Environmental Impact Assessment for the
proposed Banna Ba Pifhu Wind Energy Project
near Humansdorp, Eastern Cape:
Draft Environmental Impact Assessment Report

Chapter 9:

Noise Impacts

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GLOSSARY OF TERMS & DEFINITIONS	
Ambient noise	Totally encompassing sound in a given situation at a given time, and usually composed of sound from many sources, both near and far. **Note:** Ambient noise includes the noise from the noise source under investigation.
Annoyance	General negative reaction of the community or person to a condition creating displeasure or interference with specific activities
A-weighted sound pressure level (L_{pA} and $L_{Aeq,T}$)	A-weighted sound level L_{pA} which is the sound pressure level at specific frequencies and is given using the following equation: $L_{pA} = 10\text{Log}\left(\frac{P_A}{P_O}\right)_2$ Where: *PA* = is the root-mean-square sound pressure, using the frequency weighting network A *PO* = is the reference sound pressure (*PO* = 20 μPa). A-weighted sound pressure level is expressed in decibels dBA **Note:** For clarity in this study L_{pA} shall equal $L_{Aeq,T}$
dBA	The decibel is the unit used to measure sound pressure levels. The human ear does not perceive all sound pressures equally at all frequencies. The “A” weighted scale adjusts the measurement to approximate a human ear response.
Equivalent continuous day/night rating level ($L_{R,dn}$)	Equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$) during a reference time interval of 24 h, plus specified adjustments for tonal character, impulsiveness of the sound and the time of day; and derived from the following equation: $L_{R,dn} = 10Log\left[\left(\frac{d}{24}\right)10^{L_{Req,d}\frac{\square}{10}} + \left(\frac{24-d}{24}\right)10^{L_{Req,n+k_n}\frac{\square}{10}}\right]_{dB}$ Where: $L_{R,dn}$ is the equivalent continuous day/night rating level; *d* is the number of daytime hours; $L_{Req,d}$ is the rating level for daytime; $L_{Req,n}$ is the rating level for night-time; K_n is the adjustment of 10 dB added to the night-time rating level.
High-energy impulsive sound	Sound from one of the following categories of sound sources: quarry and mining explosions, sonic booms, demolition and industrial processes that use high explosives, explosive industrial circuit breakers, military ordnance (e.g. armour, artillery, mortar fire, bombs, explosive ignition of rockets and missiles), or any other explosive source where the equivalent mass of TNT exceeds 25 g, or a sound with comparable characteristics and degree of intrusiveness
Highly impulsive sound	sound from one of the following categories of sound sources: small arms fire, metal hammering, wood hammering, drop-hammer pile driver, drop forging, pneumatic hammering, pavement breaking, or metal impacts of rail yard shunting operations, or sound with comparable characteristics and degree of intrusiveness
Infra sound	Sound which predominantly contains sound energy at frequencies below 10 Hz
Isopleth	Lines of equal intensity

GLOSSARY OF TERMS & DEFINITIONS	
Low frequency noise	Sound which predominantly contains sound energy at frequencies below 100 Hz
m/s	Metres per second
MW	Megawatt of electricity (1000 kilowatts)
NSA	Noise Sensitive Area
Reference time interval	Representative duration of time periods that are regarded as typical for sound exposure of the community within a period of 24 h: – Daytime: 06:00 to 22:00 – Night-time: 22:00 to 06:00
Residual noise	Totally encompassing sound in a given situation at a given time, and usually composed of sound from many sources, both near and far, excluding the noise under investigation
Specific noise	Component of the ambient noise which can be specifically identified by acoustical means and which may be associated with a specific source **Note:** Complaints about noise usually arise as a result of one or more specific noises.
WTG	Wind Turbine Generator

9.1 IMPACT OF NOISE

This Chapter presents the Noise Specialist Study conducted by Safetrain CC (trading as Safetech) under the leadership of Mr Brett Williams, as input to the EIA being conducted by CSIR for the proposed Wind Current Banna Ba Pifhu Wind Energy Project.

9.2 INTRODUCTION & METHODOLOGY

The approach to the noise assessment is presented here. WKN Windcurrent SA (Pty) Ltd is intending to construct a wind energy electricity generation project at Humansdorp, Eastern Cape. WKN Windcurrent SA (Pty) Ltd is investigating a number of different turbine types. This study only addresses the noise impact. The study was requested by the CSIR as part of the overall Environmental Impact Assessment for the project.

9.2.1 Methodology

The methodology used in the study consisted of three approaches to determine the noise impact from the proposed project and associated infrastructure:

- A desktop study to model the likely noise emissions from the site;
- Field measurements of the existing ambient noise at different locations in the vicinity of the project; and
- The identification of potential noise sensitive areas.

The desktop study was done using the available literature on noise impacts from wind turbines as well as numerical calculations of the possible noise emissions. A Danish modelling program, EMD WindPro Software Version 2.7 was used and is specifically developed for wind turbine noise assessment. This program is used extensively worldwide and has been developed and validated in Denmark. The method described in SANS 10357:2004 version 2.1 (The calculation of sound propagation by the Concawe method) was used as reference for further calculations where required.

WindPro uses the methods described in ISO 9613-2 (Acoustics – Attenuation of sound during propagation outdoors. Part 2 – General method of calculation). This method is very comparable to SANS 10357:2004 and is used worldwide for modelling noise from various sources including wind turbine generators (Wind turbines). Where a tonal character is identified in the noise emitted from the turbines, a 5 dB(A) penalty is included in the modelling result.

The numerical results were then used to produce “noise maps” that visually indicates the extent of the noise emissions from the site. The noise emissions were modelled for various wind speeds from 4 m/s to 12 m/s. The direction of the wind is not taken into consideration as the wind could blow from any direction at the speeds that were modelled. The modelling is thus for worst case scenarios and takes the topography around the turbine and noise sensitive area (NSA) into account. The site elevation data was sourced from NASA and imported into WindPro. A comparison was done using the digital elevation data and the contour heights from a 1:50 000 topographical map. The comparison showed that the digital data and the map corresponded well. Furthermore, the digital data provided a better resolution.

Field Study

A number of measurements were taken by placing the noise meter on a tripod and ensuring that it was at least 1.2 m from floor level and 3.5 m from any large flat reflecting surface.

All measurements were conducted over at least 10 minutes, except where indicated. The noise meter was calibrated before and after the survey. At no time was the difference more than one decibel (If the difference is more than 1 decibel the meter is not calibrated properly and the measurement is discarded). The weighting used was on the A scale and the meter placed on impulse correction, which is the preferred method as per Section 5 of SANS 10103:2008. No tonal correction was added to the data. Measurements were taken during the day and at night. The meter was fitted with a windscreen, which is supplied by the manufacturer. The screen is designed so as to reduce wind noise around the microphone and not bias the measurements.

The test environment contained the following noise sources:

- Vehicular traffic that included trucks and cars;
- Birds and insects;
- Farm animals;
- Wind noise; and
- Noise from the chicken houses fans.

The instrumentation that was used to conduct the study is as follows:

- Rion Precision Sound Level Meter (NL32) with 1/3 Octave Band Analyzer
- Serial No. 00151075;
- Microphone (UC-53A) Serial No. 307806; and
- Preamplifier (NH-21) Serial No. 13814.

All equipment was calibrated in October 2011 (see Appendix 9.2)

9.2.2 Terms of Reference

The Terms of Reference provided by CSIR for this noise study included the following:

Objectives of the noise study:

- Describe the affected environment covered by the scope of the noise specialist study, drawing on existing information, professional experience and limited field work;
- Contribute to the scoping process by identifying issues and concerns that need to be addressed in the specialist study, based on the experience of the specialist;
- Identify relevant protocols, legal and permit requirements (if any); and
- Assess the potential impacts of the project, and provide management actions to avoid/reduce negative impacts or enhance benefits, as well as associated monitoring requirements.

The scope of work of the noise study includes the following:

- Conduct a desktop study of available information that can support and inform the specialist noise study;

- Identify issues and potential impacts, as well as possible cumulative impacts related to the noise aspects of the project;
- Measure the existing ambient noise at the proposed site, during both the day and night time;
- Identify the components of the project that could generate significant noise levels;
- Identify the sensitive noise receptors in the vicinity of the proposed project;
- Conduct a noise study of the predicted (future) noise impacts during construction and operation of the proposed wind farm;
- Assess the potential impacts associated with the proposed project for the construction, operation and decommissioning phases; and
- Identify management and mitigation actions to enhance positive impacts and avoid/reduce negative impacts respectively.

The required EIA end-product from the noise assessment is to provide a comprehensive and detailed Noise Impact Assessment (NIA) that presents and evaluates the noise impact of the wind turbines <u>under different operating conditions</u>. The specialists will be required to assess impacts for the <u>preferred layout and an alternative layout</u>.

9.2.3 Declaration of independence

The declaration of independence by the noise specialist is provided in Box 9.1 below:

BOX 9.1: DECLARATION OF INDEPENDENCE FOR NOISE IMPACT ASSESSMENT

I Brett Williams declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Wind Current Banna Ba Pifhu Wind Energy Project, application or appeal in respect of which I was appointed, other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

BRETT WILLIAMS

9.3 DESCRIPTION OF THE NOISE IMPACTS

The sources of sounds emitted from operating wind turbines can be divided into two categories, firstly mechanical sounds, from the interaction of turbine components, and secondly aerodynamic sounds, produced by the flow of air over the blades.

9.3.1 Mechanical Sounds

Mechanical sounds originate from the relative motion of mechanical components and the dynamic response among them. Sources of such sounds include the:

- Gearbox;
- Generator;
- Yaw Drives;
- Cooling Fans; and
- Auxiliary Equipment (e.g., hydraulics).

