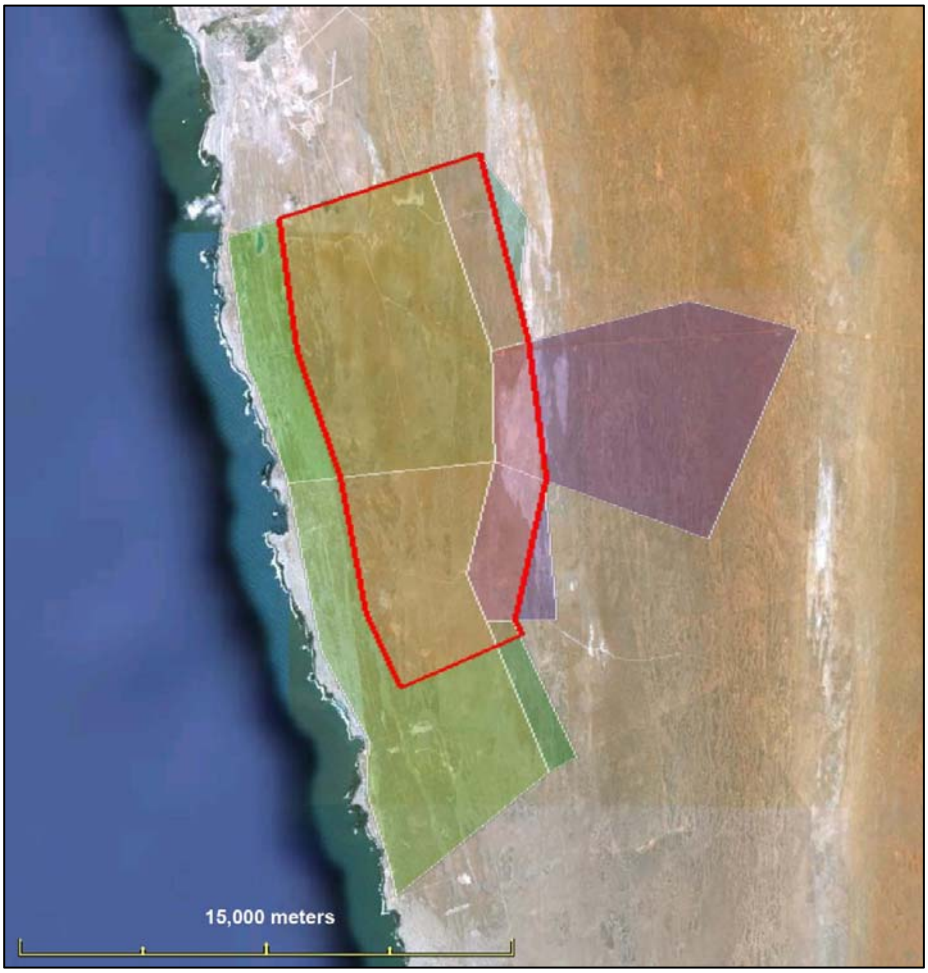
Eskom Holdings Limited

NOISE IMPACT ASSESSMENT

FOR SCOPING PURPOSES

Establishment of the Kleinzee Wind Energy Facility on various farms near the town of Kleinzee, Northern Cape Province



Study done for:

Savannah Environmental (PTY) LTD

M² Environmental Connections cc
P.O. Box 2047
Garsfontein East
0060
Tel: 012 – 993 2165
Fax: 086 – 621 0292
E-mail: morne@menco.co.za

Title:

Noise Impact Assessment for Scoping purposes: Establishment of the Kleinzee Wind Energy Facility on various farms near the town of Kleinzee, Northern Cape Province.

Client:

Savannah Environmental (Pty) Ltd
for
Eskom Holdings Limited

PO BOX 148
Sunninghill
Gauteng
2157

Report no:

EHL-KWEF/SNR/201107-Rev 1

Authors:

M. de Jager *(B. Ing (Chem))*

Review:

Johan Maré *(M. Sc., Pr.Sci.Nat)*

DATE:

July 2011

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

GLOSSARY OF ABBREVIATIONS

DALRCE	Department of Agriculture, Land Reform, Conservation and Environmental
DENC	Department of Environment and Nature Conservation
DEA	Department of Environmental Affairs
EAP	Environmental Assessment Practitioner
ECA	Environment Conservation Act (Act 78 of 1989)
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
ENIA	Environmental Noise Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
FEL	Front End Loader
IAPs	Interested and Affected Parties
i.e.	that is
IEM	Integrated Environmental Management
km	kilometres
LHD	Load haul dumper
m	Meters (measurement of distance)

m^2	Square meter
m^3	Cubic meter
mamsl	Meters above mean sea level
MENCO	M² Environmental Connections cc
NEMA	National Environmental Management Act, 1998 (Act 107 of 1998)
NCR	Noise Control Regulations (under Section 25 of the ECA)
NGO	Non-government Organisation
PPE	Personal Protective Equipment
PPP	Public Participation Process
SABS	South African Bureau of Standards
SANS	South African National Standards
SHEQ	Safety Health Environment and Quality
WEF	Wind Energy Facility
WHO	World Health Organisation
WTG	Wind Turbine Generator

GLOSSARY OF TERMS

A – Weighting	An internationally standardised frequency weighting which approximates the frequency response of the human ear and gives an objective reading, which 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 note 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 which 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.
Audible Frequency Range	Generally assumed to be the range from about 20 Hz to 20,000 Hz, the range of frequencies which our ears perceive as sound.
Background 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.
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.
dB(A)	Sound Pressure Level in decibel which 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	Modification of the progressive wave distribution due to the presence of obstacles in the field. Reflection and refraction are special cases of diffraction.
Direction of Propagation	The direction of flow of energy associated with a wave.
Disturbing noise	Means 'n 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.
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 manage 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 which requires authorisation of permission by law and which 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 whose 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).
Footprint area	Area to be used for the construction of the proposed development, which does not include the total study area.
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.
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 which requires further investigation before it can be resolved.
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.
Loudness	The attribute of an auditory sensation which 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 which 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 which 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 shall include 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
Reverberant Sound	The sound in an enclosure excluding that which is received directly from the source.
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, provide reasonable grounds for mitigating measures to be included in the environmental management report. The onus shall 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.
Sound Level	The level of the frequency weighted and time weighted sound pressure as determined by a sound level meter.
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 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).
Zone of Potential Influence	The area defined as the radius about an object, or objects beyond which the noise impact will be insignificant.
Zone Sound Level	Means a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. This is similar to the Rating Level as defined in SANS10103.

1 INTRODUCTION

1.1 INTRODUCTION AND PURPOSE

M2 Environmental Connections was commissioned to undertake a specialist study to determine the potential noise impact on the surrounding environment due to the establishment of the Kleinzee Wind Energy Facility (WEF) (also referred to as a wind farm) on various farms located approximately 6km south of the town of Kleinzee. This facility would be situated in the Northern Cape Province.

This report is the result of a first phase study (desktop) on the potential impact of such a facility 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, and little is yet known of the proposed Kleinzee Wind Energy Facility. Being preliminary, the report presents scenarios to illustrate important concepts.

1.2 BRIEF PROJECT DESCRIPTION

Eskom Holdings Limited (hereafter referred as the developer) proposes the establishment of a commercial Wind Energy Facility and associated infrastructure on various farms approximately 6 km south of the town of Kleinzee.

The proposed footprint is 8,722 hectares, yet the study area would include the area up to 2,000 meters from the boundary of this footprint. The facility is projected to generate up to a 300 MW of energy and the associated infrastructure could include:

- Between 150 and 200 wind turbines (rated between 1.5MW and 2MW respectively) and associated concrete foundations
- An on-site substation to facilitate the connection between the facility and the electricity grid
- An overhead power line (400kV) feeding into Eskom's electricity grid at Gromis Substation, approximately 60 km from the site
- Internal access roads
- Borrow pits within the site for construction of access roads
- Office/Workshop area for maintenance and storage, and
- A visitors center with parking

1.3 PROJECT LOCATION

The study area falls within the Nama Khoi Local Municipality with the proposed facility being situated on the following farms:

- RE of Brazil 329,
- RE of Goraap 323,
- RE of Honde Vlei 325,
- RE of Kannabieduin 324,
- Portions 2 and 3 of Rooivlei 327.

