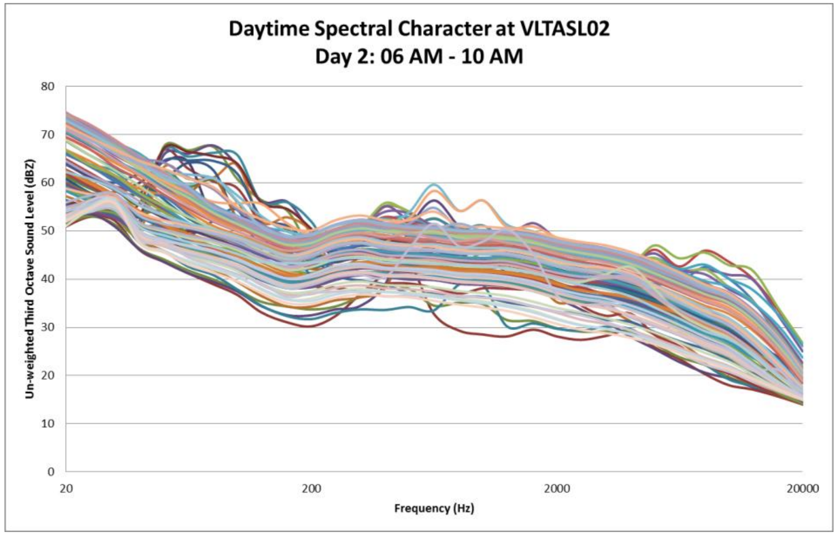

Figure 3-12: Spectral frequencies - VASL02, Day 2

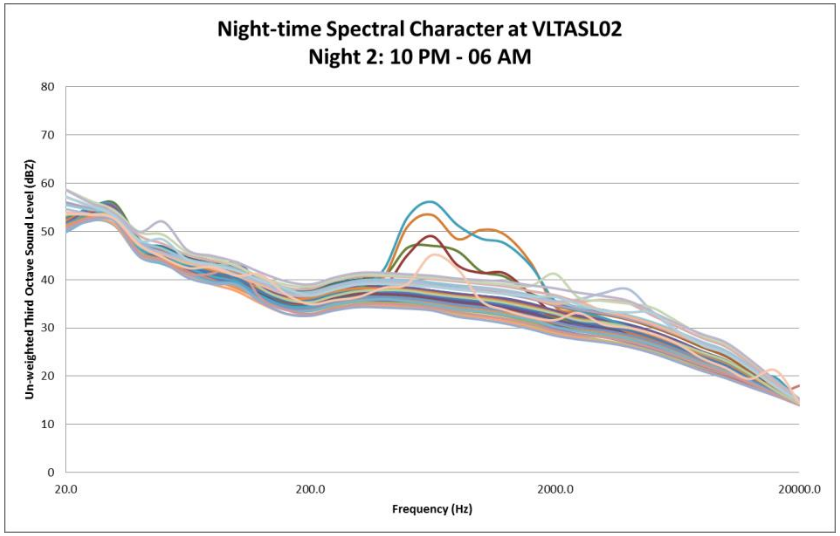

Figure 3-13: Spectral frequencies - VASL02, Night 2

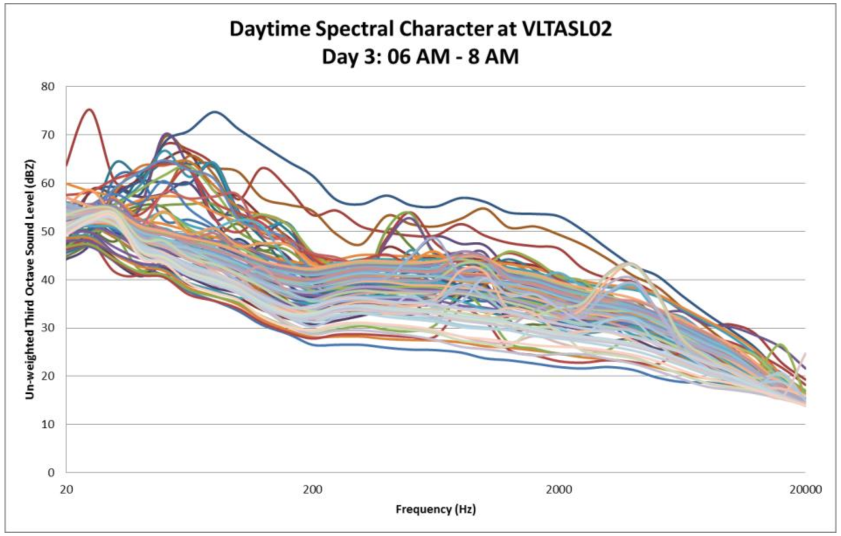

Figure 3-14: Spectral frequencies – VASL02, Day 3

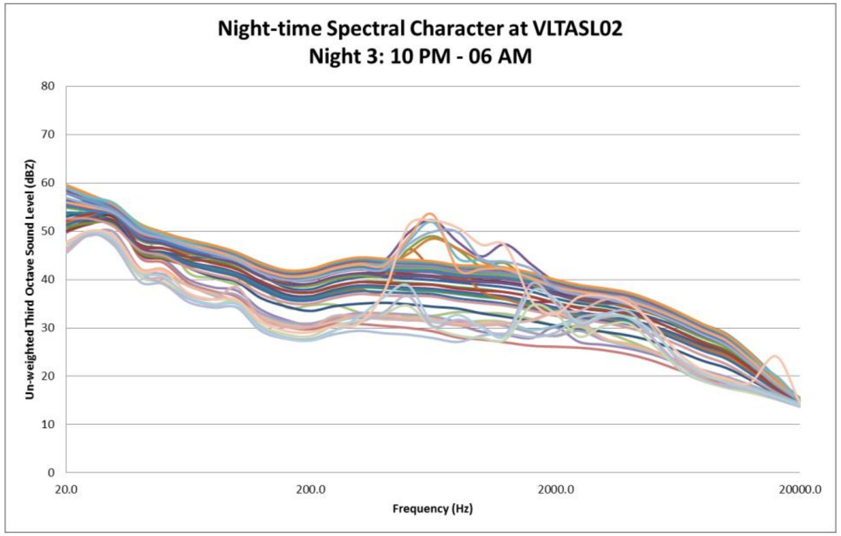

Figure 3-15: Spectral frequencies - VASL02, Night 3

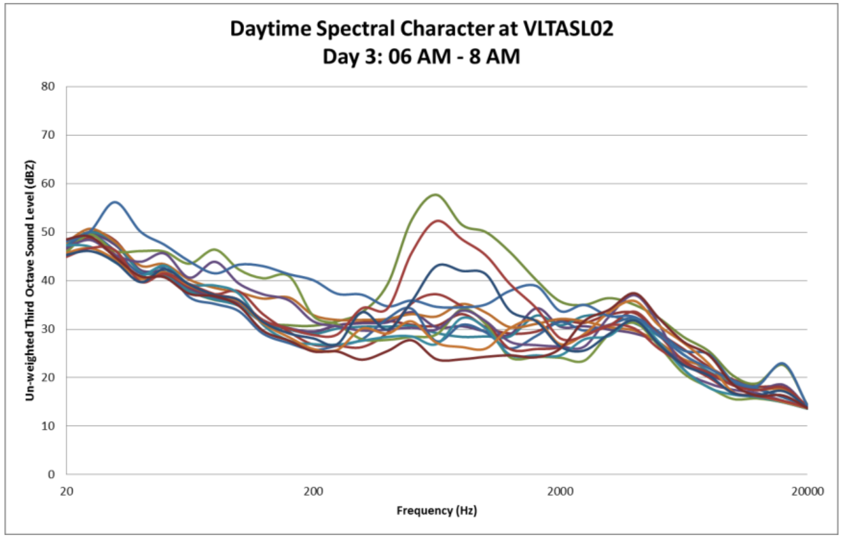

Figure 3-16: Spectral frequencies - VASL02, Day 4

3.3.3 Single measurements around project area

A number of single measurements were collected to gauge the ambient sound character and levels around the project site for other projects, including WCO WEF. The soundscape indicates an area with a sound level character typical of a rural area (away from the ocean, any dwellings, roads and towns) during periods when wind speeds were below 3 m/s. Areas closer than 1,000m from the Atlantic ocean had higher ambient sound levels due to the surf but as the measurements were collected further inland sound levels generally dropped closer to the levels expected for a rural area.

Sound levels close to dwellings are generally significantly higher than the sounds away from residential dwellings, mainly because occupation significantly alters the surrounding environment, developed infrastructure and additional vegetation can also change the sound character.

People staying in the area moved here for the natural quiet of the area. Considering the developmental character of the area it is likely that the dwellings would have a sub-urban district rating (see SANS 10103:2008) with the less dense areas likely to have a Rural Rating Level. For the purpose of this study the quieter night-time Rural Rating Level ($L_{R,n}$= 35 dBA) will be selected for the areas surrounding the proposed facility for wind speeds below 3 m/s. Dwellings that belong to people that are beneficiaries of the project will be subject to increased noise level of 45 dBA at night.

4 POTENTIAL NOISE SOURCES

Increased noise levels are directly linked with the various activities associated with the construction of the WF and related infrastructure, as well as the operation phase of the activity. The specific activities relating to construction of the WF will only be known during the EIA phase of the project, and therefore will only be discussed in a generalised manner in the following sections.

However, commonly the most significant stage relating to noise is the operation phase, and not the construction phase. This is because the duration of activities during the construction phase are generally short.

In addition, the exact locations of the various Wind Turbine Generators (WTGs) will only be defined during the EIA phase, and only then can their noise impact be calculated in detail.

4.1 POTENTIAL NOISE SOURCES: CONSTRUCTION PHASE

4.1.1 Construction equipment

There are a number of factors that determine the audibility as well as the potential of a noise impact on receptors. Maximum noises generated can be audible over a large distance, however, are generally of very short duration. If maximum noise levels however exceed 65 dBA at a receptor, or if it is clearly audible with a significant number of instances where the noise level exceeds the prevailing ambient sound level with more than 15 dB, the noise can increase annoyance levels and may ultimately result in noise complaints. Potential maximum noise levels generated by various construction equipment as well as the potential extent of these sounds are presented in **Table 4.1**.

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 4.2**.