Since the emitted sound is associated with the rotation of mechanical and electrical equipment, it tends to be tonal (of a common frequency), although it may have a broadband component. For example, pure tones can be emitted at the rotational frequencies of shafts and generators, and the meshing frequencies of the gears.

In addition, the hub, rotor, and tower may act as loudspeakers, transmitting the mechanical sound and radiating it. The transmission path of the sound can be air-borne or structure-borne. Air-borne means that the sound is directly propagated from the component surface or interior into the air. Structure-borne sound is transmitted along other structural components before it is radiated into the air.

The type of transmission path and the sound power levels for the individual components for a 2 MW wind turbine is shown in Figure 9.1.

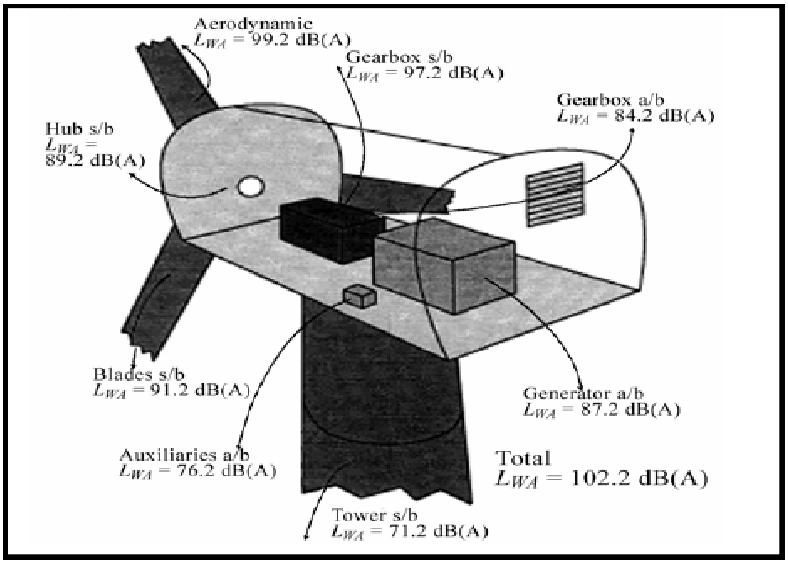

Figure 9.1: Typical Sound Power Levels of a 2 MW Turbine

9.3.2 Aerodynamic Sound

Aerodynamic broadband sound is typically the largest component of wind turbine acoustic emissions. It originates from the flow of air around the blades. As shown in Figure 9.2, a large number of complex flow phenomena occur, each of which might generate some sound.

Aerodynamic sound generally increases with rotor speed. The various aerodynamic sound generation mechanisms that have to be considered are divided into three groups:

- *Low Frequency Sound:* Sound in the low frequency part of the sound spectrum is generated when the rotating blade encounters localized flow deficiencies due to the flow around a tower, wind speed changes, or wakes shed from other blades;
- *Inflow Turbulence Sound:* Depends on the amount of atmospheric turbulence. The atmospheric turbulence results in local force or local pressure fluctuations around the blade; and
- *Airfoil Self Noise:* This group includes the sound generated by the air flow right along the surface of the airfoil. This type of sound is typically of a broadband nature, but tonal components may occur due to blunt trailing edges, or flow over slits and holes.

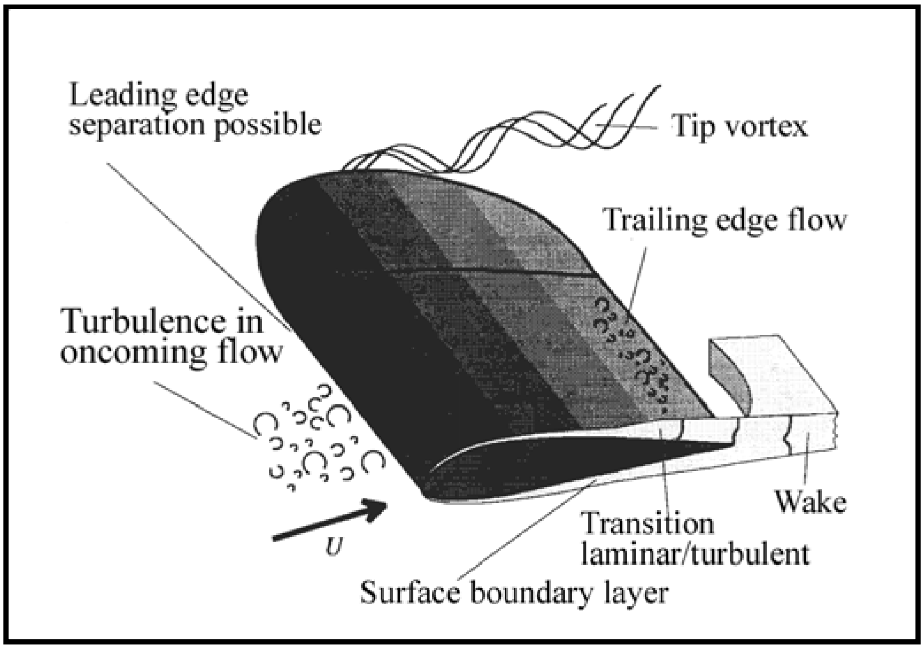

Figure 9.2: Sources of Aerodynamic Noise

Modern airfoil design takes all of the above factors into account and is generally much quieter that the first generation of bade design.

9.3.3 Ambient Sound & Wind Speed

The ability to hear a wind turbine in a given installation depends on the ambient sound level. When the background sounds and wind turbine sounds are of the same magnitude, the wind turbine sound gets lost in the background. Both the wind turbine sound power level and the ambient sound pressure level will be functions of wind speed. Thus whether a wind turbine exceeds the background sound level will depend on how each of these varies with wind speed.

The most likely sources of wind-generated sounds are interactions between wind and vegetation. A number of factors affect the sound generated by wind flowing over vegetation. For example, the total magnitude of wind-generated sound depends more on the size of the windward surface of the vegetation than the foliage density or volume.

The sound level and frequency content of wind generated sound also depends on the type of vegetation. For example, sounds from deciduous trees tend to be slightly lower and more broadband than that from conifers, which generate more sounds at specific frequencies. The equivalent A-weighted broadband sound pressure generated by wind in foliage has been shown to be approximately proportional to the base 10 logarithm of the wind speed.

Sound levels from large modern wind turbines during constant speed operation tend to increase more slowly with increasing wind speed than ambient wind generated sound. As a result, wind turbine noise is more commonly a concern at lower wind speeds and it is often difficult to measure sound from modern wind turbines above wind speeds of 8 m/s because the background wind-generated sound masks the wind turbine sound above 8 m/s.

It should be remembered that average sound pressure measurements might not indicate when a sound is detectable by a listener. Just as a dog’s barking can be heard through other sounds, sounds with particular frequencies or an identifiable pattern may be heard through background sounds that is otherwise loud enough to mask those sounds. Sound emissions from wind turbines will also vary as the turbulence in the wind through the rotor changes. Turbulence in the ground level winds will also affect a listener’s ability to hear other sounds. Because fluctuations in ground level wind speeds will not correlate exactly with those at the height of the turbine, a listener might find moments when the wind turbine could be heard over the ambient sound.

9.3.4 Low Frequency Noise and Infrasound

Infrasound was a characteristic of some types of wind turbine that has been attributed to early designs in which turbine blades were downwind of the main tower. The effect was generated as the blades cut through the turbulence generated around the downwind side of the tower. Modern designs generally have the blades upwind of the tower. Wind conditions around the blades and improved blade design minimise the generation of the effect.

Low frequency pressure vibrations are typically categorized as low frequency sound when they can be heard near the bottom of human perception (10-200 Hz), and infrasound when they are below the common limit of human perception. Sound below 20 Hz is generally considered to be infrasound, even though there may be some human perception in that range. Because these ranges overlap in these, it is important to understand how the terms are intended in a given context.