1.4 TERMS OF REFERENCE

SANS 10328:2008 (Edition 3) specifies the methodology to be adopted for tie assessment of the noise impacts on the environment due to a proposed activity that might impact on the environment. The 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:

- 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 background noise levels will be determined and the identification of potential sensitive areas.
- A statement regarding the potential significance of any identified noise-related issues based on the evaluation of the issues/impacts.
- The identification of potential noise-related issues to be investigated in more detail during the Environmental Impact Assessment phase,
- Details regarding the methodology followed to estimate and assess the potentially significant noise impacts during the EIA phase.

1.5 STUDY AREA

The proposed Wind Energy Facility (WEF) will be situated in a relatively flat area that slopes towards the Atlantic Ocean. The area has a rural character with a few residences in the area. Vegetation appears to be sparse. A site locality map is presented in **Figure 1-1**.

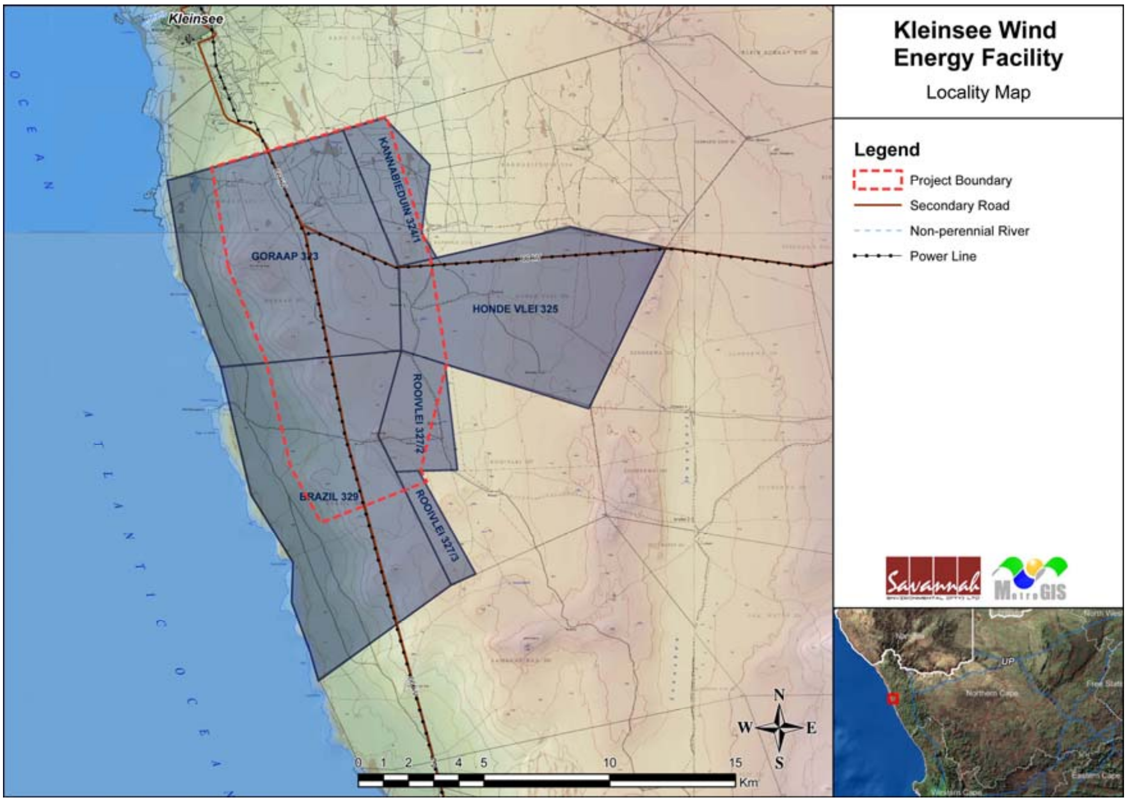


Figure 1-1: Locality map indicating locations of the proposed Wind Energy Facility

1.6 AVAILABLE INFORMATION

There is no information available regarding the existing soundscape of the area.

1.7 NOISE-SENSITIVE DEVELOPMENTS

An assessment of the area was done using available topographical maps to identify Noise-sensitive developments (NSD) in the study area (within area proposed, as well as potential NSD's up to 2 km from boundary of 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 these Noise-sensitive developments will be confirmed during a future site visit. The assessment indicated there are a number of such developments in the area.

Noise-sensitive developments identified are highlighted in **Figure 1-2**. It is believed that available topographical maps, GoogleEarth® imagery and information that can be gained during a site visit should be sufficient to identify and confirm any such developments.

Figure 1-2: Aerial Image indicating Noise-sensitive developments (green dots)

Table 1.1: Identified potential noise-sensitive developments and likely SANS zone sound level

NSD	Latitude	Longitude	SANS Daytime Zone Sound Level (dBA)	SANS Night-time Zone Sound Level (dBA)
NSD01	-29.759283°	17.094164°	45	35
NSD02	-29.776286°	17.145335°	45	35
NSD03	-29.776651°	17.150208°	45	35
NSD04	-29.743369°	17.146610°	45	35
NSD05	-29.825855°	17.146986°	45	35
NSD06	-29.772114°	17.175474°	45	35
NSD07	-29.771755°	17.174559°	45	35
NSD08	-29.739615°	17.115503°	45	35
NSD09	-29.738195°	17.116162°	45	35
NSD10	-29.749770°	17.154607°	45	35
NSD11	-29.843365°	17.179037°	45	35

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 well-being. The general approach of the common law is to define an acceptable level of noise as that which the reasonable person can be expected to tolerate in the particular circumstances. The subjectivity of this approach can be problematic, however, which has led to the development of noise standards (see Section 2.7).

"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") allowed 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 made noise control regulations (see **section 2.5**) under the ECA, yet the Northern Cape Province have not yet issued their own Provincial Noise Control Regulations.

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 WEF 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 licence issued in terms of section 22 may contain conditions in respect of noise. This however will not be relevant to the WEF.

2.5 NOISE CONTROL REGULATIONS

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 NCR was devolved to provincial and local authorities. The Northern Cape has not yet promulgated any Provincial Noise Control Regulations. The National Noise Control Regulations would therefore be of relevance.

This regulation defines:

"**controlled area**"

means 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**"
means 'n 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**"
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.

In terms of Regulation 2 (d):
"A local authority may –
before changes are made to existing facilities or existing uses of land or buildings, or before new buildings are erected, in writing require that noise impact assessments or tests 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 3 (c):
"No person shall –
make changes to existing facilities or existing uses of land or buildings or erect new buildings, if it shall in the opinion of a local authority house or cause activities which shall, after such change or erection, cause a disturbing noise, unless precautionary measures to prevent the disturbing noise have been taken to the satisfaction of the local authority";

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

2.6 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 differs 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. It is still in draft format during the EIA process.

2.7 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.*

2.8 INTERNATIONAL GUIDELINES

While a number of international guidelines and standards that could encompass a document in itself exist, 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.

These guidelines are included as international countries have significant experience in Wind Energy Facilities and its associated noise issues and have developed legislation and guidelines that considers the changing (and higher) ambient sound environment during periods when these facilities are operational.

2.8.1 Guidelines for Community Noise (WHO, 1999)

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

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

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

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

2.8.2 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

[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 organisations in academia and industry. In 1996, ETSU became part of AEA Technology plc which was separated from the UKAEA by privatisation.

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 5-2**) are more appropriate
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 are measured onsite in terms of the $L_{A90,10min}$ descriptor for a period sufficiently long enough for a set period
5. Wind Energy Facilities should be limited to 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 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 some of the methodologies used in the ETSU R97 document will be recommended in this Scoping Report for consideration during the Environmental Noise Impact Assessment phase should projected noise levels (from the proposed WEF at PSRs) exceed the zone sound levels as recommended by SANS 10103:2008.

2.8.3 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 a 10 m height
- The Noise Assessment Report, including;
  - Information that must be part of the report
  - Full description of noise sources
  - Adjustments, such as due to the wind speed profile (wind shear)
  - The identification and defining of NSDs
  - 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)

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

3 POTENTIAL NOISE SOURCES

Increased noise levels are directly linked with the various activities associated with the construction of the WEF and related infrastructure, as well as the operational phase of the activity. The specific activities relating to construction of the WEF 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 operational phase, and not the construction phase. This is because the duration of activities during the construction phase are generally short in comparison to the operational phase.