Table 4.1: Potential maximum noise levels generated by construction equipment

Equipment Description[4]	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 modeling 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
Auger Drill Rig	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
Backhoe	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Chain Saw	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Compactor (ground)	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Compressor (air)	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Concrete Batch Plant	No	117.7	92.7	86.7	80.6	72.7	66.7	63.1	60.6	57.1	52.7	49.2	46.7	40.6
Concrete Mixer Truck	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Concrete Pump Truck	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Concrete Saw	No	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
Crane	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Dozer	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Drill Rig Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Drum Mixer	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Dump Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Excavator	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Flat Bed Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Front End Loader	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Generator	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Generator (<25KVA)	No	104.7	79.7	73.7	67.6	59.7	53.7	50.1	47.6	44.1	39.7	36.2	33.7	27.6
Grader	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Impact Pile Driver	Yes	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6
Jackhammer	Yes	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Man Lift	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Mounted Impact 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

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

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

Table 4.2: Potential equivalent noise levels generated by various equipment

Equipment Description	Equivalent (average) Sound Levels (dBA)	Operational Noise Level at given distance considering equivalent (average) sound power emission levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
		5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Air compressor	92.6	67.6	61.6	55.5	47.6	41.6	38.0	35.5	32.0	27.6	24.1	21.6	15.5
Bulldozer CAT D10	111.9	86.9	80.9	74.9	66.9	60.9	57.4	54.9	51.3	46.9	43.4	40.9	34.9
Cement truck (with cement)	111.7	86.7	80.7	74.7	66.7	60.7	57.2	54.7	51.2	46.7	43.2	40.7	34.7
Crane	107.5	82.5	76.5	70.5	62.5	56.5	53.0	50.5	46.9	42.5	39.0	36.5	30.5
Diesel Generator (Large - mobile)	106.1	81.2	75.1	69.1	61.2	55.1	51.6	49.1	45.6	41.2	37.6	35.1	29.1
Dumper/Haul truck - Terex 30 ton	112.2	87.2	81.2	75.2	67.2	61.2	57.7	55.2	51.7	47.2	43.7	41.2	35.2
Excavator - Hitachi EX1200	113.1	88.1	82.1	76.1	68.1	62.1	58.6	56.1	52.6	48.1	44.6	42.1	36.1
FEL (988) (FM)	115.6	90.7	84.6	78.6	70.7	64.6	61.1	58.6	55.1	50.7	47.1	44.6	38.6
General noise	108.8	83.8	77.8	71.8	63.8	57.8	54.2	51.8	48.2	43.8	40.3	37.8	31.8
Grader - Operational Hitachi	108.9	83.9	77.9	71.9	63.9	57.9	54.4	51.9	48.4	43.9	40.4	37.9	31.9
Road Truck average	109.6	84.7	78.7	72.6	64.7	58.7	55.1	52.6	49.1	44.7	41.1	38.7	32.6
Rock Breaker, CAT	120.7	95.7	89.7	83.7	75.7	69.7	66.2	63.7	60.2	55.7	52.2	49.7	43.7
Vibrating roller	106.3	81.3	75.3	69.3	61.3	55.3	51.8	49.3	45.8	41.3	37.8	35.3	29.3
Water Dozer, CAT	113.8	88.8	82.8	76.8	68.8	62.8	59.3	56.8	53.3	48.8	45.3	42.8	36.8
Wind Turbine: Acciona AW125/3000	108.4	85.4	79.4	73.4	65.4	59.4	55.9	53.4	49.9	45.4	41.9	39.4	33.4
Wind Turbine: Vesta V66, ave	102.6	77.7	71.6	65.6	57.7	51.6	48.1	45.6	42.1	37.7	34.1	31.6	25.6
Wind Turbine: Vesta V66, max	108.0	83.0	77.0	71.0	63.0	57.0	53.5	51.0	47.5	43.0	39.5	37.0	31.0
Wind Turbine: Vesta V66, min	96.3	71.3	65.3	59.3	51.3	45.3	41.8	39.3	35.8	31.3	27.8	25.3	19.3
Wind Turbine: Vestas V117 3.3MW	107.0	82.0	76.0	70.0	62.0	56.0	52.5	50.0	46.4	42.0	38.5	36.0	30.0

Construction activities include:

- construction of access roads,
- establishment of turbine tower foundations and electrical substation(s),
- the possible establishment, operation and removal of concrete batching plants,
- the construction of any buildings,
- digging of trenches to accommodate underground power cables; and
- the erection of turbine towers and assembly of WTGs.

The equipment likely to be required to complete the above tasks will typically include:

- excavator/graders, bulldozer(s), dump trucks(s), vibratory roller, bucket loader, rock breaker(s), drill rig, flatbed truck(s), pile drivers, TLB, concrete truck(s), crane(s), fork lift(s) and various 4WD and service vehicles.

4.1.2 Material supply: Concrete batching plants and use of Borrow Pits

Instead of transporting the required material to the site using concrete trucks, portable concrete batching plants may be required to supply concrete on site. Batching plant equipment may be relocated between the sites as the works progress to different areas of the site. The need for such batching plants, the number, and whether they will be moved is unknown at this stage.

Similarly, the need and potential location(s) for a borrow pit are unknown. A portable rock crusher plant and screen will most likely be required if the developer selects the use of a borrow pit.

4.1.3 Blasting

Blasting may be required as part of the civil works to clear obstacles or to prepare foundations. Should a borrow pit be used to supply rocks for construction purposes, blasting could also be expected. However, no information regarding the use, or even the feasibility of such a borrow pit is known.

However, blasting will not be considered during the EIA phase for the following reasons:

- Blasting is highly regulated, and control of blasting to protect human health, equipment and infrastructure will ensure that any blasts will use minimum explosives and will occur in a controlled manner. With regards to blasting in borrow pits, explosives are used with a low detonation speed, reducing vibration, sound pressure levels and air blasts. The breaking of obstacles with explosives is also a specialized field, and when correct techniques are used, it causes less noise than using a rock-breaker.

- People are generally more concerned over ground vibration and air blast levels that might cause building damage than the impact of the noise from the blast.
- Blasts are an infrequent occurrence, with a loud but a relative instantaneous character. Potentially affected parties normally receive sufficient notice (siren), and the knowledge that the duration of the siren noise as well as the blast will be over relative fast, resulting in a higher acceptance of the noise.

4.1.4 Traffic

The last significant source of noise during the construction phase is additional traffic to and from the site, as well as traffic on the site. The use of a borrow pit(s), on site crushing and screening and concrete batching plants will significantly reduce heavy vehicle movement to and from 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 during the construction period. Noise levels due to traffic will be estimated using the methodology stipulated in SANS 10210:2004 (Calculating and predicting road traffic noise).

4.2 POTENTIAL NOISE SOURCES: OPERATION PHASE

Noise emitted by wind turbines can be associated with two types of noise sources. These are aerodynamic sources due to the passage of air over the wind turbine blades and mechanical sources which are associated with components of the power train within the turbine, such as the gearbox and generator and control equipment for yaw, blade pitch, etc. These sources normally have different characteristics and can be considered separately. In addition there are other lesser noise sources, such as the sub-stations, traffic (maintenance) and transmission line noise.

4.2.1 Wind Turbine Noise: Aerodynamic sources[5]

Aerodynamic noise is emitted by a wind turbine blade through a number of sources such as:

1. Self-noise due to the interaction of the turbulent boundary layer with the blade trailing edge.
2. Noise due to inflow turbulence (turbulence in the wind interacting with the blades).
3. Discrete frequency noise due to trailing edge thickness.

[5] *Renewable Energy Research Laboratory, 2006; ETSU R97: 1996*

4. Discrete frequency noise due to laminar boundary layer instabilities (unstable flow close to the surface of the blade).
5. Noise generated by the rotor tips.

Therefore, as the wind speed increases, noises created by the wind turbine also increases. At a low wind speed the noise created by the wind turbine is generally (relatively) low, and increases to a maximum at a certain wind speed when it either remains constant, increase very slightly or even drops as illustrated in **Figure 4-1**.

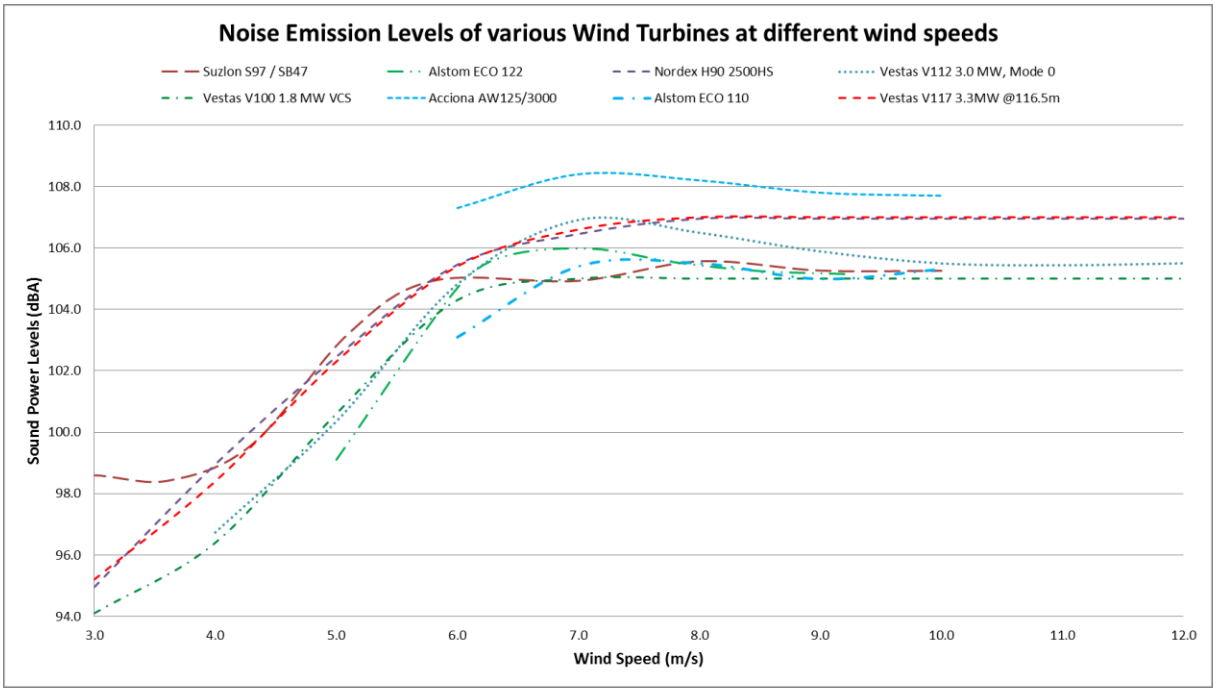

Figure 4-1: Noise Emissions Curve of a number of different wind turbines (figure for illustration purposes only)

4.2.2 Wind Turbine: Mechanical sources[6]

Mechanical noise is normally perceived within the emitted noise from wind turbines as an audible tone(s) which is subjectively more intrusive than a broad band noise of the same sound pressure level. Sources for this noise are normally associated with:

- the gearbox and the tooth mesh frequencies of the step up stages;
- generator noise caused by coil flexure of the generator windings which is associated with power regulation and control;
- generator noise caused by cooling fans; and

[6] *Renewable Energy Research Laboratory, 2006; ETSU R97: 1996; Audiology Today, 2010; HGC Engineering, 2007*

- control equipment noise caused by hydraulic compressors for pitch regulation and yaw control.