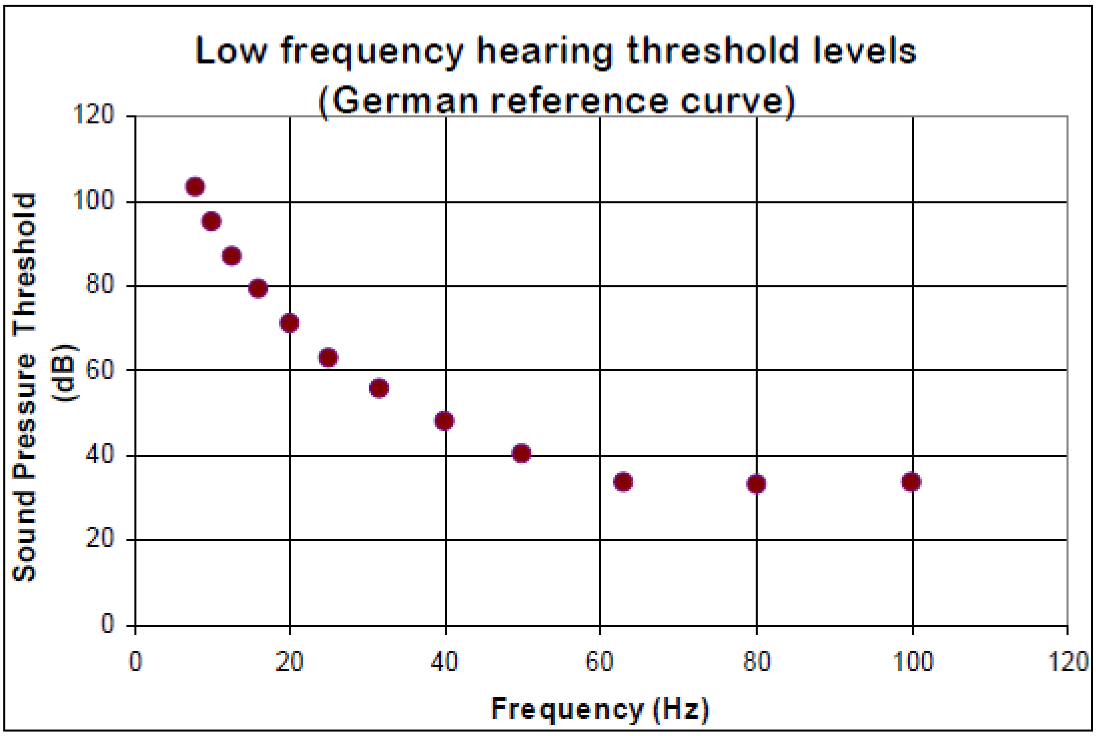

Figure 9.3: **Low frequency Hearing Threshold Levels**

Infrasound is always present in the environment and stems from many sources including ambient air turbulence, ventilation units, waves on the seashore, distant explosions, traffic, aircraft, and other machinery. Infrasound propagates farther (i.e. with lower levels of dissipation) than higher frequencies. To place infrasound in perspective, when a child is swinging high on a swing, the pressure change on its ears, from top to bottom of the swing, is nearly 120 dB at a frequency of around 1 Hz.

Some characteristics of the human perception of infrasound and low frequency sound are:

- Low frequency sound and infrasound (2-100 Hz) are perceived as a mixture of auditory and tactile sensations;
- Lower frequencies must be of a higher magnitude (dB) to be perceived, e.g. the threshold of hearing at 10 Hz is around 100 dB (see Figure 9.4 above);
- Tonality cannot be perceived below around 18 Hz; and
- Infrasound may not appear to be coming from a specific location, because of its long wavelengths.

The primary human response to perceived infrasound is annoyance, with resulting secondary effects. Annoyance levels typically depend on other characteristics of the infrasound, including intensity, variations with time, such as impulses, loudest sound, periodicity, etc. Infrasound has three annoyance mechanisms:

- A feeling of static pressure;
- Periodic masking effects in medium and higher frequencies; and
- Rattling of doors, windows, etc. from strong low frequency components.

Human effects vary by the intensity of the perceived infrasound, which can be grouped into these approximate ranges:

- 90 dB and below: No evidence of adverse effects;
- 115 dB: Fatigue, apathy, abdominal symptoms, hypertension in some humans;
- 120 dB: Approximate threshold of pain at 10 Hz; and
- 120 – 130 dB and above: Exposure for 24 hours causes physiological damage.

There is no reliable evidence that infrasound below the perception threshold produces physiological or psychological effects.

The typical range of sound power level for wind turbine generators is in the range of 100 to 105 dBA – a much lower sound power level (10 dB or more) than the majority of construction machinery such as dozers. In order for infrasound to be audible even to a person with the most sensitive hearing at a distance of, say, 300 m would require a sound power level of at least 140 dB at 10 Hz and even higher emission levels than this at lower frequencies and at greater distances. There is no information available to indicate that wind turbine generators emit infrasound anywhere near this intensity (Bellhouse 2004).

Several studies have confirmed that there are no physiological effects from low frequency or infrasound from wind turbines (Bellhouse 2004; Leventhall. 2003; Mackenzie. 2006; Rogers *et al* 2006; Pedersen 2003).

9.4 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The proposed Banna Ba Pifhu wind energy project is to be constructed on farmland in an area adjacent to the R330 near Humansdorp located in the Eastern Cape Province of South Africa. The project is planned to host up to 27 turbines. The modelling for the noise study was done for the 2 MW, 2.5 MW and the 3 MW turbine. The maximum number of turbines that was modelled are 25 turbines for the 2MW layout, plus the option to add a further three turbines (total turbines modelled are therefore 28). Both options are modelled in this report.

After the modelling was done, WKN Windcurrent decided to include additional turbine types of 1.8 MW and 3.2 MW. The maximum number of turbines therefore changed from 25 (for the 2 MW turbine) to 27 for the 1.8 MW turbine. The noise modelling that was done covered a total of 28 turbines, therefore it included/assessed the current “worst case scenario” of 27 turbines. WKN Windcurrent has agreed to undertake additional noise monitoring once the final tubine type has been selected (should this turbine type differ from the ones that were modelled).

The topography surrounding the site is characterised by undulating hills.

9.4.1 Site Location

The location and position of the various wind turbines are contained in the Table 9.1 below.

Table 9.1: Wind Turbine Location Co-ordinates

	Option – 2MW; 2.5MW or 3.0MW Units	
WTG Name	**X**	**Y**
1	291812	6227175
2	292673	6226886
3	292350	6227317
4	293012	6227343
5	292296	6227875
6	292873	6227884
7	293438	6227966
8	292419	6228373
9	293035	6228451
10	293556	6228588
11	295584	6226654
12	294040	6228149
13	293959	6227576
14	294527	6227305
15	294983	6226923
16	295336	6227346
17	295881	6227230
18	296483	6227334
19	296533	6227896
20	295818	6227797
21	294925	6228404
22	295151	6227885
23	294532	6227912
24	296103	6228255
25	295561	6228295
26 optional	296244	6226797
27 optional	296516	6226264
28 optional	296813	6225724

The positions of the turbines are shown in Figures 9.4 below.

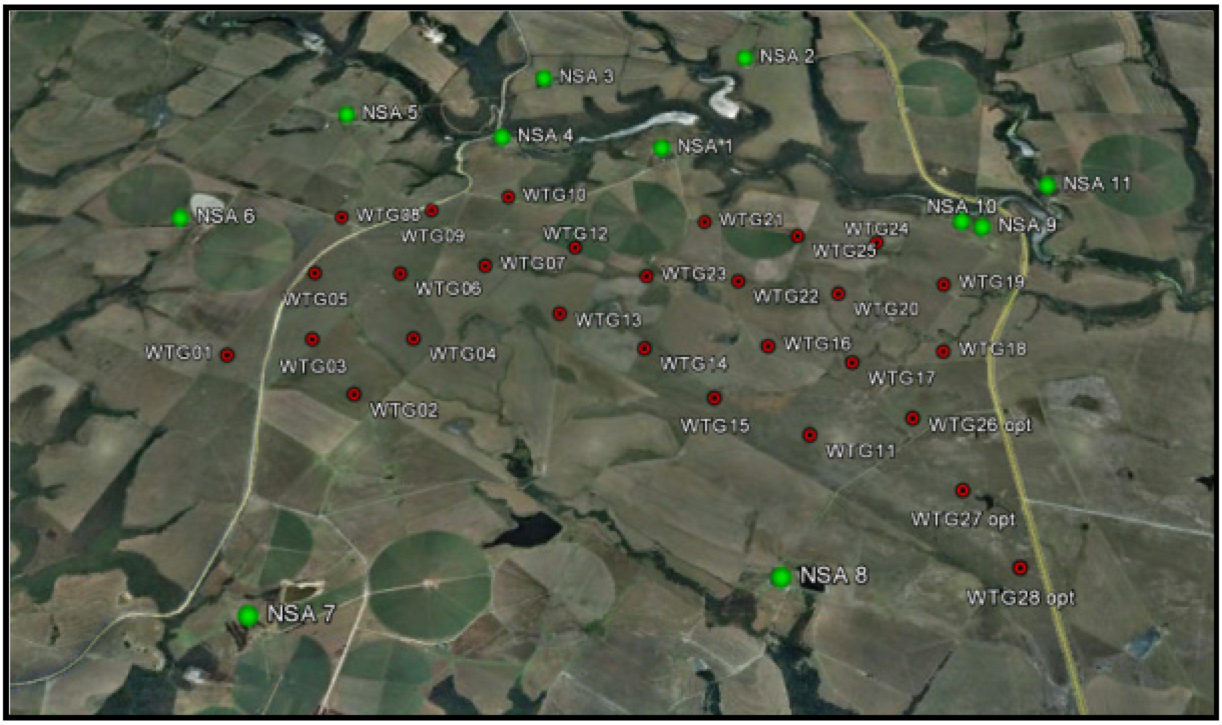

Figure 9.4: Wind turbine locations (Vestas V90, V112 or N80)

The potential sensitive receptors are discussed below. The main noise sensitive receptors that could be impacted by noise pollution are the terrestrial fauna, the avifauna and human receptors.

9.4.2 Noise Sensitive Areas

Human Sensitive Receptors

The site is situated in a farming community. Several homesteads are located on the properties where the turbines will be erected as well as on neighbouring farms. The sensitive noise receptors have been recorded in Table 9.2 below.

Table 9.2: Noise Sensitive Areas (NSA)

Label	Location Description	X	Y
NSA 1	House	294617	6229073
NSA 2	House	295228	6230009
NSA 3	House	293743	6229744
NSA 4	House	293468	6229172
NSA 5	House	292338	6229340
NSA 6	House	291301	6228331
NSA 7	House	292225	6225279
NSA 8	House	295370	6225611
NSA 9	House	296838	6228406
NSA 10	House	296700	6228454
NSA 11	House	297340	6228823

Natural Environment Receptors

The vegetation around the site is characterised by grassy fynbos with thicket in areas of richer soil. The fauna includes bats, birds, commercial livestock and a variety of buck.

9.4.3 Ambient Noise at Proposed Site

The ambient noise was measured at two locations as described in the methodology and results thereof are contained in Table 9.3 below. The author is confident that this represents the ambient noise at the project site.