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 modeled in detail.

3.1 Potential Noise Sources: Construction Phase

3.1.1 Construction equipment

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 potentially other infrastructure such as pipelines; and
- the erection of turbine towers and assembly of Wind Turbine Generators.

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

- excavator/grader, bulldozer, dump trucks, vibratory roller, bucket loader, rock breaker, *(potentially)* drill rig, dump truck, flat bed trucks, concrete truck(s), cranes, fork lift and various 4WD and service vehicles.

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

Instead of transporting the required ready-mix concrete to the site using concrete trucks, portable concrete batching plants may be required to supply concrete onsite. Batching plant equipment may be relocated between different locations on the site as the work progress to different locations on the site. The need for such batching plants, the number, and whether they will be moved is yet unknown.

The developer indicated that they are considering the use of a borrow pit for the internal road development. A portable rock crusher plant and screen will most likely be required.

3.1.3 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.

3.1.4 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), onsite 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 dependant 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).

3.2 Potential Noise Sources: Operational Phase

Noise generated during the operational phase is mainly associated with the operation of the Wind Turbines.

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.

3.2.1 Wind Turbine Noise: Aerodynamic sources[2]

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.
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.

3.2.2 Wind Turbine: Mechanical sources[3]

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

---

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

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 energy facilities (international), tonal noise from the installed wind turbines appears to have increased the annoyance perceived by the complainants and indeed have 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 minimise 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***.

3.2.3 Transformer noises (Sub-stations)

Also known as magnetostriction, this 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 or EIA study.

3.2.4 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 70 kV 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 ***it is generally only a feature during fog or rain***.

Corona noise 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.

3.2.5 Low Frequency Noise[4]

3.2.5.1 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 energy in the region below 20Hz. Almost all noise in the environment has

---

[4] *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*

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.

3.2.5.2 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 (>1.0 MW) 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.

3.2.5.3 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 depravation, a feeling of uneasiness; and
- reduction in building sound transmission loss at low frequencies compared to mid- or high frequencies.

3.2.5.4 Measurement, Isolation and Assessment of Low Frequency Sounds

There remain 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 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.

3.2.5.5 Summary: Low Frequency Noise[5]

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.

3.2.6 Amplitude modulation[6]

Although very rare, there is one other characteristic of wind turbine sound that could increase 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 synchronised 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 (low significance due to very low probability)***.

[5] *BWEA, 2005*
[6] *Renewable Energy Research Laboratory, 2006; Audiology Today, 2010; HGC Engineering, 2007; Whitford, 2008; Noise-con, 2008; DEFRA, 2007; Bowdler, 2008*

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

4.1 MEASUREMENT PROCEDURE

The measurements will be carried out in accordance with the procedures specified in SANS 10103[7] using the noise parameter A-weighted equivalent sound pressure level, $L_{Aeq,T}$. The work will be done using Type 1 instrumentation as required by National Standards and Legislation.

At each selected measurement point the ambient noise level will be sampled for a minimum duration of 10 minutes each. Subjective observations of the sound climate at the measurement point will at the same time be noted. Sampling will be conducted in a manner to allow future repeatability.

4.2 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[8]. 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;
- Topographical layout;
- Acoustical characteristics of the ground;
- Low-frequency noise impacts.

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[9]. Corrections such as the following will be considered:

- Distance of a noise-sensitive development from roads;
- Road construction material;

[7] SANS 10103:2004. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication'
[8] SANS 10357:2004 The calculation of sound propagation by the Concave method'
[9] SANS 10210:2004. 'Calculating and predicting road traffic noise'

- Average speeds of travel;
- Types of vehicles used;
- Ground acoustical conditions.

5 METHODOLOGY: NOISE IMPACT ASSESSMENT AND SIGNIFICANCE

5.1 NOISE IMPACT ON ANIMALS[10]

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 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.

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

5.2 WHY NOISE CONCERNS COMMUNITIES[11]

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 generalize 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 behavioral 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 neighboring 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).

[11] World Health Organization, 1999; Noise quest, 2010; Journal of Acoustical Society of America, 2009

5.3 Impact Assessment Criteria

5.3.1 Overview: The common characteristics

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

- Intensity
- Loudness
- Annoyance
- Offensiveness

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

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

5.3.2 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 (April 1998) in terms of the NEMA, SANS 10103 as well as guidelines from the World Health Organisation (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 5-1**.
- *Zone Sound Levels:* Previously referred as the acceptable rating levels, it sets acceptable noise levels for various areas. See also **Table 5.1**.
- *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.

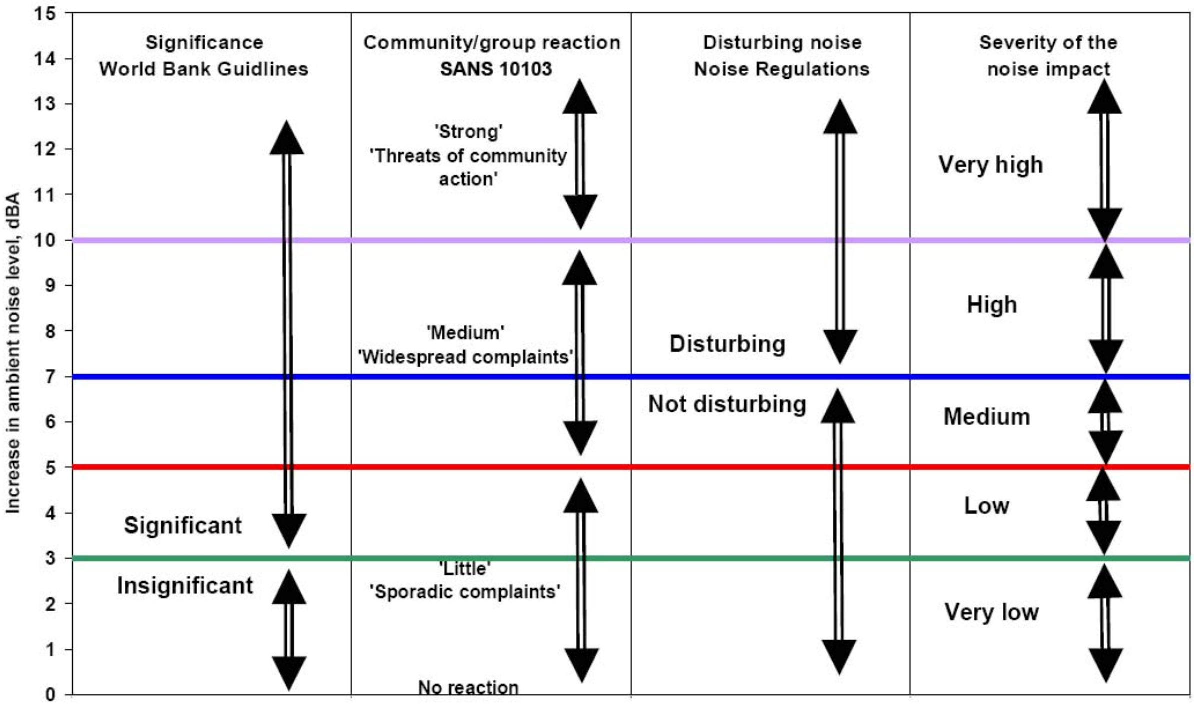


Figure 5-1: Criteria to assess the significance of impacts stemming from noise

In South Africa the document that addresses the issues concerning environmental noise is SANS 10103. See also **Table 5.1**. The standard 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 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 and 'sporadic complaints' might be expected. 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 could result in '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 5.1: 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

5.3.3 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 again 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 12m/s it is most 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 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 5-2**. 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).

For the purpose of the EIA, **Figure 5-2** will be considered, together with the zone sound levels as stipulated in SANS 10103.