Tones are noises with a narrow sound frequency composition (e.g. the whine of an electrical motor). Annoying tones can be created in numerous ways: machinery with rotating parts such as motors, gearboxes, fans and pumps often create tones. An imbalance or repeated impacts may cause vibration that, when transmitted through surfaces into the air, can be heard as tones. Pulsating flows of liquids or gases can also create tones, which may be caused by combustion processes or flow restrictions. The best and most well-known example of a tonal noise is the buzz created by a flying mosquito.

Where complaints have been received due to the operation of wind farms, tonal noise from the installed wind turbines appears to have increased the annoyance perceived by the complainants and has indeed been the primary cause for complaint.

However, tones were normally associated with the older models of turbines. All turbine manufacturers have started to ensure that sufficient forethought is given to the design of quieter gearboxes and the means by which these vibration transmission paths may be broken. Through the use of careful gearbox design and/or the use of anti-vibration techniques, it is possible to minimize the transmission of vibration energy into the turbine supporting structure. The benefits of these design improvements have started to filter through into wind farm developments which are using these modified wind turbines. ***New generation wind turbine generators do not emit any clearly distinguishable tones***.

4.2.3 Transformer noises (Sub-stations)

Also known as magnetostriction, is when the sheet steel used in the core of the transformer tries to change shape when being magnetized. When the magnetism is taken away, the shape returns, only to try and deform in a different manner when the polarity is changed.

This deformation is not uniform; consequently it varies all over a sheet. With a transformer core being composed of many sheets of steel, these deformations is taking place erratically all over each sheet, and each sheet is behaving erratically with respect to its neighbour. The resultant is the "hum" frequently associated with transformers. While this may be a soothing sound in small home appliances, various complaints are logged in areas where people stay close to these transformers. At a voltage frequency of 50 Hz, these "vibrations" take place 100 times a second, resulting in a tonal noise at 100Hz. ***However, this is a relative easy noise to mitigate with the use of acoustic shielding and/or placement***

of the transformer and will not be considered further in this noise scoping report or ENIA study.

4.2.4 Transmission Line Noise (Corona noise)

Corona noise is caused by the partial breakdown of the insulation properties of air surrounding the conducting wires. It can generate an audible and radio-frequency noise, but generally only occurs in humid conditions, as provided by fog or rain. A minimum line potential of 70kV or higher is generally required to generate corona noise depending on the electrical design. Corona noise does not occur on domestic distribution lines.

Corona noise has two major components: a low frequency tone associated with the frequency of the AC supply (100 Hz for 50 Hz source) and broadband noise. The tonal component of the noise is related to the point along the electric waveform at which the air begins to conduct. This varies with each cycle and consequently the frequency of the emitted tone is subject to great fluctuations. Corona noise can be characterised as broadband 'crackling' or 'buzzing', but ***fortunately it is generally only a feature during fog or rain***.

It will not be further investigated, as corona discharges results in:

- Power losses,
- Audible noises,
- Electromagnetic interference,
- A purple glow,
- Ozone production; and
- Insulation damage.

As such Electrical Service Providers, such as ESKOM, go to great lengths to design power transmission equipment to minimise the formation of corona discharges. In addition, it is an infrequent occurrence with a relatively short duration compared to other operational noises.

4.2.5 Low Frequency Noise[7]

4.2.5.1 Background and Information

Low frequency sound is the term used to describe sound energy in the region below ~200Hz. The rumble of thunder and the throb of a diesel engine are both examples of sounds with most of their energy in this low frequency range. Infrasound is often used to describe sound

[7] *Renewable Energy Research Laboratory, 2006; DELTA, 2008; DEFRA, 2003; HGC Engineering, 2006; Whitford, Jacques, 2008; Noise-con, 2008; Minnesota DoH, 2009; Kamperman, 2008, Van den Berg, 2004*

energy in the region below 20Hz. Almost all noise in the environment has components in this region although they are of such a low level that they are not significant (wind, ocean, thunder).

While significant work has been done on this field, there exist uncertainties around Infrasound and Low Frequency Noise.

4.2.5.2 The generation of Low Frequency Sounds

Because of the low rotational rates of the blades of a WTG, the peak acoustic energy radiated by large wind turbines is in the infrasonic range with a peak in the 8-12 Hz range. For smaller machines, this peak can extend into the low-frequency "audible" (20-20KHz) range because of higher rotational speeds and multiple blades.

4.2.5.3 Detection of Low Frequency Sounds

Investigations have shown that the perception and the effects of sounds differ considerably at low frequencies as compared to mid- and high frequencies. The main aspects to these differences are:

- a weakening of pitch sensation as the frequency of the sound decreases below 60 Hz;
- perception of sounds as pulsations and fluctuations;
- a much more rapid increase of loudness and annoyance with increasing sound level at low frequencies than at mid- or high frequencies;
- complaints about the feeling of ear pressure;
- annoyance caused by secondary effects like rattling of building elements, e.g. windows and doors or the tinkling of bric-a-brac;
- other psycho acoustic effects, e.g. sleep deprivation, a feeling of uneasiness; and
- reduction in building sound transmission loss at low frequencies compared to mid- or high frequencies.

4.2.5.4 Measurement, Isolation and Assessment of Low Frequency Sounds

There remains significant debate regarding the noise from WTG's, public response to that noise, as well as the presence or not of low frequency sound and how it affects people. While low frequency sounds can be measured, it is far more difficult to isolate low frequency sounds due to the numerous sources generating these sounds.

From sound power level emission tables (for Wind Turbines) it can be seen that a wind turbine has the potential to generate low frequency sounds with sufficient energy to warrant the need to investigate WTG as a source of low frequency sounds. Each turbine make, model and size has a specific noise emission characteristic. The larger a wind turbine (especially the blades), the higher the acoustical energy in the lower frequencies and the potential for low frequency sounds should be evaluated for each project and turbine proposed.

SANS 10103:2004 proposes a method to identify whether low frequency noise could be an issue. It proposes that if the difference between the A-frequency weighted and the C-frequency weighted equivalent continuous (L_{Aeq} >> L_{Ceq}) sound pressure levels is greater than 10 dB, a predominant low frequency component **may** be present.

4.2.5.5 Summary: Low Frequency Noise[8]

Low frequency noise is always present around us as it is produced by both man and nature. While problems have been associated with older downwind wind turbines in the 1980s, this has been considered by the wind industry and modern upwind turbines do not suffer from the same problems.

4.2.6 Amplitude modulation[9]

Although very rare, there is one other characteristic of wind turbine sound that increases the sleep disturbance potential above that of other long-term noise sources. The amplitude modulation of the sound emissions from the wind turbines creates a repetitive rise and fall in sound levels synchronized to the blade rotation speed, sometimes referred to as a "swish" or "thump".

Regrettably the mechanism of this noise is not known though various possible reasons have been put forward. Although the prevalence of complaints about amplitude modulation is relatively small, it is not clear whether this is because it does not occur often enough or whether it is because housing is not in the right place to observe it. Furthermore the fact that the mechanism is unknown means that it is not possible to predict when or whether it will occur.

Even though there are thousands of wind turbine generators in the world, amplitude modulation is one subject receiving the least complaints and due to this very few complaints, little research has gone into this subject. ***It is included in this report to highlight all potential risks, albeit extremely low risks such as this (low significance due to very low probability)***.

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[8] *BWEA, 2005*

[9] *Renewable Energy Research Laboratory, 2006; Audiology Today, 2010; HGC Engineering, 2007; Whitford, 2008; Noise-con, 2008; DEFRA, 2007; Bowdler, 2008*

5 METHODOLOGY: CALCULATION OF FUTURE NOISE EMISSIONS DUE TO PROPOSED PROJECT

5.1 NOISE EMISSIONS INTO THE SURROUNDING ENVIRONMENT

The noise emissions into the environment from the various sources as defined by the project developer will be calculated during the EIA phase using the sound propagation models described by ISO 9613-2 and SANS 10357[10]. The following will be taken into account:

- The octave band sound pressure emission levels of processes and equipment;
- The distance of the receiver from the noise sources;
- The impact of atmospheric absorption;
- The meteorological conditions in terms Pasquill stability;
- The preliminary layout details of the proposed project;
- The height of the noise source under investigation;
- Topographical layout; and,
- Acoustical characteristics of the ground.

The potential impact from traffic will not be considered during the Scoping phase, but only in the EIA phase. During the EIA phase the noise emission into the environment from the various traffic options will be calculated using the sound propagation model described in SANS 10210[11]. Corrections such as the following will be considered:

- Distance of a noise-sensitive development from roads;
- Road construction material;
- Average speeds of travel;
- Types of vehicles used;
- Ground acoustical conditions.

[10] SANS 10357:2004 The calculation of sound propagation by the Concave method'
[11] SANS 10210:2004. 'Calculating and predicting road traffic noise'

6 ASSUMPTIONS AND LIMITATIONS

6.1 MEASUREMENTS OF AMBIENT SOUND LEVELS

- Ambient sound levels are the cumulative effects of innumerable sounds generated at various instances both far and near. High measurements may not necessarily mean that noise levels in the area are high. Similarly, a low sound level measurement will not necessarily mean that the area is always quiet, as sound levels will vary over seasons, time of the day, faunal characteristics, vegetation in the area and meteorological conditions (especially wind). This is excluding the potential effect of sounds from anthropogenic origin. It is impossible to quantify and identify the numerous sources that influenced one 10-minute measurement using the reading result at the end of the measurement. Therefore trying to define ambient sound levels using the result of one 10-minute measurement will be very inaccurate (very low confidence level in the results) for the reasons mentioned above. The more measurements that can be collected at a location the higher the confidence levels in the ambient sound level determined. The more complex the sound environment, the longer the required measurement.
- Ambient sound levels are depended not only time of day and meteorological conditions, but also change due to seasonal differences. Ambient sound levels are generally higher in summer months when faunal activity is higher and lower during the winter due to reduced faunal activity. Winter months unfortunately also coincide with lower temperatures and very stable atmospheric conditions, ideal conditions for propagation of noise. Many faunal species are more active during warmer periods than colder periods. Certain cicada species can generate noise levels up to 120 dB for mating or distress purposes, sometimes singing in synchronisation magnifying noise levels they produce from their tymbals[12];
- Only two measurements were done during 2010 in the vicinity of the proposed development. These measurements indicated an area that is very quiet. Considering the measurements, vegetation, climate, faunal activity as well as the very low developmental character of the area, it is the opinion of the Author that the levels measured is representative of the sound levels in the area; and
- As a residential area develops the presence of people will result in increased sounds. These are generally a combination of traffic noise, voices, animals and equipment (incl. TV's and Radios). The result is that ambient sound levels will increase as an area matures.