Table 9.3: Ambient Noise Results during the day – 09th November 2011

Location	Start Time	Duration (minutes)	Wind (m/s) *(At Microphone)	Temperature (° Celsius) *(At Microphone)	$L_{Req.T}$ dB(A)	Comments
Point 1 (NSA 1)	11:50	10	8.9	22.1	51.2	• Wind noise • One vehicle passing • Tractor passing in distance
Point 2 (NSA 9)	12:50	10	8.0	23.4	52.1	• Numerous vehicles on R330 • Wind noise

*Author measurements of wind speed and temperature at microphone height (1.2 m).

Table 9.4: Ambient Noise Results during the night – 09th November 2011

Location	Start Time	Duration (minutes)	Wind (m/s) *(At Microphone)	Temperature (° Celsius) *(At Microphone)	$L_{Req.T}$ dB(A)	Comments
Point 1 (NSA 1)	22:00	10	2.9	14.6	41.3	
Point 2 (NSA 9)	22:45	10	2.8	14.7	43.1	• Vehicles on R330

*Author measurements of wind speed and temperature at microphone height (1.2 m).

The general ambient noise at each location varies substantially as the ambient sound is influenced by human activities, vehicles, wind noise and animal sounds.

9.5 IDENTIFICATION OF ISSUES AND IMPACTS

The key issues regarding the noise impact are:

- What is the current noise ambient noise in the vicinity of the proposed project;
- What is the likely noise impact during construction and operation of the site and associated infrastructure;
- Where are local sensitive human receptors located and how is the noise going to affect them; and
- Could low frequency sound and infra sound be a problem.

9.6 APPLICABLE LEGISLATION AND STANDARDS

South Africa has noise legislation or standards that could be applied to the project. The draft scoping report has identified that the applicable environmental legislation places a general onus on the developer to ensure that the environment is not affected negatively by the development.

The following legislation and standards have been used to aid the study and guide the decision making process with regards noise pollution:

- South Africa - GNR.154 of January 1992: Noise control regulations in terms of section 25 of the Environment Conservation Act (ECA), 1989 (Act No. 73 of 1989);

- South Africa - GNR.155 of 10 January 1992: Application of noise control regulations made under section 25 of the Environment Conservation Act, 1989 (Act No. 73 of 1989);

- South Africa - SANS 10103:2008 Version 6 - The measurement and rating of environmental noise with respect to annoyance and to speech communication;

- South Africa - SANS 10210:2004 Edition 2.2 – Calculating and predicting road traffic noise;

- South Africa - SANS 10357:2004 Version 2.1 - The calculation of sound propagation by the Concawe method; and

- International Finance Corporation – 2007 General EHS Guidelines: Environmental Noise.

SANS 10103:2008 provides typical rating levels for noise in various types of districts, as described in the table below. The project is being proposed for a rural district, therefore this is the typical rating level chosen as per the SANS standard.

Table 9.5: Typical rating levels for noise in various types of districts

Type of District	Equivalent Continuous Rating Level, LReq.T for Noise					
	Outdoors (dB(A))			Indoors, with open windows (dB(A))		
	Day-night	Daytime	Night-time	Day-night	Daytime	Night-time
Rural Districts	**45**	**45**	**35**	**35**	**35**	**25**
Suburban districts with little road traffic	50	50	40	40	40	30
Urban districts	55	55	45	45	45	35
Urban districts with one or more of the following: Workshops; business premises and main roads	60	60	50	50	50	40
Central business districts	65	65	55	55	55	45
Industrial districts	70	70	60	60	60	50

SANS 10103:2008 defines Daytime as 06:00 to 22:00 hours and night time as 22:00 to 06:00 hours. The rating levels in the table above indicate that in rural districts the ambient noise should not exceed 35 dB(A) at night and 45 dB(A) during the day or a combination of 45 dB(A) for day/night. These levels can thus be seen as the target levels for any noise pollution sources.

Furthermore the South African noise control regulations describe a disturbing noise as **any** noise that exceeds the ambient noise by more than 7 dB. This difference is usually measured at the complainants location should a noise complaint arise. Therefore, if a new noise source is introduced into the environment, irrespective of the current noise levels, and the new source is louder than the existing ambient environmental noise by more than 7 dB, the complainant will have a legitimate complaint.

SANS 10103: 2004 also provides a guideline for expected community responses to excess environmental noise above the ambient noise. These are reflected in table below.

Table 9.5: Categories of environmental community / group response (SANS 10103:2008)

EXCESS Lr dB (A)	ESTIMATED COMMUNITY/GROUP RESPONSE	
	CATEGORY	DESCRIPTION
0 - 10	Little	Sporadic complaints
5 - 15	Medium	Widespread complaints
10 - 20	Strong	Threats of community / group action
> 15	Very Strong	Vigorous community / group action

International Standards

There are various international criteria levels for ambient sound from wind turbines. These are listed below:

- New Zealand – 40 dB(A);
- Denmark – 40 dB(A); and
- United Kingdom (L_{A90}) 35 – 40 dB(A).

Australia has set the following limits that wind turbine noise should not exceed:

- 35 dB(A) at relevant receivers in localities which are primarily intended for rural living, or
- 40 dB(A) at relevant receivers in localities in other zones, or
- the background noise (L_{A90}) by more than 5 dB(A).

Germany has set the following standards

- Purely residential areas with no commercial developments 50 dBA (day) and 35 dBA (night); and
- Areas with hospitals, health resorts, etc. 45 dBA (day) 35 dBA (night)

The rationale behind the criteria levels is that the design limit should be 5 dB below the natural ambient limit. This corresponds well with the South African guideline limit of 45 dB for rural districts.

9.7 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

9.7.1 Predicted noise levels for the Construction Phase

9.7.1.1 Construction Equipment

The construction noise at the various sites will have a local impact. Safetech has conducted noise tests at various sites in South Africa and has recorded the noise emissions of various pieces of construction equipment. The results are presented in Table 9.7 below.

Table 9.6: Typical Construction Noise

Type of Equipment	$L_{Req.T}$ dB(A)
CAT 320D Excavator measured at approximately 50 m.	67.9
Mobile crane measured at approximately 70 m	69.6
Drilling rig measured at approximately 70 m	72.6

The impact of the construction noise that can be expected at the proposed site can be extrapolated from the tables above. As an example, if a number of pieces of equipment are used simultaneously, the noise levels can be added logarithmically and then calculated at various distances from the site to determine the distance at which the ambient level will be reached (refer to *Tables 9.8 - 9.10*).

Table 9.7: Combining Different Construction Noise Sources – High Impacts (Worst Case)

Description	Typical Sound Power Level (dB)
Overhead and mobile cranes	109
Front end loaders	100
Excavators	108
Bull Dozer	111
Piling machine (mobile)	115
Total*	**117**

*The total is a logarithmic total and not a sum of the values (at approximately 3m).

Table 9.8:Combining Different Construction Noise Sources – Low Impacts (at approximately 3m).

Description	Typical Sound Power Level (dB)
Front end loaders	100
Excavators	108
Truck	95
Total	**111**

The information in the Tables 9.8 and 9.9 above can be used to calculate the attenuation by distance. Noise will also be attenuated by topography and atmospheric conditions such as temperature, humidity, wind speed and direction etc. but this is ignored for this purpose. Therefore, the distance calculated below would be representative of maximum distances to reach ambient noise levels.

An illustration of attenuation by distance from a noise of 117 dB measured from the source is presented in Table 9.10.

Table 9. 9: Attenuation by distance for the construction phase (worst case)

Distance from noise source (metres)	Sound Pressure Level dB(A)
10	89
20	83
40	77
80	71
160	65
320	59
640	53
1280	47

What can be inferred from the Table 9.10 is that if the ambient noise level is at 45 dB(A), the construction noise will be similar to the ambient level at approximately 1280 m from the noise source, if the noise characteristics are similar. Beyond this distance, the noise level will be below the ambient noise and will therefore have little impact. The above only applies to the construction noise and light wind conditions. In all likelihood, the construction noise will have little impact on the surrounding community as it will most likely occur during the day when the ambient noise is louder and there are unstable atmospheric conditions.

9.7.2 Low frequency noise concerns

The effects of low frequency noise include sleep disturbance, nausea, vertigo etc. These effects are unlikely to impact upon residents due to the distance between the plant and the nearest communities. Sources of low frequency noise also include wind, train movements and vehicular traffic.