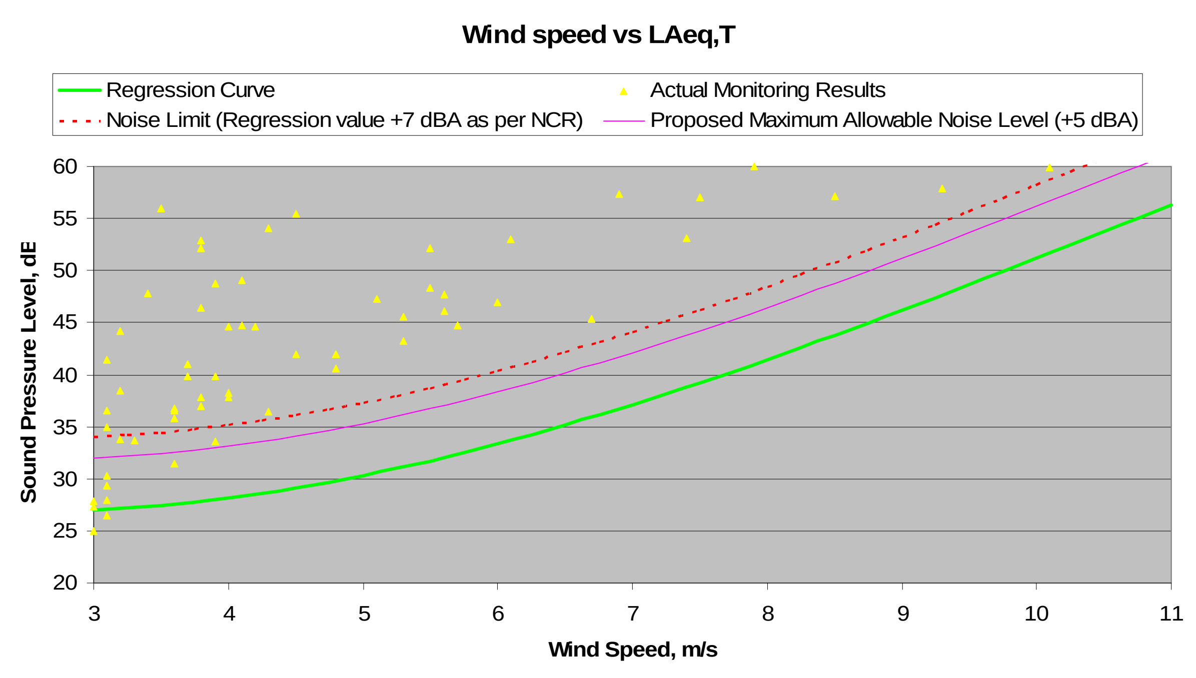


Figure 5-2: Background noise measurements and noise criteria curve considering wind speeds

5.3.4 Annoyance associated with Wind Energy Facilities[12]

Annoyance is the most widely acknowledged effect of environmental noise exposure, and is considered to the most widespread. It is estimated that less than a third of the individual noise annoyance is accounted for by acoustic parameters, and that 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 5.3, are recommended in an European Union position paper published in 2002, stipulating policy regarding the quantification of annoyance. This can be used in Environmental Health Impact Assessment and cost-benefit analysis to translate noise maps into overviews of the numbers of persons that may be annoyed, thereby giving insight into the situation expected in the long term. It is not applicable to local complaint-type situations or to an assessment of the short-term effects of a change in noise climate.

[12] Van den Berg, 2011; Milieu, 2010.

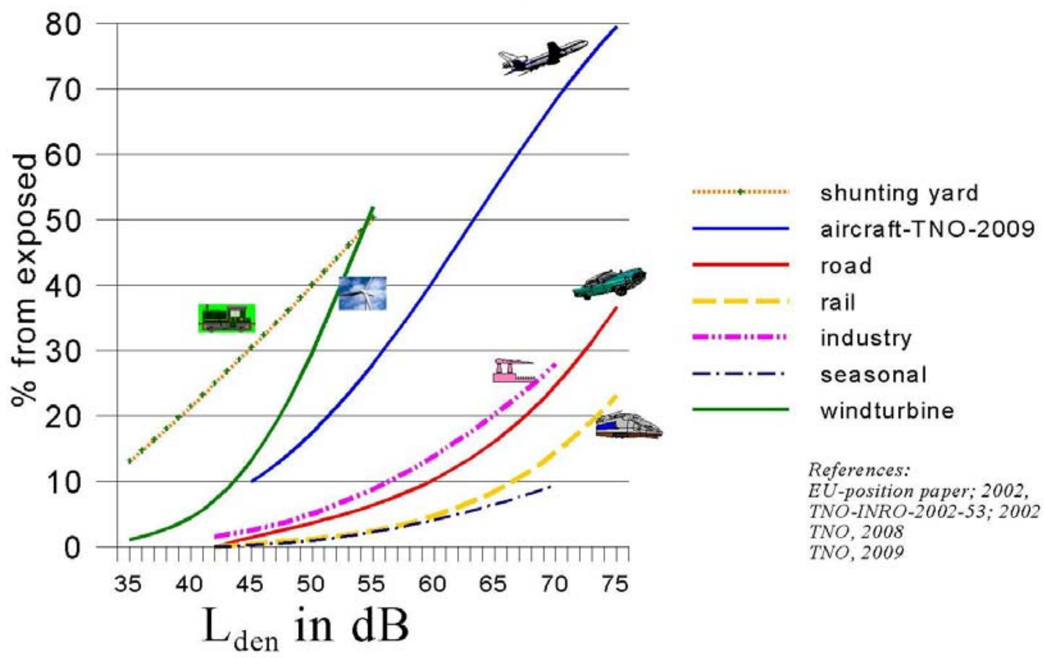


Figure 5.3: Percentage of annoyed persons as a function of the day-evening-night noise exposure at the façade of a dwelling

5.3.5 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 was assigned a value, ranging from one (1) to five (5), depending on its definition. This assessment is a relative evaluation within the context of all the activities and the other impacts within the framework of the project. An explanation of the impact assessment criteria is defined in **Table 5.2**.

Table 5.2: 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 Noise-sensitive development be subjected to increased noise levels for the lifetime duration of the project, or only infrequently.	
Temporary	The impact will either disappear with mitigation, will be mitigated through a natural process, or will last less than an hour.
Short term	The impact will be applicable less than 24 hours.
Medium term	The impact will last up to a week.
Long term	The impact will last up to a month.
Permanent	Any impacts lasting more than a month. It is considered non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact is transient.

Spatial scale	
Classification of the physical and spatial scale of the impact	
Site	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.
Local	The impact could affect the local area (within 1.0 km from footprint of activity).
Regional	The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns.
National	The impact could have an effect that expands throughout the country (South Africa).
International	Where the impact has international ramifications that extend beyond the boundaries of South Africa.
Probability	
This describes the likelihood of the impacts actually occurring, and whether it will impact on an identified NSD. 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:	
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 %).
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 %.
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 %.
Highly Likely	It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up before carrying out the activity. The chances of this impact occurring is defined to be between 50 % to 75 %.
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 %.
Magnitude	
This defines the impact as experienced by any Noise-sensitive development. In this report a NSD is defined as per SANS 10103:2008	
Low	Increase in sound pressure levels between 0 and 3 from the expected wind induced ambient sound level. The change is just discernable. Total projected noise level is less than the Zone Sound Level in wind-still conditions.
Low Medium	Increase in sound pressure levels between 3 and 5 from the expected wind induced ambient sound level. The change is easily discernable. Total projected noise level is less than the Zone Sound Level in wind-still conditions.
Medium	Increase in sound pressure levels between 5 and 7 from the expected wind induced ambient sound level. Sporadic complaints. Defined by the National Noise Regulations as being legally 'disturbing'. Any point where the zone sound levels are exceeded during wind still conditions.
High	Increase in sound pressure levels between 7 and 10. Change of 10 dBA is perceived as 'twice as loud', leading to widespread complaints. Any point where noise levels exceed zone sound level during wind still conditions.
Very High	Increase in sound pressure levels higher than 10. Threats of community or group action. Any point where noise levels exceed 65 dBA at any receptor.

In order to assess each of these factors for each impact, the following ranking scales as contained in **Table 5.3** will be used.

Table 5.3: Assessment Criteria: Ranking Scales

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

5.3.6 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.

5.3.7 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.

5.4 Expression of the Noise Impacts

The noise impacts can be expressed in terms of the increase in present ambient noise levels caused by noise emissions from the proposed project. The background ambient noise level used will be 28 dBA for the purpose of the Scoping report.

Contours of equal increases in ambient sound levels will be used to illustrate changes in ambient sound levels using an appropriate scale.