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

6.2 CALCULATING NOISE EMISSIONS – ADEQUACY OF PREDICTIVE METHODS

The noise emissions into the environment from the various sources, as defined, will be calculated for the operation phase in detail, using the sound propagation model described in SANS 10357:2004.

The following was considered:

- The octave band sound pressure emission levels of defined equipment;
- The distance of the receiver from the noise sources;
- The impact of atmospheric absorption;
- The operational details of the proposed project, such as projected areas where activities will be taking place;
- Acoustical characteristics of the ground. Hard ground conditions were modelled.

The noise emission into the environment due to additional traffic will not be considered during this scoping phase but only generalized, due to the limited extent of traffic noises (due to low traffic volumes).

6.3 ADEQUACY OF UNDERLYING ASSUMPTIONS

Noise experienced at a certain location is the cumulative result of innumerable sounds emitted and generated both far and close, each in a different time domain, each having a different spectral character at a different sound level. Each of these sounds are also impacted differently by surrounding vegetation, structures and meteorological conditions that result in a total cumulative noise level represented by a few numbers on a sound level meter.

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

6.4 UNCERTAINTIES OF INFORMATION PROVIDED

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

- The octave sound power levels selected for processes and equipment accurately represent the sound character and power levels of this processes/equipment. The determination of these 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 change depending on the load, the process and equipment. 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. Normally these measurements are collected when the process or equipment is under high load. The result is that measurements generally represent a worse-case scenario;
- During the scoping phase it is unknown which processes and equipment will be operational (and when operational and for how long), modelling considers a scenario where all processes and equipment are under full load for a set time period. Modelling assumptions complies with the precautionary principle and operational time periods which are frequently overestimated. The result is that projected noise levels would likely over-estimate noise levels;
- Ambient sound levels vary over time of day, season and largely depend on the complexity and development character of the surrounding environment. To allow the calculation of change in ambient sound levels, a potential ambient sound level of 20 dBA is assumed. This level represents a very quiet environment.
- Modelling cannot capture the potential impulsive or tonal character of a noise that can increase the potential nuisance factor.
- 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;
- Acoustical characteristics of the ground are over-simplified with ground conditions accepted as uniform.

7 METHODOLOGY: ENVIRONMENTAL NOISE IMPACT ASSESSMENT AND SIGNIFICANCE

7.1 NOISE IMPACT ON ANIMALS[13]

A great deal of research was conducted in the 1960's and 1970's on the effects of aircraft noise on animals. While aircraft noise have a specific characteristic, the findings should be relevant to most noise sources.

Overall, the research suggests that species differ in their response to:

- Various types of noise
- Durations of noise
- Sources of noise

A general animal behavioural reaction to aircraft noise is the startle response. However, the strength and length of the startle response appears to be dependent on:

- which species is exposed
- whether there is one animal or a group
- whether there have been some previous exposures

Unfortunately, there are numerous other factors in the environment of animals 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.

From these and other studies the following can be concluded:

- Animals respond to impulsive (sudden) noises (higher than 90 dBA) by running away. If the noises continue, animals would try to relocate. This is not relevant to wind energy facilities because the turbines do not generate any impulsive noises close to these sound levels.
- Animals of most species exhibit adaptation with noise, including aircraft noise and sonic booms (far worse than noises associated with Wind Turbines).
- More sensitive species would relocate to a more quiet area, especially species that depend on hearing to hunt or evade prey, or species that makes use of sound/hearing to locate a suitable mate.
- Noises associated with helicopters, motor- and quad bikes significantly impact on animals.

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

7.2 WHY NOISE CONCERNS COMMUNITIES[14]

Noise can be defined as "unwanted sound", 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),
- 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 no noise, but the person in the traffic behind them hears nothing but noise.

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

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

Severity of the annoyance depends on factors such as:

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

7.2.1 Annoyance associated with Wind Energy Facilities[15]

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

[14] World Health Organization, 1999; Noise quest, 2010; Journal of Acoustical Society of America, 2009
[15] Van den Berg, 2011; Milieu, 2010.

noise annoyance is accounted for by acoustic parameters, and that non-acoustic factors plays 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.

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 7-1, are recommended in a European Union position paper published in 2002, stipulating policy regarding the quantification of annoyance. This can be used in an 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 climate.

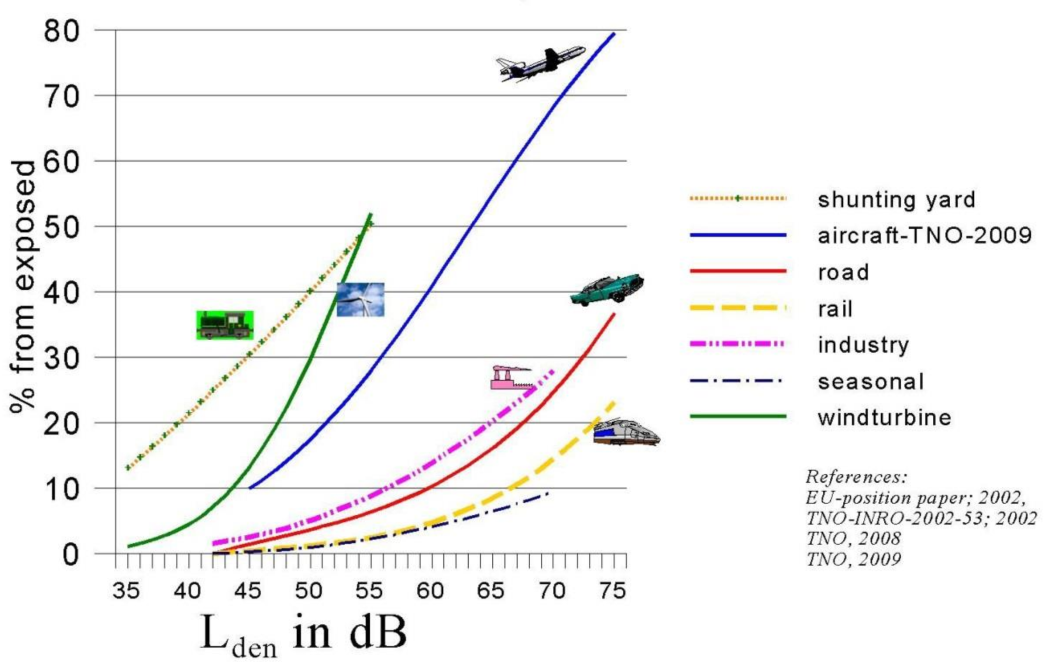

Figure 7-1: Percentage of annoyed persons as a function of the day-evening-night noise exposure at the façade of a dwelling

7.3 IMPACT ASSESSMENT CRITERIA

7.3.1 Overview: The common characteristics

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

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

7.3.2 Noise criteria of concern

The criteria used in this report were drawn from the criteria for the description and assessment of environmental impacts from the EIA Regulations, published by the Department of Environmental Affairs and Tourism (DEAT, 2002) in terms of the NEMA, SANS 10103 as well as guidelines from the World Health Organization (WHO).

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

- *Increase in noise levels:* People or communities often react to an increase in the ambient noise level they are used to, which is caused by a new source of noise. With regards to the Noise Control Regulations, an increase of more than 7 dBA is considered a disturbing noise. See also **Figure 7-2**.
- *Zone Sound Levels:* Previously referred as the acceptable rating levels, it sets acceptable noise levels for various areas. See also **Table 7.1**.
- *Absolute or total noise levels:* Depending on their activities, people generally are tolerant to noise up to a certain absolute level, e.g. 65 dBA. However, anything above this level is considered unacceptable.

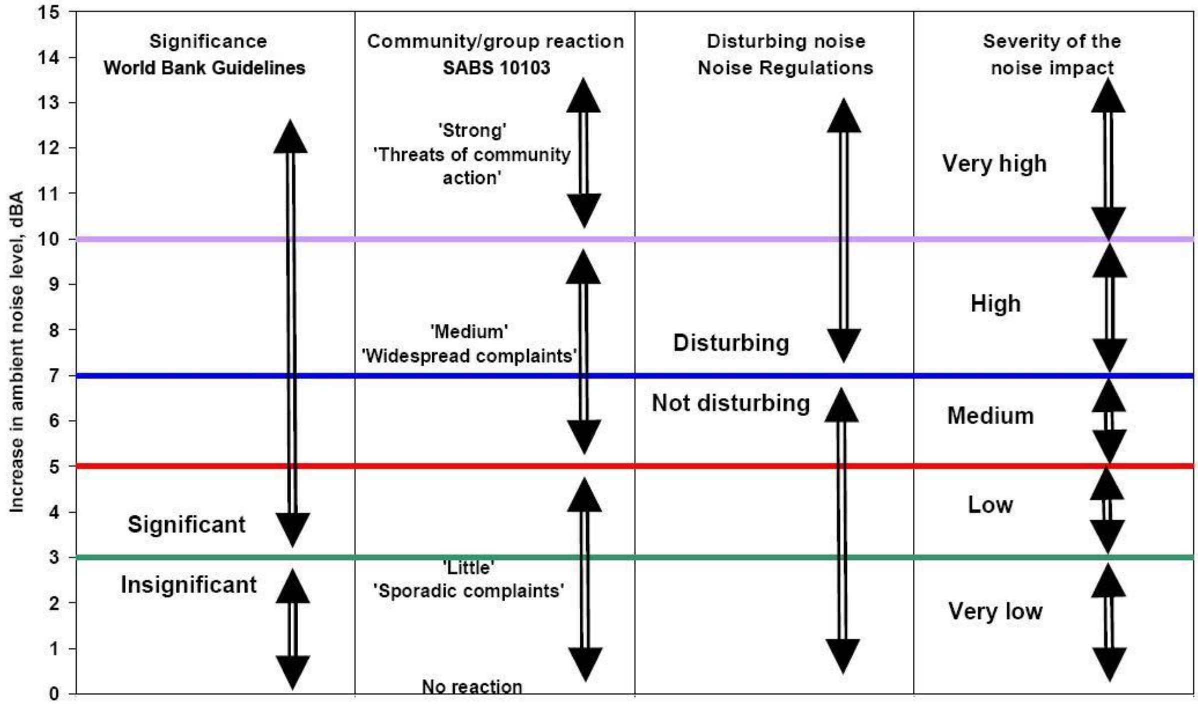

Figure 7-2: Criteria to assess the significance of impacts stemming from noise

In South Africa the document that addresses the issues concerning environmental noise is SANS 10103. See also **Table 6.1**. It provides the maximum average ambient noise levels, $L_{Req,d}$ and $L_{Req,n}$, during the day and night respectively to which different types of developments may be exposed. For rural areas the Zone Sound Levels (Rating Levels) are:

- Day (06:00 to 22:00) - $L_{Req,d}$ = 45 dBA, and
- Night (22:00 to 06:00) - $L_{Req,n}$ = 35 dBA.