9.7.3 Predicted noise levels for the Wind Turbines Generators

The table and figures below indicate the isopleths for the noise generated by the turbines at wind speeds from 4 m/s to 12 m/s. The modelling was conducted for three different turbine sizes, namely the Vestas V90 (2MW), Nordex N80 (2.5MW) and the Vestas V112 (3.0MW). A further option is modelled using 25 or 28 turbines of each type. The results are contained in Table 9.10 below (maximum allowable = 45dB(A):

Table 9.10: Table of Results of the Noise Impacts at the Noise Sensitive Areas (NSA's)

Name	Wind speed	V90-25 WTG	V90-28 WTG	Difference between 25 & 28 WTG's	N80-25 WTG	N80-28 WTG	Difference between 25 & 28 WTG's	V112-25 WTG	V112-28 WTG	Difference between 25 & 28 WTG's
	[m/s]	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
NSA 1	4	30.1	30.1	0.0	33.7	33.7	0.0	33.4	33.4	0.0
	5	35.1	35.1	0.0	36.2	36.2	0.0	37.1	37.1	0.0
	6	38.2	38.2	0.0	38.2	38.2	0.0	40.4	40.4	0.0
	7	39.3	39.3	0.0	38.7	38.7	0.0	42.4	42.4	0.0
	8	39.7	39.7	0.0	39.2	39.2	0.0	42.4	42.4	0.0
	9	39.7	39.7	0.0	39.7	39.7	0.0	42.4	42.4	0.0
	10	39.7	39.7	0.0	39.7	39.7	0.0	42.4	42.4	0.0
	11	39.7	39.7	0.0	40.2	40.2	0.0	42.4	42.4	0.0
	12	39.7	39.7	0.0	40.7	40.7	0.0	42.4	42.4	0.0
NSA 2	4	23.6	23.7	0.1	27.2	27.3	0.1	26.8	26.9	0.1
	5	28.6	28.7	0.1	29.7	29.8	0.1	30.5	30.6	0.1
	6	31.7	31.8	0.1	31.7	31.8	0.1	33.8	33.9	0.1
	7	32.8	32.9	0.1	32.2	32.3	0.1	35.8	35.9	0.1
	8	33.2	33.3	0.1	32.7	32.8	0.1	35.8	35.9	0.1

Name	Wind speed	V90-25 WTG	V90-28 WTG	Difference between 25 & 28 WTG's	N80-25 WTG	N80-28 WTG	Difference between 25 & 28 WTG's	V112-25 WTG	V112-28 WTG	Difference between 25 & 28 WTG's
	[m/s]	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
	9	33.2	33.3	0.1	33.2	33.3	0.1	35.8	35.9	0.1
	10	33.2	33.3	0.1	33.2	33.3	0.1	35.8	35.9	0.1
	11	33.2	33.3	0.1	33.7	33.8	0.1	35.8	35.9	0.1
	12	33.2	33.3	0.1	34.2	34.3	0.1	35.8	35.9	0.1
NSA 3	4	25.9	26.0	0.1	29.5	29.6	0.1	29.2	29.2	0.0
	5	30.9	31.0	0.1	32.0	32.1	0.1	32.9	32.9	0.0
	6	34.0	34.1	0.1	34.0	34.1	0.1	36.2	36.2	0.0
	7	35.1	35.2	0.1	34.5	34.6	0.1	38.2	38.2	0.0
	8	35.5	35.6	0.1	35.0	35.1	0.1	38.2	38.2	0.0
	9	35.5	35.6	0.1	35.5	35.6	0.1	38.2	38.2	0.0
	10	35.5	35.6	0.1	35.5	35.6	0.1	38.2	38.2	0.0
	11	35.5	35.6	0.1	36.0	36.1	0.1	38.2	38.2	0.0
	12	35.5	35.6	0.1	36.5	36.6	0.1	38.2	38.2	0.0
NSA 4	4	29.4	29.4	0.0	33.0	33.0	0.0	32.5	32.5	0.0
	5	34.4	34.4	0.0	35.5	35.5	0.0	36.2	36.2	0.0
	6	37.5	37.5	0.0	37.5	37.5	0.0	39.5	39.5	0.0
	7	38.6	38.6	0.0	38.0	38.0	0.0	41.5	41.5	0.0
	8	39.0	39.0	0.0	38.5	38.5	0.0	41.5	41.5	0.0
	9	39.0	39.0	0.0	39.0	39.0	0.0	41.5	41.5	0.0
	10	39.0	39.0	0.0	39.0	39.0	0.0	41.5	41.5	0.0
	11	39.0	39.0	0.0	39.5	39.5	0.0	41.5	41.5	0.0
	12	39.0	39.0	0.0	40.0	40.0	0.0	41.5	41.5	0.0
NSA 5	4	27.0	27.0	0.0	30.6	30.6	0.0	30.3	30.3	0.0
	5	32.0	32.0	0.0	33.1	33.1	0.0	34.0	34.0	0.0
	6	35.1	35.1	0.0	35.1	35.1	0.0	37.3	37.3	0.0
	7	36.2	36.2	0.0	35.6	35.6	0.0	39.3	39.3	0.0
	8	36.6	36.6	0.0	36.1	36.1	0.0	39.3	39.3	0.0
	9	36.6	36.6	0.0	36.6	36.6	0.0	39.3	39.3	0.0
	10	36.6	36.6	0.0	36.6	36.6	0.0	39.3	39.3	0.0
	11	36.6	36.6	0.0	37.1	37.1	0.0	39.3	39.3	0.0
	12	36.6	36.6	0.0	37.6	37.6	0.0	39.3	39.3	0.0
NSA 6	4	26.5	26.5	0.0	30.1	30.1	0.0	29.8	29.8	0.0
	5	31.5	31.5	0.0	32.6	32.6	0.0	33.5	33.5	0.0

Name	Wind speed	V90-25 WTG	V90-28 WTG	Difference between 25 & 28 WTG's	N80-25 WTG	N80-28 WTG	Difference between 25 & 28 WTG's	V112-25 WTG	V112-28 WTG	Difference between 25 & 28 WTG's
	[m/s]	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
	6	34.6	34.6	0.0	34.6	34.6	0.0	36.8	36.8	0.0
	7	35.7	35.7	0.0	35.1	35.1	0.0	38.8	38.8	0.0
	8	36.1	36.1	0.0	35.6	35.6	0.0	38.8	38.8	0.0
	9	36.1	36.1	0.0	36.1	36.1	0.0	38.8	38.8	0.0
	10	36.1	36.1	0.0	36.1	36.1	0.0	38.8	38.8	0.0
	11	36.1	36.1	0.0	36.6	36.6	0.0	38.8	38.8	0.0
	12	36.1	36.1	0.0	37.1	37.1	0.0	38.8	38.8	0.0
NSA 7	4	21.5	21.6	0.1	25.1	25.2	0.1	24.7	24.8	0.1
	5	26.5	26.6	0.1	27.6	27.7	0.1	28.4	28.5	0.1
	6	29.6	29.7	0.1	29.6	29.7	0.1	31.7	31.8	0.1
	7	30.7	30.8	0.1	30.1	30.2	0.1	33.7	33.8	0.1
	8	31.1	31.2	0.1	30.6	30.7	0.1	33.7	33.8	0.1
	9	31.1	31.2	0.1	31.1	31.2	0.1	33.7	33.8	0.1
	10	31.1	31.2	0.1	31.1	31.2	0.1	33.7	33.8	0.1
	11	31.1	31.2	0.1	31.6	31.7	0.1	33.7	33.8	0.1
	12	31.1	31.2	0.1	32.1	32.2	0.1	33.7	33.8	0.1
NSA 8	4	25.6	27.0	1.4	29.2	30.6	1.4	28.8	30.3	1.5
	5	30.6	32.0	1.4	31.7	33.1	1.4	32.5	34.0	1.5
	6	33.7	35.1	1.4	33.7	35.1	1.4	35.8	37.3	1.5
	7	34.8	36.2	1.4	34.2	35.6	1.4	37.8	39.3	1.5
	8	35.2	36.6	1.4	34.7	36.1	1.4	37.8	39.3	1.5
	9	35.2	36.6	1.4	35.2	36.6	1.4	37.8	39.3	1.5
	10	35.2	36.6	1.4	35.2	36.6	1.4	37.8	39.3	1.5
	11	35.2	36.6	1.4	35.7	37.1	1.4	37.8	39.3	1.5
	12	35.2	36.6	1.4	36.2	37.6	1.4	37.8	39.3	1.5
NSA 9	4	30.9	31.1	0.2	34.5	34.7	0.2	34.3	34.4	0.1
	5	35.9	36.1	0.2	37.0	37.2	0.2	38.0	38.1	0.1
	6	39.0	39.2	0.2	39.0	39.2	0.2	41.3	41.4	0.1
	7	40.1	40.3	0.2	39.5	39.7	0.2	43.3	43.4	0.1
	8	40.5	40.7	0.2	40.0	40.2	0.2	43.3	43.4	0.1
	9	40.5	40.7	0.2	40.5	40.7	0.2	43.3	43.4	0.1
	10	40.5	40.7	0.2	40.5	40.7	0.2	43.3	43.4	0.1
	11	40.5	40.7	0.2	41.0	41.2	0.2	43.3	43.4	0.1

Name	**Wind speed**	**V90-25 WTG**	**V90-28 WTG**	**Difference between 25 & 28 WTG's**	**N80-25 WTG**	**N80-28 WTG**	**Difference between 25 & 28 WTG's**	**V112-25 WTG**	**V112-28 WTG**	**Difference between 25 & 28 WTG's**
	[m/s]	**dB(A)**	**dB(A)**	**dB(A)**	**dB(A)**	**dB(A)**	**dB(A)**	**dB(A)**	**dB(A)**	**dB(A)**
	12	40.5	40.7	0.2	41.5	41.7	0.2	43.3	43.4	0.1
NSA 10	4	31.7	31.9	0.2	35.3	35.5	0.2	35.1	35.2	0.1
	5	36.7	36.9	0.2	37.8	38.0	0.2	38.8	38.9	0.1
	6	39.8	40.0	0.2	39.8	40.0	0.2	42.1	42.2	0.1
	7	40.9	41.1	0.2	40.3	40.5	0.2	44.1	44.2	0.1
	8	41.3	41.5	0.2	40.8	41.0	0.2	44.1	44.2	0.1
	9	41.3	41.5	0.2	41.3	41.5	0.2	44.1	44.2	0.1
	10	41.3	41.5	0.2	41.3	41.5	0.2	44.1	44.2	0.1
	11	41.3	41.5	0.2	41.8	42.0	0.2	44.1	44.2	0.1
	12	41.3	41.5	0.2	42.3	42.5	0.2	44.1	44.2	0.1
NSA 11	4	24.3	24.7	0.4	27.9	28.3	0.4	27.6	27.9	0.3
	5	29.3	29.7	0.4	30.4	30.8	0.4	31.3	31.6	0.3
	6	32.4	32.8	0.4	32.4	32.8	0.4	34.6	34.9	0.3
	7	33.5	33.9	0.4	32.9	33.3	0.4	36.6	36.9	0.3
	8	33.9	34.3	0.4	33.4	33.8	0.4	36.6	36.9	0.3
	9	33.9	34.3	0.4	33.9	34.3	0.4	36.6	36.9	0.3
	10	33.9	34.3	0.4	33.9	34.3	0.4	36.6	36.9	0.3
	11	33.9	34.3	0.4	34.4	34.8	0.4	36.6	36.9	0.3
	12	33.9	34.3	0.4	34.9	35.3	0.4	36.6	36.9	0.3