In addition predicted ambient noise levels will be presented in an appropriate scale using contours of constant sound pressure levels to illustrate the projected noise levels in the area.

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.

6 RESULTS AND PRELIMINARY IMPACT ASSESSMENT

6.1 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 detail during the Environmental Impact Assessment phase.

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)).

6.2 OPERATIONAL PHASE: ESTIMATED IMPACT AND IMPORTANT CONCEPTS

For the purpose of the Scoping phase the impact that traffic may have on the surrounding noise environment are excluded, only to be considered during the EIA phase.

Unfortunately no preliminary layout of the WEF was available for evaluation. Conceptual scenarios were therefore considered and modelled for the Scoping Noise Report. This is illustrate the potential spatial extent of noise impacts that wind turbines may have on a potential receptor, as well as to illustrate other aspects that could influence the noise impact.

Five different scenarios were investigated, and the model ran for the worst case scenario as well as a more realistic scenario. The scenarios included:

- One wind turbine operating upwind from a Potentially Sensitive Receptor,
- Five wind turbines operating upwind from a Potentially Sensitive Receptor,
- Thirteen (13) wind turbines operating upwind from a Potentially Sensitive Receptor,
- Fifty-two (52) wind turbines operating upwind from a Potentially Sensitive Receptor, and
- Fifty-two (52) wind turbines operating downwind (eastern wind) from a Potentially Sensitive Receptor.

In all cases other variables were the same, being:

- Height penalty of -3 dBA,
- Atmospheric pressure of 100 kPa,

- Air temperature of 20 °C,
- Relative humidity of 80%,
- Westerly wind (selected to illustrate the issues, with the wind blowing in the direction of the PSR, excluding the last scenario, where the wind blows from the PSR to the wind turbines),
- Pasquill stability category D (Night/early evening, fast winds, little cloud cover);
- Background noise levels at 28 dBA;
- Wind speed 6 m/s (noise from wind turbines dominating sound character); and
- Closest wind turbine 1,500 meters from the PSR.

In addition each scenario was run with hard ground conditions (-3 dBA penalty) as well as soft ground conditions (potential impact that ground conditions such as vegetation could have). The first scenario potentially illustrates the worst case scenario (the **A**-case) where sound propagates undisturbed, with the second illustration per scenario (the **B**-case) being a optimal situation where vegetation and/or surface conditions assist in the attenuation of noise.

6.2.1 One Wind Turbine operating

In this scenario there is one wind turbine operating at point 500, 1000 (x, y) with a potential receptor at point 2000, 1000. The axes indicates the X and Y location. Unit of measure is meters. The potential receptor is therefore 1,500 meters from this conceptual wind turbine.

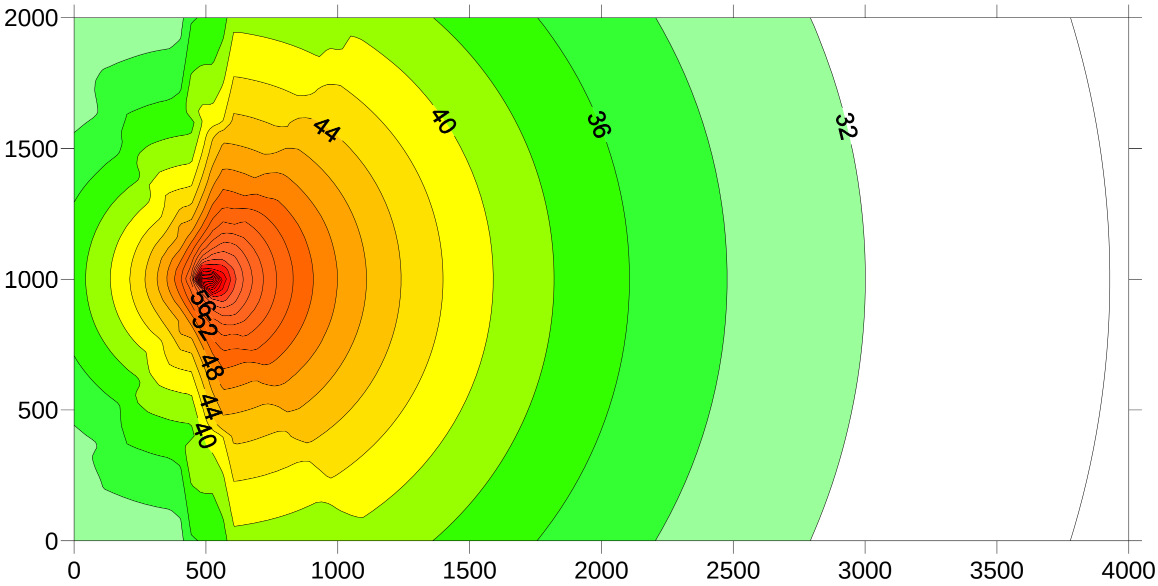


Figure 6-1: One WTG operating, all hard ground scenario

In this scenario (**Figure 6-1**) the potential receptor would be subject to noise in the order **36.7** dBA, and if one accept a background ambient noise level of **28** dBA, it represents a change of **8.7** dBA.

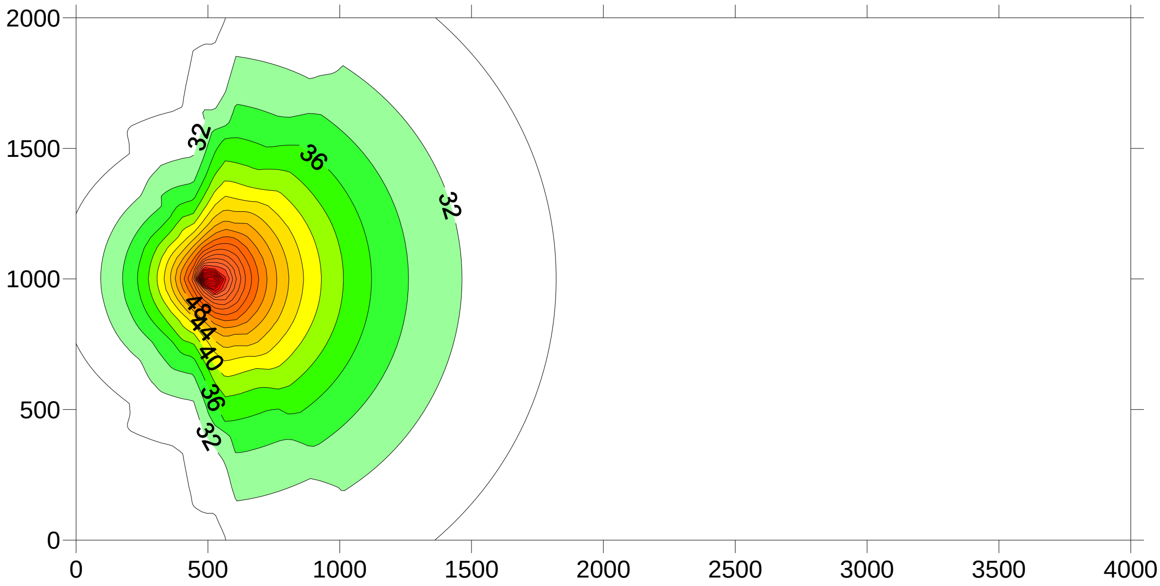


Figure 6-2: One WTG operating, all soft ground scenario (i.e vegetation attenuates some of the noise)

Figure 6-2 illustrates the situation where ground surface assist in the attenuation of the noise. This would be factors such as vegetation, ploughed fields or even a very uneven ground surface. In this scenario it would be difficult for the potential receptor to "hear" the sounds from the wind turbine as it would be part of the background ambient noise levels.

The "hard ground scenario" indicates that the potential receptor would be subject to noise in the order **36.7** dBA whereas the "soft ground scenario" indicates no noise above the ambient sound level due to the vegetation significantly reduces the noise experienced.

6.2.2 Five (5) Wind Turbines

However, when adding 4 more wind turbines (2 north, 2 south of the existing conceptual wind turbine of **Figure 6-1**), all on the 500 meter X-axes, the impact on the potential receptor (still at 2000, 1000) changes significantly (**Figure 6-3**). At **42.9** dBA, the ***cumulative effect*** from the 4 additional WTGs results in a noise level that is higher than **6.2** dBA from the scenario where there is only one turbine (hard ground scenario).