SANS 10103 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 noise level, the following criteria are of relevance:

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

increase of more than 15 dBA the community reaction will be 'strong' with 'threats of community action'.

In addition, it should be noted that the Noise Control Regulations defines disturbing noise to be any change in the ambient noise levels higher than 7 dBA than the background.

Table 7.1: Acceptable Zone Sound Levels for noise in districts (SANS 10103)

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

7.3.3 Determining appropriate Zone Sound Levels

SANS 10103 unfortunately does not cater for instances when background noise levels change due to the impact of external forces. Locations close to the sea for instance always have a background noise level exceeding 35 dBA, and, in cases where the sea is rather turbulent, it can easily exceed 45 dBA. Similarly, noise induced by high winds is not included.

Setting noise limits relative to the background noise level is relatively straightforward when the prevailing background noise level and source level are constant. However, wind turbines emit noise that is related to wind speed, and the environment within which they are heard will probably also be dependent upon the strength of the wind and the noise associated with its effects. It is therefore necessary to derive a background noise level that is indicative of the noise environment at the receiving property for different wind speeds so that the turbine noise level at any particular wind speed can be compared with the background noise level in the same wind conditions.

Therefore, when assessing the overall noise levels emitted by a wind farm it is necessary to consider the full range of operating wind speeds of the wind turbines. This covers the wind speed range from around 3-5m/s (the turbine cut-in wind speed) up to a wind speed range of 25-35m/s measured at the hub height of a wind turbine. However, the Noise Working Group proposes that noise limits only be placed up to a wind speed of 12 m/s for the following reasons:

1. Wind speeds are not often measured at wind speeds greater than 12m/s at 10m height.
2. Reliable measurements of background noise levels and turbine noise will be difficult to make in high winds due to the effects of wind noise on the microphone and the fact that one could have to wait several months before such winds were experienced.
3. Turbine manufacturers are unlikely to be able to provide information on sound power levels at such high wind speeds for similar reasons.
4. If a wind farm meets noise limits at wind speeds lower than 12 m/s it is unlikely to cause any greater loss of amenity at higher wind speeds. Whilst turbine noise levels will still be reasonably constant, even in sheltered areas the background is likely to contain much banging and rattling due to the force of the wind.

Available data indicates that noises from a Wind Turbine is drowned by other noises (wind howling around building, rustling of leaves in trees, rattling noises, etc) above a wind speed of 8 – 10 m/s, even if the wind blows in the direction of the receiver.

A typical background noise vs. wind speed regression curve is illustrated in **Figure 7-3**. It should be noted that curves for daytime (6:00 – 22:00) and night time (22:00 – 6:00) would be different, but as wind speeds increase, the wind induced noise levels approach each other (wind speeds exceeding 15 m/s).

The curve was developed by plotting all measurement data (as collected by the author during periods when the wind was blowing) and fitting a curve through the points. The measurement points were selected to be away from structures (buildings, trees, etc.) that could significantly impact the ambient sound levels during high winds. This is because ambient sound levels are generally significantly higher closer to dwellings or other structures than at points further away from such structures (during times when a wind is blowing). In addition data collected when other noise sources were present (traffic, industrial noises) were not included.

For the purpose of the EIA, **Figure 7-3** will be considered, together with the zone sound levels as stipulated in SANS 10103.

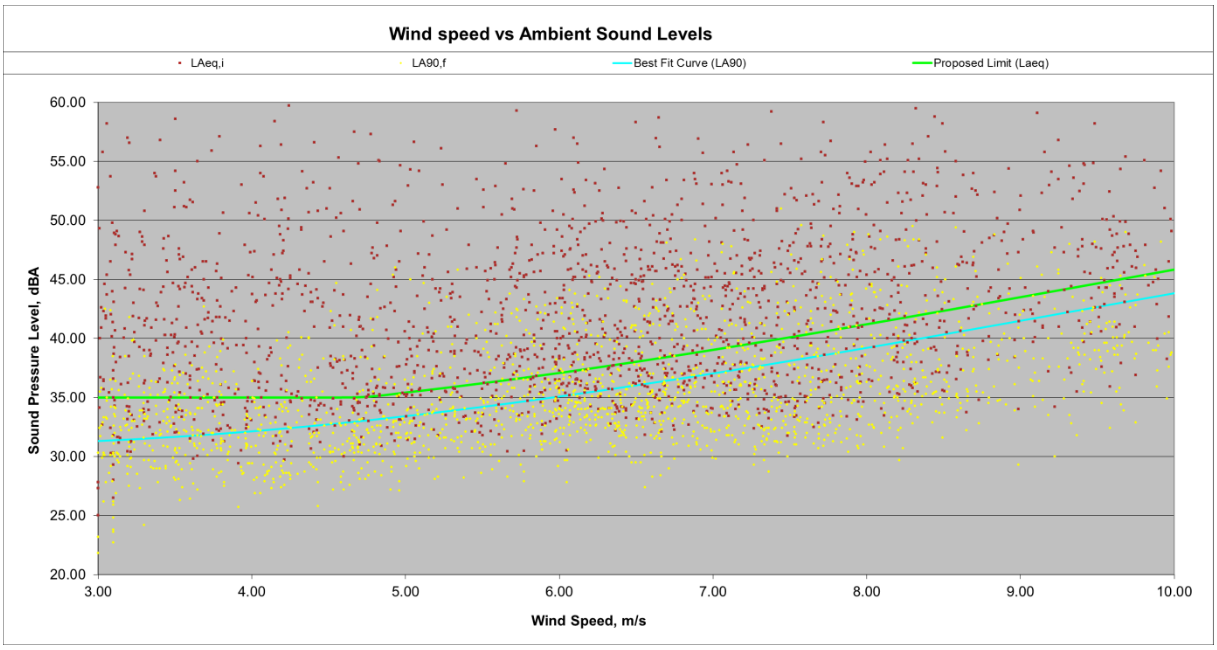

Figure 7-3: Ambient sound measurements and noise criteria curve considering wind speeds

7.3.4 Determining the Significance of the Noise Impact

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

The impact consequence is determined by the summing the scores of Magnitude (**Table 7.2**), Duration (**Table 7.3**) and Spatial Extent (**Table 7.4**). The impact significance is determined by multiplying the Consequence result with the Probability score (**Table 7.5**).

An explanation of the impact assessment criteria is defined in the following tables.

Table 7.2: Impact Assessment Criteria - Magnitude

This defines the impact as experienced by any receptor. In this report the receptor is defined as any resident in the area, but excludes faunal species.		
Rating	**Description**	**Score**
Minor	Increase in average sound pressure levels between 0 and 3 dB from the expected wind induced ambient sound level (proposed rating level). No change in ambient sound levels discernable. Total projected noise level is less than the Zone Sound Level in wind-still conditions.	2
Low	Increase in average sound pressure levels between 3 and 5 dB from the (expected) ambient sound level (proposed rating level). The change is barely discernable, but the noise source might become audible.	4
Moderate	Increase in average sound pressure levels between 5 and 7 dB from the (expected) ambient sound level (proposed rating level). Sporadic complaints expected. Any point where the zone sound levels are exceeded during wind still conditions.	6
High	Increase in average sound pressure levels between 7 and 10 dB from the (expected) ambient sound level (proposed rating level). Medium to widespread complaints expected.	8
Very High	Increase in average sound pressure levels higher than 10 dBA from the (expected) ambient sound level (proposed rating level). Change of 10 dBA is perceived as 'twice as loud', leading to widespread complaints and even threats of community or group action. Any point where noise levels exceed 65 dBA at any receptor.	10

Table 7.3: Impact Assessment Criteria - Duration

The lifetime of the impact that is measured in relation to the lifetime of the proposed development (construction, operational and closure phases). Will the receptors be subjected to increased noise levels for the lifetime duration of the project, or only infrequently.		
Rating	**Description**	**Score**
Temporary	Impacts are predicted to be of short duration (portion of construction period) and intermittent/occasional (0 - 1 years).	1
Short term	Impacts that are predicted to last only for the duration of the construction period (1 - 5 years).	2
Medium term	Impacts that will continue for a part of the operational phase, well after the construction phase stopped (5 – 15 years).	3
Long term	Impacts that will continue for the life of the Project, but ceases when the Project stops operating (> 15 years).	4
Permanent	Impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime.	5

Table 7.4: Impact Assessment Criteria – Spatial extent

Classification of the physical and spatial scale of the impact (defined as the area where the noise impact may change the ambient sound levels with 7 dBA or more)		
Rating	**Description**	**Score**
Site	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.	1
Local	The impact could affect the local area (within 1,000 m from site).	2
Regional	The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns (further than 1,000 m from the site).	3
National	The impact could have an effect that expands throughout the country (South Africa).	4
International	Where the impact has international ramifications that extend beyond the boundaries of South Africa.	5

Table 7.5: Impact Assessment Criteria - Probability

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

7.3.5 Identifying the Potential Impacts without Mitigation Measures (WOM)

Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned probabilities, resulting in a value for each impact (prior to the implementation of mitigation measures). Significance without mitigation is rated on the following scale:

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

7.3.6 Identifying the Potential Impacts with Mitigation Measures (WM)

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

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

		regarded as a fatal flaw. An impact regarded as high significance, after mitigation could render the entire development option or entire project proposal unacceptable.

7.4 EXPRESSION OF THE NOISE IMPACTS

Sound or noise levels generally refers to a level as measured using an instrument, whereas the noise rating level refers to a calculated sound exposure level to which various corrections and adjustments was added. These noise rating levels are further processed into a 3D map illustrating noise contours of constant rating levels or noise isopleths. In this noise scoping report it can be used to define the potential extent of noises of the project and not a noise level at a specific moment in time.

The noise impacts can be expressed in terms of the increase in present ambient noise levels caused by noise emissions from the proposed project.