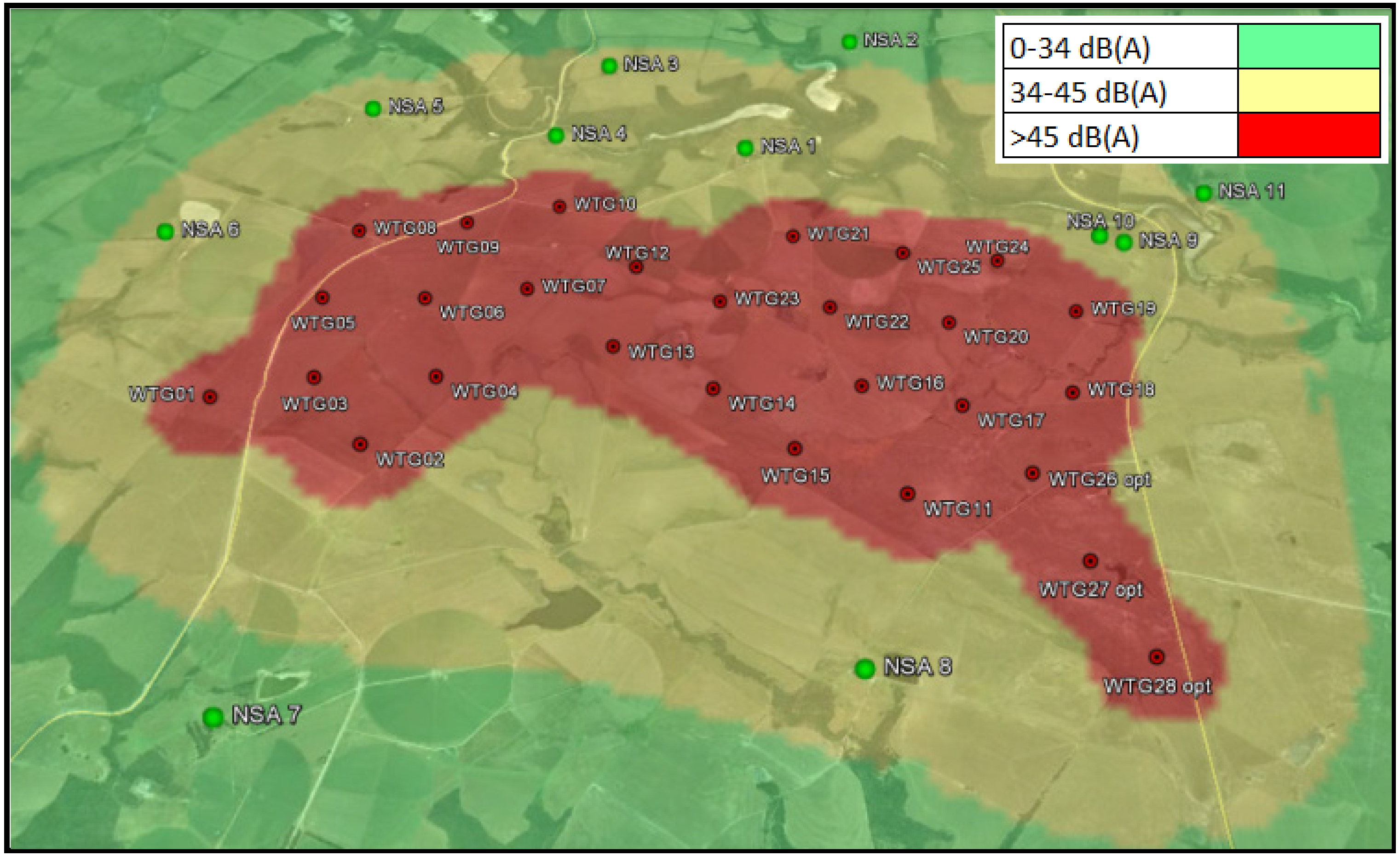

Figure 9.5: **Raster Image of Noise Isopleths & Noise Sensitive Areas (28 WTG Vestas V90 at 8 m/s)**

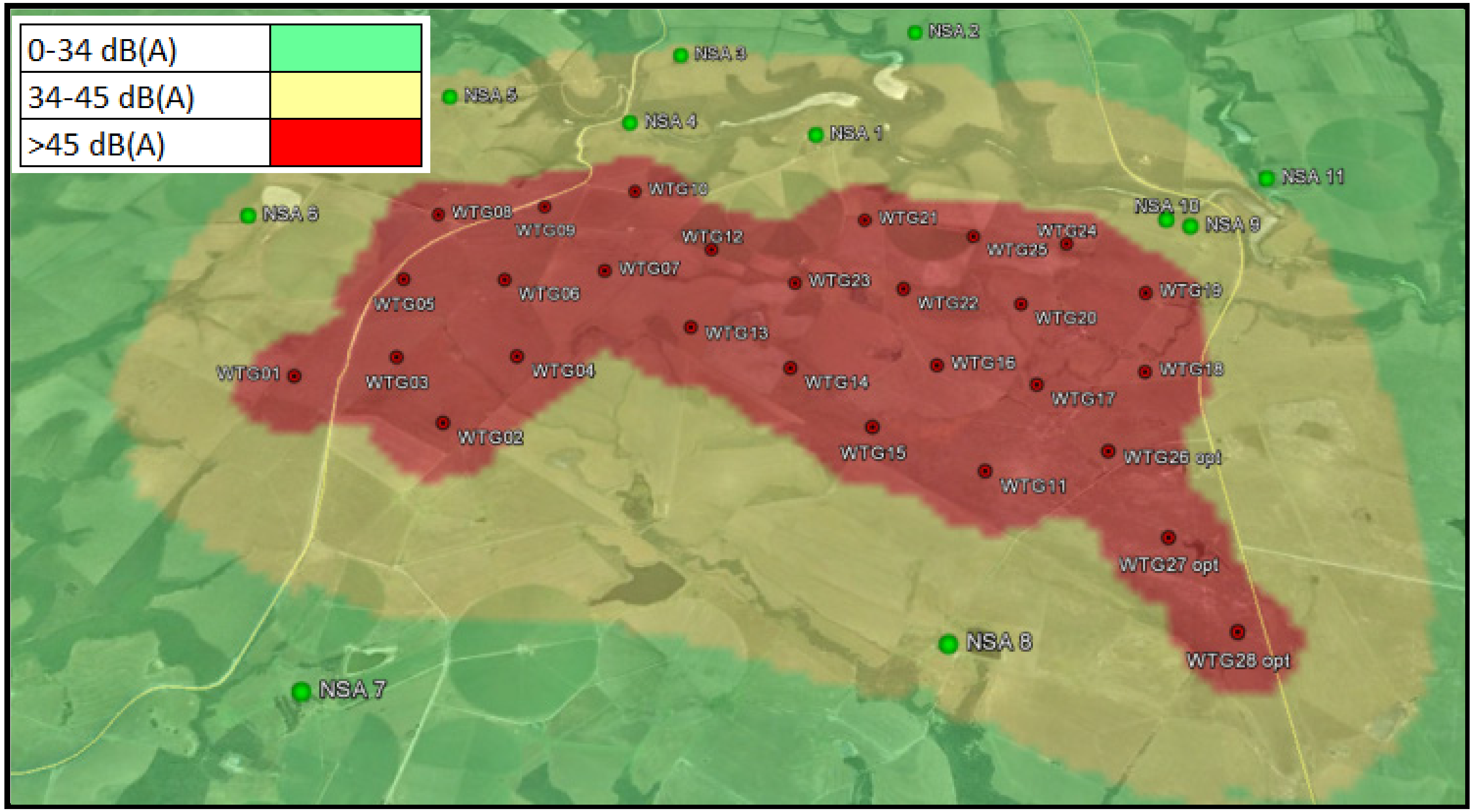

Figure 9.6: **Raster Image of Noise Isopleths & Noise Sensitive Areas (28 WTG Nordex N80 at 8 m/s)**