The soft ground scenario is illustrated in **Figure 6-4**, again indicating that soft ground conditions can significantly reduce the propagation of sound, with the total projected noise level at the PSR just exceeding **32** dBA.

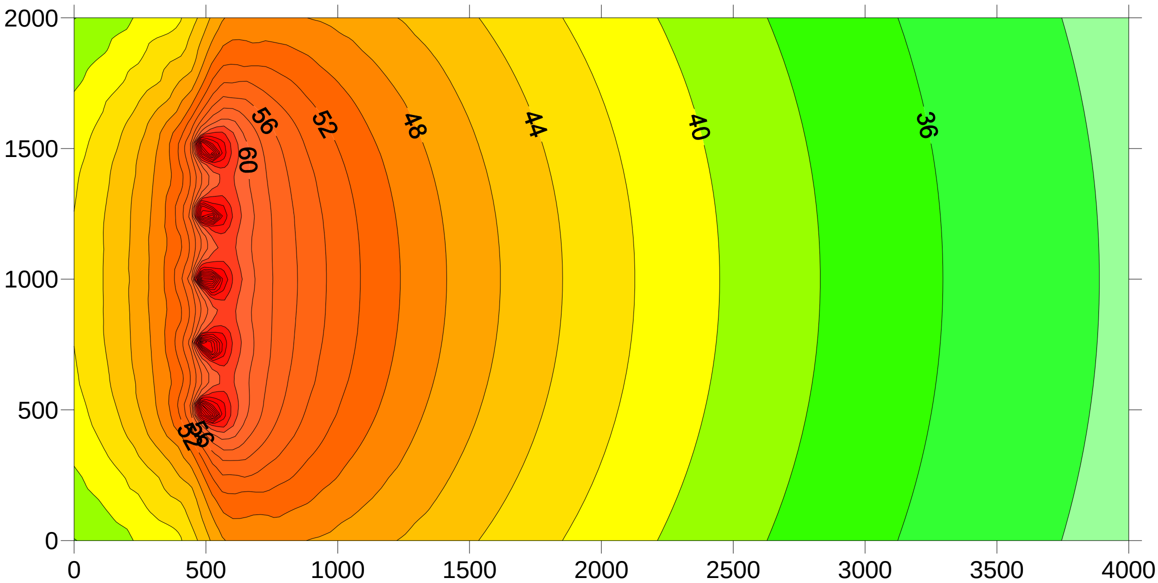


Figure 6-3: 5 WTGs operating, all hard ground scenario

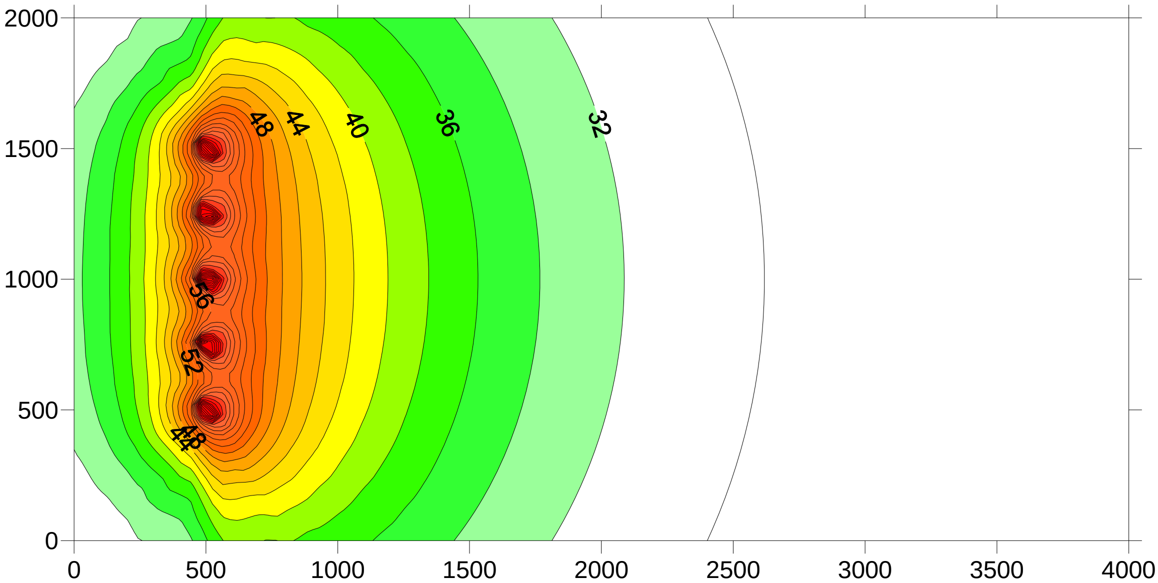


Figure 6-4: 5 WTGs operating, all soft ground scenario

6.2.3 13 Wind Turbines in one line

Adding 8 more turbines in the 500m X-axes (a total of 13 turbines in one line), the cumulative impact further increases to more than **45.7** dBA at the potential receptor (see **Figure 6-5**), a change of **2.8** dBA from the 5 turbine situation (**Figure 6-3** – hard ground).

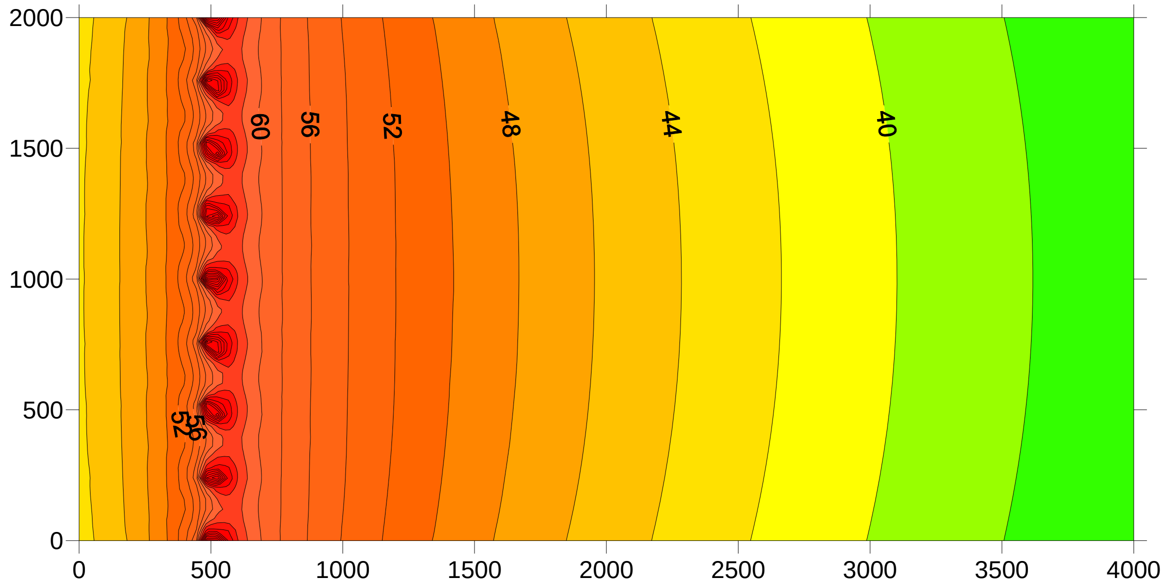


Figure 6-5: 13 WTGs operating, WTGs in one line on 500 m X-axes, all hard ground scenario

Again soft ground conditions could significantly reduce sound propagation (**Figure 6-6**). As per the 5 wind turbine scenario, it must be observed that a cumulative impact can be identified in both of these scenarios (**Figure 6-5** and **Figure 6-6**) with the noise level at the receptor exceeding **34** dBA. While not yet exceeding the acceptable night-time ambient zone sound levels, the operation of the wind turbines in this conceptual scenario would result in a change from the ambient sound levels (28 dBA) of more than 6 dBA. The increased noise level would therefore be easily detectible, yet just below the 7 dBA defining a potential "disturbing noise".