For the purpose of this Scoping document, predicted sound levels have only been included for illustrative purposes, as well as to indicate the potential overall spatial extent of noise impacts that wind turbines may have. The purpose is to identify areas of possible concern for both the developer as well as stakeholders, highlighting important criteria for the EIA phase.

8 RESULTS AND PRELIMINARY IMPACT ASSESSMENT

8.1 CONSTRUCTION PHASE

Projected impacts from the construction phase can only be modelled once more information regarding the duration of construction and equipment used are known. Therefore the construction phase will only be dealt with in more detail during the Environmental Noise Impact Assessment phase.

As no specific construction details or possible locations of major ancillary activity sites are available at this stage, the anticipated noise from various types of construction activities cannot be calculated and will only be estimated.

Considering the location of the project site in relation to the closest potential NSDs, there are a number of potential receptors that can be influenced by sounds from these wind turbines.

Based on **Table 4.1**, maximum noise levels could be in the region of 90 – 105 dBA when working in close quarters to equipment (within 5 m), but noise levels will reduce the further a conceptual receptor (such as employees) is from construction activities. For all construction work, the workers working with or in close proximity to equipment will be exposed to high levels of noise as can be seen from **Table 4.1** (when working within 10 m of noisy equipment).

While maximum noise levels may reach up to 60 dBA at 1,000 meters (worst-case scenario for a pile driver), such noise levels are not a constant, and equivalent A-weighted noise levels can range between 56 (at 500m for a Rock Breaker) and 50 dBA (at 1,000 for a Rock Breaker) (refer also **Table 4.2**).

There are number of potential NSDs identified living within and adjacent to the properties where construction activities can take place. These activities can increase the noise levels at these receptors, with the levels either changing the ambient sound levels with more than 7 dB or resulting in noise levels higher than the rural night-time rating levels (potentially exceeding the levels recommended by international guidelines such as IFC - see also **section 2.6.5**).

During the EIA phase construction activities such as the (potential) borrow pit, concrete batching/delivery, foundation preparation, the digging of trenches and increased traffic (deliveries and movement onsite) will be considered, taking cognisance of the worst-case scenario (simultaneous activities close to a NSD(s)).

8.2 OPERATIONAL PHASE: ESTIMATED IMPACT AND IMPORTANT CONCEPTS

This preliminary operational assessment makes use of the data defined in **Table 4.2.** This will allow defining extent and potential magnitude of noise rating levels.

This Scoping document considers, as will the Environmental Noise Impact Assessment, the impacts on the surrounding noise environment during times when a quiet environment is highly desirable. Noise limits should therefore be appropriate for the most noise-sensitive activity.

Noise-sensitive activities such as sleeping, or areas used for relaxation or other activities (places of worship, school, etc.) should determine appropriate Zone Sound Levels. However, for this Scoping report the $L_{Req,N}$ of **35dBA** as proposed by SANS 10103 is used.

Considering the location of the project site in relation to the closest potential NSDs, there is a potential for a noise impact when considering the noise levels presented in **Table 4.2**, noise rating levels could be higher than 35 dBA (using the sound power emission data of the Vestas V117 3.3MW). This is higher than the SANS 10103 night-time rating level of 35dBA.

It should be noted that this is a simplistic model, as the exact noise rating level will depend on factors such as:

- Total number of wind turbines operating within a distance of 2,000m that can cumulatively increase the noise levels,
- Atmospheric conditions that can assist in the attenuation of the sound levels,
- Ground conditions, that can assist in absorbing some of the acoustic energy of certain frequencies reflected from the ground,
- Height corrections.

These factors will only be considered during the Environmental Noise Impact Assessment phase. However, considering the potential noise level of 42 dBA (potential noise rating level at 500m from a Vestas V117 3.3MW wind turbine), no wind turbines should be developed within 500m from any NSD.

9 PRELIMINARY SIGNIFICANCE OF THE NOISE IMPACT

9.1 CONSTRUCTION PHASE NOISE IMPACT

The impact assessment for the various activities defined in **Section 4.1** and assessed in **Section 8.1** that can create noise and may impact on the surrounding environment is summarized in the following **Table 9-1**.

Table 9-1: Scoping level Noise Impact Assessment: Construction Activities

<table>
<tr><td colspan="4">Impacts:
Increases in noise levels at closest receptors.
Noise levels exceeding the SANS 10103 rating level.</td></tr>
<tr><td colspan="4">Desktop Sensitivity Analysis:
Rural area with daytime $L_{R,d}$ rating level of 45 dBA.
Rural area with night-time $L_{R,n}$ rating level of 35 dBA.</td></tr>
<tr><td>Issue</td><td>Nature of Impact</td><td>Extent of Impact</td><td>No-go areas</td></tr>
<tr><td>Increase in noise level at receptors. Disturbing noises. Noises exceeding rating level.</td><td>Increased noises or disturbing noises may increase annoyance levels with project. Noise levels could reach 56 dBA during construction.</td><td>Multiple construction activities taking place simultaneously may impact an area within 2,000m from the activities</td><td>No wind turbines to be developed within 500m from identified NSD and prevent the development of access roads within 250m from these NSD (the upgrade of existing roads is acceptable within 250m of an identified NSD subject to this being undertaken during the day time)</td></tr>
<tr><td colspan="4">Description of expected significance of impact:
Without noise propagation modeling it is difficult to access the potential significance of the noise impact. However, if the developer only constructs wind turbines further than 500m from identified NSD, the potential significance could be medium (night-time construction activities mainly) to low, with the noise impact depending on the type and number of construction activities taking place simultaneously. These noise impacts:
(a) Is highly reversible;
(b) Will not result in the irreplaceable loss of resources; and
(c) Potential noise impacts can be managed, mitigated or even avoided.</td></tr>
<tr><td colspan="4">Gaps in Knowledge:
Accurate noise rating levels to be modeled during EIA phase once a layout is available.</td></tr>
<tr><td colspan="4">Comments:
Low confidence in assessment.</td></tr>
<tr><td colspan="4">Mitigation Measures:
Mitigation (if required) will depend on the layout of infrastructure (location where construction activities could take place) and the significance of the potential noise impact.</td></tr>
<tr><td colspan="4">Recommendations:
Scoping level assessment is not sufficient, full Environmental Noise Impact Assessment is required.</td></tr>
</table>

9.2 Operational Phase Noise Impact

The impact assessment for the various activities defined in **Section 4.2** and calculated in **section 8.2** will increase the ambient noise levels in the area. The noise impact is assessed and summarized in the following **Table 9-2**. Only the night-time scenario was assessed as this is the most critical time period when a quiet environment is desired.

Table 9-2: Impact Assessment: Operational Activities

<table>
<tr><td colspan="4">Impacts:
Increases in noise levels at closest receptors.
Noise levels exceeding the SANS 10103 rating level.</td></tr>
<tr><td colspan="4">Desktop Sensitivity Analysis:
Rural area with night-time $L_{R,n}$ rating level of 35 dBA, although data indicate that noise levels increase as the wind speeds increase.</td></tr>
<tr><td>Issue</td><td>Nature of Impact</td><td>Extent of Impact</td><td>No-go areas</td></tr>
<tr><td>Increase in noise level at receptors. Noises exceeding rating level.</td><td>Increased noises may increase annoyance levels with project. Noise levels could reach 42 dBA during the operation phase.</td><td>Multiple wind turbines operating at night could impact on an area up to 2,000m from the turbines.</td><td>No wind turbines to be developed within 500m from identified NSD</td></tr>
<tr><td colspan="4">Description of expected significance of impact:
Without noise propagation modeling it is difficult to access the potential significance of the noise impact. However, if the developer only develops wind turbines further than 500m from identified NSD, the potential significance could be medium to low, with the noise impact depending on the specific sound power emission characteristics of the wind turbine as well as the number of wind turbines located within 2,000m from these NSD (cumulative effects). These noise impacts:
(a) Is reversible at the end of the project;
(b) Will not result in the irreplaceable loss of resources; and
(c) Potential noise impacts can be managed, mitigated or even avoided.</td></tr>
<tr><td colspan="4">Gaps in Knowledge:
Accurate noise rating levels to be modeled during EIA phase once a layout and the details of the selected wind turbine are available.</td></tr>
<tr><td colspan="4">Comments:
Low confidence in assessment.</td></tr>
<tr><td colspan="4">Mitigation Measures:
Mitigation (if required) will depend on the layout of the wind farm, the exact details of the wind turbine selected and the significance of the potential noise impact.</td></tr>
<tr><td colspan="4">Recommendations:
Scoping level assessment is not sufficient, full Environmental Noise Impact Assessment is required.</td></tr>
</table>

10 CONCLUSIONS

This report is a Scoping assessment of the predicted noise environment due to the development of the proposed Boulders WF on various farms in the vicinity of Vredenburg. It is based on a desktop assessment as well as a basic predictive model to identify potential issues of concern.

This assessment indicated that the proposed project could have a noise impact on the surrounding area as there may be NSD within the area of acoustical influence of the wind turbines in the project area. The main factors that will determine the potential noise impact is the distance that the wind turbines of the wind farm would be from a NSD, the sound power emission characteristics of the selected wind turbine and the total number of wind turbines that could cumulatively impact on this NSD.

The results of the evaluation indicated that certain data (see **Recommendations – Section 11**) is critical in order to define the noise impact on NSDs during the EIA phase.

Wind Turbines do emit noises at sufficient levels to propagate over large distances. The fact that there would be a number wind turbines operating simultaneously in an area where there are noise-sensitive developments increase the possibility that a noise impact could occur. At this preliminary stage it is impossible to determine whether the significance of this noise impact would be low, medium or high.

However, other projects (local and international) indicated that with the implementation of correct mitigation measures (especially a sufficient setback or buffer zone, see Figure 10-1) it would be possible to minimize the potential noise risks and reduce the noise impacts to a more acceptable medium or low significance.