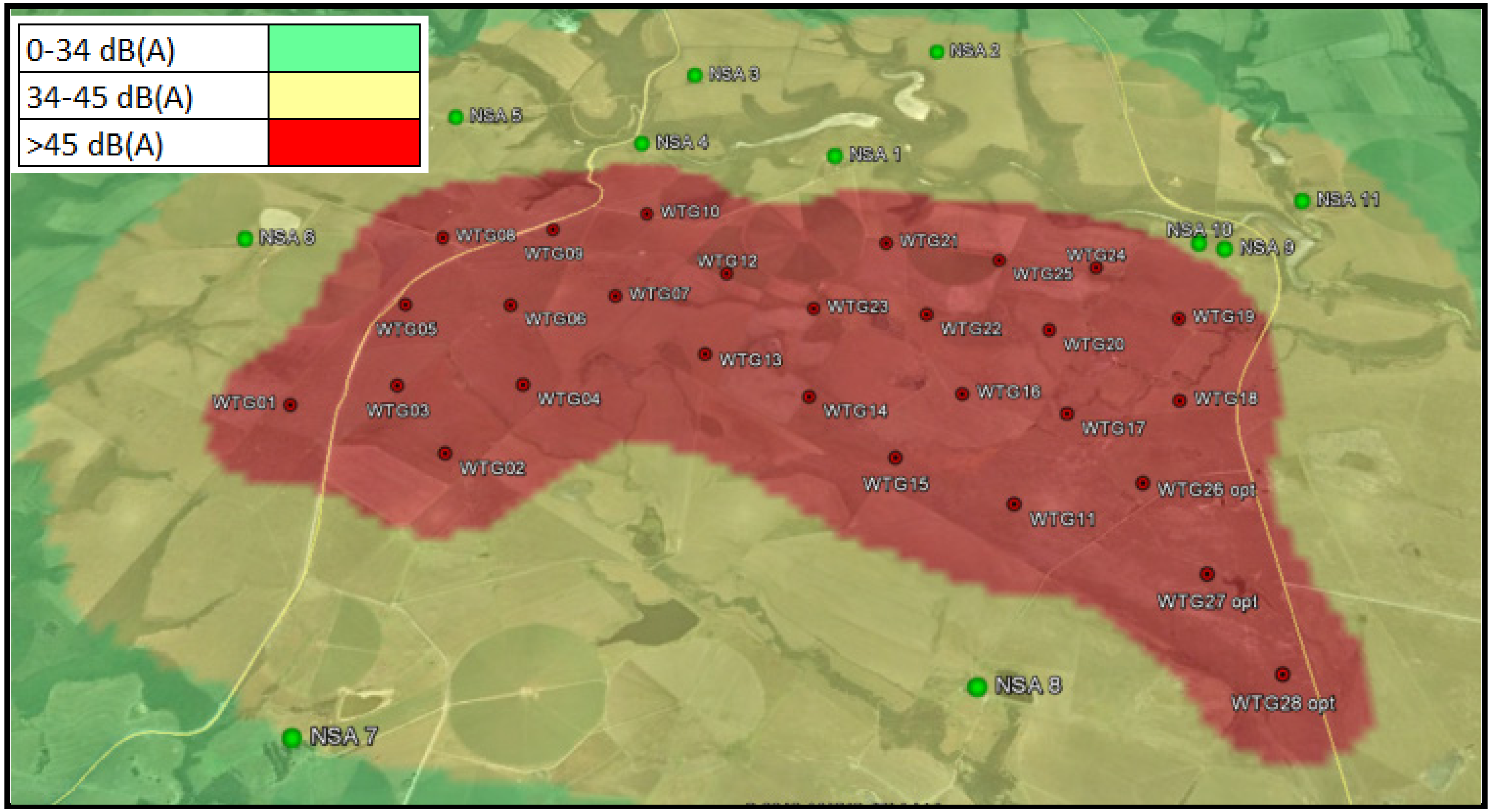

Figure 9.7: Raster Image of Noise Isopleths & Noise Sensitive Areas (Vestas V112 at 12 m/s)

9.7.4 Assessment of Noise Impacts

The impact of the noise that can be expected to be generated on the site during the construction and operational phases is presented below. A summary of the noise impact assessment using the standard assessment criteria is provided in Tables 9.12 – 9.14.

9.7.4.1 Assessment and mitigation for Construction Phase

1) There will be an impact on the immediate surrounding environment from the construction activities, especially if pile driving is to be done. This, however, will only occur if the underlying geological structure requires piling.
2) The area surrounding the construction site will be affected for a short period of time in all directions by construction noise impacts, should several pieces of construction equipment be used simultaneously.
3) The number of construction vehicles that will be used in the project will add to the existing ambient levels and will most likely cause a disturbing noise, albeit for a short period of time.

In conclusion, there will be a short term increase in noise in the vicinity of the site during the construction phase as the ambient noise level will be exceeded. The impact during the construction phase will be difficult to mitigate. The significance of the construction noise impact is predicted to be ***low*** (without mitigation).

The following **mitigation measures** are recommended for construction activities:

- All construction operations should only occur during daylight hours, if possible;
- No construction piling should occur at night. Piling should only occur during the hottest part of the day to take advantage of unstable atmospheric conditions; and
- Construction staff should be given “noise sensitivity” training in order to mitigate the noise impacts caused during construction.

9.7.4.2 Assessment and mitigation for Operational Phase

The ambient noise increases as the wind speed increases. Under very stable atmospheric conditions, a temperature inversion or a light wind, the turbines will in all likelihood not be operational as the cut-in speed is 4 m/s. As the wind speed increases above the cut-in speed the ambient noise will also increase. If the atmospheric conditions are such that the wind is very light (<4 m/s) at ground level but exceeds the cut-in speed at hub height, it is feasible that little ambient noise masking will occur. As the wind speed increases, the ambient noise also increases and masks the wind turbine noise. The critical wind speeds are thus between 4-6 m/s when there is a possibility of little masking. Above 8 m/s the wind noise starts masking the wind turbine noise. The noise modelling indicates that, in general, noise from the turbines will be below the SANS 10103 limits for rural areas at a distance of approximately 500 m from the turbines.

The results indicate the following:

Table 9.11: Summary of Noise Impacts (Vestas V90 – 2MW)

Wind Speed	NSA 1	NSA 2	NSA 3	NSA 4	NSA 5	NSA 6	NSA 7	NSA 8	NSA 9	NSA 10	NSA 11
4m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

NSA = Noise Sensitive Area
✓ = Within Recommended Noise Limits
X = Exceeds 45 dB (A) Rural Recommended Limit

Table 9.12: Summary of Noise Impacts (Nordex N80 – 2.5MW)

Wind Speed	NSA 1	NSA 2	NSA 3	NSA 4	NSA 5	NSA 6	NSA 7	NSA 8	NSA 9	NSA 10	NSA 11
4m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

NSA = Noise Sensitive Area
✓ = Within Recommended Noise Limits
X = Exceeds 45 dB (A) Rural Recommended Limit

Table 9.13: Summary of Noise Impacts (Vestas V112 – 3.0 MW)

Wind Speed	NSA 1	NSA 2	NSA 3	NSA 4	NSA 5	NSA 6	NSA 7	NSA 8	NSA 9	NSA 10	NSA 11
4m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

NSA = Noise Sensitive Area
✓ = Within Recommended Noise Limits
X = Exceeds 45 dB (A) Rural Recommended Limit

Table 9.14: Summary of distances from NSA to the nearest WTG

Label	Distance to Nearest WTG in metres – Minimum 500 m
NSA 1	737
NSA 2	1633
NSA 3	1171
NSA 4	591
NSA 5	970
NSA 6	1119
NSA 7	1668
NSA 8	1065
NSA 9	594
NSA 10	582
NSA 11	1229

The results indicate the following:

- The Vestas V90 2.0 MW did not exceed the 45 dB(A) guideline at any of the identified noise sensitive sources for the 25 WTG and the 28 WTG options;
- The Nordex N80 2.5 MW did not exceed the 45 dB(A) guideline at any of the identified noise sensitive sources for the 25 WTG and the 28 WTG options; and
- The Vestas V112 3.0 MW did not exceed the 45 dB(A) guideline at any of the identified noise sensitive sources for the 25 WTG and the 28 WTG options.

All the turbine positions met the required 500 m setback distance.

9.7.5 Reversibility and Irreplaceability of Noise Impacts:

Reversibility:
The reversibility of noise impacts is considered to be **high**. The main noise impacts associated with the proposed project include the generation of noise and an increase in ambient noise levels during the construction phase of development, and during the operational phase as a result of the turbine itself. Once the project has reached the end of its life cycle, the wind turbines will be dismantled and the noise impact associated with the proposed project will be reversed. It should be noted that some noise impacts will be experienced during the project closure and dismantling, however once this has been completed there will be no noise impacts.

Irreplaceability:
The irreplaceability of resources likely to have been impacted upon by the proposed project is considered to be **replaceable**. The proposed project would impact on sensitive noise receptors through means of an increase in ambient noise levels. However the removal of the proposed project will restore the ambient noise levels (granted that ambient noise levels have not been significantly increased as a result of future developments within the Coega IDZ, in which case the ambient noise level will be permanently altered).

9.7.6 Recommendations

The results of the study indicate that the following conclusions can be drawn:

- There will be a short term increase in noise in the vicinity of the site during construction as the ambient level will be exceeded. The impact during construction will be difficult to mitigate; and
- The impact of low frequency noise and infra sound will be negligible and there is no evidence to suggest that adverse health effects will occur as the sound power levels generated in the low frequency range are not high enough to cause physiological effects.

The following is recommended:

9.7.6.1 Construction Activities

- All construction operations should only occur during daylight hours if possible.
- No construction piling should occur at night. Piling should only occur during the hottest part of the day to take advantage of unstable atmospheric conditions. Ensure that the construction staff is given "noise sensitivity" training such as:

  - Potential sources of noise on construction sites;
  - Local noise sensitive areas;
  - Critical times of the day to minimise noise pollution; and
  - Actions to be taken to minimise noise pollution.

9.7.6.2 Operational Activities

- Ambient noise monitoring is recommended at all noise sensitive areas once the turbines are erected. This is to determine if the noise rating limits are not being exceeded.