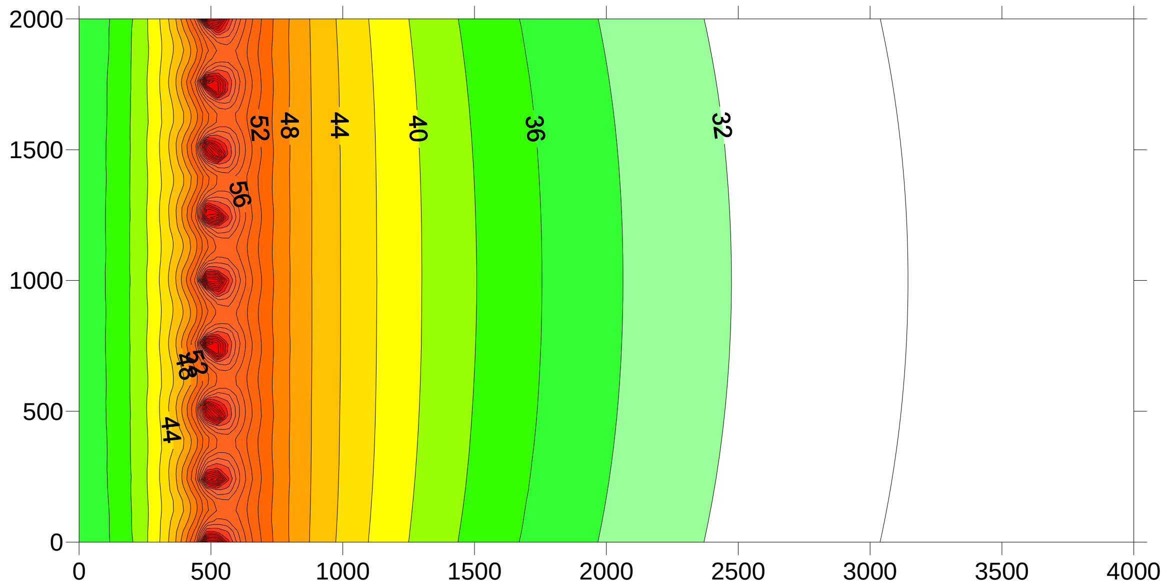


Figure 6-6: 13 WTGs operating. WTGs in one line on 500 m X-axes, all soft ground scenario

6.2.4 52 Wind Turbines upwind from receptor

In this scenario 52 turbines was added upwind from the receptor in X-axes lines 500m, 250m, 0m and -250m (13 wind turbines in each line).

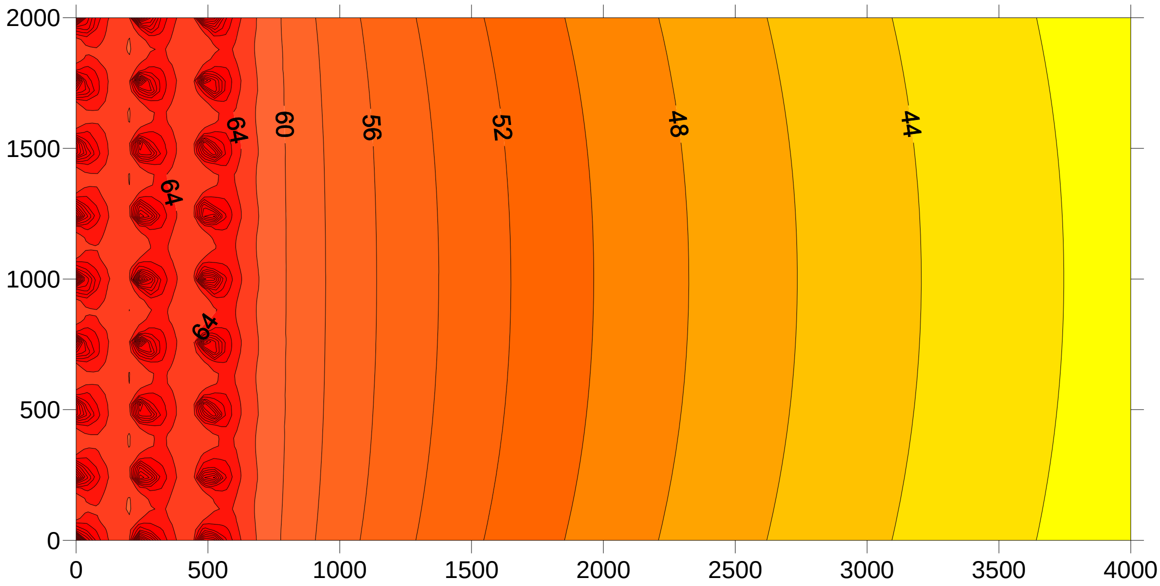


Figure 6-7: 52 WTGs operating in 4 lines (500, 250, 0, -250 on X-axes), all hard ground scenario

In this improbable scenario the total (estimated) cumulative impact on the potential receptor increases to **49.8** dBA (**Figure 6-7**), adding an additional **4.1** dBA from the situation where there is only one line with 13 turbines (**Figure 6-5**). While the additional lines are all further from the potential receptor, they still contribute to the cumulative noise impact, again illustrating that the cumulative impact (total number as well as locations of WTGs) must be considered with larger Wind Energy Facilities.

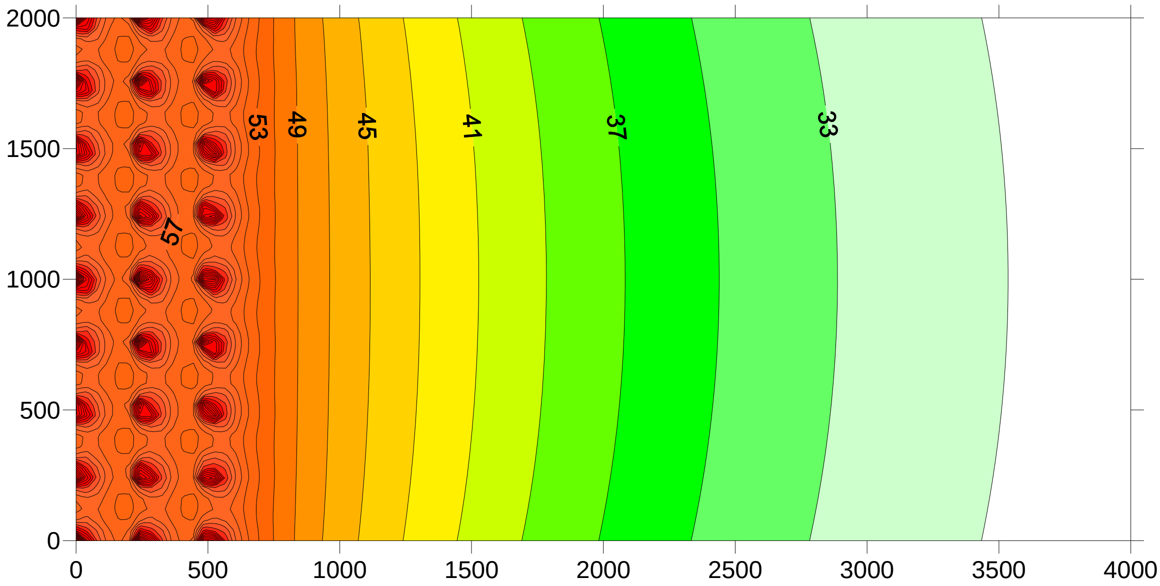


Figure 6-8: 52 WTGs operating in 4 lines (500, 250, 0, -250 on X-axes), all soft ground scenario

Similarly, **Figure 6-8** presents the more realistic scenario for 52 wind turbines, where the attenuation from soft ground (vegetation, uneven ground such as ploughed lands etc.) is considered.

6.2.5 52 Wind Turbines downwind from receptor

The previous figures illustrate the impact on a potential receptor when the wind is blowing from the wind turbines to the receptor, with the following figure (**Figure 6-9**) illustrating the situation where the wind is blowing from the receptor to the facility. In this scenario there are again 52 turbines operating downwind from a potential receptor with a buffer zone (setback) of 1,500 meters.