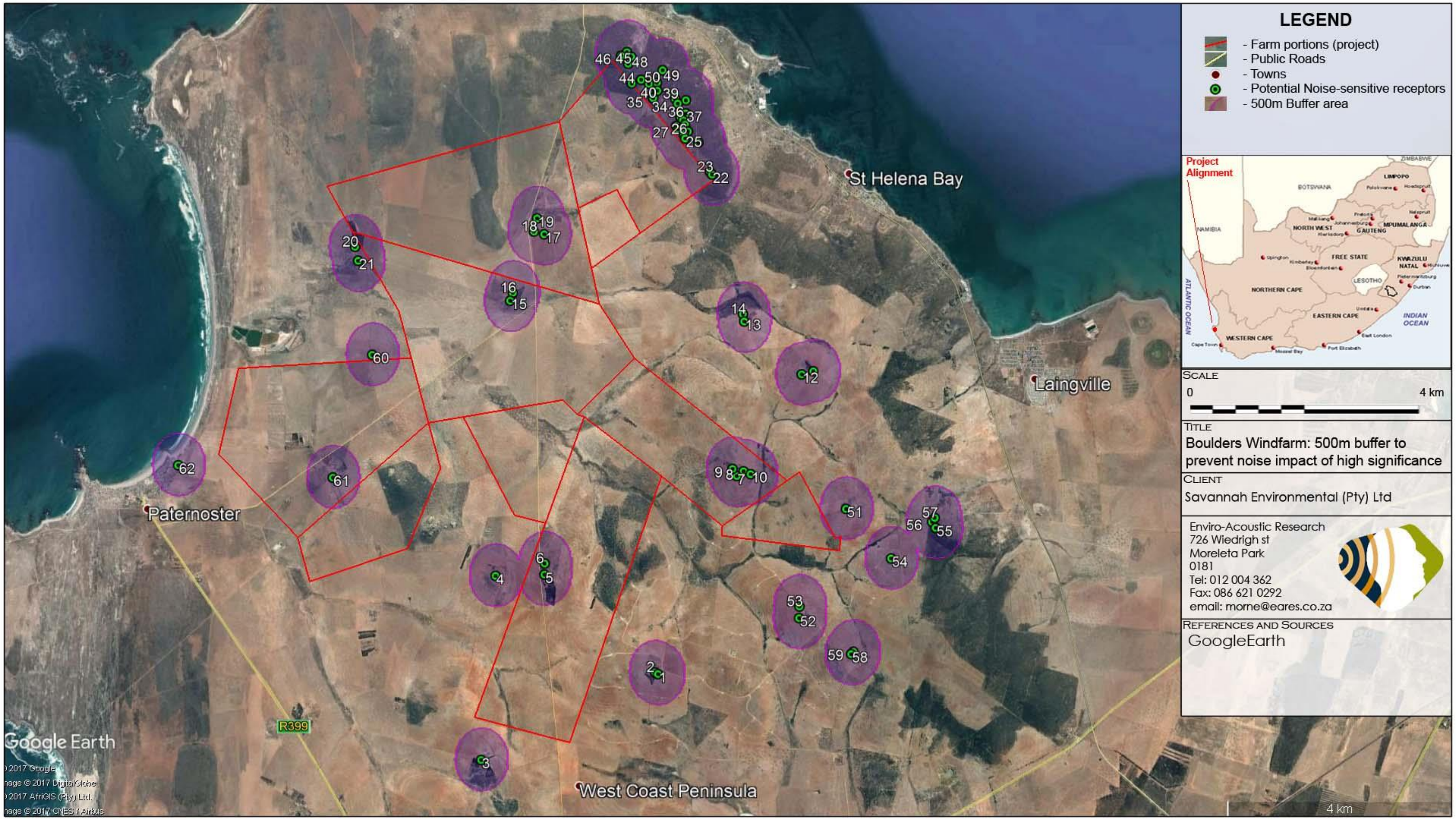

Figure 10-1: Proposed buffer area to prevent a noise impact of high significance

11 RECOMMENDATIONS

This assessment indicated that the development of the Boulders WF could have a potential noise impact on the surrounding environment. The layout (main factor) and selection of the wind turbine (minor factor) will determine the potential magnitude of such a noise impact.

It is recommended that the potential noise impact associated with the proposed WF be investigated in more detail in the Environmental Impact Assessment phase.

The following information is considered critical:

1. The exact locations of the various wind turbines in the WF (final layout); and
2. The Sound Power Emission Levels of the selected Wind Turbine.

12 TERMS OF REFERENCE FOR THE ENVIRONMENTAL NOISE IMPACT PHASE

Work that will take place during the Environmental Noise Impact Assessment phase is defined in section 8 of SANS 10328:2008.

12.1 PURPOSE OF THE ENVIRONMENTAL NOISE IMPACT ASSESSMENT

The purpose of an environmental noise impact investigation and assessment is to determine and quantify the acoustical impact of, or on a proposed development.

12.2 PLAN OF STUDY FOR ENVIRONMENTAL NOISE IMPACT INVESTIGATION AND ASSESSMENT

In this regard the following will be included to assist the EAP in the compilation of the Plan of Study (PoS) for the EIA:

- Data as received from the developer will be used to model the potential noise impact;
- The potential impact will be evaluated (where possible) in terms of the nature (description of what causes the effect, what/who might be affected and how it/they might be affected) as well as the extent of the impact;
- The potential significance of the identified issues will be calculated based on the evaluation of the issues/impacts;
- The development of an Environmental Management Plan and a proposal of potential mitigation measures (if required); and
- Recommendations.

12.3 ENVIRONMENTAL NOISE IMPACT INVESTIGATION

12.3.1 Sound emission from the identified noise sources

Sound emission data as warranted by the wind turbine manufacturer would be used to calculate the potential noise emissions from the wind turbines. In the instance that this data is unavailable, sound emission data as measured and calculated in accordance with EIA 61400-11 (Wind turbine generator systems – Part 11: Acoustic noise measurements techniques) could be used.

The operating cycle and nature of the sound emission (impulsiveness, tonal character or potential low frequencies) would, where relevant, be considered when the expected rating level in the target area is calculated.

12.3.2 Determination of Rating levels

The Concawe model defined in SANS 10357:2004 (construction phase) as well as the propagation model defined in ISO 9613-2 (operation phase) will be used to calculate projected equivalent noise levels.

Other input parameters used would include:

- Atmospheric pressure of 100 kPa;
- Air temperature of 20 °C;
- Relative humidity of 80%;
- Prevailing wind direction as input into Concawe model as made available by developer;
- Appropriate ambient sound levels associated with a selected wind speed;
- Layout of the proposed facility as provided by the developer;
- Topography details;
- Height of turbine above sea level as well as height of wind turbine above surface level;
- Projected outside equivalent noise levels at Potentially Sensitive Receptors at height above sea-level (plus 1.5 meters);
- 75% soft ground surface.

12.3.3 Assessment of the noise impact: No mitigation

The significance will be determined considering the defined magnitude of the noise level, the extent as well as the duration of the projected noise impact, as well as the probability that this impact may take place.

The magnitude of the noise impact will be assessed by considering:

- The total projected cumulative noise level compared to the appropriate acceptable rating levels as defined in table 2 of SANS 10103:2008;
- The potential community response from table 5 of SANS 10103:2008. In addition, other relevant and suitable literature may be consulted as defined in the scoping report. In particular the likely ambient sound levels due to wind induced noises will be estimated at the wind speed under investigation and considered; and
- Projected noise levels considering the likely and projected ambient sound levels (refer also to **Figure 7-3**).

Likely ambient sound levels associated with wind speeds as well as the projected change in ambient sound levels would also be considered when estimating the probability that a NSD may be impacted by increased noise levels.

12.3.4 Assessment of the noise impact: Implementation of mitigation measures

Should the significance of the impact be medium or high, the potential significance will be recalculated considering that the developer would be implementing reasonable mitigation measures.

12.4 ENVIRONMENTAL NOISE IMPACT REPORT

The Environmental Noise Impact Report will cover the following points:

- the purpose of the investigation;
- a brief description of the planned development or the changes that are being considered;
- a brief description of the existing environment including, where relevant, the topography, surface conditions and meteorological conditions during measurements;
- the identified noise sources together with their respective sound pressure levels or sound power levels (or both) and, where applicable, the operating cycles, the nature of sound emission, the spectral composition and the directional characteristics;
- the identified noise sources that were not taken into account and the reasons as to why they were not investigated;
- the identified Potentially Sensitive Receptors and the noise impact on them;
- where applicable, any assumptions, with references, made with regard to any calculations or determination of source and propagation characteristics;
- an explanation, either by a brief description or by reference, of all measuring and calculation procedures that were followed, as well as any possible adjustments to existing measuring methods that had to be made, together with the results of calculations;
- an explanation, either by description or by reference, of all measuring or calculation methods (or both) that were used to determine existing and predicted rating levels, as well as other relevant information, including a statement of how the data were obtained and applied to determine the rating level for the area in question;
- the location of measuring or calculating points in a sketch or on a map;
- quantification of the noise impact with, where relevant, reference to the literature consulted and the assumptions made;
- alternatives that were considered and the results of those that were investigated;
- a list of all the interested or affected parties that offered any comments with respect to the environmental noise impact investigation (if comments are received);

- 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 (if comments are received);
- conclusions that were reached;
- proposed recommendations including potential mitigation measures;
- any follow-up investigation which should be conducted at completion of the project as well as at regular intervals after the commissioning of the project so as to ensure that the recommendations of this report will be maintained in the future.

13 THE AUTHOR

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

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

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

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

Wind Energy Facilities	*Full Environmental Noise Impact Assessments for - Bannf (Vidigenix), iNCa Gouda (Aurecon SA), Kangnas (Aurecon), Plateau East and West (Aurecon), Wolf (Aurecon), Outeniqwa (Aurecon), Umsinde Emoyeni (ARCUS), Komsberg (ARCUS), Karee and Kolkies Wind Farms (ARCUS), Canyon Springs (Canyon Springs), Perdekraal (ERM), Zen (Savannah Environmental – SE), Goereesoe (SE), Springfontein (SE), Garob (SE), Project Blue (SE), ESKOM Kleinzee (SE), Walker Bay (SE), Oyster Bay (SE), Hidden Valley (SE), Happy Valley (SE), Deep River (SE), Tsitsikamma (SE), AB (SE), West Coast One (SE), Hopefield II (SE), Namakwa Sands (SE), VentuSA Gouda (SE), Dorper (SE), Amakhala Emoyeni (SE), Klipheuwel (SE), Cookhouse (SE), Cookhouse II (SE), Rheboksfontein (SE), Suurplaat (SE), Karoo Renewables (SE), Koningaas (SE), Eskom Aberdene (SE), Spitskop (SE), Castle (SE), Khai Ma (SE), Poortjies (SE), Korana (SE), IE Moorreesburg (SE), Gunstfontein (SE), Vredenburg (Terramanzi), Loeriesfontein (SiVEST), Rhenosterberg (SiVEST), Noupoort (SiVEST), Prieska (SiVEST), Dwarsrug (SiVEST), Msenge Emoyeni (Windlab), Isivunguvungu Wind Farm (Aurecon), Graskoppies (SiVEST), Hartebeest Leegte (SiVEST), Ithemba (SiVEST), !Xha Boom (SiVEST), Kokerboom 1 (Aurecon),*