9.8 IMPACT ASSESSMENT RATING TABLE

Table 9.15: Table of impact assessment rating

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
Construction Phase									
1.1 Impact of the construction noise on the Noise Sensitive Areas (NSAs)	Negative	**Local**, given impact is limited to one NSA at a time.	**Short**, only for the duration of the construction (approx 22 months**)**	**Low** no change in the environment is expected	**Improbable,** based on calculations	**Low**	Staff to receive noise sensitivity training; Monitoring of noise; Limit high noise activities to daytime operations when possible, noting that operational requirements might not allow this due to various factors e.g. Crane use optimization, weather conditions etc.	**Low**	**High**, since based on actual measurements
Operational Phase									
1.1 Impact of the operational noise on the Noise Sensitive Areas (NSAs) using the Vestas V90, Vestas V112, Nordex N80.	Negative	**Local**, given impact is limited to a one NSA at a time.	**Long Term**	**Low** – no change in the environment is not expected	**Probable**, based on calculations	**Low**	Ensure that noise monitoring is conducted during the commissioning phase to determine the actual noise impact during operation.	**Low**	**High**, since based on modelling and ambient measurements

9.9 MONITORING ACTIONS

Table 9.16: Table of monitoring actions (Construction)

Impact	Mitigation/Management action	Monitoring		
		Methodology	*Frequency*	*Responsibility*
Reduce construction noise	Conduct noise sensitivity training for all construction staff	Training	Before construction commences	Contractor
Monitor construction noise	Ambient noise monitoring to be conducted at the 11 NSAs as well as any other areas the specialist bird study will identify.	As per the requirements of SANS 10103	Four times during the construction phase	Specialist noise consultant

Table 9.17: Table of monitoring actions (Operation)

Impact	Mitigation/Management action	Monitoring		
		Methodology	*Frequency*	*Responsibility*
Reduce operational noise	Ambient noise monitoring to be conducted at the 11 NSAs when operations commence to verify the noise emissions meet the noise rating limit.	As per the requirements of SANS 10103	During project commissioning	Specialist noise consultant
Reduce operational noise	Confirm the noise impact by conducting annual monitoring.	As per the requirements of SANS 10103	Annually for the first 3 years of the operational phase.	Specialist noise consultant

9.10 CONCLUSIONS

Provided that the mitigation measures presented in the noise specialist study are implemented effectively, the noise from the turbines at the identified noise sensitive areas is predicted to be less than the 45 dB(A) limit for rural areas presented in SANS 10103:2008. The overall noise impact with recommended mitigation is expected to be negative and of **Low** significance.

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APPENDIX 9.1: AIA APPROVAL CERTIFICATE

DEPARTMENT OF LABOUR

Certificate

This is to certify that

SAFETRAIN CC
TRADING AS T\A SAFETECH

has been approved as an

APPROVED INSPECTION AUTHORITY

in terms of the Occupational Health and Safety Act, 1993,
for the monitoring of

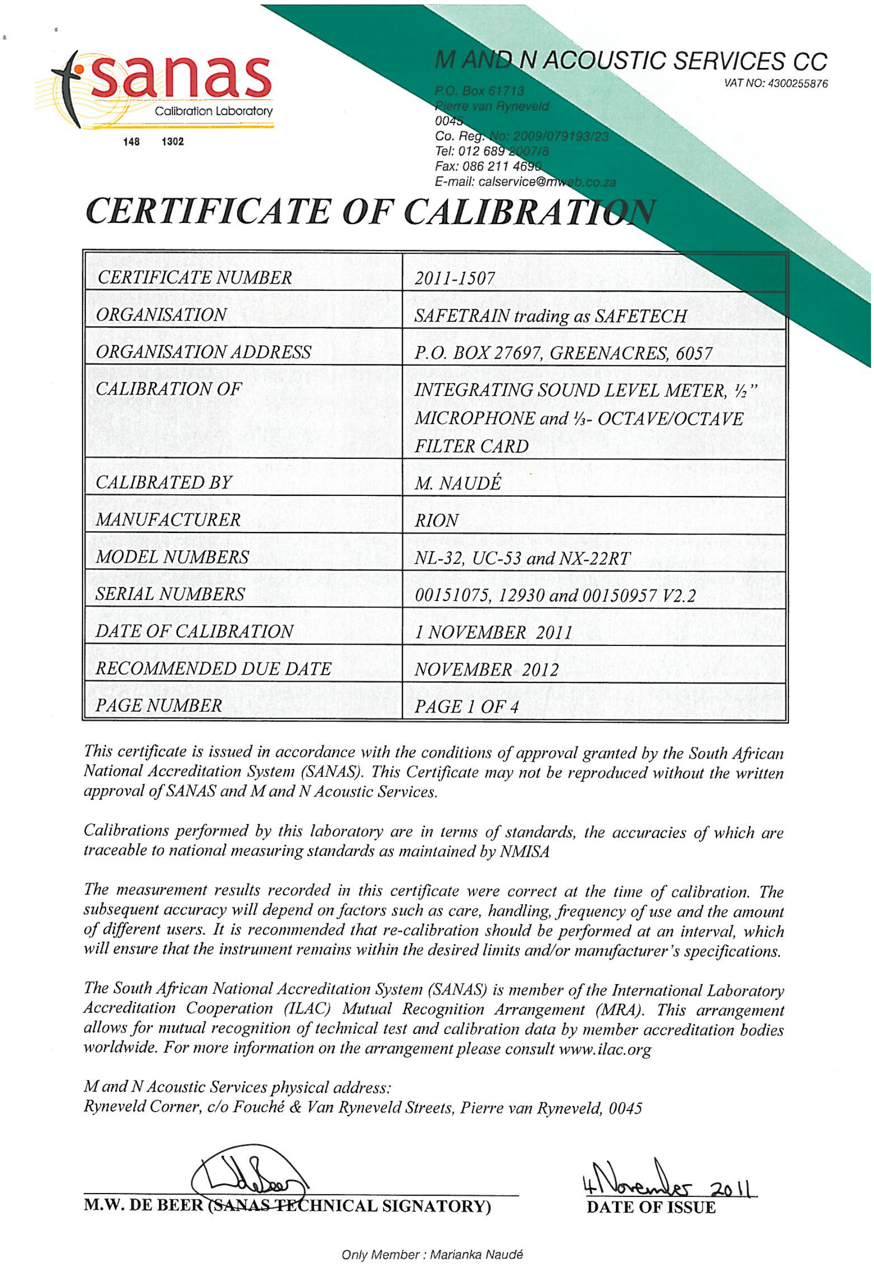
Physical Stress Factors and Chemical Stress Factors (including Lead and Asbestos, Ergonomic hazards and Ventilation Installation) and Biological Factors

2009-08-27
DATE

CI 049 OH
CERTIFICATE NUMBER

CHIEF INSPECTOR

APPENDIX 9.2:
CALIBRATION CERTIFICATE



sanas
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CERTIFICATE OF CALIBRATION

CERTIFICATE NUMBER	*2011-1507*
ORGANISATION	*SAFETRAIN trading as SAFETECH*
ORGANISATION ADDRESS	*P.O. BOX 27697, GREENACRES, 6057*
CALIBRATION OF	*INTEGRATING SOUND LEVEL METER, ½" MICROPHONE and ⅓- OCTAVE/OCTAVE FILTER CARD*
CALIBRATED BY	*M. NAUDÉ*
MANUFACTURER	*RION*
MODEL NUMBERS	*NL-32, UC-53 and NX-22RT*
SERIAL NUMBERS	*00151075, 12930 and 00150957 V2.2*
DATE OF CALIBRATION	*1 NOVEMBER 2011*
RECOMMENDED DUE DATE	*NOVEMBER 2012*
PAGE NUMBER	*PAGE 1 OF 4*

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The measurement results recorded in this certificate were correct at the time of calibration. The subsequent accuracy will depend on factors such as care, handling, frequency of use and the amount of different users. It is recommended that re-calibration should be performed at an interval, which will ensure that the instrument remains within the desired limits and/or manufacturer's specifications.

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M.W. DE BEER (SANAS TECHNICAL SIGNATORY)

4 November 2011
DATE OF ISSUE

Only Member : Marianka Naudé

APPENDIX 9.3: TYPICAL SOUND POWER AND SOUND PRESSURE LEVELS

Acoustic Power	Degree		Pressure Level	Source
32 GW	Deafening	🟥	225 dB	12” Cannon @ 12ft in front and below
25 to 40 MW		🟥	195 dB	Saturn Rocket
100 Kw		🟥	170 dB	Turbojet engine with afterburner
10 Kw		🟥	160 dB	Turbojet engine, 7000lb thrust
1 kW		🟥	150 dB	4 Propeller Airliner
100 W		🟥	140 dB	Artillery Fire
10 W	Threshold of pain	🟥	130 dB	Pneumatic Rock Drill
		🟥		130 dB causes immediate ear damage
3 W		🟨	125 dB	Small aircraft engine
1.0 W		🟨	120 dB	Thunder
100 Mw		🟨	110 dB	Close to train
		🟨		
10 mW	Very Loud	🟨	100 dB	Home lawn mower
1 mW		🟨	90 dB	Symphony or a Band
		🟨		85 dB regularly can cause ear damage
100 uW	Loud	🟩	80 dB	Police whistle
10 uW		🟩	70 dB	Average radio
		🟩		
1 uW	Moderate	🟩	60 dB	Normal conversational voice
100 nW		🟩	50 dB	Quiet stream
		🟩		
10 nW	Faint	🟩	40 dB	Quiet conversation
1 nW		🟩	30 dB	Very soft whisper
		🟩		
100 pW	Very faint	🟩	20 dB	Ticking of a watch
10 pW	Threshold of hearing	🟩	10 dB	
1 pW		🟩	0 dB	Absolute silence

Sound Perception

Change in Sound Level	Perception
3 dB	Barely perceptible
5 dB	Clearly perceptible
10 dB	Twice as loud