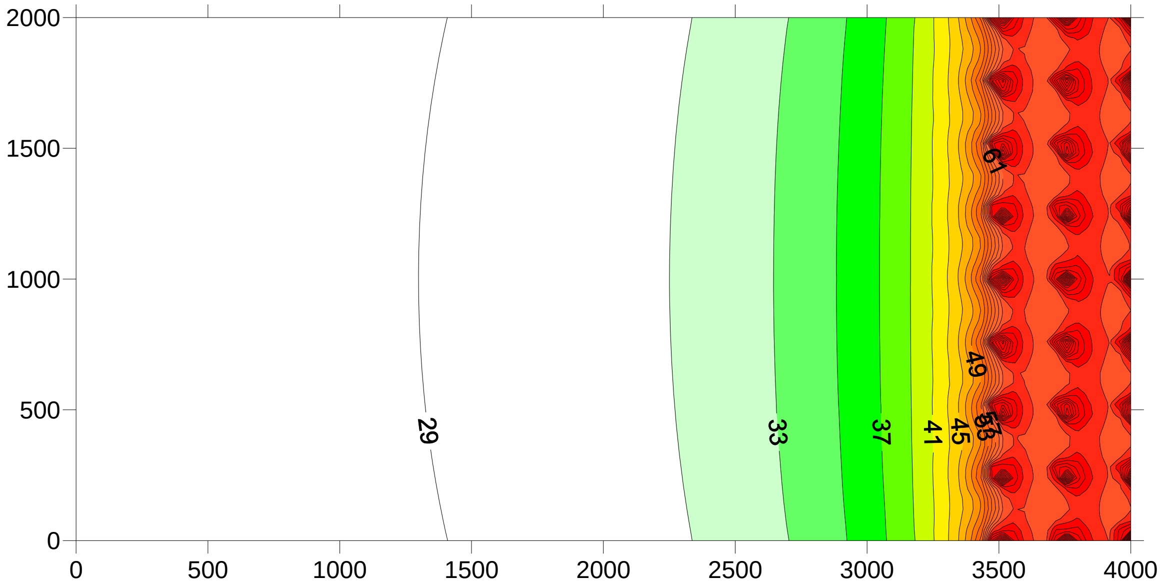


Figure 6-9: 52 WTGs operating in 4 lines (3500m, 3750m, 4000m and 4250m on X-axes) downwind from receptor, all hard ground scenario

However, in this case the potential impact is only **30.2** dBA (**Figure 6-9**), even less than the impact that one wind turbine could have on a downwind receptor (hard ground conditions). This illustrates that the prevailing wind direction is of critical importance to allow the estimation of the impact on potential receptors.

6.2.6 Estimation of Impacts

This Scoping Noise Report, as will the Environmental Noise Impact Assessment, considers 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.

The previous conceptual scenarios (worst case) illustrate the situation where atmospheric conditions are favorable for sound propagation, with the wind speeds above the cut-in speeds of the WTG, but before wind induced noises start to mask the noises from the WTG.

Depending on the background noise levels, total number of wind turbines to be constructed, their distance from Noise-sensitive developments and the prevailing meteorological conditions, there might be NSDs that could be affected by the facility. The potential impact from low frequency noises will only be considered during the EIA phase.

Applying the precautionary principle, due to the various unknowns and uncertainties, a first assessment of potential impacts is presented in **Table 6.1**.

Table 6.1: Preliminary Impact Estimation: Operational Phase

Component	Conceptual Scenarios
Magnitude	Low to High. The noise will be a combination of the cumulative effects of a number of WTGs operating at night (see **section 3.2** for nature of noise).
Spatial Extent	Regional. In terms of the set definition, the noise could impact on potential noise-sensitive developments up to 1,000 meters from the boundary of the WEF (worst case scenario – wind blowing from wind turbines to NSD).
Potential Significance	**Low to High. Based on the preliminary impact estimations, Noise-sensitive developments closer than 1,000 meters could be impacted.**

Once more information is available, this preliminary impact estimate can be reviewed. However, based on the current identified significance, further investigation is required.

7 CONCLUSIONS

This report is a Scoping Noise Report of the predicted noise environment due to the development of the proposed Kleinzee Wind Energy Facility on various farms South of the town of Kleinzee. It is based on a desktop assessment as well as a predictive model (making use of the worst case scenario in terms of the precautionary approach, as well as a best case scenario) to identify potential issues of concern.

This assessment indicated that the proposed project could have an impact of a low to high significance on the noise climate in the surrounding area in the unmanaged situation, as there are numerous Noise-sensitive developments within the area of influence.

As no preliminary layout of the WEF was available for evaluation (in terms of the potential noise impact), five scenarios were used to illustrate that a noise-sensitive development could be impacted by the development of the proposed facility. The results of the scenarios indicated that additional information (see **Recommendations – Section 8**) is critical in order to estimate the 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 it would be possible to minimize the potential noise risks and reduce the noise impacts to a more acceptable low significance.

8 RECOMMENDATIONS

It is recommended that the potential noise impact associated with the Kleinzee Wind Energy Facility be investigated in more detail in the Environmental Impact Assessment phase. The following information is considered critical:

1. The prevailing night-time background ambient noise levels,
2. The available meteorological data,
3. The exact locations of the various WTGs in the WEF,
4. The full specifications of the WTGs,
5. The confirmation of the Noise-sensitive developments, and;
6. An overview of the equipment, processes and schedules for the construction phase.

9 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.

9.1 PURPOSE

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

9.2 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:

- A site visit will be conducted to allow the measurement of ambient sound levels as well as to confirm the status of identified potential noise-sensitive developments.
- 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).
- Recommendations.

9.3 ENVIRONMENTAL NOISE IMPACT INVESTIGATION

9.3.1 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.

9.3.2 Determination of Rating levels

The Concawe model defined in SANS 10357:2004 (construction and operational phases), as well as the propagation model defined in ISO 9613-2 (operational 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,
- Pasquill stability category D (Night/early evening, fast winds, little cloud cover);
- Appropriate ambient sound levels associated with a selected wind speed;
- Layout of the proposed facility as provided by the developer;
- Study area in a grid of 100 x 100 meters. An average height is selected if the topography xyz-file is not available in the correct co-ordinate system. This output is used the develop 3D-soundscape maps of the projects equivalent noise environment;
- 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);
- 50% soft ground surface.

9.3.3 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.

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

9.3.4 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.

9.4 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.

10 THE AUTHOR

The author of this report, M. de Jager (B. Ing (Chem), UP) graduated in 1998 from the University of Pretoria. He has been interested in acoustics as from school days, doing projects mainly related to loudspeaker enclosure design. Interest in the matter brought him into the field of Environmental Noise Measurement, Prediction and Control. As from 2007 he has been involved with the following projects:

- Full Noise Impact Studies for a number of Wind Energy Facilities, including: Cookhouse, Amakhala Emoyeni, Dassiesfontein/Klipheuwel, Rheboksfontein, AB, Dorper, Suurplaat, Gouda, Riverbank, Deep River, West Coast, West Coast One, Karoo, Velddrift and Saldanha.
- Full Noise Impact Studies for a number of mining projects, including: Skychrome (Pty) Ltd (A Ferro-chrome mine), Mooinooi Chrome Mine (WCM), Buffelsfontein East and West (WCM), Elandsdrift (Sylvania), Jagdlust Chrome Mine (ECM), Apollo Brick (Pty) Ltd (Clay mine and brick manufacturer), Arthur Taylor Expansion project (X-Strata Coal SA), Klipfontein Colliery (Coal mine), Landau Expansion project (Coal mine), Modelling for Tweefontein Colliery Expansion.

The author is an independent consultant to the project, the developer as well as Savannah Environmental (Pty) Ltd. He,

- o does not and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations
- o have and will not have no vested interest in the proposed activity proceeding
- o have no and will not engage in conflicting interests in the undertaking of the activity
- o undertake to disclose all material information collected, calculated and/or findings, whether favourable to the developer or not
- o will ensure that all information containing all relevant facts be included in this report.

11 REFERENCES

In this report reference was made to the following documentation:

1. Norton, M.P. and Karczub, D.G.: Fundamentals of Noise and Vibration Analysis for Engineers, Second Edition, 2003
2. SANS 10103:2008. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication'.
3. SANS 10210:2004. 'Calculating and predicting road traffic noise'.
4. SANS 10328:2008. 'Methods for environmental noise impact assessments'.
5. SANS 10357:2004. 'The calculation of sound propagation by the Concave method'.
6. The Assessment and Rating of Noise from Wind Farms: Working Group on Noise from Wind Turbines, September 1996 – ETSU-97'.
7. NZS 6808:2010. 'Acoustics – Wind farm noise'.