	Kokerboom 2 (Aurecon), Teekloof (Mainstream), Sutherland (CSIR), Rietrug (CSIR), Sutherland 2 (CSIR), Spitskop West (Terramanzi)
Mining and Industry	*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 Boshoek Chrome (JMA), Langpan Chrome (PE), Vlakpoort Chrome (PE), Sekoko Coal (SE), Frankford Power (REMIG), Strahrae Coal (Ferret Mining), Transalloys Power Station (Savannah), Pan Palladum Smelter, Iron and PGM Complex (Prescali 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), Pofadder CSP (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), Haakdoorndrift Opencast at Amandelbult Platinum (Aurecon), Landau Dragline relocation (Aurecon), Stuart Coal Opencast (CleanStream Environmental), Tetra4 Gas Field Development (EIMS), Kao Diamonds – Tiping Village Relocation (EIMS), 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)*
Road and Railway	*K220 Road Extension (Urbansmart), Boskop Road (MTO), Sekoko Mining (AGES), Davel-Swaziland-Richards Bay Rail Link (Aurecon), Moloto Transport Corridor Status Quo Report and Pre-Feasibility (SiVEST), Postmasburg Housing Development (SE), Tshwane Rapid Transport Project, Phase 1 and 2 (NRM Consulting/City of Tshwane), Transnet Apies-river Bridge Upgrade (Transnet), Gautrain Due-diligence (SiVest), N2 Piet Retief (SANRAL), Atterbury Extension, CoT (Bokomoso Environmental)*
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 (Cennergi 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), 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 (Cennergi), Waainek WEF Operational Noise Measurements (Innowind), Sedibeng Brewery Noise Measurements (MENCO), Tsitsikamma Community Wind Farm Operational noise measurements (Cennergi), Noupoort Wind Farm Operational noise measurements (Mainstream),
Small Noise Impact Assessments	*TCTA AMD Project Baseline (AECOM), NATREF (Nemai Consulting), Christian Life Church (UrbanSmart), Kosmosdale (UrbanSmart), Louwlardia K220 (UrbanSmart), Richards Bay Port Expansion (AECOM), Babalegi Steel Recycling (AGES), Safika Slag Milling Plant (AGES), Arcelor Mittal WEF (Aurecon), RVM Hydroplant (Aurecon), Grootvlei PS Oil Storage (SiVEST), Rhenosterberg WEF, (SiVEST), Concerto Estate (BPTrust), Ekuseni Youth Centre (MENCO), Kranskop Industrial Park (Cape South Developments), Pretoria Central Mosque (Noman Shaikh), Soshanguve Development (Maluleke Investments), Seshego-D Waste Disposal (Enviroxcellence), Zambesi Safari Equipment (Owner), Noise Annoyance Assessment due to the Operation of the Gautrain (Thornhill and Lakeside Residential Estate), Upington Solar (SE), Ilangalethu Solar (SE), Pofadder Solar (SE), Flagging Trees WEF (SE), Uyekraal WEF (SE), Ruuki Power Station (SE), Richards Bay Port Expansion 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)*
Project reviews and amendment reports	*Loperberg (Savannah), Dorper (Savannah), Penhoek Pass (Savannah), Oyster Bay (RES), Tsitsikamma Community Wind Farm Noise Simulation project (Cennergi), 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)*

14 DECLARATION OF INDEPENDENCE

I, Morné de Jager declare that:

- I act as the independent environmental practitioner in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting environmental impact assessments, including knowledge of the National Environmental Management Act (107 of 1998), the Environmental Impact Assessment Regulations of 2010, and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in regulation 8 of the regulations when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will ensure that the comments of all interested and affected parties are considered and recorded in reports that are submitted to the competent authority in respect of the application, provided that comments that are made by interested and affected parties in respect of a final report that will be submitted to the competent authority may be attached to the report without further amendment to the report;
- I will keep a register of all interested and affected parties that participated in a public participation process; and
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not
- all the particulars furnished by me in this form are true and correct;
- will perform all other obligations as expected from an environmental assessment practitioner in terms of the Regulations; and
- I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2010.

____

Signature of the environmental practitioner:

Enviro-Acoustic Research cc

Name of company:

____

Date:

15 REFERENCES

In this report reference was made to the following documentation:

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APPENDIX A

Glossary of Acoustic Terms, Definitions and General Information

1/3-Octave Band	A filter with a bandwidth of one-third of an octave representing four semitones, or notes on the musical scale. This relationship is applied to both the width of the band, and the centre frequency of the band. See also definition of octave band.
A – Weighting	An internationally standardised frequency weighting that approximates the frequency response of the human ear and gives an objective reading that therefore agrees with the subjective human response to that sound.
Air Absorption	The phenomena of attenuation of sound waves with distance propagated in air, due to dissipative interaction within the gas molecules.
Alternatives	A possible course of action, in place of another, that would meet the same purpose and need (of proposal). Alternatives can refer to any of the following, but are not limited hereto: alternative sites for development, alternative site layouts, alternative designs, alternative processes and materials. In Integrated Environmental Management the so-called "no go" alternative refers to the option of not allowing the development and may also require investigation in certain circumstances.
Ambient	The conditions surrounding an organism or area.
Ambient Noise	The all-encompassing sound at a point being composed of sounds from many sources both near and far. It includes the noise from the noise source under investigation.
Ambient Sound	The all-encompassing sound at a point being composite of sounds from near and far.
Ambient Sound Level	Means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such a meter was put into operation. In this report the term Background Ambient Sound Level will be used.
Amplitude Modulated Sound	A sound that noticeably fluctuates in loudness over time.
Applicant	Any person who applies for an authorisation to undertake a listed activity or to cause such activity in terms of the relevant environmental legislation.
Assessment	The process of collecting, organising, analysing, interpreting and communicating data that is relevant to some decision.
Attenuation	Term used to indicate reduction of noise or vibration, by whatever method necessary, usually expressed in decibels.
Audible frequency Range	Generally assumed to be the range from about 20 Hz to 20,000 Hz, the range of frequencies that our ears perceive as sound.
Ambient Sound Level	The level of the ambient sound indicated on a sound level meter in the absence of the sound under investigation (e.g. sound from a particular noise source or sound generated for test purposes). Ambient sound level as per Noise Control Regulations.
Broadband Noise	Spectrum consisting of a large number of frequency components, none of which is individually dominant.
C-Weighting	This is an international standard filter, which can be applied to a pressure signal or to a *SPL* or *PWL* spectrum, and which is essentially a pass-band filter in the frequency range of approximately 63 to 4000 Hz. This filter provides a more constant, flatter, frequency response, providing significantly less adjustment than the A-scale filter for frequencies less than 1000 Hz.
Controlled area (as per National Noise Control Regulations)	a piece of land designated by a local authority where, in the case of- (a) road transport noise in the vicinity of a road- (i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period extending from 06:00 to 24:00 while such meter is in operation, exceeds 65 dBA; or (ii) the 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 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;
dB(A)	Sound Pressure Level in decibel that has been A-weighted, or filtered, to match the response of the human ear.
Decibel (db)	A logarithmic scale for sound corresponding to a multiple of 10 of the threshold of hearing. Decibels for sound levels in air are referenced to an atmospheric pressure of 20 µ Pa.
Diffraction	The process whereby an acoustic wave is disturbed and its energy redistributed in space as a result of an obstacle in its path, Reflection and refraction are special cases of diffraction.
Direction of Propagation	The direction of flow of energy associated with a wave.
Disturbing noise	Means a noise level that exceeds the zone sound level or, if no zone sound level has been designated, a noise level that exceeds the ambient sound level at the same measuring point by 7 dBA or more.
Environment	The external circumstances, conditions and objects that affect the existence and development of an individual, organism or group; these circumstances include biophysical, social, economic, historical, cultural and political aspects.
Environmental Control Officer	Independent Officer employed by the applicant to ensure the implementation of the Environmental Management Plan (EMP) and manages any further environmental issues that may arise.
Environmental impact	A change resulting from the effect of an activity on the environment, whether desirable or undesirable. Impacts may be the direct consequence of an organisation’s activities or may be indirectly caused by them.
Environmental Impact Assessment	An Environmental Impact Assessment (EIA) refers to the process of identifying, predicting and assessing the potential positive and negative social, economic and biophysical impacts of any proposed project, plan, programme or policy that requires authorisation of permission by law and that may significantly affect the environment. The EIA includes an evaluation of alternatives, as well as recommendations for appropriate mitigation measures for minimising or avoiding negative impacts, measures for enhancing the positive aspects of the proposal, and environmental management and monitoring measures.
Environmental issue	A concern felt by one or more parties about some existing, potential or perceived environmental impact.
Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$)	The value of the average A-weighted sound pressure level measured continuously within a reference time interval *T*, which have the same mean-square sound pressure as a sound under consideration for which the level varies with time.
Equivalent continuous A-weighted rating level ($L_{Req,T}$)	The Equivalent continuous A-weighted sound exposure level *($L_{Aeq,T}$)* to which various adjustments has been added. More commonly used as ($L_{Req,d}$) over a time interval 06:00 – 22:00 (T=16 hours) and ($L_{Req,n}$) over a time interval of 22:00 – 06:00 (T=8 hours). It is a calculated value.
F (fast) time weighting	(1) Averaging detection time used in sound level meters. (2) Fast setting has a time constant of 125 milliseconds and provides a fast reacting display response allowing the user to follow and measure not too rapidly fluctuating sound.

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

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

	100 millipascals in water. SPL is reported as L_p in dB (not weighted) or in various other weightings.
Soundscape	Sound or a combination of sounds that forms or arises from an immersive environment. The study of soundscape is the subject of acoustic ecology. The idea of soundscape refers to both the natural acoustic environment, consisting of natural sounds, including animal vocalizations and, for instance, the sounds of weather and other natural elements; and environmental sounds created by humans, through musical composition, sound design, and other ordinary human activities including conversation, work, and sounds of mechanical origin resulting from use of industrial technology. The disruption of these acoustic environments results in noise pollution.
Study area	Refers to the entire study area encompassing all the alternative routes as indicated on the study area map.
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland Commission, 1987).
Tread braked	The traditional form of wheel brake consisting of a block of friction material (which could be cast iron, wood or nowadays a composition material) hung from a lever and being pressed against the wheel tread by air pressure (in the air brake) or atmospheric pressure in the case of the vacuum brake.
Zone of Potential Influence	The area defined as the radius about an object, or objects beyond which the noise impact will be insignificant.
Zone Sound Level	Means a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. This is similar to the Rating Level as defined in SANS 10103:2008.

APPENDIX B

Photos of measurement locations

Photo 1: Measurement Location VASL01 (Mr. Dough Portsmouth)

Photo 2: Measurement Location VASL02 (Mr. Nico Lombard)

End of Report